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A TEXTBOOK OF THE PRACTICE OF MEDICINE

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A TEXTBOOK OF THE PRACTICE OF MEDICINE

By VARIOUS AUTHORS

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THIS BOOK IS DEDICATED

TO

THE MEMORY OF

THE RIGHT HON. SIR CLIFFORD ALLBUTT

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PREFACE TO THIRD EDITION

THE continued expression of appreciation with which this work has been received has been a source of great satisfaction and encouragement to the authors and the editor.

The third edition has been thoroughly revised and brought up-to-date.

The only alterations in the classification and general arrangement are that the articles on Yellow Fever, Phlebotomus Fever and Dengue have been moved from the section on Spirochætal Infections to that on Infectious Diseases of Doubtful or Unknown Ætiology, the article on Verruga Peruviana from the section on Tropical Diseases of Doubtful or Unknown Nature to that on Tropical Diseases of Doubtful or Unknown Ætiology, that on Rickets from Diseases of Metabolism to Deficiency Diseases, the article on Arterial Blood-pressure has been transferred from the early part of Diseases of the Circulatory System to the end of this section, that on Uræmia has been placed after Nephritis, the article on Toxæmic Kidney has been included in that on Nephritis, and several other modifications in the classification of the latter disease have been made.

New articles have been added on the following: Melioidosis, Lead Tetra Ethyl Poisoning, Carbon Monoxide Poisoning, Basal Metabolism, Lipodystrophia Progressiva, Vitamins, Tumours of the Thymus, Polyglandular Syndrome, Internal Secretion of the Sex Glands, Achalasia of the Pharyngo-Œsophageal Sphincter (Plummer-Vinson Syndrome), Intestinal Carbohydrate Dyspepsia, Megacolon in Adults, Familial Icterus Gravis Neonatorum, Biliary Colic without Gallstones, Sickle-celled Anæmia, Congenital Auriculo-Ventricular Block, Intraventricular (Arborisation) Block, Nodal Rhythm, Ventricular Fibrillation, Infarction of the Heart, Syphilitic Affections of the Aorta, the Heart, and the Pericardium, Thrombo-Angiitis Obliterans, Periarteritis Nodosa, Congenital Laryngeal Stridor, Diseases of the Diaphragm, Hyperpietic Kidney, Senile or Atheromatous Kidney, Acrocyanosis, Oidiomycosis, Schilder's Disease (Encephalitis Periaxialis), Morvan's Disease, The Veronal Habit, Stupor, and Chronic Hallucinatory Psychosis.

Other new matter has reference to: Oculogyric Crises in Encephalitis, The Prophylaxis of Syphilis by the Administration of Arsenical Preparations, The Use of Malaria and other Pyrogenic Agents in the Treatment of Syphilis, The Treatment of Malaria by "Plasmochin" or "Plasmoquin," The Serum Prophylaxis of Measles, The Dick Test, The Method of Inducing Immunity in Scarlet Fever, The Use of Anti-Scarlatinal Serum, Laboratory Tests for

Smallpox, The Treatment of Blackwater Fever and Sprue by Blood Transfusion, Diagnostic Tests of Drunkenness, The Pathology of Achalasia of the Cardia and of the Anal Sphincter (Hirschsprung's Disease), Cholecystography, Atypical Chloromata, The Clinical Manifestations of the Various Degrees of Cardiac Failure, Adrenalin Therapy, Barium Therapy, The Surgical Treatment of Mitral Stenosis, Paradoxical Embolism, Electrical Treatment of Raynaud's Disease, Protein Cutaneous Tests in Asthma, Lipiodol Investigations and The Surgical Treatment of Bronchiectasis, The Technique of Artificial Pneumothorax Treatment, Nephrosis, The Treatment of Scalp Ringworm by Thallium Acetate, Nuclear Ophthalmoplegia, The Signs of Local Lesions of the Brain, Spontaneous Subarachnoid Hæmorrhage, Amaurotic Family Idiocy, and Dementia Præcox.

The following articles have been wholly or largely rewritten: Glandular Fever, The Treatment of Acidæmia, Alkalæmia, and Allied Conditions, The Treatment of Diabetes Mellitus, The Treatment of Obesity, Diseases of the Suprarenal Glands, The Treatment of Hyperthyroidism, Diseases of the Parathyroid Glands, Diseases of the Pineal Gland, Chronic Gastritis, The Treatment of Pernicious Anæmia, Purpura, Gaucher's Type of Splenomegaly, Functional Disorders of the Heart, Adams-Stokes Syndrome, Arterial Hypertrophy, The Treatment of Malignant Disease of the Larynx, The Estimation of Renal Function, Hepato-Lenticular Degeneration (Progressive Lenticular Degeneration), Disseminate Sclerosis, and Epilepsy.

Four illustrations (Figs. 11, 89, 90, and 91) have been added.

It is a great pleasure to offer to each of the contributors my warmest thanks.

It is my confident opinion that the book will continue to be considered a credit to the London School of Medicine.

FREDERICK W. PRICE.

133 HARLEY STREET, LONDON, W.
September 1929.

PREFACE TO SECOND EDITION

THE very favourable reception of the first edition has been most gratifying and encouraging to the authors and editor. The second edition has been thoroughly revised and brought up-to-date. The only alterations in the classification and general arrangement are that the article on Rickets has been moved from the section on Deficiency Diseases to that on Diseases of Metabolism, and the article on Mikulicz's Syndrome from the section on Diseases of the Salivary Glands to that on Diseases of the Lymphatic System. Articles on Tularæmia, Botulism, Apical Dental Infection, Chylous Diarrhœa, Chronic Duodenal Ileus, and Tuberculosis of the Kidney have been added. Other new matter includes articles on the Schick Test in Diphtheria and the Method of Producing Active Immunity, the Dick Test in Scarlet Fever, the Investigation of Diseases of the Liver and Pancreas, Quinidine Therapy, the Pathology of Auricular Fibrillation and Auricular Flutter, Mental Sequelæ of Encephalitis Lethargica, and Paraphrenia. The following articles have been wholly or largely re-written : the Pathology of Scarlet Fever, Diabetes Mellitus, Secretory Disorders of the Stomach, Diverticulosis, Hirschsprung's Disease, Cholecystitis, Aphasia and other Defects of Speech, Epilepsy, Hysteria, Neurasthenia, and Dystrophia Myotonica. Fourteen illustrations (Nos. 9, 10, and 12–23) have been added.

Again I wish to offer to each of the contributors my warmest thanks.

FREDERICK W. PRICE.

133 HARLEY STREET, LONDON, W.
January 1926.

PREFACE TO FIRST EDITION

It is generally recognised that within recent years there has been a great advance in knowledge throughout the domain of Medicine As an example of this might be cited the branch of cardiology. As the result of the introduction of the clinical polygraph and of the electrocardiograph we are now able to analyse the cardiac action in a manner which was never possible before, and many of the problems in the study of diseases of the heart which have baffled clinicians for generations have been practically solved, while others are in process of solution. In the department of neurology the progress made has been scarcely less notable. It seemed to me, therefore, that now, more than ever, it has to be acknowledged that it is beyond the scope of any authority, however varied his range of knowledge, to do full justice to the ever-widening field of Medicine, and that a useful purpose might be served by the publication of a work of moderate compass and in one volume, in which the different branches of Medicine were dealt with by authors who have made a special study of each. It has also been thought advisable to include sections on Diseases of the Skin and Psychological Medicine. Tropical Diseases are also included.

In order to secure greater uniformity of method and style, I have generally adopted the principle of allotting a whole section to one author, or to two writing in collaboration, instead of enlisting the services of a large number of writers. I confidently anticipate that it will be recognised that I have been most fortunate in the selection of the various contributors to the volume, and I wish to offer to each of them my warmest thanks. I also desire to express my gratitude to Dr. A. P. Beddard, for the time he has very generously placed at my disposal, and for much valuable advice. It is a pleasant duty gratefully to acknowledge my indebtedness to Dr. Claude B. Ker for the use of blocks of figures taken from his *Manual of Fevers*, and to Dr. James Collier and Sir James Purves Stewart for a block of figure 96.

It is my earne t hope that the book may be considered a credit to the London School of Medicine.

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January 1922.

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A TEXTBOOK OF THE PRACTICE OF MEDICINE

SECTION I

FEVER

FEVER is a complex response, or reaction, to infection, and, as such, is to be regarded as a protective mechanism, or one of the defences of the body, closely connected with the development of immunity. Fever is not the disease; the invading enemy is the infective organism and fever is evidence of the fight maintained by the invaded body.

The process of fever in the infective diseases is associated so closely with a rise in the temperature of the patient that the term "fever" has been often, and is still, used to denote the heightened temperature. A similar ambiguity has arisen in the use of the medical term, "pyrexia." Some writers have used it to signify a heightened bodily temperature; others have reserved it for the rise of temperature associated with infection, and others have used it sometimes in the one sense, sometimes in the other. In this article the use of the term "pyrexia" will be restricted to the rise of temperature, which is so often a marked characteristic of fever, and the high temperature produced by causes other than infection will be described as "hyperthermia." Fever is a complex process in which a disturbance in the temperature is only a part of the reaction of the organism.

The significance of fever will be recognised more readily by a study of the regulation of temperature and metabolism and the means whereby this regulation may be disturbed. The knowledge so obtained can be used as a basis for treatment. Stress will be laid upon temperature, for the practical reason that the physician, by the intelligent use of the thermometer, can study the disturbance of disease without resort to the complicated methods which are involved in the determination of the exchange of material in the body.

The regulation of temperature in health and during fever.—In the long process of evolution, in the constant struggle against heat and cold, the warm-blooded animal has developed its power of regulating its temperature so perfectly that its internal temperature is the same in the height of summer as in the depth of winter. In disease other conditions are present and may influence the temperature of the body in various ways.

A temperature raised above the normal level must be due in all cases to a disturbance of the balance between the production and the loss of heat;

this in turn must be caused by intrinsic or extrinsic factors or a combination of these. The simplest examples are muscular work and exposure to a hot and humid atmosphere; in the former the internal temperature may rise to 101° or 102° F. (38°·33 to 38°·89 C.), owing to the great increase in the production of heat in the active muscles; in the latter case the loss of heat from the body may be prevented by the conditions of the surroundings. The usual rise of temperature produced by muscular work is beneficial, for it not only increases the activity of the respiratory centre, but also enables the oxygen-carrier, the hæmoglobin of the blood, to part more readily with its oxygen to meet the needs of the active tissues. On the other hand, the high temperature of the body produced by simple exposure to excessive heat and moisture increases the production of heat in the body directly the optimum temperature has been passed, and thus leads in a vicious circle to hyperthermia and death from heat-stroke. In the pyrexia of an infectious disease it has long been a question whether the rise of temperature is beneficial or detrimental to the patient or whether both possibilities may not exist, according to the amount and duration of the increased heat. It is necessary to consider the less complex cases in which the temperature is raised above the normal, for the processes involved throw light upon the nature of pyrexia; there is no reason to believe that some entirely new principle is involved.

Considered from such a point of view, pyrexia may be due to increased production or diminished loss of heat, or any combination of these which leaves a balance in favour of the production.

Production of heat.—The muscles and the glands are the chief seats of the production of heat, for although all the other tissues produce heat during oxidation their bulk is relatively small and their chemical changes comparatively slight. The muscles form 40 to 50 per cent. of the weight of the body; the liver and kidneys have a weight of 1579 and 250 grammes respectively.

The relation between muscular activity and the production of heat is notorious; even the child knows that it can warm its body on a cold day by running. Exact observations by the combined respiration apparatus and calorimeter have proved that the respiratory exchange and the production of heat bear a definite relation to work; the law of the conservation of energy applies to physiological processes. Gross muscular activity may double or treble the production of heat, and of this there is now no doubt. The difficulty, however, is that such activity is not seen in the process of fever and cannot be advanced without further consideration as the cause of pyrexia. During apparent rest, even during deep sleep, the muscles are active in a subdued form, which is called "tone." A further reduction in activity is produced by the paralysing effects of anæsthetics; the limbs are now limp; the respiratory exchange and the production of heat are reduced, it may be, to one-half the healthy minimum of sleep. Some investigators hold the view that the muscles have, apart from contraction, a special power of producing heat, an exaggeration of the process of oxidation which is common to all cells. The evidence upon which this is based appears to be insufficient. The relationship between the ordinary activity of muscle and the production of heat is shown clearly by comparative physiology; during the natural process of hibernation the warm-blooded mammal passes into a condition of torpor, its temperature may fall as low as 2° above the freezing-point, it responds to changes of external temperature in a similar

manner to that seen in cold-blooded animals. When the torpid animal awakes, the rise in the temperature of its body is accompanied by shivering; and in the marmot, in which the fore part of the body is warmed more rapidly than the hind parts, shivering may be seen in the region of the head and neck at a time when the hind limbs are still paraplegic. In a rabbit, paraplegic from section of the spinal cord directly below the shoulder girdle, the temperature of the mouth is higher than that of the rectum, especially when the unparalysed muscles are thrown into activity by the action of a stimulating drug. In pyrexia there is similar evidence; a rigor is involuntary muscular activity, shivering; the respiratory exchange and the production of heat are increased and may be, as experiments show, nearly doubled during the shivering produced by exposure to cold. If the temperature be raised above the optimum then the muscles would share in the general increased production of heat which is common to all the tissues, and during a long-continued fever would waste considerably. On these grounds a continuation of the contractions observed during rigor in the first stage of the fever, would not be necessary for the maintenance of the heat during the fastigium or second stage.

Loss of heat.—In the next place, the loss of heat demands consideration. Constriction of the cutaneous blood vessels diminishes the loss of heat, and the internal temperature will rise, if the production of heat in the body remains the same or is increased. During a rigor the patient complains of feeling cold; his teeth chatter and he shivers with cold, although his internal temperature is rising above the normal. As a sensitive being he is cold, for his sensations of temperature arise in his skin, not in his viscera; his skin is pale and cold from the spasm of the involuntary muscles of his vessels, and determinations of the surface temperature prove that it is below the normal. The onset of pyrexia is indicated by a rigor; the production of heat is increased, the loss of heat is diminished, the balance is disturbed, the heat of the body must rise.

Evidence, both clinical and experimental, indicates that at the onset of pyrexia the production of heat in the muscles is increased and the loss of heat from the skin is diminished. This comparison is with the condition of a fasting man at rest. The glandular source of heat would appear to be of relatively small importance, owing to the diminished appetite and intake of food, although it is true that the muscles would need for their activity the products of the glands of internal secretion, including the liver. When the pyrexia is continued other factors come into play; the increased production of heat due to the rigor of the onset may be replaced by that due to the rise of the temperature above the optimum; the diminished loss of heat due to the constriction of the cutaneous blood vessels will cease with the relaxation or dilatation of the vessels, but nevertheless, owing to the absence of sweating, the balance may be against the loss. The inefficiency of vascular dilatation and the importance of sweating are shown by the case of a man born without sweat glands but otherwise healthy; he was unable to do muscular work in summer owing to the abnormal rise in his temperature, and could compensate only when he worked in a shirt previously soaked in water. During the pyrexia of pneumonia the skin is abnormally hot, the vessels are dilated but the skin is dry; on the other hand, a great increase in the loss of heat occurs at the crisis, which is accompanied by profuse sweating.

Regulation of the production and loss of heat.—As far as the production and loss of heat are concerned, the process of pyrexia can be explained in accordance with ordinary physiological principles. The difficulty is to solve the question, What is the power which maintains the balance in health, and how is that balance disturbed in pyrexia? Some advance may be made by considering the means whereby the balance is maintained, suspended or abolished. The regulation of temperature depends upon the control of the nervous system over the production of heat in the muscles and glands and over the loss of heat by the skin and the respiratory tract; the control is exerted in response to sensations of heat and cold. There are some natural conditions which afford evidence upon these points.

The evolution of the capacity to regulate the temperature.—This can be traced in the animal series and in the individual animal. There are rudiments of this power in the so-called cold-blooded animals; in the lowest mammals, the monotremes, the capacity is imperfect; in the hibernating mammals it is suspended during torpidity, for they have retained some of the characteristics of their cold-blooded ancestors. Furthermore, young mammals born in a condition of immaturity need the warmth of their parent's body, for they themselves cannot maintain their temperature. The same is true of many newly hatched birds. On the other hand, there are examples, such as the guinea-pig, in which the nervous control is wonderfully developed even at birth; it is able to run about and maintain its temperature. This passage from the cold-blooded to the warm-blooded stage can be traced in the embryo chick during incubation. In all of these cases the power of regulating temperature appears to be bound up inseparably with the control of the voluntary muscles and the muscles of the blood vessels. Observations upon premature infants and the effects of baths upon weak and strong infants agree with the results of comparative physiology; a premature infant should be washed with oil, not with water, so that its loss of heat may be diminished, and an incubator is used to supply a warm environment, for an immature infant resembles in many respects a cold-blooded animal.

Influence of lesions of the central nervous system.—Experimental evidence has a similar significance. Anæsthetics will abolish for the time the power of regulation of temperature; so also will drugs, such as curare, and alcohol in large doses. The investigation is carried a stage further by observations upon the effects of lesions of the central nervous system. The cerebrum influences the regulation, but is not essential for the maintenance of the bodily heat. Pigeons can regulate their temperature after the complete removal of their cerebral hemispheres, and a similar operation upon a dog only curtails its range of adaptation to the temperature of its surroundings; in both cases the brainless animal is not paralysed, for it can perform complicated muscular movements and respond to cutaneous impulses. Similar evidence for man is incomplete, for the condition of anencephalic monsters does not appear to have been investigated sufficiently. Section of the spinal cord by cutting off the incoming and outgoing impulses produces a complex condition in animals and man; the control is lost in the paraplegic portions of the body, and, if the paraplegia is extensive, the condition may resemble that of a cold-blooded animal, the internal temperature varying with and in the same direction as the temperature of the surroundings. A man in whom paraplegia has been produced by a traumatic transverse section of the spinal

cord shivers with the muscles supplied by nerves above the lesion when he feels cold; on the other hand, when he is hot he sweats only as far as the line between the non-paralysed and the paralysed portions of his skin. These conditions are in practice valuable indications of the position and severity of a spinal lesion. The method of exclusion leaves the control of the temperature in the mid-brain and medulla. For such a localisation confirmation can be obtained from the results of lesions of the basal ganglia produced by experiment or disease; a disturbance of the temperature is so constant a feature of these lesions that the ganglia have been designated the "heat centres." It is possible, however, that the true interpretation is to be found in the evolution of the regulation of temperature, the connection of these ganglia with the incoming impulses from the skin and the outgoing impulses to the muscles. The response of these centres to heat and cold is usually due to sensations arising in the skin, but in some cases there is evidence that it may occur from direct action, through the medium of the blood, upon the excitability of the centres. Be this as it may, no explanation of the response can be offered as long as the nature of sensation is unknown. Notwithstanding this fundamental gap in knowledge, it is possible to make a further advance towards an explanation of pyrexia.

Influence of drugs.—The nervous control of the regulation of temperature can be influenced by drugs; it can be paralysed by anæsthetics, and in its balanced effect can be disturbed in one direction or the other, so that the temperature rises with pyretics and falls with antipyretics. This comparison of pyrexia with the hyperthermia produced by drugs has yielded results of importance. There are no gross anatomical changes to be found in the nervous system as a characteristic of pyrexia, and the microscopic appearances, such as chromatolysis and other alterations in the neurons, are probably the effect, not the cause of pyrexia, for they can be seen in cases of heat-stroke produced experimentally in animals, or by accident in man.

The most interesting of the so-called pyretic drugs is tetrahydro-β-naphthylamine, which may raise the temperature as high as 112°·1 F. (44°·5 C.). Its action is upon the central nervous system; there is increased excitability, accompanied by muscular activity, spasms or convulsions, and at an early stage there is vaso-constriction in the cutaneous vessels. The production of heat, as measured by the respiratory exchange, is increased to a degree sufficient to explain the rise of temperature. It is of interest also that in some cases a lethal dose may cause the temperature to fall 3° or 4° below the normal.

Influence of micro-organisms.—In the pyrexia of fever the toxic agent must be sought in the micro-organism which has induced the disease. To produce pyrexia the animal is infected by an injection of a culture of the micro-organism, or it may be subjected to the filtered products obtained from the culture. Pyrexia is one of the reactions of the animal to the invasion of a pathogenic organism, and it may be a means of defence, evolved in the struggle for existence. Upon this more must be said at a later stage, for it is necessary now to consider in more detail the question whether the micro-organism attacks by producing a specific toxin, which will act upon the nervous system and disturb the regulation of temperature. It is well known that such toxins can be obtained by the action of bacteria; it is sufficient to mention tuberculin as an example. The mode of action, however,

may be more complex, for, in addition to the specific toxin, the activity of the micro-organism may cause other changes in the chemical composition of the infected animal; some forms of protein and even excess of salts may be factors in the production of pyrexia.

A pyretic injected into the body causes a rise of temperature, hyperthermia, but it has been maintained throughout this article that pyrexia is more complex. It has indeed been long recognised that there are different types of pyrexia; there may be continuous "fever," remittent or intermittent, and the variation in the temperature may be peculiar to the disease and thus supply a diagnostic sign of great value. Increased production of heat and diminished loss of heat of the degrees to be found in fevers will not explain the pyrexia, for a healthy man can compensate readily for far greater changes; the regulation of temperature is disordered during pyrexia or, as some would maintain, is set at a new level. Pyrexia is only one sign of the complex response in metabolism to the invasion of micro-organisms, and the explanation of the course of the temperature in different fevers must be sought in the processes of infection and immunity. The micro-organisms not only produce different toxins, but they have a different life-history. The toxins circulating in the body produce a disturbance in the exchange of material and in the regulation of temperature; the response of the body to the presence of the toxin is the production of an antitoxin. The effect of the one may be antagonised by that of the other; the type of temperature may depend upon the relative production of each. The life-history of the micro-organism will affect the production of its toxin. Thus, in malaria the rise in the temperature of the patient coincides with the segmentation and sporulation of the parasite; in tertian ague this occurs every 48 hours, and in quartan ague every 72 hours. In relapsing fever a relationship has also been found. Further, this view is confirmed by the beneficial effect of those so-called antipyretics, which destroy the micro-organisms; quinine kills the malarial parasite and prevents the rise of temperature.

Difficulties in such explanations no doubt arise. The effects may not be constant in animals of different species, or in individuals of the same species; instead of a rise of temperature following the injection of the micro-organism or its toxin, there may be no effect or a fall in temperature below the normal. These are not fatal objections, for similar results are produced by simple drugs, and it is known that mixed infections may occur, for even in the healthy animal pathogenic organisms can be found.

Stages of fever.—Further progress will be made as the result of investigations upon the relationship of micro-organisms, toxins and antitoxins, to the different stages of pyrexia. Three stages are recognised: the initial stage, which may be accompanied by a definite *rigor*; the second stage, or *fastigium*, in which the height of the pyrexia is reached; and the third stage, or *defervescence*, in which the temperature falls by *crisis* or *lysis*. In the first stage the successful invasion by the micro-organism appears to have a stimulating effect upon the nervous control of the muscles, including the muscles of the cutaneous blood vessels; the result is shivering, a pallid contracted skin, known as "goose skin"; the temperature rises owing to increased production and diminished loss of heat. During the second stage the regulation is disturbed, but not paralysed, for the patient can respond to heat and cold, and shows a daily variation in his temperature; the disordered nervous

control is a part of the complex reaction in metabolism, the patient is fasting, and his reserves of carbohydrates having been consumed at an early stage he draws upon his nitrogenous materials as well as his fat. Apart from the inanition, the nitrogenous destruction may be due in part to the effect of the high temperature, which increases the general metabolism, and to some destructive action produced by the micro-organism or its toxin. The skin is flushed during the second stage, owing to the relaxation of the blood vessels, but in many cases the sweat glands appear to be paralysed as a part of the general toxic effect of the infection upon the secretory and excretory glands; the loss of heat is not sufficient to compensate for the increased production, the pyrexia is maintained. The rashes characteristic of certain infections are related probably to the toxins or other substances produced by the bacteria, or the cells of the tissues attacked.

In the final stage the action of the micro-organism or its toxin appears to be neutralised by the various protective mechanisms of the body, such as antitoxins; the loss of heat is greatly increased by profuse sweating, the temperature falls and with it the abnormal production of heat caused by the rise above the optimum temperature. The vicious circle is broken. The contest is over.

Significance of fever.—The pyrexia appears to be an essential part of the defence, for experiments show that recovery from infection is aided by a high temperature, and micro-organisms, even if they are not killed, may have their virulence attenuated by the high temperature. The rise of temperature produces increased metabolic changes, and some of these are of a special kind, and may be necessary for the formation of protective substances. Experiments have shown that agglutinins and bacteriolytic substances are produced more quickly and abundantly in infected animals kept at a high temperature than in similar animals kept at ordinary temperatures for the purpose of control. If the pyrexia be beneficial, how are the good results of the remedies which combat the high temperature to be explained? Quinine destroys the malarial parasite; its beneficial effect is not due to the reduction of the temperature. The cold water treatment of fevers has other effects besides the reduction of temperature, for it is recognised now that the skin, the largest organ for the reception of stimuli, has a great effect upon the nervous system and through it upon all parts of the body; the improvement produced by sponging the body is often out of proportion to the reduction of temperature. The mortality from fevers in man does not, as statistics indicate, depend upon the height of the temperature, and physicians have recognised that serious dangers may arise from the use of some antipyretic drugs. In the struggle for existence the body has evolved its protective mechanisms, and among these must be placed pyrexia as a part of the response to the invasion of micro-organisms.

The regulation of temperature and the factors which disturb it have been considered in detail, because there is considerable neglect of the subject, and a widespread tendency to describe as "fever" or "pyrexia" every rise of temperature in man above 100°·4 F. (38° C.). *Fever is a response in metabolism to the invasion of micro-organisms and a toxic disturbance of the nervous regulation of temperature.* It is possible for fever to be accompanied by no rise of temperature, and this is recognised clinically as "apyrexial fever" or "non-febrile fever"; such a condition is seen especially in in-

fections occurring in old and feeble subjects. The high temperatures often observed in lesions of the central nervous system at the onset have no relation to infection, and confusion only results if the hyperthermia is regarded as fever. The same remarks apply to heat-stroke.

The effects of fever on the various systems.—These may be mentioned briefly, in so far as they are common to the various infections.

1. *Metabolism.*—A characteristic feature is the increased katabolic or destructive phase of the metabolism, or exchange of material in the body. The destruction of protein is abnormally great, as proved by the increased output of nitrogenous substances in the urine, the wasting and loss of weight of the patient. This is doubtless in part explained by the inanition, due to the loss of appetite and diminished consumption of food. Other factors, however, are concerned, for a fevered patient loses nitrogen more rapidly than a healthy man who is starving. The rise in temperature increases the destructive changes, and the toxins of the infections, which may be compared with those in malignant disease, produce a similar effect. These changes are shown by the large amounts of creatinin and purine bodies in the urine during pyrexia and the increased excretion of urea during the crisis. The balance of water and salts is disturbed, there is a decrease in sodium chloride in the urine during pyrexia, and owing to the imperfect oxidation of fat acidosis is produced. At present little is known upon these points; life depends upon the adjustment of variations, one extreme produces "water poisoning," the other "salt poisoning."

2. *Secretion and excretion.*—The diminished activity of the alimentary system appears to be the resultant of the combined effects of the toxins, inanition and high temperature. In some infections there may be actual damage to the glandular tissues, such as occurs in the kidneys in scarlet fever. In the absence of such direct action, the albumin and albumoses present in the febrile urine are probably due to the abnormal destruction of protein in the body, the high temperature and circulatory disturbance.

In many cases the sweat glands appear to be paralysed by the toxins, for as a general rule sweating is absent during the rigor and fastigium, but abundant during defervescence. In rheumatic fever and acute miliary tuberculosis sweating is present during the fastigium.

It is known that the glands of internal secretion influence the production and loss of heat, but the part which they may play during pyrexia still requires clear demonstration by observation and experiment.

3. *Respiration.*—The cause of the increase in the rate of respiration observed during fever is to be sought in the high temperature and chemical changes in the composition of the blood supplying the respiratory centre in the medulla oblongata. An increase in the gaseous exchange is evidence of increased production of heat; in tuberculosis, typhoid fever and malaria percentage increases of 32, 48 and 60 respectively above the normal have been observed.

4. *Circulation.*—The regulation of the circulation of the blood is disturbed by the high temperature, inanition, and the toxic substances which affect not only the nervous control but also the tissues of the heart and blood vessels. The heart is very susceptible to a rise of temperature and malnutrition, and there is evidence of toxic action in the cardiac failure which may occur in diphtheria. In recent times special attention has been directed

to the impaired condition of the heart after an attack of influenza; the injury appears to bear no direct relationship to the height of the pyrexia. The blood pressure is generally raised during the onset of a fever, when the cutaneous arterioles are contracted and the heart is beating rapidly; later, when the blood vessels dilate and the heart beats less strongly, the blood pressure falls and the pulse becomes dicrotic.

5. *Nervous system.*—The disturbance of the nervous system is shown by the restlessness, depression and general vague sensations of "feeling unwell." Delirium is common, especially in the evening when the temperature is generally higher. The causes appear to be the drug-like action of the toxin and the rise of temperature.

Treatment.—If the foregoing general account of fever represents the balance of evidence, it is obvious that an analysis of the causes in each case must be the guide for treatment. A rise in temperature is no proof of fever, for muscular work will produce a rise to 101° or 102° F. (38°·33 to 38°·89 C.) in perfectly healthy men; a failure to recognise this physiological hyperthermia appears to be responsible for the retardation of the recovery of many patients suffering from tuberculosis. It is true that such patients react unduly to muscular work, especially if there be active disease, but it is equally true that prolonged rest in bed will diminish the capacity and resistance of a healthy man.

The abnormally high temperature in cases of heat-stroke is not hyperpyrexial in the strict sense, for there is no satisfactory evidence of infection; the condition can be produced by exposure of healthy men or animals to a high temperature when the air is moist and especially when muscular work is performed. Treatment by drugs is useless, whereas the external and internal application of cold, by baths, cold packs or iced-water enemata have given excellent results.

In young children the regulation of temperature may be more easily disturbed than in adults, and a rise of temperature may be produced by trivial causes.

The routine treatment of fever by antipyretics is not justified by knowledge or results. The use of drugs which destroy the infective organism, such as quinine in malaria, can be defended, likewise that of vaccines and antitoxins, which increase the resistance of the patient.

The fever of tuberculosis will yield to those conditions, such as exposure in the open air and progressive muscular work, which increase the metabolism and resistance of the body to the infective organism. Antipyretics appear to be useless, for none is known to be specific, in the sense that quinine is for the malarial parasite. The evidence for the value of vaccines and antitoxins is given in detail elsewhere (see p. 24, *et seqq.*).

When delirium or other nervous disturbances are present, the best and safest treatment appears to be sponging with cold water, for it has been mentioned already that the skin is the largest nervous receptor in the body. The internal temperature may or may not be reduced much, but the temperature of the skin is. Even in perfectly healthy subjects, nervous inactivity and sleep cannot be obtained if the skin is too hot at night during a heat wave, or too cold in winter. It must be recognised that the tone of the peripheral blood vessels is influenced greatly by the temperature of the skin.

The thirst, which is a demand for water, should be fully satisfied by cold water or lemonade made from lemons. Although the skin may be dry owing to the absence of sweating there is an increased loss of moisture by the breath of the fevered patient, and the scanty and concentrated urine is evidence of a lack of water. There is no physiological reason for undue distrust of a patient's likes and dislikes; on the contrary, they are probably the expression of physiological needs. The desire for water and fruits appears to be a natural response to the needs for fluid, sugar and vegetable acids, which in the body will supply carbonates, assist the balance of water and salts, and mitigate acidosis.

In vigorous patients there appears to be no advantage in urging them to take food against their inclination, for the reserves of the body are adequate for a long fast. As a general rule the appetite is the best expression of the need for food. The mouth should be cleansed by a wet rag or by rinsing out with water, so that the excess of fur may be removed from the organs of taste, often covered with débris and dried by breathing through the mouth. Such simple attention and care will increase the enjoyment and digestion of food. On a fever diet a daily evacuation of the bowels is not to be expected and need not be produced by purgatives.

M. S. Pembrey.

INFECTION

Effects of Bacterial Activity

When a bacterial invasion of the body tissues occurs the result is disease; the process is spoken of as an infection, and the bacterium is said to be pathogenic. Such a micro-organism, being capable of flourishing at body temperature, belongs to the parasitic group of bacteria. By no means all parasitic organisms are capable of pathogenicity, and, moreover, any one pathogenic micro-organism varies under changing conditions as to its pathogenicity for any particular animal, and may, while generally pathogenic to any one species, be incapable of infecting other species.

Again, micro-organisms that are potentially infective may and do exist under saprophytic conditions, that is to say, apart from the animal body, and under different conditions as regards temperature, etc. Saprophytic bacteria that are incapable of invading living animal tissues may yet invade the animal body when any part thereof is so injured as to be dead, or is in process of dying, and by proteolytic destruction of such dead tissue may elaborate substances called ptomaines, which substances are poisons capable of bringing about the death of the host. Ptomaines are analogous to alkaloids and are not destroyed by heat; and as they may be produced by the action of saprophytic organisms in diverse kinds of decaying animal and vegetable tissues, they account for a certain proportion of the cases of food poisoning produced by the eating of canned and tainted food products, but true ptomaine poisoning is rare.

Certain varieties of bacteria, usually infective, may become saprophytic. The hosts are then termed "carriers." The best known examples thereof are the typhoid bacillus, the diphtheria bacillus and the meningococcus.

The two former examples generally, if not always, occur after an infection, whereas the meningococcus is more often found existing in a saprophytic than in a pathogenic state. In these cases the bacteria do not exert any apparent harmful effect, but they are, of course, of great potential danger to the surrounding community.

A similar condition exists in connection with the paratyphoid bacilli and those of the food-poisoning group generally. In these cases, however, there are usually symptoms of a recurrent nature, such as more or less mild attacks of gastro-enteritis associated with malaise, which symptoms may recur over long periods of years. A history can frequently be elicited of the initial attack of fever associated with symptoms of enteritis. This condition differs to some slight extent from that of the carriers noted above, in that there is some evidence, continuous or recurrent, of constitutional disturbance, though in the periods between recurrence, which may be prolonged, the condition closely resembles that of a carrier. Whether the condition that determines a recurrence is one of increased virulence of the bacillus or decreased resistance of the host is not yet clear.

Infective bacteria are generally aerobic, or facultatively aerobic. True anaerobes have very little power of spreading through uninjured animal tissues unless they are accompanied by aerobes, though they may cause localised infections in tissues in which the oxygen supply is limited. Hence the bacteria usually associated with infections are aerobic organisms that flourish at body temperature.

It has been stated that a bacterium usually pathogenic may vary under different conditions. These conditions may pertain to the bacterium itself or to the animal infected. A microbe may belong to a highly infective variety and yet vary greatly in its infectivity. This property is known as *virulence*, and depends on various factors. Mere subculture in the laboratory usually lowers the virulence, markedly in the case of typhoid, and slightly or not at all in the case of Malta fever. Passage through an animal of similar species raises the virulence to that species, while usually lowering it towards members of different species. Growth under conditions other than the optimum—for instance, growth at lower or higher temperature or growth in the presence of antiseptics—tends to lower virulence.

The subject of virulence, however, presents many difficulties. For instance, in the case of anthrax, animals whose serum is markedly bactericidal to anthrax bacilli will succumb if quite small quantities of anthrax bacilli are injected. Bail, investigating this observation, brought forward the contention that certain bacteria when invading an animal elaborated an offensive substance which paralysed the protective powers of the host, chief of which would be phagocytosis. He termed this substance aggressin, and described experiments showing that sublethal doses of infective bacteria became lethal doses when aggressin was added. He also classified bacteria in relationship to their powers of forming aggressin. His theories were, however, attacked by Wassermann, Citron and others, who showed that Bail's exudates might act in the way he claimed they did by reason of containing endotoxins, in that they paralleled his results by aqueous extracts of bacteria. Notwithstanding the doubtful position of the aggressin theory there seems to be some offensive mechanism differentiating virulent from avirulent bacteria, apart from such characteristics as the possession of capsules, and

not altogether explained by the inhibition of positive chemiotaxis by direct toxic action.

The *dose of infecting organisms* introduced is a matter of importance. Whereas one or two anthrax bacilli cause a fatal infection in a white mouse, a considerable quantity of even a virulent streptococcus may be necessary to cause an infection in a susceptible animal. The normal tissues are capable of dealing immediately with a certain quantity of even moderately virulent organisms.

The *path of infection* has an important bearing on the results of any given infection. Thus staphylococci injected subcutaneously in a rabbit produce a local abscess, while if the injection be intravenous, pyæmic abscesses may lead to death. Typhoid bacilli must be swallowed to be infective, while it has been demonstrated that plague may be caused by rubbing *B. pestis* into the skin.

Subject of infection.—Normal healthy individuals differ greatly in their reaction to infective microbes. They differ because of individual or racial characteristics, or because of environment or age. Many micro-organisms, for instance, that are pathogenic to man are non-pathogenic to the lower animals. Thus syphilis can be transmitted experimentally to the higher apes only, and leprosy is incapable of infecting any animal but man. The susceptibility of a given individual is increased by prolonged exposure, great fatigue and starvation, or any condition leading to a generally diminished vitality.

A *local susceptibility* may be brought about by trauma so injuring the part as to cause a loss of vitality by shock, or interference with the circulation, a condition which may by reason of deficiency of oxygen permit even anaerobic organisms to flourish. Trauma also may be the direct agency of introduction of large quantities of infective material into tissues which by the same action are rendered less resistant.

An existing disease or condition may modify the reaction of the host to an infection. Thus the subjects of diabetes are abnormally prone to staphylococcal and tuberculosis infections.

There is some evidence that the activity of an infecting micro-organism can disturb the normal relationship between the host and its saprophytic inhabitants. Thus in typhoid fever, symptoms occur which appear to be connected with abnormal activity of the bacilli of the intestinal coliform group. Also any chronic intestinal infection appears to conduce to an increase in the intestinal streptococcal flora. It is not uncommon to find in amœba-carriers or subjects recovered from amœbic dysentery a very marked profusion of intestinal streptococci, and this condition is occasionally noted as a sequel to paratyphoid and similar infections.

Bacteria that are capable of spreading in the tissues, when such tissues are not rendered abnormal by reason of trauma, shock or inhibition of circulation, or by reason of the existence of some such disease as diabetes, usually have the power of causing *septicæmia*, that is, of flourishing in the blood stream, and, as a sequel, have the power of producing pyæmic infective processes.

Other bacteria causing acute infections do at certain stages of the infection appear in the blood stream, but at a later stage disappear therefrom, the *bacteriæmia* being incidental to, but not coextensive with, the infection. Thus streptococci and staphylococci and certain other bacteria may establish

themselves in the blood stream, and the resulting embolic abscesses may cause death; while in typhoid fever there is always a temporary bacteriæmia which tends to disappear before the termination of the disease, and only rarely causes localised abscesses, but is possibly responsible for the infection of the Peyer's patches.

The faculty of invading the blood stream comes under consideration when estimating the infectivity of such an organism as *M. catarrhalis*, which is never recovered from the blood stream, and, unlike the diphtheria bacillus, which also does not invade the blood stream, does not elaborate a soluble toxin. Important facts in connection with this faculty of invading the blood stream possessed by certain bacteria have been adduced by Wright. He showed, in connection with suppurating wounds, that whereas the discharge from a wound showed a very diverse flora, the fresh serum exuding into such a wound would only permit the growth of streptococci, and to a less extent staphylococci. These organisms in consequence he terms serophytes. He also showed that the fresh serum was more antitryptic than the wound discharge, and attributed the lessened antitryptic value of the discharge to trypsin set free by leucocytolysis. The divers varieties of bacteria able to flourish in the tryptic discharge he termed serosaprophytes. It will be noticed that the serophytes correspond to those bacteria most likely to be found in cases of septicæmias.

Results of Bacterial Infection

Having thus briefly considered the relationship between the animal and human organism and infective bacteria, we pass on to trace the results of bacterial invasion.

If the individual be in a normal state of health, even a large quantity of virulent micro-organisms can gain admission to his body, and owing to the local defences may be destroyed before damage occurs; such a repelled invasion causes no symptoms, and the subject thereof will remain unconscious of it.

Or a local engagement of greater magnitude may ensue, resulting in an abscess, or a condition of cellulitis, or chronic suppuration. While, again, if the local defences prove insufficient a general infection occurs which is spoken of as septicæmia or bacteriæmia, or according to the nature of the infecting organism a diffusion of pyæmic abscesses may occur.

If the process remains a localised one the only effects may be a greater or less amount of necrosis of the tissues in that region, the ultimate defect depending upon the importance of the tissues in question. On the other hand a greater or less degree of general poisoning may occur by reason of soluble poisons liberated from the bacteria. These poisons are termed toxins.

Toxins are of two varieties, exotoxins and endotoxins.

Exotoxins are soluble poisons elaborated by certain classes of bacteria—notably diphtheria and tetanus—and recoverable from the medium in which these bacteria have grown, without the death of the elaborating microbes having necessarily occurred.

Endotoxins, on the other hand, cannot be recovered separate from their elaborating microbes. This means that those bacteria which only elaborate

endotoxins can only poison an animal organism by proliferating within that organism, while the poisoning produced by exotoxin may occur without the actual invasion of the body by the elaborating organism.

Inasmuch as autolysed cultures of endotoxin-forming bacteria give toxic filtrates, owing to the solution of the bacterial substance, it is not easy to differentiate between true toxins, the exotoxins of organisms like diphtheria and tetanus, and the endotoxins. The ultimate differentiation rests upon the fact that the injection of soluble toxin into an animal calls forth a response of an antibody—antitoxin, whereas the injection of the solution of endotoxin though calling forth a response of antibody does not induce the elaboration of antitoxin.

Incidentally it may be here remarked that the difference between exotoxin and endotoxin is a fundamental one in specific therapy, as in a toxæmia from exotoxin a suitable antitoxin in appropriate amount constitutes an adequate defence, while in the case of toxæmia from an endotoxin the elaborating bacterium itself has to be proceeded against, and this most often necessitates the use of a vaccine prepared from the bacteria involved.

The mode of action of toxins is very variable and depends upon the variety of bacterium. The true toxins of diphtheria and tetanus tend to produce profound poisoning effects on the nerve tissues. Thus the ingestion of sufficient diphtheria toxin leads to paralysis notably of the soft palate; but according to the size or virulence of the dose, or condition of the subject, all the voluntary muscles of the body may become paralysed. Tetanus toxin is selective to the cells of the central nervous system, chiefly those of the motor areas, leading to a condition of tonic spasm.

The toxins associated with other acute and chronic infections produce various effects, prominently fever and degeneration of muscle tissue, such as the heart muscle in pneumonia and influenza. The toxins produced as the result of streptococcal activity have a wide range of effect. Thus in acute infections the heart muscle suffers specially as well as the synovial membranes of joints, while in chronic streptococcal infections, such as pyorrhœa alveolaris, a general fibrosis of connective tissue may occur, leading to arthritis and involving the bony and connective tissues of joints, and fibrositis generally. Associated with these changes there is frequently marked mental depression, which is possibly a direct effect of the toxin on the nervous system.

JOHN MATTHEWS.
THOMAS HORDER.

IMMUNITY

Definition.—Immunity is that function of the animal organism by virtue of which the effects of bacterial activity are resisted.

Immunity is either natural or acquired.

NATURAL IMMUNITY

Many diseases commonly infecting man do not spontaneously occur in animals, and conversely many animal diseases do not spontaneously affect man. Experimentally a naturally immune animal may be infected; thus the

chimpanzee can be infected with syphilis. These experimental infections of naturally immune animals are usually, however, of a mild character. Moreover, different species of animals show great variability in immunity. For instance, rats and dogs are immune to anthrax. The factors determining these differences of immunity are not well understood, but variations in diet, as between carnivora and herbivora, the environment and habits, and variations in physiological metabolism partly account for them. There are also degrees of natural immunity in the different races of man. Thus the natives of countries where certain diseases are endemic may be far more resistant to those diseases than inhabitants of countries where the diseases are not endemic, as shown by the resistance of the negro to yellow fever. Conversely, diseases that have existed for years endemically among one race or group of races may cause a veritable plague when introduced to a fresh race. Thus tuberculosis ravaged the North American Indians, and syphilis when introduced to Europe from America, where it was probably endemic, followed the course of an epidemic of a highly contagious disease.

These racial types of immunity, however, are to some extent acquired, either by constant exposure of individuals to contagion, or by survival of the fittest.

As regards the mechanism of natural immunity there might be two explanations. One, that naturally immune animals were resistant to the bacteria themselves, and the other, that they were resistant to the toxins of the bacteria—in other words, that the bacteria possessed the power of invading the animal, but that the invasion had no toxic effects. As a matter of fact, naturally immune animals possess the power of resisting the invasion of bacteria, and the resistance seems to be a function of phagocytosis, as the phagocytic power of naturally immune animals varies according to their immunity, whereas the bactericidal action of their serum does not vary in this direct relationship. Nevertheless phagocytic activity depends largely upon substances in the serum, as will be shown later.

There is also individual immunity, as shown by the fact that in any epidemic some individuals entirely escape infection, while in those infected all degrees of resistance are noted.

In contradistinction to individual natural immunity, which condition does not lend itself to analysis, there is the condition of individual susceptibility—a condition to which considerable study has been devoted, chiefly in the direction of non-bacterial toxæmias such as hay fever and the various toxic idiopathies. Possibly, however, the various manifestations of the rheumatic state are destined to be grouped under a condition of individually decreased resistance to the endotoxins of streptococci.

There is a tendency, specially among American writers, to range all the phenomena of the toxic idiopathies under anaphylaxis.

The outlines of immunity which have been hitherto considered have chiefly been concerned with the reactions between bacteria and the body fluids, and together with further principles in connection with toxins and antitoxins, which will be studied later (p. 19), were in the main formulated by the German school of bacteriologists, especially Ehrlich and Pfeiffer.

The theory of immunity elaborated by this school was termed the Humoral Theory.

Phagocytosis.—Concurrently with the elaboration of this theory, however,

Metchnikoff's school was bringing to light many important facts in connection with the action of bacteria upon the cellular elements of the body. And Metchnikoff, holding the view that phagocytosis was the essential principle in immunity, formulated the Cellular Theory. The facts on which this theory was founded are briefly as follows: Amongst the lowest unicellular animals nutrition takes place by the ingestion of particles, those unsuitable for nutrition being extruded, while suitable ones become surrounded by a vacuole and, by the aid of a proteolytic ferment, digested.

Ascending the animal scale this function of ingestion becomes limited to special groups of cells, and in the higher animals to a still more circumscribed group of cells, the phagocytes. Moreover, the function itself ceases to be of nutritional benefit to the animal, but becomes specialised to the service of immunity.

Phagocytes are divided into two groups—microphages, comprising the polymorpho-nuclear *leucocytes, and macrophages, including the endothelial* cells lining the serous cavities, blood and lymph vessels, and the large mononuclear lymphocytes.

The microphages are chiefly concerned with phagocytosis of bacteria, while foreign cells or impaired cells of the animal host, as well as animal parasites, are accounted for by the macrophages.

A local infection of staphylococci, or the injection into the body of staphylococci, or even nutrient broth, at first causes a diminution in the number of leucocytes locally, but quickly a great increase of phagocytes occurs. This phenomenon is termed positive chemiotaxis. The degree of chemiotaxis varies greatly according to the variety or virulence of the bacterium involved, and there may be a definite repellent action which is termed negative chemiotaxis. The exact mechanism of the phenomenon is not well understood. There is, however, a definite relationship between positive chemiotaxis and phagocytosis, apart from the fact that unless positive chemiotaxis exists phagocytosis cannot take place. And though positive chemiotaxis varies to some extent inversely with virulence, yet virulent and living organisms may be phagocyted. Phagocytosis is preparatory to digestion, though the facility with which organisms are digested varies greatly; some, such as anthrax and tubercle bacilli, being very resistant to digestion though easily phagocyted.

It was shown by Metchnikoff that there was a direct relationship between the development of immunity in an artificially immunised animal and the phagocytosis of its white cells. As the result of a vast amount of experimental work, Metchnikoff claimed that phagocytosis was the fundamental factor in immunity, while Pfeiffer and the German school claimed that the important factors of immunity pertained to the anti-substances elaborated in the blood fluids and serous exudates, and that the phagocytes were simply concerned with scavenging duties in connection with the dead or dying bacteria, damaged by the action of specific antibodies elaborated in the serum.

It must be noted that Metchnikoff recognised the existence of these antibodies, but claimed that they were derivatives of leucocytes; and his later contention was that the immune substance in the serum acted directly upon the leucocytes, and, indeed, he used the term "stimulin" to denote that substance.

This view was opposed by Denys and Leclef in 1895, who suggested that the immune principle acted upon the bacteria.

The controversy was carried a step further as the result of the researches of Wright and Douglas in 1904 and 1905. They showed that washed corpuscles, *i.e.* leucocytes deprived of serum, had a very slight phagocytic effect on bacteria, but that when a mixture of washed corpuscles, bacterial emulsion and normal serum was incubated, phagocytosis took place, whereas if the normal serum had been previously heated to 55° C. no phagocytosis occurred. Moreover, if a mixture of normal serum and bacterial emulsion were incubated, and the bacteria freed from serum were added to washed corpuscles, phagocytosis occurred freely. They called this thermolabile substance opsonin (ὀψωνέω, to prepare victuals).

By showing that the washed leucocytes of highly immunised animals had no more phagocytic powers than those of a normal animal, they effectively disposed of Metchnikoff's stimulin theory, supplanting it by the Opsonic Theory, founded on their discovery that opsonin, the immune principle on which phagocytosis depends, acts on the bacteria alone, preparing them for ingestion by the phagocytes.

Shortly after, Neufeld and Rimpau drew attention to an immune principle they termed bacteriotropin, differing from opsonin in that the former is thermostable. It was suggested that normal opsonin differed from bacteriotropin—immune opsonin; and various workers, Dean, Muir and Martin, have claimed that immune opsonin has all the reactions of immune substance or amboceptor.

Wright and Douglas showed that opsonin was increased in amount by active immunisation; and Wright suggests that the difference between normal and immune opsonin is merely one of quantity, and, in that opsonin may be only relatively thermolabile, a certain amount may survive heating.

The specificity of opsonin was shown by Bullock and others by means of absorption experiments.

However interesting, theoretically, the exact classification of opsonins may be with reference to other immune bodies, the practical outcome of Wright's discovery has achieved far-reaching results. Wright and Douglas demonstrated that the quantitative estimation of the opsonin content of any serum, in respect to any particular organism, was possible by comparing the phagocytosis occurring in a mixture of definite volumes of homologous bacterial emulsion, washed corpuscles and, respectively, normal serum and the serum in question. The measure of phagocytosis achieved in the serum under observation, divided by the phagocytosis of the normal serum, which latter is taken as unity, is termed the Opsonic Index.

In skilled hands the accuracy of the opsonic index, within the limits of experimental error, is very exact. Thus the index of a normal person to tubercle bacillus, or staphylococcus, rarely falls outside a measurement of between 0·8 and 1·2, whereas much greater variations are commonly found in the serum of individuals infected with either of these organisms.

It is obvious that in connection with those organisms which undergo bacteriolysis with immune serum the estimation of the opsonic index is at the best unreliable, as it also is with certain organisms which when in virulent condition are refractory to phagocytosis.

At the present time the practical application of the opsonic index is

chiefly directed to the detection of rapid changes in the amount of opsonin in connection with vaccine inoculations, to measure the effect of treatment, or with passive congestion experiments undertaken with a view to diagnosis.

The opsonic index of an infected individual to the organism causing the infection varies within wide limits. If a suitable staphylococcal inoculation be made, the initial result of the injection is a fall in the opsonic index corresponding to a fall in resistance, called by Wright the negative phase. After a brief period the index is found to be rising, corresponding to a rise in the resisting power, called the positive phase. The positive phase tends to last a considerable time in a non-infected individual, but is more or less transient in an infected patient. The object of vaccine therapy is to achieve the maximum of positive phases compatible with negligible negative phases. The amount of negative phase permissible depends upon the severity of the infection under treatment.

By bringing into application these principles, Wright elaborated the principles of vaccine therapy, which will be discussed under the heading of Immune Therapy.

Acquired Immunity

(i.) *As the result of recovery from infection*

When an individual has recovered from an acute infection such as typhoid fever it is a matter of common knowledge that he experiences immunity against that disease in future, so much so that the occurrence of a second attack is very rare. So also a second attack of scarlet fever, measles and the other exanthemata are unusual occurrences. This acquired immunity was recognised, but of course not understood, centuries ago, and history shows that attempts at protection were made by inoculating infective material; and it was on account of this knowledge, but with a fuller understanding thereof, that Pasteur commenced his study of protective inoculation that forms the basis of the modern knowledge of immunity.

Immunity acquired as the result of recovering from an infection varies greatly in different diseases, and in contrast with the lengthy immunity following recovery from typhoid fever and the exanthemata, the immunity following such a disease as pneumonia may be quite short. Indeed, there are those who say one attack of pneumonia predisposes to another.

It is doubtful if such an assertion is justifiable; and even if it were, it probably depends upon the fact that even successful recovery from acute pneumonia may still leave the individual a carrier of pneumococcus of modified but potential virulence.

(ii.) *Artificial Immunity; Active and Passive*

Pasteur in 1880 showed that injections of attenuated cultures of the organism of chicken cholera would protect the inoculated fowl against lethal doses of the virulent bacilli. From this observation resulted artificial

immunity, and because the protection is elaborated solely by the action of the tissues of the infected animal the term Active Immunisation was introduced by Ehrlich.

Von Behring in 1890 discovered that the serum of actively immunised animals when transferred to other animals conferred immunity on the latter, and this process is termed Passive Immunity. It differs broadly from active immunity in that the protection afforded is comparatively transient, depending as it does on the actual amount of immune substance introduced.

Active immunisation is the process underlying the whole practice of vaccine therapy, while passive immunisation is exploited in serum therapy. In the interests of clarity active immunity and vaccine therapy will be discussed in the first instance, and passive immunity and serum therapy will be considered later, but it must be understood that in point of time the basic principles and discoveries became available at more or less parallel periods, and though active immunity of necessity precedes passive immunity the principles of serum therapy were comparatively well understood before vaccine therapy was evolved as a general phylactic method.

Active immunity may be produced by the injection of—(1) living virulent bacteria; (2) living attenuated bacteria; (3) killed bacteria; (4) killed bacteria sensitised; (5) bacterial derivatives; and (6) active immunity can also be produced by feeding.

1. The injection of *living virulent bacteria* is accompanied by certain obvious disadvantages, and even where eventually, in order to obtain high degrees of resistance, such a method is advisable, it is usually preceded by the injection of attenuated or killed cultures.

2. *Attenuation of cultures* may be brought about by various means, such as growing bacteria in air or a current of oxygen, by growing them at abnormal temperatures or in the presence of weak antiseptics. The mere subculture of bacteria under laboratory conditions in many cases causes attenuation of virulence, while the passage of an organism through one species of animal usually attenuates its virulence for an animal of another species.

3. *The injection of killed cultures.*—This forms the fundamental process of the practice of vaccine therapy, and is also largely utilised in the production of specific sera for laboratory diagnostic methods, and specific antibacterial sera for the purposes of serum therapy in connection with those diseases in which an antitoxin is not indicated.

4. *The injection of killed sensitised cultures.*—This method was introduced by Besredka as a refinement. The bacteria are treated with an homologous anti-bacterial serum at body temperature. The serum is then separated. The antigenic properties of the vaccine produced are theoretically greatly diminished, in view of which the higher doses of such vaccine which can be given are by some considered to be of doubtful advantage.

5. *The injection of bacterial derivatives—filtrates of cultures—toxins.*—This process constitutes the basis of the manufacture of antitoxins, that is antisera for the treatment of diseases due to those bacteria which are harmful by reason of exotoxins—diphtheria and tetanus.

6. *Active immunity can be produced by feeding.*—Thus Ehrlich immunised

mice against ricin and abrin, and Frazer immunised rabbits against snake venom by feeding. The method, however, has not much practical application, otherwise a spontaneous cure of such a disease as pyorrhœa would be more evident.

Antitoxins.—We come now to the consideration of the immunity produced by the injection of bacterial filtrates to which the name toxins has been given. Injections of toxins call forth the production of anti-substances known by the name of Antitoxins, which figure last in our list of anti-substances; this position, however, is merely for the sake of convenience, for the study of antitoxin formation is particularly important as it was first in the point of time, and it furnished a great proportion of the principles constituting the present knowledge of immunity.

We have seen that bacteria fall into two groups—one which produces exotoxin, the other producing endotoxin. The exotoxin group, small in the point of numbers, comprising the diphtheria and tetanus bacilli, is important in that it furnishes almost the whole of the facts in connection with antitoxin formation.

As the result of the systematic use of diphtheria antitoxin the mortality of that disease has been estimated in a review of 50,000 cases to have decreased by 50 per cent.

For the production of a satisfactory antitoxin a powerful toxin is necessary. Less than 0·01 c.c. should be capable of killing a 250-grammes guinea-pig in 4 or 5 days.

Various methods of raising the virulence of bacteria have been alluded to, and they are brought into application in this connection. Horses have been found the most suitable animals in the process, and they should be sound as regards constitution, and of from 4 to 6 years of age.

Small initial doses of toxin, or toxin mixed with antiseptics or with antitoxin, are used; the doses being gradually increased until at the end of 2 or 3 months more than ten times the original dose may be given.

In favourable cases each cubic centimetre of horse serum may then contain up to 800 units of antitoxin.

A unit of antitoxin is that amount that will save the life of a guinea-pig if injected with 100 units of toxin, while the unit of toxin is that quantity sufficient to kill a guinea-pig of 250 grammes in from 4 to 5 days. Hence a unit of antitoxin is that quantity that suffices to save the life of a guinea-pig injected with 100 minimal lethal doses of toxin.

As antitoxin when evaporated to dryness is comparatively stable compared with toxin, such products form the standard, and are to be obtained from various institutions.

Ordinary antitoxin, however, will retain its potency for a year if kept in a dark, cool place.

Antitoxic sera produce their effects by simple combination with, and neutralisation of, the toxins eliciting them, in which their action differs from that of opsonins and agglutinins, in both of which instances visible and measurable effects are observable.

Much discussion has occurred as to the nature of their union. Ehrlich maintained there was firm chemical union; Arrhenius and Madsen considered the union similar to that of two substances in weak chemical union, a union to some extent reversible; while Bordet considered it was a physical

process, the smaller molecule of toxin becoming, as it were, entangled in the larger molecule of antitoxin. The union has a time factor, as shown by an experiment of Martin and Cherry, who forced toxin and antitoxin through filters under high pressure. At first all the toxin passed through, but after 2 hours no toxin passed, as it was held back by union with the antitoxin.

A great deal of work has also been done in connection with the question of the composition of toxin, but it must suffice to say that toxin represents more than one poisonous substance, and that the proportions vary in different samples. Similarly, the composition of antitoxin has been the subject of much discussion. That antitoxin is not merely altered toxin is certain in that antitoxin may be obtained in an amount many times greater than that of the toxin injected.

Normal horse serum may contain a certain amount of antitoxin to diphtheria, and probably high immunity to toxin represents merely an elaboration of a normal substance and not an entirely fresh product. It is, however, certain that antitoxin is the product of cellular activity.

Antitoxin substance probably belongs to the globulins, and it has been shown that, in general, highly immune sera contain more globulin than normal sera. This, in fact, is the only chemical difference that has been demonstrated between normal and highly immune sera.

Anti-bacterial sera.—In connection with cerebro-spinal meningitis much work has recently been done in reference to anti-meningococcus serum. A horse is injected with killed cultures of mixed strains and with autolysed cultures, and finally with living cultures. The result is an antiserum which contains immune bodies which bind complement, agglutinins and opsonins, and the presence of these substances is made use of in estimating the potency of the serum. There is also probably anti-endotoxin present, as Gordon has described a method of estimating the titre thereof.

As the result of intrathecal injections of the antiserum the meningococci in the cerebro-spinal fluid show a marked decrease, which decrease is thought to be due to increased phagocytosis, as owing to the absence of complement no direct bactericidal action can occur. Anti-meningococcus serum is thus in marked contrast to diphtheria or tetanus antitoxin, in that the effects of the former are chiefly directed against the bacteria and only partly against the endotoxin content of the bacteria.

Extensive use has been made of anti-streptococcal sera. They are prepared by injecting horses with, firstly, killed cultures and subsequently living bacteria. Marmorek increased the virulence of his streptococci by growing them alternately in the peritoneal cavity of a guinea-pig and in a mixture of human blood serum and broth. The potency of the serum was measured by mixing it with a certain quantity of virulent streptococci and injecting the mixture into a rabbit. Marmorek found, however, that the serum had little protective power as against filtrates of cultures.

Such occasional good effects as follow the use of anti-bacterial sera are explained by some authorities as being due to the antigenic action of the streptococcal substance contained in the serum, causing it to function as a vaccine, or to the anti-bacterial substances contained in normal horse serum.

Dysentery antisera which have lately come into use are apparently anti-bacterial and antitoxic.

The Properties of Immune Sera

Von Behring's discovery that the sera of immune animals could passively confer immunity shows that such immune sera contain substances either different from those, or in excess of those, present in normal sera; and in 1894 Pfeiffer showed that if cholera spirilla were injected into the peritoneal cavity of a highly immunised guinea-pig, the bacilli lost motility, became granular and swollen and finally disappeared. This phenomenon became known as Pfeiffer's phenomenon, or Bacteriolysis.

It was then shown by Metchnikoff and Bordet that a similar result occurred *in vitro* in a mixture of heated immune serum and cholera vibrios if, and only if, normal serum be added. As result of these and subsequent researches it was recognised that two substances are present in immune sera, one of which is peculiar to immune and the other common to immune and normal sera. The former, originally called "substance sensibilitrice" (Bordet), is now generally known as *amboceptor* (Ehrlich); while the latter, formerly called alexin by French writers, is now usually known as *complement* (Ehrlich).

It will be recognised from Metchnikoff's and Bordet's experiment alluded to above that the former resists heating, while the latter, destroyed by heating, was again supplied by the addition of normal serum. As a matter of fact, amboceptor resists a temperature of 70° C. for one hour, while complement is destroyed by a temperature of 60° C. for 10 minutes. The amount of complement in any serum is apparently not affected by immunity.

It will also be recognised that the specific change that has occurred in an immune serum is the presence of amboceptor, which can only act in the presence of complement. Amboceptor is specific in that it only acts in connection with the bacterium or inoculating substance which calls it forth (antigen), while complement acts independently and in connection with amboceptor of any kind.

Bacteriolysis also occurs in connection with typhoid immune sera, but many other varieties of bacteria are not subject to it; it can, however, be demonstrated that those organisms, immunity against which is unaccompanied by bacteriolysis, are susceptible to other properties of immune sera.

In connection, however, with bacteriolysis must be mentioned hæmolysis. Bordet in 1898 showed that if an animal be immunised with the serum of another species the serum of the immune animal acquires the property of destroying the red corpuscles of that species. This phenomenon of hæmolysis has become of great importance, as it forms the indicating phenomenon in the complement deviation test of Bordet and Gengou, and of its modification the Wassermann reaction.

Similarly many other cytotoxic sera can be elaborated by injecting emulsions of appropriate cells. Thus Metchnikoff produced a cytotoxic serum capable of destroying spermatozoa, by injecting spermatozoa; and such cytotoxic sera as leucotoxin, neurotoxin and others have been made. Inasmuch as most of them are also hæmolytic, their effects on the homologous organs are difficult of estimation, and their use is not of practical importance.

Agglutinins.—When a small quantity of immune serum is added to an emulsion of the corresponding bacterium, the organisms become agglutinated. If the organisms are motile they simultaneously lose motility. The phenomenon is most familiar in connection with typhoid and paratyphoid fevers, but can be experimentally observed in connection with all immune sera and their corresponding organisms.

In connection with typhoid fever Widal first published the observation that agglutination was observable shortly after infection took place, and increased as the disease progressed according to the degree of immunity achieved.

In practice it is usually sufficiently marked by the tenth day of the disease to enable a positive diagnosis to be made.

The physics of the phenomenon are as yet imperfectly understood. Agglutination occurs in connection with non-motile as well as with motile organisms, though it is most marked in the case of the latter. It also occurs with bacterial substance which is precipitated when the corresponding immune serum is added. A correct salt content of the solutions is necessary for agglutination as shown by Bordet, who resolved clumps of agglutinated bacilli by washing in distilled water and found the bacilli agglutinated again when salt was added.

It has been suggested that some analogous factor to surface tension may be involved.

Agglutinins are not destroyed at 55° C. as are bacteriolysins and opsonins.

Precipitins.—Krause gave the name of precipitin to the substance which produced the precipitate when an immune serum was added to filtrates of bacterial cultures. The phenomenon is closely allied to agglutination, and is by many authorities considered identical. As a method of diagnosis in bacterial infections it is not so useful as agglutination, but it has been highly developed by Nuttall, who has shown that when one animal is highly immunised against the serum of another animal a precipitin is produced in the serum of the former that will cause precipitation in the serum of the latter. With an appropriate rabbit serum highly immunised to human serum minute traces of human serum may be definitely identified.

Opsonins.—These substances have been already referred to in detail (see p. 17).

Anaphylaxis.—When a foreign protein is introduced into an animal hyper-susceptibility may be produced, which hyper-susceptibility can be demonstrated by injecting after the lapse of ten days a further—in itself non-lethal—dose of the protein, when there occurs a condition varying from slight signs of illness ranging through various stages of respiratory distress up to sudden death.

This constitutes anaphylaxis. The condition may be brought about by vegetable as well as animal proteins, and it is said by bacterial proteins. Most study has, however, been directed to the anaphylaxis produced in suitable animals—preferably guinea-pigs—by the serum of an animal of another species.

Originally compelling attention during antitoxin experiments, it was thought to have some connection with the action of the toxin, but it was soon recognised that the reaction had no relationship to the toxin or anti-

toxin content of the serum but was concerned only with the horse serum as being a foreign protein.

The anaphylactic state may be transferred by injecting a second animal with serum from an anaphylactic animal (passive anaphylaxis), and may be transferred from mother to offspring.

It has been claimed that the tuberculin and mallein reactions are anaphylactic phenomena, but it is difficult to understand why such reactions are universal in infected individuals, as it might be expected that desensitisation would be a frequent natural occurrence owing to repeated small doses of bacterial substance. Similarly the phenomena known as serum sickness following the injection of diphtheria antitoxin have been ascribed to anaphylaxis, but many of these cases may be due to a toxic idiopathy to horse serum and not to anaphylaxis.

It is, however, certain that a second injection of antitoxin after a sufficient interval may produce anaphylaxis. In consequence of this the question of desensitisation becomes of great importance. If at some period more than 10 days after an injection of antitoxin it is desired to give a further dose the presence of the anaphylactic state should be negatived. This is done by a skin reaction. A small quantity, say 0·25 c.c., of normal horse serum (or antitoxin) is injected intradermally, or rubbed into a scarified surface. There occurs, if anaphylaxis—or a toxic idiopathy to horse substance—exists an urticarial patch sometimes progressing to a vesicular eruption with a surrounding area of erythema.

This usually occurs within half an hour, but is occasionally delayed. If anaphylaxis be demonstrated the patient should be desensitised. If time be not of paramount importance, 0·025 c.c. of antitoxin is given subcutaneously and the amount is doubled every half an hour. After 1 c.c. has been given subsequent doses are given intravenously until 25 c.c. in all have been administered. If any anaphylactic symptoms occur, longer intervals and more cautious increments are indicated.

JOHN MATTHEWS.
THOMAS HORDER.

IMMUNE THERAPY

(A) GENERAL

NON-SPECIFIC AND SPECIFIC THERAPY

Two sorts of therapeutic measures may be employed in the control of diseases due to microbic infection—(1) measures that can be used to assist the patient's general functions (nervous, circulatory, respiratory, digestive and eliminative) during the extra strain which is being put upon them; and (2) measures that can be attempted in order to give help to the special function, or mechanism, of immunity against the particular infection. Treatment coming under the first of these heads is termed *non-specific*; treatment coming under the second head is termed *specific*. In regard to their degree of relative theoretical importance it is clear that specific measures should take precedence. But in practice dependence in a good many diseases may have to be placed entirely upon non-specific measures because, as yet, specific

measures are not available. The absence of available remedies for immune therapy may depend upon absence of exact knowledge of the causative agent in the disease or, this knowledge not lacking, absence of a sufficiently convincing or potent means of stimulating immunity or of supplying ready-made immune substances.

Whether immune therapy is practicable or not, it is of fundamental importance that no effort be relaxed in regard to the employment of accredited non-specific measures, and the use of these at as early a moment as possible in the disease. It behoves the practitioner to be just as prompt, and to be just as thorough, in the exercise of the various means by which a patient's general resistance to infection can be kept at a high level, as to be prompt and thorough in the use of any specific remedy that may have experience or experiment, or both, to recommend it.

Available Remedies in Immune Therapy

A study of the preceding articles upon infection and immunity will have made clear the methods by which resistance to microbic infection can be helped along specific lines. The actual substances that are available for this purpose, and which are in actual practice to-day, may be summarised as follows:

A. Immune Sera.—(*a*) Antitoxin sera, which act chiefly by neutralisation of exotoxin formed by bacteria in the body. (*b*) Anti-bacterial sera, which act chiefly by destruction of the bacteria and thereby preventing the increase of endotoxin.

B. Bacterial Vaccines, which serve to stimulate the natural mechanism of immunity. — (*a*) Ordinary vaccines. (*b*) "Sensitised" vaccines. (*c*) "Live" vaccines. (*d*) "Phylacogens." (*e*) "Detoxicated" vaccines.

Some general comments will now be made concerning these various substances.

A. (*a*) *Antitoxin sera* remain the most strikingly successful, as they are historically the earliest of all the remedies used in specific therapy; and this applies especially to *anti-diphtheria* serum; less so to *anti-tetanus* serum, but the more limited success of the latter remedy is undoubtedly due to the difficulty entailed by the path of infection of the virus rather than to lack of potency in the serum. Given at the earliest possible moment, given liberally, and given by the intrathecal route as well as by the subcutaneous, the results are frequently very encouraging. Of the prophylactic value of this serum no doubt can be held after the experiences of the Great War.

(*b*) *Anti-bacterial sera* have never yet attained anything like the same degree of success as antitoxin sera. By none of the methods yet employed have these sera been produced with a sufficiently rich content of antibody to lead to any uniformly good results. A difficulty connected with the preparation of these sera is the fact that most of the bacteria against which they are manufactured exist in groups, and a serum prepared against one group is by no means specific in respect of antibody for another group.

The attempt made in the case of streptococci to produce "multivalent" serum to overcome this difficulty has not proved successful. More hope appears to lie along the line of producing univalent sera against the different groups. In the case of streptococcus infections a univalent *S. pyogenes* serum has been available for some years, as the result of suggestions put forward by Andrewes and Horder.

Cole's grouping of the pneumococci, and Gordon's grouping of the meningococci, have quite recently enabled serum manufacturers to produce sera for the different groups of these micro-organisms, and, in the case of the meningococcus, the use of these group-sera may possibly re-establish the reputation which anti-meningococcus serum obtained in the New York epidemic, and which it failed to retain in Great Britain.

Since the introduction of specific inoculation in the treatment of bacterial infections antisera have, with many workers, fallen largely into disuse. The production of "group-sera" may lead to results of so much better value that this type of remedy will be found to be once more in demand.

B. (*a*) *Ordinary vaccines.*—The earliest form of vaccine remains the one in most common use—a simple suspension of the killed microbe in normal salt solution. Most immunologists kill the bacterial elements by heat. Some prefer the system known as autolysis—allowing the micro-organism to undergo auto-digestion in the warm incubator after counting. Others rely upon a sufficiency of some such antiseptic as tricresol, believing that heat interferes with the efficacy of the vaccine. *If we knew exactly what are the initial processes going on in the human body when living microbes invade it we should be better able to decide how best to prepare the cell-element before we inject it in the form of a vaccine.* It seems reasonable to suppose that undue heat, and the presence of chemical agents, are both of them to be avoided if the tissue is to digest the bacterial cell as the preliminary step in the process of active immunisation.

(*b*) "*Sensitised*" *vaccines* ("sero-vaccines") are made by bringing a bacterial emulsion into contact with the appropriate immune serum (*e.g.*, a *Streptococcus pyogenes* is mixed with a univalent *S. pyogenes* serum). The specific antibody in the serum becomes "fixed" by the bacteria, and the combination is termed a sensitised vaccine. There is considerable doubt whether this "sensitisation" of the vaccine actually takes place, and whether, therefore, its therapeutic value is in any way enhanced. Much must depend upon being able to secure a potent serum for the process, and we possess as yet very little guidance as to the amount of antibody present in a serum. The type of case in which sensitised vaccines have seemed to promise good results has been acute and generalised infection, especially by streptococci. The dosage of sensitised vaccines is 10 to 20 times that of the unsensitised material.

(*c*) "*Live*" *vaccine* has been used by Alcock and others; in some cases of gonococcus infection, and in one or two other infections. No special results appear to have been obtained—certainly none which counterbalance the obvious risks that might be run if such a system became generally adopted. The vaccines must be given intravenously, and there are reasons for regarding this route as less serviceable than the more solid tissues for vaccine introduction.

(*d*) The substances termed "*phylacogens*" come next under consideration. In the preparation of these substances the makers have made an effort to prepare the cell-body, which constitutes the essential part of the vaccine material, for easy assimilation by the tissues into which it is injected. This is obviously a move in the right direction. They argue, and pertinently, that valuable time may be lost during these preliminary efforts on the part of the tissues at digesting or disintegrating the bacterial cell-element in order to start the specific interaction that shall result in the formation of antibody. They therefore endeavour, partly by appropriate temperatures and partly by chemical agency, to get the bacterial cell-structure into solution. During this process there is inevitably added to the solution a certain amount of exotoxin, an amount depending, no doubt, upon the nature of the medium in which the bacteria are grown. But as this medium is invariably a fluid one, the amount of exotoxin cannot be negligible. This exotoxin perhaps accounts for the very sharp reaction sometimes seen after the use of this class of remedy. It is possible that some of these reactions are of the nature of "protein shock." On general principles, seeing that the object in view is certainly not to add more exotoxin to the patient's burden, this feature must be regarded as undesirable. To what extent the endotoxin of the bacterial cell goes into solution it is not possible to say, because unfortunately we have no chemical means of measuring this substance; but it seems fairly certain that in the preparation of phylacogens a more successful effort has been made in this direction than hitherto.

No doubt the most valuable constituents in a phylacogen solution are the products of disintegration or autolysis of the cell-body other than endotoxin—substances which are capable of stimulating the formation of antibody possessing specific properties of service in the destruction of living bacteria. It is obvious, therefore, that phylacogens are extremely complex in their composition; they contain a certain amount of exotoxin, some endotoxin, the products of autolysis of the bacterial cell-body, and a little antiseptic. With such a mixture it must be extremely difficult to produce anything like a uniform solution, and it must be equally difficult to decide upon appropriate dosage. But the complication does not end here. There is introduced into the preparation of phylacogens another principle, altogether independent of that which attempts at securing solution of the antigen contained in the body of the bacterium. Considering every infection to be a mixed and not a single one, the manufacturers prepare what is termed a "mixed infection case," a solution in which the above-mentioned ingredients are derived from staphylococci, streptococci, *B. pyocyaneus*, *Diplococcus pneumoniæ*, *B. coli*, *B. diphtheriæ*, and the streptococci associated with rheumatism and erysipelas. Fifty per cent. of this basic phylacogen is added to each of the specific phylacogens during its preparation. Even though the general principle of mixed infections may have much to support it, it seems of doubtful value to load the tissues of a patient suffering, say, from typhoid fever, with toxins of the diphtheria bacillus and *S. erysipelatosus*. Too much has probably been attempted in the hope of producing a substance that will be of general, rather than of particular, service.

(*e*) The most modern of all the remedies of the bacterial vaccine type are the substances termed "*detoxicated*" *vaccines*. It is thought that, with

the endotoxin removed, it may be possible to use much larger doses of the vaccine, and thus obtain proportionately large responses in the way of cell-destroying antibody. If a means has been devised of removing the endotoxin, without at the same time altering the nature of the bacterial cell-substance, which is then left for purposes of inoculation, the antigen produced may be of service. These detoxicated vaccines are on trial, but as yet we cannot judge of their value. It remains to be seen (1) whether it has been possible to effect the segregation attempted, and (2) whether, after all, the endotoxin may not really be an essential ingredient of a specific bacterial vaccine designed to stimulate active immunity; in which case, although it would of course be possible to give much larger doses of the "detoxicated" material without producing undesirable reactions, the practitioner would risk being constantly subminimal in his dosage of the vaccine.

The Choice of the Remedy

It is not always easy to decide as between the use of an appropriate serum or an appropriate vaccine—assuming both of these have proved virtues—in any given case of infection. In acute cases it is a sound practice to begin by the use of a serum and follow this by the use of an autogenous vaccine if obtainable. It should be remembered that sera and vaccines act in quite different ways. Sera act quickly, but their action is soon over. Vaccines act slowly, but their action lasts longer. Sera call for no active response on the part of the patient's tissues. Vaccines stimulate the patient's tissues to the production of specific substances. It is difficult to lay down any general rules, but it may be said, *cæteris paribus*, that if the infection is acute (and) or generalised, and if the patient is very ill, the use of a serum is likely to prove efficacious; whereas if the infection is chronic (and) or local, and the patient is not very ill, the use of a vaccine is likely to be of service.

The Mode of Administration of Immune Sera

(*a*) *By subcutaneous injection.*—This is the method in common use. The best place for reception of the serum is the loose cellular tissue of the flank or lower abdomen. After cleansing the skin by soap and water followed by absolute alcohol or acetone, or after painting it with a little iodine in spirit, the serum is injected very slowly, avoiding as far as possible any jerky movements of the piston. The syringe and needle have been previously boiled, and the phial containing the serum has been warmed to body-heat. In making the injection it is important to make sure that the needle has really entered the subcutaneous tissues and is not still in the deep layer of the skin, which may easily happen if the common practice of pinching up a narrow fold of skin for the purpose of the puncture is followed. It is much better to keep the skin well stretched by means of finger and thumb and to insert the needle boldly into the stretched surface. The patient will be grateful for the choice of a fine rather than a coarse needle,

and one which is either new or freed from all traces of rust before use. In the event of 50 c.c. of serum being given, half of this quantity should be injected on either side.

(*b*) *By intravenous injection.*—This method deserves wider use, especially in cases of very acute and serious infection, and in others in which the use of antiserum has been delayed. The method involves no risk, although it needs care and scrupulous asepsis. The serum is generally diluted before use, with two or three times its bulk of normal saline. In many severe cases intravenous saline solution is itself of service, and when this is thought to be so, the serum may be added to the saline infusion.

The injection is best made into a prominent vein at the ante-cubital fossa, the skin being treated as described in (*a*). When the syringe has been filled with the warm serum, the arm is constricted by a single round of bandage well above the elbow, or an assistant constricts the arm by firm pressure of the hand, so as to render the veins prominent. The patient's arm is fully extended and his hand is tightly clenched. When blood is seen oozing into the barrel of the syringe, the operator knows his needle has entered the vein; the bandage or pressure can now be relaxed and he can now slowly inject the contents of the syringe. If blood does not appear, the needle is withdrawn slightly lest its point may have re-entered the wall of the vein on the opposite side. The serum must not be injected unless it is certain that the point of the needle is in the lumen of the vein. The injection being completed, the needle is quickly withdrawn, the skin being supported by the operator's finger. The patient's arm is then raised at right angles to the body.

(*c*) *Per rectum.*—This method is sometimes used because it is assumed that the subcutaneous route is painful and distressing, or because the resulting serum reaction is not so marked. But neither of these considerations is of such importance as to determine this route if an immune serum is really indicated. If this route should be decided upon, however, the dose of the serum should be diluted with normal saline solution to make the total bulk not less than 100 c.c. The rectum should be cleaned by an ordinary enema of water, prior to the injection of the diluted serum.

(*d*) *Per os.*—There is still less to be said in favour of this route, despite the fact that it has been proved that certain antitoxic sera (*e.g.* diphtheria antitoxin) are capable of exerting their specific effects when given by the mouth. The objections to the method are obvious. If, however, this route is chosen, the serum should be diluted to at least 50 c.c. in bulk, and should be given as far as possible when the stomach is empty.

(*e*) *By intrathecal injection.*—In cerebro-spinal fever, in other cases of meningitic infection and in some cases of tetanus, this is the best route by which to administer serum. Lumbar puncture is first performed in the ordinary manner and an amount of cerebro-spinal fluid at least equal to the amount of serum to be injected is allowed to run off. The serum is then allowed to flow into the lumbar cisterna by gravity from a height of about 9 to 12 inches, or it is injected very slowly by means of an all-glass syringe. If due care be taken to inject very slowly, there appears to be no objection to the former method, despite the claims made for the latter by certain American observers. In either case the serum should be warmed to body-

heat before it is injected. The patient is placed with a slight inclination of the shoulders downwards during the injection, and this inclination may be increased somewhat afterwards, and kept so for an hour or more. In most cases the injection, as the preliminary lumbar puncture, is best done with the patient under general anæsthesia.

Serum Sickness and Anaphylaxis

(*a*) *Serum sickness.*—The use of horse serum, whether normal or immunised, and especially when given by the subcutaneous route, often leads to certain symptoms of a non-specific character on or about the eighth day after the first dose has been administered. These symptoms consist of an urticarial rash, with pruritus which may be very troublesome, mild pyrexia, pain in and swelling of the joints, and some malaise. The urticaria may be concentrated about the site of injection of the serum, or it may be generalised. There may be local or general œdema, but the latter is uncommon ; so, too, are albuminuria and swelling of the lymph glands. In some cases the local urticaria appears much earlier than the eighth day ; it may appear within a few hours of the initial puncture, the more general symptoms showing themselves towards the end of the week. " Serum sickness " is rarely serious. Treatment is by anti-pruritic lotions, such as saturated bicarbonate of soda solution, or dilute carbolic acid (1 : 100), and by aspirin internally. Some observers consider lactate of calcium of service, but the authors' experience of the drug in this condition does not confirm this view of its helpfulness. It may be added that if the joint symptoms precede the rash—a rare event—some difficulty may arise in diagnosis.

(*b*) *Anaphylaxis* (see p. 23).

The Mode of Administration of Vaccines

(*a*) *By subcutaneous injection.*—This is the method of administration in common use ; the site usually chosen is the outer aspect of the arm, about one-third of the distance down from the shoulder to the elbow. But when the patient is in bed, the flank or buttock or infraclavicular region is even better, because the subcutaneous tissues are looser in these regions. It is considered by some authorities that in the case of local lesions, some advantage is to be gained by injecting the vaccine near by, but as to this there are no data of a confirmatory kind available. Before inserting a dose of vaccine the skin is prepared as already described (see p. 28). The same precautions are observed in regard to the syringe and needle. No dressing is required to cover the minute puncture.

(*b*) *By intravenous injection.*—This method has often been employed recently, and its value is still a matter of much debate. It is complicated by the fact that it is liable to lead to the condition termed protein shock, a state of affairs somewhat alarming, induced by the introduction of foreign protein matter into the blood stream. *Protein shock* is in itself capable of exercising a curative action in certain disease-processes, and it may be employed for this reason quite apart from vaccines used for their true

specific effects. It remains to be seen, after much more work has been done in this sphere, how much of the benefit at present ascribed to vaccine therapy is really due to this peculiar reaction.

(*c*) *Per os.*—The oral use of vaccine therapy is open to the same inherent objections as the oral use of serum. But in little children and in patients who cannot overcome their natural antipathy to inoculations, it may be permissible to employ it. As in the case of sera, the vaccine must be brought up to a certain minimum bulk and must be administered when the stomach is empty (see p. 29).

The Immediate Effects of Vaccine Administration

There are three kinds of reaction possible after vaccine administration—*local*, *general*, and *focal*. (*a*) *Local reaction.*—It is only after the use of prophylactic doses of vaccine that a local reaction is likely to appear, *i.e.* when the dose chosen is considerable, as in the preventive treatment of typhoid fever. In curative inoculation it is doubtful if local reactions are of any value in order to get results.

(*b*) *General reaction.*—Here, again, the prophylactic use of vaccines is usually accompanied by this form of reaction, whereas in their curative use, little or no such disturbance is aimed at. After a prophylactic inoculation the temperature may rise to 101° or 102°, and there may be considerable malaise. There may even be a slight rigor. The symptoms subside after 12 hours, and they are usually milder if a second prophylactic dose be given a few days later.

In curative inoculation, provided the scheme of dosage be carefully chosen, general reactions of this character do not occur. After the initial dose there may be slight headache and lassitude, with a rise of temperature to 99° or 99°·5 F., but quite often, if the patient be not apprehensive and therefore anticipating malaise, no disturbance of the general health occurs at all. In acute and generalised infections such small doses of vaccine are usually chosen that no constitutional disturbance results. The degree of the general reaction is probably proportionate to the size of the dose and to the virulence of the bacterial endotoxin. Unfortunately there is at present no standard of virulence of the bacterial endotoxins. Different strains of the same micro-organism differ much in virulence, and a virulent strain is apt to lose its potency, it may be very quickly, on subculture.

For these reasons it is very difficult to anticipate the degree of reaction which a vaccine of known strength as regards the content of bacteria it contains will produce. The principle guiding most workers in practice seems to be that in cases of chronic and local infection a mild but definite reaction is aimed at, but in cases of acute and of general infection no reaction is sought. This mild reaction need not, of course, be produced by the first dose of vaccine; indeed, it is probably better to lead up to it by the use of preliminary doses that do not lead to reaction.

(*c*) *Focal reaction.*—Neither the local nor the general reaction can be said

to be specific in nature. Sometimes, however, a focal reaction occurs—that is, an exacerbation of the inflammatory interaction going on at the seat of the lesion, if such be present. Such a reaction is probably specific, and for this reason deserves very careful observation. There is a growing belief that such focal reactions should not be aimed at, though they are not necessarily prejudicial if they are mild in their degree.

The Prophylactic Use of Vaccines

A good deal of useful exploitation of the principle of preventive inoculation has recently been undertaken. The most promising results have been those obtained in typhoid and paratyphoid fevers. In plague and in cholera the results, though on the whole favourable, have not been so uniformly good. During the recent epidemics of influenza, a good opportunity has been afforded of testing preventive inoculation: the results will be considered later (see Sect. B, under Influenza).

Experiments, by one of the present writers, have demonstrated the fact that rabbits are rendered less susceptible to infection by pyogenic cocci if they are previously inoculated by vaccines derived from these micro-organisms. This fact, and some general experience, makes it probable that patients who are about to be operated upon, and who are the subjects of sub-infection by cocci, especially when the sub-infection involves the area of operation, have something to gain by similar preventive inoculation. Instances of such operations are the removal of the tongue, prostatectomy, and certain operations upon the throat and the gastro-intestinal tract. It is difficult to understand why this field of therapeutics is at present so little cultivated.

It is possible that preventive inoculation of contacts in an epidemic of cerebro-spinal fever may prove to be of service seeing that rabbits have been proved to acquire considerable immunity against the meningococcus after inoculation by the killed coccus (Horder and Gordon).

Cases suitable for Vaccine Treatment

Provided that the employment of a vaccine is not allowed to interfere with any other recognised and helpful method of treatment, and provided the dosage employed be carefully chosen, the actual field of trial may be made very extensive. This may be said without subscribing to the commonly expressed opinion concerning a case in which the use of a vaccine is being discussed, that "if it does no good, at least it does no harm." For it is scarcely credible that any remedy which possesses potentialities for great good is not also possessed of power for harm when misapplied. Two subsidiary points often require consideration in connection with the decision to use vaccines in the treatment of an infective process. the assistance of a thoroughly trained and competent bacteriologist and the supervision of the treatment by an observant practitioner.

No hard and fast rules can be laid down as to which cases are, and which cases are not, suitable for treatment by inoculation. Some authorities will

advise that every case of infection be so treated; others will doubt if the method is indicated with an almost equally sweeping embargo. No doubt wisdom lies, as usual, somewhere between these two extremes. The reader must be warned against confusing certain hypotheses of a purely theoretical kind as to the operation of vaccines with the ascertained facts of clinical medicine. On the other hand, he must also be warned that conclusions based upon prejudice against the method, either from ignorance or from lack of personal acquaintance with it, are equally fallacious. It will be assumed that he is aware of the element of commercialism that has not been slow to creep into the whole subject of specific therapy and threaten to disturb the true indications for its use.

Autogenous and Stock Vaccines

Whenever it is possible to prepare an autogenous vaccine within reasonable time, this should be done, and the use of any other kind of vaccine should be regarded as *faute de mieux*. If the nature of the infection is definitely established it may be advisable to employ a vaccine of a kind known to correspond with the infection, but made from another source, pending the arrival of the autogenous vaccine. Such vaccines prepared in readiness for use in well-established infections are, for convenience, termed "stock" vaccines. With the growing popularity of vaccine therapy the use of stock vaccines has increased enormously, and it is probable that this fact has led to a good deal of the disrepute into which this system of treatment has fallen in some quarters. There are certain circumstances in which the use of stock vaccines is not only justified but obligatory. (1) In most instances where the vaccine is used for prophylactic purposes. (2) In cases where the nature of the infection is certain, but in which the infecting micro-organism cannot be isolated, as in some cases of gonococcal arthritis or of erysipelas. (3) In cases of infection in which the causative microbe grows on artificial media with great slowness, as in tuberculosis, streptothrix infections and simple acne. (Recent methods of facilitating the growth of these micro-organisms render the use of autogenous vaccine less difficult than formerly.) (4) It is good practice to use a stock vaccine of a more virulent strain of micro-organism or of several different strains, if it is found that little or no good follows the use of an autogenous vaccine. (5) The expense of making an autogenous vaccine may be prohibitive.

Dosage of Vaccines

For the choice of dose and for the frequency of vaccine administration, reliance must be placed at present upon a careful study of the clinical condition of the patient and upon a large experience of similar cases already treated by this method. In the concrete suggestions made in the following sections with regard to dosage in the various infections, it is experience that will be taken as the chief guide in the matter, fallacious as this guide is notoriously known to be.

There are several reasons for regarding the opsonic index, though it

may be of value in diagnosis, as an inadequate measure of the degree of total immunity of a patient to the infecting microbe. These reasons cannot well be gone into here. And in any case, whether it is that this opinion is now shared by clinical pathologists generally, whether the hypothesis upon which the opsonic index rested is now regarded as improbable, or whether, as is more likely, a determination of the opsonic index has been found to be unnecessary for the purpose of actual practice, it is certain that, as a technical guide to dosage in vaccine therapy, this system of notation is no longer practised.

Experience has shown that the effective range of dosage, at least as regards the pyogenic cocci, is fairly wide; within this range, though the expert will probably cure more quickly and more pleasantly than will the amateur, by his more judicious choice of dose and time-interval, no bad effect is likely to follow in chronic diseases. In acute and in generalised infections no doubt the range of safety is much less; this only means, however, that in any case of doubt the smaller of two proposed doses should be chosen, at least for the beginning of the treatment.

This experience confirms the results of animal experiments, which prove that, in the case of staphylococcal vaccine, the immunity conferred upon rabbits will be independent of doses varying as much as 100 per cent., and this without any demonstrable ill effect (Horder).

Brief reference should perhaps be made to the variation in the strength of antigen in different preparations of the same vaccine. This seems inevitable in the present state of our knowledge. Different cultures possess different degrees of virulence, according to the nature of the strain of the micro-organism, the particular culture media, etc. These remarks apply in particular to the gonococcus, the pneumococcus, and various strains of streptococci. This fact detracts much from the value of suggested sizes of dose of those and some other vaccines.

There is more agreement, or rather more conformity in practice, in regard to the time-intervals between the inoculations, than there is in regard to the size of the initial dose and the rate of increment. Speaking quite generally, a time-interval of a week to 10 days is the rule of practice in cases of chronic or of subacute infection, and of 48 to 72 hours in acute infections. The increment in the dose is chosen arbitrarily, but the immunisation is guided by the size of the initial dose, by the degree of reaction (if any), by the nature of the infecting agent, and by the clinical condition of the patient. In regard to these two factors (increment of dose and time-interval between the doses) different observers employ different systems. Thus, the successive doses may show the same definite percentage increase throughout the series: 5, 7½, 10, 15, 20, etc. million, or 5, 10, 20, 40, 80, etc. million, or they may be given in pairs of the same size: 5, 5, 10, 10, 20, 20, etc. million. In both cases the same time-interval, would be maintained throughout. The advantage of the latter method, a favourite one with the writers, is that undesirable reactions are more likely to be avoided, and a good comparison is given between the effects of the same individual dose upon the patient's condition at different stages of his disease. Still a third system is sometimes followed: a series of three doses is given at short and regular intervals, with a definite increment (say 100 per cent.) between the doses, a larger interval is then allowed to elapse and a second series of doses is given, the first dose of which is

the same size as the second dose of the first series, and so on. The third system is useful in acute infections, and when large doses of a sensitised vaccine are being used.

The factor of *sex* does not introduce much variation in response to vaccines, but the writers' experience suggests the advisability of choosing somewhat smaller doses in females. *Age* introduces a very definite variation: in children under 6 years the adult dose should be divided by four, and in children between 6 and 12 it should be halved. From 12 to 16 two-thirds of the adult dose should be given.

When there is any considerable difference of practice, the writers have taken the mean position; for where both extremists claim excellent results, and are temperate observers, there should be wisdom in striking an average. The doses are stated tentatively, because they are by no means arbitrary, and they are to be modified in individual cases as seems necessary. Custom is a potent influence in this matter, as in medicine generally, and, though the method of inoculation has long since passed the stage of experiment in its main principles, rules of practice are frequently changing.

Some General Rules in the Use of Vaccines

1. Use every effort to establish an accurate diagnosis, not only in regard to the nature of the infecting micro-organism or micro-organisms, but also in regard to the duration, course and degree of the disease-process.
2. Use only pure cultures in the preparation of the vaccine.
3. Use autogenous vaccines whenever possible.
4. In the case of mixed infections, endeavour to get some close approximation to the actual condition in regard to the chief, as against the secondary, infecting agents.
5. Avoid the use of vaccines that have been subjected to much heat in their preparation, and vaccines that have been kept for a longer period than 6 months.
6. In the treatment of a prolonged case, reconsider the bacteriological diagnosis now and again. There are two reasons for this: the flora may have changed in the meanwhile, thus necessitating the use of an entirely different vaccine; and there are some reasons for thinking that a micro-organism gets "acclimatised" to its corresponding vaccine.
7. Begin by small doses until the patient's response is ascertained; no harm is done if the initial dose is subminimal in its size. It is easy to waste time, but it is difficult to save it, by overdoses.
8. Do not "flog" the patient's immunity mechanism by too rapid repetition of the inoculations.
9. Do not get into a panic, and mistake undue hurry in the preparation and administration of a vaccine in the case of acute infections, for promptness in treatment. Panic may be excusable in the patient's friends, but it is unforgivable in the doctor.
10. On the other hand, do not conclude that a vaccine is useless because a miracle does not follow its initial application. If you decide to try it, the reasons guiding you should be such as to justify a thorough, and not a casual, trial of the remedy. Especially is this important in very chronic

cases in which results may not be apparent until the inoculations have been steadily continued over a lengthy period.

11. If in doubt as to whether a dose of vaccine should be given or deferred, defer it. Intercurrent illness, a long journey, a menstrual period, the anticipation of a fatiguing or exciting time immediately after the inoculation—any of these should lead to postponement of the injection.

12. Relax no single adjunct in the general treatment of the patient because vaccines are being employed. Remember that the immune process is extremely complex in its operation, and therefore that it is open to assistance in many different ways, of which the most important, no doubt, is some form of immune therapy. But non-specific measures are also of importance, especially in the fight against those diseases concerning which, as yet, the measures for increasing specific resistance are in an experimental stage.

13. Know what it is you are trying to do, and, so far as is possible, understand the nature of the material with which you are trying to do it. Control your remedy, do not let it control you.

(B) PARTICULAR

We shall now deal in concrete with the various infectious diseases and infective processes for which there are available remedies in respect of immune therapy. For convenience of reference an alphabetical arrangement will be followed. Stress will be laid upon those infections that are commonly met with in Great Britain.

Anthrax

The best treatment probably consists in simple excision of the pustule and the early use of an immune serum. The extensive surgical procedures that were once in common use are not now in favour. There are two sera in present use, Sclavo's, to be obtained in England from Messrs. Allen & Hanburys, and Mulford's. A liberal dose should be injected subcutaneously, not less than 50 cc., which may be repeated. In very acute cases, and especially if the treatment has been deferred, the initial dose should be given intravenously, following the general rule of practice. Anti-anthrax serum is believed to be "bactericidal" in its action.

Catarrhs, Chronic and Recurring

Treatment, both prophylactic and curative, by means of vaccines, may be adopted for the various forms of recurring sore throat, the common cold, chronic naso-pharyngitis, and chronic or recurring tracheitis and bronchitis. The micro-organisms most often isolated are pneumococci, *M. catarrhalis*, streptococci, and Pfeiffer's bacillus. It is not possible to generalise as to dosage and time intervals where so many varying ætiological factors are concerned. But the results of vaccine treatment in this group, though

by no means uniformly good, are sufficiently encouraging to justify thorough trial, especially when other methods (non-specific) fail to relieve the patient.

Cerebro-spinal Fever (and Meningococcus Infection generally)

Much work has been done in recent years in connection with anti-meningococcus sera. At first the results were disappointing; then a serum prepared by Flexner against the strain of meningococcus present in the New York epidemic appeared to have good results; then this serum, and others, seemed to fail conspicuously in a large number of the cases occurring in Great Britain in 1914–1916. The experience of the epidemic in this country led Gordon to group the meningococci responsible for the cases; and for Gordon's four types of the coccus, corresponding sera have been manufactured and are on trial. In the case of anti-meningococcus serum, *which must be given intrathecally*, it is difficult to say how much of any benefit that follows its injection is due to the action of the serum and how much is due to the attendant drainage effected by the lumbar puncture. The usual dose of serum is from 20 to 50 cc., according to the severity of the case, and according also to the amount of cerebro-spinal fluid allowed to drain off at the time of the puncture. (Rather less serum must be run into the theca than the amount withdrawn.) The technique is referred to in the article on Cerebro-spinal Fever. The serum is repeated from time to time according to the progress of the case. If good results are not obtained, it is wise to change the serum for another brand.

Meningococcus septicæmia is treated by a full dose of the serum given intravenously—not injecting less than 50 c.c.

Meningococcus arthritis is treated by serum subcutaneously, and may also be treated by injections of the serum into the affected joints.

Coliform Infections[1] ("*B. coli*" Infections)

Anti-colon bacillus sera have given but little evidence of value as therapeutic agents. Coliform vaccines are, however, of definite service in a large number of these infections. In the experience of many, their efficacy ranks next to that of staphylococcus vaccine.

The great number of different coliform infections that are met with makes it imperative to deal with autogenous vaccine if any degree of success is to be expected.

1. *Infections of the urinary tract.*—Opinion varies much as regards the results of vaccine therapy in these cases. The diversity of experience may find an explanation in the fact that the cases are of such divers sorts. (See p. 79, *Bacillus coli* Infections.) There seems no doubt, however, that the method is a very useful adjunct to general and local measures in certain cases, constitutional symptoms being relieved, dysuria reduced, and pus in the urine much lessened in amount. In true *Bacilluria* the same good results must not be expected as in states of infection.

The most common system of dosage is to begin with 5 million bacilli,

[1] *I.e.* infections by bacilli of the coliform group.

in order to test the patient's tolerance, increase to 10 million a week later, and gradually increase farther up to 100 or 250 million, maintaining the time-interval at 7 to 10 days throughout. Whenever the treatment is carried out over a lengthy period it is important to secure a fresh culture from the urine from time to time for the purpose of making a new vaccine.

Prophylactic treatment by coliform vaccine may be advisedly resorted to before the operation of prostatectomy, should this procedure be decided upon in the presence of an infected urine.

2. *Post-operative suppuration* is frequently due to coliform infection, with or without infection by the pyogenic cocci: a common instance is appendix operation during or after abscess formation. The question of inoculation should arise in any such case if convalescence, or healing, be delayed. Some gall-bladder operations call for the same comment.

The dose of vaccine, whether "pure" or "mixed," should be small, at least at first—5 to 10 million coliform bacilli, the same number of streptococci (assuming the infection to be by *S. fæcalis*), and 50 to 100 million staphylococci. The frequency of dose, and its subsequent increase, are determined by the clinical features of the particular patient.

3. In "*colitis*," careful consideration must be given to the question of an exact diagnosis, if at all possible. Thus, it must never be assumed, as it not seldom is, that any unselected case of colon infection is of necessity coliform: the contrary is quite frequently the fact: cases of ulcerating colitis are quite often associated more nearly with streptococcal than with coliform infection. Then, again, considerable care should be shown in the choice of the colonies from the culture plates obtained by the examination of the fæces, so as to work with any coliform strain which may be found to be atypical.

For this reason the help of a skilled bacteriologist is quite essential. To use "stock" vaccines is to invite failure. As may be expected, the results will turn very largely upon the degree to which the infective element is dominant ætiologically. In the muco-membranous type of case (C. nervosa) treatment by vaccine is not likely to avail much. The dosage of vaccine may well follow the rough indications set out above.

A very important type of case is that in which there is evidence that both urinary and intestinal tracts are infected; these cases amply repay the practitioner for careful study in conjunction with an expert bacteriologist.

Diphtheria

This infection is treated wholly by serum; specific inoculation is not indicated, so successful is the serum treatment. The serum is an antitoxin serum. For success in its use two considerations are necessary: it must be given early in the disease, and it must be given in sufficiently large doses. It has been shown by careful observers that the mortality from the disease rises steadily day by day during the first week of the disease with each day's delay in the use of the serum. Delay in diagnosis, or in use of the serum, can be to some extent, but not altogether, made up by administering a larger dose than would otherwise be necessary.

In a mild case, and if the serum be given early, not later than the second day of the disease, 5000 units will probably suffice. If treatment begins only on the fourth day, 10,000 units should be given, in two successive doses at an interval of 12 hours. *If the case is a severe one,* or if there are laryngeal symptoms, these doses must be increased, respectively, to 10,000 and 20,000 units *for the initial dose*, and these doses must be repeated once or twice during the course of the disease if this is unfavourable.

Neither *age* nor *sex* should affect the size of dose of antitoxin. In any case which is clinically doubtful, the serum should be given before awaiting the bacteriologist's report. It should be remembered that a stained film of the exudate may give considerable presumptive evidence of diphtheria before a report can be obtained on the cultures.

The antitoxin is usually given by the subcutaneous route (see p. 28). A dose may well be given intravenously if the serum be administered late or if the case be very severe.

The type of the disease is quite immaterial to the success of the remedy; all varieties of infection by the Klebs-Loeffler bacillus—even skin infections—indicate the use of the serum.

Diphtheria antitoxin is of service as a prophylactic, in doses of 1000 or 2000 units. The protection thus conferred does not, however, last many weeks. Some workers prefer inoculation by one or two doses of 50 million diphtheria bacilli as a method of achieving prophylaxis.

For serum rashes and other immediate effects, see p. 30.

For immunisation by the Schick method, see p. 101.

Gonococcus Infections

At the present time there is no gonococcus serum possessing sufficient potency to justify its use; immune therapy in this infection is achieved entirely by gonococcus vaccine.

Reference has already been made to the varying virulence of different strains of gonococci. Whenever possible, therefore, it is important to employ the actual strain of gonococcus causing the infection in preparing the vaccine. It is also very important to prepare the vaccine from the first subculture at latest, so quickly does this micro-organism lose its virulence on artificial media. But in a large number of cases of gonococcus infection an autogenous vaccine is out of the question, and it is necessary to fall back upon "stock" preparations. A stock gonococcus vaccine should be made from recent cultures of several strains of gonococci. Such a vaccine can usually be obtained from pathological institutes on whose staff is a skilled bacteriologist interested in vaccine therapy.

Acute urethritis, acute vaginitis and cervicitis.—If it be decided to help the local treatment in those diseases by the use of vaccines, small doses (1 to 5 million) are given every 3 to 5 days. But such treatment is not usually given, reliance being placed entirely upon local measures.

Chronic urethritis, vaginitis, cervicitis; gleet.—Here, again, local measures form the customary rule of practice. But vaccines are of more service here than in the last-named group of diseases. Ten to fifty million cocci may be

given every 5 to 10 days. Due attention must, of course, be paid to mixed infections (*e.g.* by staphylococci).

Gonococcus arthritis (*gonorrhœal rheumatism*).—Following a general rule, that vaccines are of greater service in those infections in which there are constitutional symptoms than in those in which the whole manifestations are local, it is found that vaccines are of more help in this condition than in either of those formerly mentioned. If the case be acute, the dose should be small—1 to 5 million cocci given at intervals of 3 to 5 days. If the case be subacute, doses of 5 to 10 million cocci may be used, at about the same intervals. In chronic cases 10 to 20 million cocci form an appropriate initial dose, and this may often be increased with advantage : 50, 100, and 250 million cocci at weekly intervals. Good results sometimes follow doses of 400 or 500 cocci, when the fibrositis is of some duration and is very chronic. Some workers have used doses as large as 1000 million, and have reported good effects ; but it is probable that they have been using stock vaccine prepared from cocci whose virulence is very low. In some instances living cocci have been injected intravenously (Broughton-Alcock).

Acute iritis.—This condition calls for considerable caution if vaccines be employed : 0·5 to 1 million should be tried tentatively. It may even be wise to allow the acute attack to subside before giving any vaccine at all, and then to treat by small and graduated doses so as to check the relapses of this condition which are so prominent a feature of the disease.

Influenza

At the time of writing this article the whole subject of the pathogenesis of influenza is under discussion. The simple view that influenza is a specific entity, and that it is essentially due to infection by Pfeiffer's bacillus, can scarcely be maintained in the light of the great body of experience afforded by the pandemic of 1918–19. It seems probable that the initial causative agent is at present unknown, or certainly unisolated (but see article on Influenza, p. 123), and that the flora hitherto dealt with, even in the cases of the disease succumbing rapidly, do but cover the secondary invaders of tissues that have become highly predisposed to infection. These secondary infections are *B. pfeiffer*, the pneumoccocus, streptococci and *M. catarrhalis* chiefly, though other micro-organisms, such as staphylococci, must be added to the group.

It seems certain that uncomplicated cases of the disease are either very mild or very severe, and that intermediate cases are so much the subjects of secondary infection that this fact must be taken into account in any consideration of specific therapy. If this view be correct, it does not follow that vaccines at present obtainable may not affect the primary incidence of the disease ; because it is possible that the primary infection may not occur, or may abort early, if the resistance to these secondary infections has been raised. Such a possibility gains credence from the known fact that certain micro-organisms may multiply much more rapidly, or may not multiply at all, in close association with other micro-

organisms (Symbiosis). Whether this affects the present question or not, it remains true that so many of the serious, not to say lethal, processes taking place in the course of the disease are intimately connected with (? are due to) the secondary infections, that it is highly desirable to employ vaccines in both the prophylactic and the curative treatment of the disease.

For the prophylactic treatment the "War Office formula" advises two doses of vaccine, to be given with an interval of 10 days. The composition of the first dose is: *B. pfeiffer*, 30 million; pneumococci, 100 million; streptococci, 40 million. The second dose is to be exactly double the size of the first. Matthews and Horder both comment on the small proportion of the *B. pfeiffer* constituent in this formula, and urge that this should be much larger, such as 100 to 200 million for the first dose, and double this amount for the second dose. These increased figures assume that the bacillus is grown upon Matthews' trypsinized blood medium. Emery criticises the formula in that it contains no *M. catarrhalis*, which, as he points out, certainly occurs in vast numbers in the lungs of some of the fatal cases, and is undoubtedly a secondary infection of considerable importance. W. H. Wynn suggests that the content of pneumococci is too small. In face of these conflicting views it is not surprising to find a large number of different formulæ available, and the practitioner is not a little bewildered in consequence.

For curative treatment in influenza the present position is even more lacking in uniformity of practice than it is in regard to prophylaxis. The writers cannot do better than quote Emery's summary of these conflicting opinions (*Practitioner*, February 1919). "In severe cases of broncho-pneumonia they (*i.e.* the War Office committee) express the opinion that the use of the prophylactic vaccine cannot be recommended in view of the dangerous rapidity and severity of these cases, but when it is tried they suggest that the initial dose should not exceed one-twentieth of the first dose described above, *i.e.*, 1½ million *B. influenzæ*, 5 million pneumococci, and 2 million streptococci. Many bacteriologists hold that it is especially in these acute cases of broncho-pneumonia that the use of vaccines is most strongly indicated, always assuming that the treatment can be begun early. Thus Wynn urges the immediate treatment of influenza by giving adequate doses within a few hours of the onset; the dose that he suggests is 50 million pneumococci, 50 million streptococci, and 30 million *B. influenzæ*—how cultivated is not stated. This probably represents the best we can do for the patients, and there seems to be sufficient evidence available to justify us in the belief that patients who have had a dose of vaccine at the very beginning of the attack usually escape without severe symptoms." With this summary of Emery's, the writers agree in the main. The cases differ so notoriously in the particular course they run, and the flora is so extraordinarily variable, that the writers prefer not to continue with the formula above set out, but rather to vary it according to the investigation made in individual cases. Nor does this often require the labour and the time spent in cultural examinations: a rapid survey of films made from the sputa will again and again give very valuable indications for a formula adapted to the particular case. Emery notes the importance of this point also.

Pneumococcus Infections

Up to the present time the results of the use of anti-pneumococcus serum have been even more disappointing than has been the case with anti-streptococcus serum. But an attempt has been made to "group" the pathogenic pneumococci, and corresponding group sera have been prepared (Rufus Cole) which may give better results. Vaccines are a more popular remedy at the moment, either used as "naked" vaccines, or as sensitised vaccines.

1. *Pneumonia.*—Opinions differ, or practice differs, in regard to the utility of vaccines in the treatment of pneumonia. There is general agreement that if inoculation is to be employed, it should be during the early stage of the disease, before massive consolidation has occurred. If this stage has been reached, it is better to defer inoculation treatment until such period as "delayed resolution" occurs, or the non-advent of a crisis by the tenth day.

The vaccine used should be autogenous if practicable, the pneumococcus being obtained either from the sputa or by lung puncture. But as it is obvious that inoculation during the first 48 hours of the disease cannot be done by the use of autogenous vaccine, the immunisation must be effected at this period by the use of "stock" vaccine. A dose of 5 million cocci may be given as early as the disease is diagnosed, 10 million on the next day, and 25 million on the day following. Some observers give an initial dose of 50 million cocci, and do no more. At the later stage (crisis delayed) the doses should be of the same size.

2. *Broncho-pneumonia.*—The results of vaccine treatment are better here than in lobar pneumonia, probably because recrudescences and relapses are much more common, and may be prevented by this treatment. The patient is generally a child, and the doses should be 2, 3, 4 and 5 million, with intervals of 3 or 4 days.

3. *Empyema.*—Drainage being satisfactorily established, the closing of the sinus may be assisted by the use of 10 to 50 million pneumococci in weekly doses.

4. *Bronchitis; asthma; infections of the upper air passages.*—In this series of diseases, vaccines are often very useful adjuncts to measures of a more general kind. Success turns largely upon the degree to which the infection is "pure" and not "mixed." The course of the disease process is usually chronic, and for this reason larger doses of vaccine may be given (*e.g.* 10 to 500 million at weekly intervals), and should be maintained over a long period of time. (See also Catarrhal Infections.)

5. *Pneumococcus septicæmia and pyæmia.*—The principles and details of treatment are the same as in generalised streptococcus infections (see p. 44).

Staphylococcus Infections

The immune treatment of staphylococcus infections is entirely by vaccine. This is due to two reasons. Vaccines have been more successful in these infections than in any others; and no staphylococcus serum of any potency in bactericidal substances has as yet been produced.

1. *Chronic local infections.*—These consist of boils, carbuncles, pustular

acne, onychia, sycosis, otitis media (sometimes), eczema (sometimes), ciliary blepharitis, suppurating Meibomian cyst and certain discharging sinuses. Furunculosis and certain other staphylococcal infections were the first to be treated systematically by Wright's method of specific inoculation, and, as a class, these infections yield, with care, almost uniformly good results. It may certainly be said that it is uncommon to get an instance of complete failure to respond to vaccine treatment.

A guarded prognosis must, however, be given in connection with each of the other forms of staphylococcus infection. And in all the cases care must be exercised to see that the general points in treatment are receiving attention. If these be omitted, failures will frequently be met with in those cases in which the infective factor is not very dominant. In acne, for example, it is unlikely that vaccines alone will effect a cure if local measures be omitted. Here, as always, the inoculations must be regarded as adjuncts to the general programme of treatment, not as a substitute for it.

In the case of suppurating wounds or sinuses, vaccine treatment should never be expected to take the place of efficient drainage, which must in all cases be secured in the first instance.

In the matter of *dosage* there is still considerable difference of opinion and of practice. And yet the results are, as already stated, very good upon the whole: an illustration of the fact, mentioned in the general section of this article, that there is a considerable range of effective dosage with most vaccines. Some workers still use the comparatively small doses which followed as a sort of reaction to the quite large doses that were originally given, but most agree in using a dose of 1000 million in beginning the treatment of a straightforward case. If improvement follows, this is succeeded by doses of 250 to 300 million with intervals of 8 to 10 days. Relapses are quite common, and require a good deal of careful management. Either the doses are not sufficiently large, or the inoculations are repeated too frequently. Each case must be considered on its merits. In the experience of the writers there is often a tendency to stop the treatment too early. It is often of value to "space" the doses more widely as the treatment proceeds.

In the treatment of acne a similar plan may be followed. Some workers use a mixed vaccine of staphylococcus and the "acne bacillus," and record better results (A. Fleming). In sycosis the response to these doses is only satisfactory if the case is treated early. If it is of some standing, and much induration is present, the vaccine should be tentatively increased to 2000, 5000, and even to 8000 million cocci. The same rule applies to many cases of chronic acne. Once more let it be urged that it is courting disappointment to neglect necessary methods of treatment when dealing with these chronic skin infections.

It has become customary to employ stock vaccines in the treatment of furunculosis and other staphylococcus infections, and, as staphylococci appear to differ little in the matter of strains, the success of this convention justifies the practice. If, however, success is not attending the treatment, an autogenous vaccine should in all cases be obtained. This is perhaps more important if the infection is due to *S. aureus* than if to *S. albus*.

2. *Acute local infections.*—A single dose of vaccine certainly tends to cause an acute boil or carbuncle to abort, but it should be administered early to secure this effect. The dose chosen is usually 1000 million of mixed staphylococci. Care must, of course, be taken to give no dose of this size in the presence of any constitutional symptoms which may indicate a general infection. But a general infection may quite probably be avoided by the above-mentioned prompt treatment. In the case of boils of the external auditory meatus and other very painful situations, the more rapid development and consequent resolution of the lesion following administration of a vaccine are of considerable advantage.

Poisoned fingers and acute abscesses due to staphylococcus infection require much smaller doses. They are best treated by (say) 50 to 100 million cocci, with 3 or 4 days' interval.

3. *Chronic general infections.*—In chronic staphylococcus pyæmia vaccine therapy is disappointing. But trial should be made of 50 to 100 million of an autogenous vaccine every 4 to 7 days, omitting the inoculation just prior to, or just after, any surgical procedure, such as the evacuation of an abscess. If there is no good result these doses may be gradually increased.

4. *Acute general infections; osteomyelitis.*—In this condition, as, indeed, in many other acute staphylococcal infections, prompt surgical treatment must be always undertaken. So soon as this is done, or rather, so soon as the culture has been taken, the micro-organism grown and the vaccine prepared—these things occupying the time during which the patient's auto-inoculation from the surgical procedure is making the introduction of fresh antigen necessary—a dose of 25 to 50 million cocci is given. The same dose is repeated in (say) 2 to 3 days, and is perhaps gradually repeated, the clinical condition being carefully watched meanwhile. A case of this kind in which progress hangs fire will sometimes mend rapidly under vaccine treatment.

Streptococcus Infections

Both immune sera and autogenous vaccines are appropriate in the treatment of streptococcal infections: no fast and hard rule can be given in regard to the choice of serum or vaccines: it is a good general rule of practice to treat acute and (or) generalised infections by serum and to treat chronic and (or) local infections by vaccines. In acute cases the serum can, of course, be followed up by vaccine, and this sequence is to be recommended.

The method of using a sensitised vaccine, immediately upon the serum administration, is held by some to be the best method of procedure, but see p. 26. In a chronic case recourse may be had straightway to vaccines.

If the infection is due to *S. pyogenes* vel *S. hæmolyticus*, which it usually is in very acute infections, a univalent pyogenes serum, such as is made by Messrs. Burroughs Wellcome & Co., offers the best hopes of success (Andrewes and Horder).

If, however, the infecting coccus is of the salivary or faecal type (vel *S. viridans*), a "polyvalent" serum may be chosen. If a sensitised vaccine be used, the homologous serum should be used in making it. The chief kinds of streptococcus infection will now be dealt with in more detail.

1. *Arthritis, fibrositis, and allied conditions*, when traceable to streptococcus infection, are attributable to streptococci of feeble virulence. The dosage of vaccine, with the appropriate time-intervals, calls for detailed consideration and some general comments.

In embarking on the treatment by vaccine therapy of infective arthritis, it has to be realised that such treatment will be brief or long according to the time the lesions have existed. In this connection, moreover, it should be borne in mind that even if the lesions are not of long standing, the toxæmia leading to those lesions may be of much longer standing than at first suspected.

Recent cases of infective arthritis only rarely present themselves for treatment, but there should be an increasing tendency in this direction. Such cases will often show definite improvement after the first dose of vaccine; and if the joints involved are the knees, a definite decrease in swelling may be noted.

If well-marked "rheumatoid" changes are present, treatment may have to be carried on for as much as two years, if not more. It is as well in making plans for such lengthy treatment to prepare the vaccine accordingly. This can, as a rule, be arranged for by making two concentrations of vaccine, one concentration being ten times the strength of the other.

The authors recommend that the vaccine be made in two strengths, the weaker strength of a total concentration of 100 millions of streptococci per cubic centimetre, and the stronger one of a strength of 1000 millions per cubic centimetre.

For instance, if a combination of a salivary and an intestinal streptococcus be decided on, two bottles of vaccine are prepared as follows:

1. 25 c.c. Containing per c.c. 100 $\begin{Bmatrix}50\\50\end{Bmatrix}$ millions $\begin{Bmatrix}\text{salivary}\\\text{intestinal}\end{Bmatrix}$ streptococci.

2. 25 c.c. Containing per c.c. 1000 $\begin{Bmatrix}500\\500\end{Bmatrix}$ millions $\begin{Bmatrix}\text{salivary}\\\text{intestinal}\end{Bmatrix}$ streptococci.

In the course of treatment a stage is arrived at when 1 c.c. of the former strength is being used. The former bottle is then discarded and an equivalent dose is provided by using 0·1 c.c. of the stronger concentration. This latter bottle usually provides for all possible requirements.

The actual treatment varies in different cases. Roughly speaking, 0·1 c.c. of the weaker concentration (*i.e.* 5 millions of each variety of streptococcus in the case exemplified) usually constitutes an initial dose, and frequently weekly doses increasing by 0·05 per week may be given until a dose of 0·25 c.c. be achieved. Then such doses as 0·35 and 0·5 c.c. may be appropriate. It may then be advisable to prolong the interval between doses to 10 days, and with

such intervals 0·75 and 1 c.c. may be given. With intervals of a fortnight, further doses of 0·15, 0·2, 0·25 c.c. of the stronger vaccine, and with longer intervals still increasing doses.

The guide to the increase of the dose is solely the reaction or absence of reaction caused by the preceding dose. So long as any reaction—increase of pain, malaise, etc., lasting more than 12 hours—follows any dose, we consider that dose a maximum one, and repeat it until it fails to cause such reaction.

The result of such treatment in many cases is in the first instance a remission of symptoms of the toxæmia accompanying the arthritis. The symptoms in question are: depression, which may be very marked, loss of application, energy and joy in life, and an increasing inability to carry out the ordinary avocations, apart from the handicap imposed by the actual deformities of the disease.

The dread of increasing disability owing to arthritic deformity is replaced by a conviction of eventual cure, in a large proportion of cases, after comparatively few doses of vaccine, and this despite the fact that not rarely no actual diminution of pain may have occurred. In some cases, indeed, perhaps owing to absorption of fluid from joints, the pain becomes actually increased, and yet the patient acclaims benefit.

It is also to be noted that after a variable number of doses of vaccine various forms of local treatment, which may have been tried formerly with only temporary beneficial results, now tend to produce more permanent results.

2. *Cellulitis and acute abscess formation.*—A similar line of treatment may be adopted as is described for *Erysipelas*.

3. *Erysipelas.*—The infection is by *S. pyogenes*. Begin by giving 50 c.c. of univalent pyogenes serum intravenously (see p. 29), and follow this at once by very small doses of vaccine, preferably autogenous, such as 2 to 5 million cocci, on alternate days, for 4 to 6 doses. The serum may be repeated on two to four occasions at intervals of 24 hours, concurrently with the vaccine.

4. *Pyorrhœa alveolaris.*—The material from which the vaccine is prepared is to be taken from the depths of the pockets in the gum, or, better still, from the apex of an extracted tooth, if this be available, and not from the pus lying about the neck of a tooth, which is always the nidus of secondary infections, erroneously thought to be causative of the condition. The initial dose may well be 5 million cocci, followed at intervals of 7 to 10 days by gradually increasing doses: 10, 25, 50, and 100 million cocci. Even larger doses may be profitably given should no "reactions" occur. This treatment is only to be advised when, after conference with a dentist, it is decided not to extract the affected teeth, or only to sacrifice the worst of them.

5. *Septicæmia and pyæmia; puerperal fever; infective endocarditis.*—The treatment recommended, in so far as a general plan can be laid down, is to administer a large dose of serum, intravenously in very acute cases, subcutaneously in others, and repeat the serum in smaller amount daily, or on alternate days, for 4 to 6 doses, or more. The initial dose in very acute cases should not be less than 100 c.c. As soon as an autogenous vaccine can be procured, a very small dose is given, such as 0·5 million cocci, and this is

gradually increased to 2 to 5 million by inoculation about every third or fourth day. In cases of puerperal fever, however, and in some other instances, such as septicæmia following operations on the bowel, etc., the streptococcus isolated from the uterus or from the blood stream is often *S. fæcalis*, and as this type of streptococcus is usually much less virulent than *S. pyogenes*, the practitioner may give larger dozes of vaccine, such as 50 million cocci. According to Gordon and others, better results follow the use of sensitised vaccine.

In cases of *infective endocarditis* very little good is to be expected from any mode of immune therapy, whether by sera or by vaccines. Nor can much, if anything, be said for sensitised vaccines in this disease. Some of the cases run a prolonged course, and therefore give opportunity for obtaining a human immune serum for purposes of preparing the sensitised vaccine (Horder). See also Infective Endocarditis (p. 832).

Tetanus

Next to diphtheria, tetanus is the infection in which the employment of immune serum yields the most marked degree of immunity. Owing to the great difficulty of diagnosing this infection by bacteriological examination of the local lesion, the constitutional effects of the poison cannot often, therefore, be anticipated. By the time the disease is manifest, much of the toxin is already "fixed" in the central nervous system, and the results of treatment by antitoxin are of necessity often unsatisfactory. A certain number of cases have, however, definitely begun to improve after use of the serum, especially when its administration has been prompt.

The best route by which to give the antitoxin is still a matter of debate. Some authorities advise intrathecal and intracerebral injections of the serum, so as to try to neutralise the toxin in the nerve structures. A reasonable method of treatment is to inject 500 units of antitoxin by lumbar puncture immediately the diagnosis is made and 1000 units subcutaneously. These injections may be repeated daily for 4 to 6 days.

The *prophylactic* use of tetanus antitoxin has proved quite as successful as its use for curative purposes has been disappointing, and there is little doubt that the case-incidence of the disease was much diminished by the employment of "A.T.S." during the Great War, and that therefore a large number of lives were indirectly saved. The preventive dose of the serum is 500 units, given on four occasions at intervals of one week, subcutaneously.

Tuberculosis

A serum introduced by Marmorek has had considerable trial, but there seems little reason for regarding it as a serious contribution to the therapeutics of this infection. Nor can much more be said, in the opinion of the majority of observers, for the various forms of "tuberculin" that have been exploited very fully during the past few years. Be this as it may, there is very much less tuberculin therapy now being practised than was the case even ten

years ago. There are three types of tubercle antigen available for inoculation purposes—(*a*) *Tuberculin* (several varieties—Koch's, Denys', Beraneck's), an extract of the bacillus with or without its toxins; (*b*) *Bacillary emulsion*, a bacterial vaccine, and made like microbic vaccines generally; and (*c*) *Sero-vaccine*, a sensitised vaccine made like the sensitised vaccines described on p. 26. The bacillary emulsion is perhaps the favourite form of the remedy. Until quite recently, however, the "vaccine" in common use was Koch's tuberculin T.R. (*T. ruckstand*, "new tuberculin").

Omitting the views of enthusiasts, it is generally agreed that there are certain cases of tuberculosis in which tuberculin treatment is inadvisable—those who are markedly febrile, and especially when the pyrexia shows considerable fluctuations; those who have only just come under observation; and those who cannot remain under skilled observation during the treatment. It is also generally agreed that the most favourable cases for treatment are those in which retrogressive *changes have already begun in the infected tissues*. But to say this is equivalent to saying that the case is, as a rule, already improving, and that therefore the tuberculin may get credit which really belongs to time, the patient's natural resources, and whatever non-specific measures are also being employed.

To administer some form of tuberculin to desperate cases—desperate from the advanced state of the patient's infection, or from the generalised or fulminating character of the disease-process—can only be justified on the ground that it possesses psychic value for the patient's friends, and perhaps *assists euthanasia*.

Perhaps the best types of case to choose for the method are lupus, adenitis, lesions of bones and joints, and tuberculosis of the urinary tract.

There is very great diversity of opinion as regards *dosage*, both in relation to the size of the injection and the frequency of its administration. Most practitioners steer their course between the heroic doses recommended by certain enthusiasts and the minute doses of another school and no doubt thereby show greater wisdom. If there be nothing about the case to indicate more than the ordinary caution, a common dose to begin with is $\frac{1}{20000}$ mgr. (T.R.), and this dose may be given at weekly intervals for 4 to 6 doses. A second series of doses of strength $\frac{1}{10000}$ mgr. may follow; then a third series of $\frac{1}{5000}$, and so on, until $\frac{1}{100}$ mgr. is reached, beyond which dose it is not advisable to proceed. "Reactions" are not to be aimed at, whether general or focal. If either occurs, the next dose should not be increased, and the time-interval may be increased a little. These remarks apply to the usual—subcutaneous—route, the oral use of the antigen having nothing to recommend it.

Typhoid and Paratyphoid Fever

There is no antiserum at present available for which any good claim has been established, despite the sometime use of one in France, introduced by Chantemesse. Vaccine may be used for curative purposes either as a routine, or because the case is tedious in its course. The vaccine should be specially made for each patient, and should, by preference, be autogenous. Sensitised

typhoid vaccine has also been used. There does not yet appear to be good evidence that curative vaccine influences materially the course or the mortality of the disease. As regards dosage, here too there is considerable latitude in choice; some observers give small doses, *e.g.* 10 million bacilli on alternate days for 6 doses, to be repeated after an interval of (say) 1 week; others give doses as large as 100 to 200 million bacilli, and repeat them after 7 to 10 days' interval. This lack of uniformity in practice is probably due to too little consideration being given to the stage of the disease-process at which the treatment is tried.

The *prophylactic treatment* of typhoid fever by typhoid vaccine has been definitely proved to be successful, if reliance may be placed upon the recently published Army statistics. There is abundant evidence that the immunity conferred, though relative rather than absolute, is definite, and that it lasts certainly for a couple of years. If the vaccine be given in two doses, with an interval of 4 or 5 days, both the local and the general reaction are considerably diminished. The vaccine is usually made up to include *B. typhosus*, *B. paratyphosus* A, and *B. paratyphosus* B. The actual composition of the vaccines to be obtained from stock varies somewhat, but most of them contain 1000 million (mixed) bacilli in the first dose, and 2000 million bacilli in the second dose. The vaccine should be freshly prepared, and several different strains of bacilli should be utilised in their manufacture.

THOMAS HORDER.
JOHN MATTHEWS.

SECTION II

GENERAL INFECTIOUS DISEASES

A. BACTERIAL DISEASES

TOXÆMIA; SEPTICÆMIA; PYÆMIA

THE main results of the invasion and infection of the body by micro-organisms are discussed in the section upon infection and immunity. It is important to distinguish clearly between "invasion," "infection" and "intoxication," and the reader is referred to the section mentioned for the consideration of these several processes. The present article deals more particularly with the clinical and clinico-pathological effects of infection by the so-called pyogenic micro-organisms.

I. TOXÆMIA

This term is applied to the condition of a patient who is absorbing into the tissues and circulation toxins elaborated at some local site of microbic infection. The diseases caused by the specific microbes of diphtheria and tetanus are examples of toxæmia, the sites of infection being in the former disease the fauces or larynx, and in the latter disease the damaged tissue about a wound or abrasion. Erysipelas is a good example of toxæmia, set up by the specific dermatitis induced by infection of the skin with *S. pyogenes*. The symptoms of toxæmia are variable, and depend upon the special affinity that the toxins concerned have for certain tissues or organs. There are, therefore, general symptoms common to many microbic infections: fever, rigors, malaise, vomiting, pains in the back and limbs, headache, sweating, etc.; and special symptoms, such as are manifested by an affinity of the toxin for nerve structures (paralyses, spasms, delirium, etc.), or for the heart (arrhythmia, tachycardia, cardiac asthenia, etc.), and others.

II. SEPTICÆMIA

Septicæmia is a condition in which the infecting microbe transgresses the tissue barrier at the site of local infection and invades the blood stream, multiplying therein, and thus continuing the infection in a general manner. The mere existence of the microbe in the blood stream is not to be considered as necessarily constituting a true septicæmia. Thus we know that during the first few days of an attack of typhoid fever, of pneumonia, and of certain other diseases, the specific microbe can very often be isolated from the

circulation by blood culture. The more thoroughly the investigation of microbic infections by blood culture is undertaken, the more patent it becomes that at some stage or other the infecting organism exists in the circulation. *Bacteriæmia* is a convenient term by which to express the (temporary) existence of micro-organisms in the blood stream in other states than true septicæmia.

There are two main conditions of septicæmia in so far as this is related to the local infection. (1) The local infection may be obvious, the septicæmia clearly resulting from this; or (2) no local infection may be discoverable, or the local infection may be, at best, merely surmised. This second form of septicæmia was formerly termed "cryptogenetic." Even at a careful post-mortem examination the source of local infection may not be manifest in some of the cases illustrating this type of septicæmia.

The *microbes chiefly concerned in septicæmia* are *Staphylococcus aureus*, *Streptococcus pyogenes* (vel *hæmolyticus*) and the pneumococcus. Much less commonly the gonococcus, Pfeiffer's bacillus and *B. pyocyaneus* perform this rôle.

The *local infections tending to lead to septicæmia* are chiefly concerned with the throat (streptococcus), the uterus ("puerperal fevers"), the subcutaneous tissues of the hand and foot (infections during operations and post-mortem examinations, septic wounds, etc.), and the site of surgical operations (post-operative septicæmia).

Symptoms.—The symptoms in septicæmia vary much; there is also great variation in the intensity and course of the disease. Some of the worst cases from the point of view of prognosis are those in which physical signs are conspicuous by their absence, whether as regards the site of the local infection or as regards the development of secondary lesions (thromboses, visceral inflammations, etc.). Thus, in a case of puerperal septicæmia, if a careful examination of the pelvic organs reveals no defect in the uterus or its adnexa, and if no signs of local concentration of the infecting agent be found elsewhere, the case is likely to be one of great anxiety, and recovery is unlikely.

The symptoms include pyrexia, usually considerable in degree, and most often intermittent in character. Rigors are not uncommon, though by no means constant. The patient is generally free from pain and local discomforts, but feels exhausted and very ill. The mental state is usually normal; in some cases the outlook is disproportionately optimistic. Sweats are common, especially if the pyrexia is markedly intermittent. Diarrhœa may occur. Some degree of general abdominal distension is common. The spleen may be palpable. The pulse is quickened, the pulse tension lowered, and there may be subjective cardiac disturbances related to the toxic myocarditis which is an invariable result of the main pathological process. A progressive hæmolytic anæmia is one of the most striking features in most septicæmias, both clinically and upon examination of the blood. A steady decline is observed in the number of red cells and in the hæmoglobin content. The leucocytes vary a good deal, and their number constitutes a helpful point in prognosis: the smaller the count the worse the outlook. Loss of weight is not a noticeable symptom, except in cases which become "chronic," nor must the absence of this feature lead, of itself, to a favourable view as to the outlook. Erythemata are often seen, especially in cases due to streptococcus infection; they are prone to be evanescent. Joint pains

and swellings are also common, and these not seldom disappear without any focal abscess formation.

Prognosis.—The prognosis is serious in all cases of septicæmia, though less so now than formerly. This is partly because, as the result of the earlier and more extensive use of blood cultures, more cases are recognised, and partly because the exploitation of immune therapy has, no doubt, added a useful element of treatment in many instances of the disease. Of serious import are the following: rigors, the absence of signs of the local infection, the absence of a definite leucocytosis, rapid progression in the associated anæmia, early dilatation of the heart, vomiting and delirium or stupor.

III. Pyæmia

When septicæmia is complicated by the formation of multiple abscesses, or of multiple foci of tissue necrosis, the clinical condition is conveniently spoken of as pyæmia.

All pyæmic patients are septicæmic, but not all septicæmic patients are pyæmic. Some septicæmias tend to be pyæmias from the first, in other cases there is a late development of the pyæmia after a period of simple septicæmia lasting for days or, it may be, weeks. In the great majority of cases of pyæmia the primary infection is quite obvious.

There are three types of pyæmia according to the anatomical distribution of the primary infection in relation to the circulation.

1. *Systemic venous pyæmia.*—This is the form which is seen in osteomyelitis due to *Staphylococcus aureus*, in suppurating wounds (staphylococcus, streptococcus, *B. coli*, etc.), in suppurations of the urinary tract, and in suppurating dermatitis and cellulitis. The metastatic abscesses form in the lungs, kidneys, perirenal tissues, joints, bones, and, less often, in the heart wall and in the brain. The symptoms are those of a severe septicæmia together with those of the disease-processes set up by the focal events just referred to. Some of the cases are of long duration, and when this is so the patient is apt to become very emaciated.

2. *Portal pyæmia* (suppurating pylephlebitis).—This is the form of pyæmia resulting from certain pyogenic infections in the alimentary tract—rectum, colon, appendix, gall-bladder and elsewhere. The microbic infection follows in ascending fashion the radicles of the portal vein, setting up a septic thrombosis and ultimately causing multiple abscesses in the liver. The symptoms are those of a severe febrile illness with acute or subacute abdominal signs, moderate jaundice, and an enlarging liver. The diagnosis is sometimes difficult, but when indubitable the prognosis is extremely grave. The micro-organisms concerned are generally of the coliform group, or streptococcus; mixed infection is not uncommon.

3. *Arterial pyæmia.*—This form of pyæmia is seen in infective endocarditis, with which disease it is, for the most part, identical. The focus of primary infection, so far as the pyæmic process is concerned, is the endocardium, and especially of the valves, where colonisation of microbes takes place, and whence innumerable septic emboli proceed into the arterial system. Seeing that in the great majority of the cases this focus occurs on the left side of the heart the emboli, if they set up metastatic areas of infection, do so in organs and tissues supplied by the systemic vessels: spleen, brain, kidneys,

limbs, etc. In the less common instances, where the endocarditic focus is on the right side of the heart, the infection being grafted upon a congenital lesion, the emboli lodge in the pulmonary vessels, producing multiple infarcts in the lung, usually with associated pleurisy.

The microbes most often causing infective endocarditis are organisms of feeble virulence (streptococci of the salivary and faecal groups); this fact accounts for the infrequency of true suppuration in the infarcted areas occurring in this disease. When, however, the endocarditis is due to such virulent microbes as *Staphylococcus aureus* and *Streptococcus pyogenes*, abscess formation does occur in the infarcts.

Treatment.—The treatment of this group of infective processes, and especially of the cases of septicæmia and pyæmia, not infrequently taxes the practitioner's resources to the utmost. The widest possible view should be taken of the therapeutic position, but all highly experimental measures, of which a large number frequently come up for review in connection with the more severe or tedious cases, should be regarded with a healthy scepticism. The programme of treatment should be considered under four heads: general measures, drugs, specific therapy and surgery.

1. *General measures.*—These include rest, ample nutritious diet, abundant fresh air, the control of fever by hydrotherapeutic means, and the maintenance of a cheerful outlook in the patient and in his medical attendant. The nursing of these "septic" patients is of great importance, and experience of similar cases is a great asset.

2. *Drugs.*—Drugs having reputed bactericidal action are numerous, but experience does not, even when the chemical agent is exploited generously and by the intravenous route, justify any degree of confidence in them. There has recently been a vogue for the intravenous use of mercurochrome in cases of septicæmia, but the results have not, in the practice of the writer, proved at all promising. Perchloride (and more recently salicylate) of mercury, given in 5 c.c. doses of a 0·05 per cent. solution, and repeated daily if necessary, until salivation occurs, are two alternatives if the physician wishes to make trial of such a method. The intramuscular injection of colloidal manganese in the staphylococcus cases, and of colloidal silver in the streptococcus cases, has yielded some apparent good results, but these drugs must be considered as still on probation.

To control the progressive anæmia, over and above the general measures, arsenic is perhaps the most useful remedy; it may be given conveniently as sodium cacodylate, gr. i, once or twice daily, in the form of intramuscular injection. The writer often combines it with nucleic acid, a useful stimulant to leucocytosis, in the following formula:

℞ Sod. cacodylatis, gr. ii.
Ac. nucleici (sat.) ad ℥xv.

3. *Specific therapy.*—For a detailed account of the measures that may be used in order to combat the infection by way of immune therapy, the reader is referred to p. 24. These measures are, it goes without saying, of much greater theoretical importance than those which act non-specifically. Unfortunately our knowledge of efficient specific remedies grows very slowly, and there are many gaps and guesses in it. All the same, careful consideration should be given in every case to the nature of the infection and to the

question if some form of specific treatment, whether by immune serum or by vaccine, or by both, may not be of service.

4. *Immuno-transfusion* and *Simple Transfusion.*—These measures may be helpful in particular cases.

5. *Surgery.*—All abscesses developing in the course of a pyæmia must be drained forthwith, either by aspiration or by free incision.

TERMINAL INFECTION

Micro-organisms which are found in the tissues in the course of a post-mortem examination are related to them in four different ways. (i.) They may be the primary infection leading to the disease-process which causes death. (ii.) They may be present as secondary infections, in association with the primary infection, and they may or may not be largely responsible for the death of the patient. (iii.) They may be present as a "terminal infection," the disease-process from which the patient suffered being not itself manifestly of microbic origin, but one tending to lower the tissue resistance to infection. The terminal infection in these cases generally, as the name implies, precipitates the lethal event, or actually causes it. (iv.) They may be present merely as an agonal or sub-mortem invasion, or even as a post-mortem invasion. It is necessary carefully to distinguish between the last two of these relations. The mere isolation of organisms from certain tissues (*e.g.* the mucoid material of the middle ear) in the post-mortem room does not prove that they were present in these situations during life, still less that they were operative by way of actual infection. It is even doubtful if the cultivation of organisms from the blood of the heart, or from the cerebro-spinal fluid, after death, gives evidence of infection during life, though some authorities consider that it does. Much depends, of course, upon the conditions at the time of the investigation.

Terminal infection does certainly occur, however, in well-recognised form, and quite distinct from sub-mortem invasion. The organisms most often responsible for the condition are the less virulent strains of streptococci (*S. salivarius* and *S. facalis*), the coliform group, staphylococci and the tubercle bacillus. *B. proteus* and *B. aerogenes capsulatus* are also found to operate in this manner at times.

The disease-processes in which terminal infection frequently occurs are cirrhosis of the liver, granular kidney, diabetes, leukæmia and morbus cordis. There is a latent form of infective endocarditis (most often streptococcal in origin) which is also of the nature of a terminal infection. Serous membrane tuberculosis, and especially peritonitis, is quite common in cirrhosis of the liver. Many of the patients in whom this terminal infection occurs are so ill at the time the event arrives that it frequently goes undiscovered, partly because their responses to infection are feeble and partly because clinical examination is difficult.

STREPTOCOCCUS INFECTION

The streptococci form a group of micro-organisms in which the different members vary greatly in virulence. They also vary in their morphological

and cultural features and in their biochemical reactions. There is, therefore, no little difficulty experienced in any effort at successful classification. One result of the efforts that have been made by various workers is an unfortunate confusion in nomenclature. Broadly speaking, there are two main types of the microbe. (1) There is the highly virulent type, called *Streptococcus pyogenes* (which it is generally agreed is identical with *S. erysipelatosus*), to which the alternative name *Streptococcus hæmolyticus* has more recently been applied, on account of its property of hæmolysing when cultivated on blood-agar. (2) And there is the more feebly virulent type, including the variants *S. salivarius* and *S. fæcalis* of some authorities, and *S. viridans* and *S. mucosus* of others. The first type is usually seen in long and curling chains when recently isolated, and the second is usually seen in short chains of two, four, or some number of relatively few members.

S. pyogenes (vel *S. erysipelatosus*; *S. hæmolyticus*) is the causative microbe in erysipelas, in acute abscess formation, in acute cellulitis and lymphangitis, in severe operation and post-mortem infections when these are of streptococcus origin, and in the more virulent streptococcus infections complicating influenza, scarlet fever, and some other specific fevers.

S. salivarius and *S. fæcalis* (vel *S. viridans* and *S. mucosus*) are found in association with pyorrhœa alveolaris, with secondary streptococcus infection in rheumatic fever, with arthritis occurring in connection with focal infections, and with most chronic and subchronic infections of streptococcus origin. The streptococci found in the heart valves, and in the blood stream in cases of subacute bacterial endocarditis, are for the most part of this nature.

The clinical results of streptococcus infection vary according as the infection is by the first or by the second of these types of the microbe. In infection by *S. pyogenes* the disease-process is usually acute and often fulminant. Septicæmia results not infrequently, and pyæmia is not uncommon. If endocarditis results from the infection and embolism occurs, the infarcts suppurate. In infection by *S. salivarius* and *S. fæcalis* the disease-process is prone to be subchronic, or at most subacute. Septicæmia is uncommon, except in association with endocarditis, in which condition embolic infarcts proceed to coagulative necrosis, but not to abscess formation.

Secondary infection by streptococci (most often of type (2)) is a very common event in rheumatic fever. There are some authorities who consider that this disease is itself an expression of streptococcus infection (see article on Rheumatic Fever, p. 292).

Treatment of streptococcus infection is dealt with in the article on Specific Therapy (p. 44).

ERYSIPELAS

Definition.—An acute specific disease, due to infection of the skin by *Streptococcus pyogenes*, leading to local dermatitis and constitutional symptoms, of which fever and toxæmia are the most prominent.

Ætiological Factors.—Infection by *S. pyogenes* is certainly the essential factor. The more carefully the cases are examined and the patients questioned the more certain it becomes that in the great majority of them some abrasion,

it may be very slight, is present in the skin at the site of infection. This abrasion may be an actual wound, whether of a surgical operation or not. More often it is less apparent—a scratch, an insect bite, the chafing of a foot by a badly fitting shoe, etc. Contact by the human hand during the infliction of these slight injuries is not uncommonly a feature in the case.

Bad hygienic conditions seem to contribute to the incidence of the disease, such as defective sanitation and ventilation in public institutions. Formerly the disease was rife, almost epidemic, in hospitals, and chiefly amongst the surgical patients. During the puerperium a woman is prone to erysipelatous infection.

The disease is said to have a seasonal incidence (January to May), and Newsholme showed that the curves of its prevalence conformed somewhat to those of scarlet fever and acute rheumatism. We do not know, however, the reasons for this.

The disease is more common in women than in men, perhaps because of the puerperal cases. Alcoholism is a great predisposing factor, and appears to determine recurrences of the infection in certain liable individuals. Gout is another factor rather commonly present in the cases.

Symptoms.—There is an incubation period of some 2 to 5 days. The onset is usually abrupt, often with a rigor (or a convulsion in little children) and a sharp rise of temperature—102° to 103° F. In severe cases the patient suffers from malaise, aching pains about the body, and headache. The headache may be so severe as to mislead the observer into thinking there is some cerebral infection (*e.g.* meningitis). Delirium may be present, rendering the doubt still greater. If, as is sometimes the case, the local lesion is not apparent to the patient, or is not discovered on examination, the case may be very obscure indeed. But in the majority of instances there is a feeling of heat, tightness, or pain at the site of infection, leading to the recognition of the dermatitis. The inflammation usually appears during the second day—the skin is red, hot to the hand, slightly raised, with a spreading margin upon which there may be minute vesicles containing clear or turbid fluid. The area spreads rapidly, and becomes œdematous, the degree of this latter effect varying with the situation of the inflammation. If this is the face, the œdema is marked, especially if the eyelids and lips are involved: the whole face may then be greatly swollen and the patient's features scarcely recognisable. On the limbs there is frequently present some degree of lymphangitis—red streaks, more or less continuous, stretching upwards towards the groin or axilla, in which situations the lymph glands are frequently swollen, painful and tender. When the dermatitis is fully developed the vesicles already referred to may become blebs of considerable size.

In less severe cases the constitutional disturbance may be much milder, but so long as the diagnosis is definite the development of serious symptoms must always be regarded as possible, especially if the patient be elderly or debilitated.

The course of the disease varies considerably. If uninterrupted by specific treatment it lasts from 1 to 3 weeks.

Complications.—Albuminuria is not uncommon in all cases in which the temperature is high. Signs of nephritis supervene in not a few severe cases; when this is so the question should arise as to the previous integrity of the

kidney. Œdema of the larynx is a rare complication ; spread of the inflammation from the face to the orbit is less uncommon, and in this event meningitis is to be feared. Pneumonia sometimes occurs, again in debilitated, elderly or alcoholic subjects. Septicæmia, it may be with a fulminating form of infective endocarditis, is another serious possibility.

Diagnosis.—Reference has already been made to those cases in which the real nature of the disease is masked by the severity of the general invasion symptoms and the non-discovery of the skin lesion. Apart from such instances the diagnosis is rarely difficult if the examination be carefully conducted. The presence of even the smallest vesicle in association with a suspicious red area of skin should be investigated by piercing it with a very fine capillary glass tube and filming and cultivating the contents, even if these seem to the naked eye to be almost clear fluid. The discovery of a long chained streptococcus in the films not only establishes the diagnosis, it enables the practitioner to adopt prompt specific measures of treatment, and gives him material for the preparation of a vaccine, should the use of this be deemed desirable.

Prognosis.—The disease is very fatal in infants and in old people. It is dangerous in alcoholics, nephritics and the plethoric gouty type of patient. In all others the outlook is good. But septicæmia is of grave omen, and if associated with endocarditis it is always fatal. Meningitis, following orbital cellulitis and ophthalmia, is scarcely less lethal. The occurrence of acute nephritis, of cellulitis of the neck or of pneumonia, though all of these give rise to great anxiety, does not render the case hopeless.

Treatment.—PROPHYLAXIS.—**The patient should be isolated, and the greatest care should be taken in nursing, as well as in all the examinations made by the medical attendant. The sick-room should be large and well ventilated.**

CURATIVE. — (i.) *Local measures.* — Various applications are in use. Perhaps one of the best is ichthyol ointment (25 per cent.), though this has the disadvantage that it somewhat obscures the local signs. A lotion of perchloride of mercury (1 in 4000), continuously applied on linen strips, is free from this objection. The old method of painting the spreading edge of the dermatitis, and the healthy skin around it, with tincture of iodine, has many advocates. In erysipelas of the face the eyes should be protected by a few drops of argyrol (5 per cent.) applied two or three times in the 24 hours.

(ii.) *General measures.*—Full diet is allowed, provided it can be digested. In severe cases ample fluid must be given, as to all "septic" diseases. Volatile stimulants (brandy) are indicated whenever the constitutional symptoms are severe and the heart flags. Febrifuge drugs are best avoided, the temperature being controlled by hydrotherapeutic or aerotherapeutic methods. There is probably no drug that possesses a "specific" value in the disease, though the writer usually follows the lead of those enthusiasts who strongly recommend perchloride of iron. If this be used it should be given in ♏xx doses, very freely diluted, every 4 or 6 hours.

(iii.) *Immune therapy.*—The prompt use of univalent *S. pyogenes* serum, followed by small doses of *S. pyogenes* vaccine, probably constitutes the best method of exploiting specific measures of treatment. For details of these see p. 46.

PNEUMOCOCCUS INFECTION

The *pneumococcus* (*Diplococcus pneumoniæ; Micrococcus lanceolatus*) is a small oval coccus, measuring about 1 μ in its long diameter, generally arranged in pairs, but also seen as single elements, and often in short chains when examined in preparations made direct from tissues or secretions. The organism is Gram-positive and possesses a capsule. It is found in healthy saliva and in the respiratory passages of healthy individuals. Outside the body it is not often found, its viability being low; sunlight kills it in one and a half hours.

Types of the pneumococcus.—It has been realised for a long time that different strains of the organism exist, of varying virulence. R. Cole and others, working at the Rockefeller Institute, have attempted a "grouping" of these strains, basing their results upon differences in immunological reactions. They described four types in relation to pneumonia. Types I. and II. together accounted for 60 per cent. of the cases studied, and were of relatively high virulence, yielding a mortality of 25 to 30 per cent. Type III. accounted for 10 to 15 per cent. of the cases, with a mortality of 50 per cent. Type IV. comprised the remainder (25 per cent.) of the cases, with a mortality of about 12 per cent. The pneumoccocus found in the healthy mouth conformed generally to Type IV. Lister, working along Cole's lines in South Africa, found that at least 30 per cent. of his cases conformed to a type not described by Cole. This work, admittedly subject to extension, has very important bearings upon the serum treatment of pneumococcus infection.

Relation of the pneumococcus to pneumonia and allied infections.—The pneumococcus is regarded as being the primary infective agent in acute lobar pneumonia, in most cases of acute broncho-pneumonia in children, and in many cases of empyema. Pneumonia may be considered as a systemic pneumococcus infection with the production of focal lesions in the lung. The organism can, in the majority of cases, be isolated from the systemic circulation by blood culture during the first 3 or 4 days of the disease. This fact also holds good for those forms of acute pneumococcus infection in which focal lesions do not appear in the lung, but in the pleura or elsewhere (see below). The factors which determine the invasion of the blood stream by an organism which is a normal inhabitant of the bronchial tract are equivocal; they are considered to be a lowering of the tissue resistance and (or) a rise in virulence of the organism. Cole's work makes it likely that in some cases at least, the invasion may be by a more virulent strain of the germ than that which occurs in the body in a saprophytic form.

The rusty sputa of pneumonia usually reveal the pneumococcus clearly when "filmed" and when cultivated. Lung puncture in pneumonia also yields the pneumococcus. The existence of positive blood cultures has already been referred to. The organism has been found in herpetic vesicles developing during the disease, and it is not very uncommon to find it in the urine under similar conditions.

Pneumococcus infections other than pneumonia. *Pericarditis* is sometimes regarded as a direct spread of the infection from the lung by means of the

lymphatics, but it is quite as likely to be an infection from the blood stream. *Endocarditis*, a very serious form of infection, is of the "ulcerating" type (see p. 825). *Meningitis*, another grave focal infection, being highly purulent in character, is perhaps the most fatal form of pyogenic infection of the meninges. *Peritonitis* occurs either as an isolated infection or, less often, as a complication in pneumonia; it is less uncommon in children than in adults. *Otitis media* is perhaps the commonest of all acute pneumococcus infections in children, if we except (broncho-) pneumonia. Of 46 cases of primary pneumococcus infection in children, Netter found that this disease was present in 29, suggesting the mouth or nasal cavities as the source of invasion. *Arthritis*, again chiefly in children, is a somewhat rare manifestation of the same infection. A true pneumococcus *nephritis* occurs, in most cases a complication of pneumonia or of empyema; hæmaturia is usually a prominent symptom. This catalogue by no means exhausts the known series of pneumococcus infections: few if any organs or tissues are wholly exempt.

Pneumococcus septicæmia occurs somewhat rarely (apart from endocarditis and its associated pyæmia), and there may be no obvious initial lesion. A few cases of puerperal septicæmia are of pneumococcus origin.

The *treatment* of pneumococcus infection, as such, and apart from the disease-processes consequent upon it, is discussed on p. 42.

GONOCOCCUS INFECTION

The *gonococcus* is a small diplococcus, having its two adjacent surfaces flattened or slightly concave, with a small oval interval between them. It is Gram-negative in its staining reaction, and, when seen in exudates and in tissues, it is very largely intracellular in distribution—a helpful feature in diagnosis. The gonococcus is a very strict parasite, being dependent for spread upon direct transference from host to host. It probably does not live outside the human body for many hours.

Modes of Infection.—Sexual intercourse is by far the most common and important mode of infection. Contamination of the conjunctival sac of the newborn infant by infected vaginal secretions is another important way by which the organism is transmitted. Least often, accidental contamination sometimes occurs from infected material, either of the vagina in little children or of the eyes in children or adults.

Characters of Gonococcus Infection.—Perhaps the most peculiar, and certainly the most important, feature of gonococcus infection is its obstinate persistence. This organism is, relatively to many others, responsible for few deaths as the direct result of acute infection, but this low mortality ratio is compensated by a high degree of morbidity incidence. Once the invasion of gonococci has led to definite tissue infection, this is prone to become very intractable, resisting the most persevering and thorough efforts at defeating it. Gonococcus infection is too often measured by years rather than months, though there are ofttimes intervals of comparative freedom from toxic effects upon the infected organs. Such a lesion as acute iritis, for example, may appear in the subject of old gonococcus infection, several years after the primary invasion, and the evidence that the inflammation is due to this

source may be unimpeachable. The writer has known this to happen fourteen years after the primary urethritis. But it is sometimes very difficult to exclude a recurrence of the initial infection.

Once the inflammatory response to infection has passed the urethral stage, it is often very difficult to obtain direct bacteriological evidence of the nature of a suspected gonococcus infection. The number of organisms concerned may be small, they are often deeply embedded in the tissue spaces and cells, and they may not be shed into any effusions or secretions that chance to be available for clinico-pathological investigation. As yet, the indirect diagnostic methods (agglutination, complement fixation, etc.) are scarcely of sufficient trustworthiness to supply the data left lacking by the negative direct bacteriological results referred to.

Secondary infection, especially by staphylococci, streptococci and diphtheroid organisms is very common.

Clinical Results of Gonococcus Infection.—These may be considered under three headings: the results of the primary infection, the results of the zone of immediate spread, and the results of general dissemination.

(i.) *The results of the primary infection.*—These are acute and chronic urethritis (with gleet); acute and chronic vaginitis, cervicitis and cervico-endometritis; and conjunctivitis. These lesions do not come under consideration in a text-book of medicine.

(ii.) *The results in the zone of immediate spread.*—These include peri-urethritis (and abscess), prostatitis, epididymitis and vesiculitis in the male; salpingitis with salpingo-ovaritis in the female; and cystitis in both sexes. In both sexes, again, the peritoneum may become infected locally, a much more common and important event in females than in males, as might be expected for anatomical reasons. Indeed, in women, varying grades of pelvic peritonitis, with plastic inflammatory changes, constitute perhaps the greatest bane of gonococcus infection, both from the physician's and the surgeon's point of view. Chronic ill-health, adhesions that permanently handicap the functions of the pelvic viscera, and acquired sterility are amongst the disabilities accruing therefrom. In the male, late results of infection are scarcely less serious by way of Nemesis: urethral stricture, chronic prostatitis, "ascending" pyelitis and secondary coliform infection of the urinary tract.

(iii.) *The results of general blood infection.*—These may be subdivided into a true septicæmia and pyæmic manifestations.

(*a*) *Septicæmia*, though rare, has been definitely established clinically and clinico-pathologically, both in America (Thayer, Blumer, Ahmann) and in England (Horder). Endocarditis, of a progressive and "ulcerating" form, is present in most of the cases, and, though recovery has taken place in one or two known instances, the disease is generally lethal. Diagnosis turns upon the isolation of the organism from the blood stream in a case presenting the clinical features of septicæmia.

(*b*) *Pyæmic manifestations.*—Of these the most important is *gonorrhœal rheumatism*, with associated arthritis, fibrositis, teno-synovitis and allied lesions (see p. 1242). Gonorrhœal rheumatism must be considered to be a form of gonococcus pyæmia, at least when seen in its acute and sub-acute types. The organism has been recovered from the affected joints in a large number of the cases, and in a few from the blood stream as well as

from the joints. *Spondylitis deformans* has been traced to (old) gonococcus infection in a considerable proportion of cases.

Pericarditis and *pleurisy* have both been described as remote results of gonococcus infection.

Iritis, already referred to, is prone to be of the recurrent type. It is often ascribed to syphilis when it is much more probably of gonorrhœal origin.

Treatment.—See general section on Immune Therapy (p. 39).

THOMAS HORDER.

TYPHOID FEVER

Synonyms.—Enteric Fever; Gastric Fever.

Definition.—An infectious fever characterised by prolonged pyrexia of distinctive type, an eruption of rose spots, enlargement of the spleen, abdominal discomfort and bowel disturbance. Ulceration of the agminate and solitary lymphoid glands of the small intestine and enlargement of the mesenteric lymph glands and spleen are distinctive lesions. Typhoid is a septicæmia caused by the *Bacillus typhosus* of Eberth, which during the septicæmic stage is carried to all parts of the body and settles and multiplies in the agminate glands (Peyer's patches) of the intestine, the mesenteric lymph glands, spleen, liver, gall-bladder and bone-marrow. Those organs which have excretory ducts, *e.g.* the liver and gall-bladder and the kidneys, as well as the intestinal tract, form the chief channels of elimination.

Ætiology.—The *Bacillus typhosus* is a flagellated, rod-shaped organism, about 3 μ in length and 0·6 μ in thickness. It is actively motile and easily grown on artificial media. It belongs to the enteric group of organisms, a group which includes also the paratyphoid bacilli. It grows best at blood heat and is quickly killed by boiling water, and within 15 minutes by exposure to a temperature of 60° C. (140° F.). It may survive for a considerable time in ice, and also in fresh or salt water. It resists ordinary drying so that typhoid may be propagated by dust or by garments and bed-clothes soiled by typhoid excreta. It has been found alive in the mantle-cavity and intestines of oysters, mussels and other shell-fish which have lived in sewage-contaminated water. It grows freely in butter and in milk.

The toxins are mainly intracellular. Inoculation of animals with virulent cultures produces a septicæmia without the characteristic intestinal lesions seen in man. Even in the latter the disease at times occurs without producing intestinal ulcers. The serum of patients has a specific agglutinative influence on cultures of the organism, a fact which is made use of in diagnosis, and at certain stages the bacillus can be cultivated from the blood. In man, infection is introduced by the alimentary tract, and is derived, directly or indirectly, from a human source—typhoid fever not being a disease of the lower animals.

Typhoid occurs in all parts of the world, but is most rife in tropical and subtropical countries. In Great Britain it is most prevalent in the months of September, October and November; in other countries the maximum incidence corresponds to the warm season. A hot, dry summer increases the prevalence in the autumn. An epidemic recrudescence is believed to occur every 5 or 7 years. Rather more males than females are attacked,

and the greatest susceptibility is between the twentieth and twenty-fourth years. Infants are rarely infected; but the disease does occur in childhood, and is then likely to be overlooked. After the thirtieth year there is a progressive fall in its incidence. It is rare but not unknown in old age.

One attack confers immunity, which usually lasts for life, but second and third attacks have been reported. Where typhoid is endemic a proportion of the community acquires immunity without having passed through a recognisable attack. The supposed racial immunity of the Japanese, Indians and certain other peoples may in reality be acquired through infection contracted in childhood. Fatigue and overwork are powerful predisposing factors, and no condition predisposes so much as war to typhoid and paratyphoid infections, owing to the aggregation of susceptible subjects under conditions of defective sanitation, fatigue and exhaustion. Prophylactic vaccination has found its greatest triumphs under these conditions.

Propagation from the human source may be indirect or direct. Of indirect causes aerial infection, apart from the influence of wind-borne dust and of flies, is very doubtful. Drinking water contaminated by sewage is the most common cause of widespread outbreaks. Milk and other articles of food may act as vehicles of infection by becoming contaminated by a carrier. Watercress and green vegetables, eaten uncooked, also spread the disease. Amongst shell-fish, oysters, mussels, cockles and periwinkles are dangerous. Fomites, enema syringes, bedpans, etc., which have been soiled by typhoid excreta undoubtedly act as infective agents. Laboratory workers have been infected by their cultures.

Direct contagion plays but a small part in the production of epidemics, but assumes importance in causing localised outbreaks, infection being conveyed by the fæces, the urine, the vomit, discharges from abscesses and possibly by the sputa. The chief danger arises with mild and unrecognised infections. Strict attention to personal cleanliness and proper disinfection of excreta, soiled linen, feeding utensils, etc., go far to eliminate infection, and prophylactic inoculation is a great safeguard. Of convalescents from typhoid, a small proportion, about 5 per cent., continue to pass bacilli in the stools for months or years. These are known as intestinal carriers. They may appear to be quite healthy, or may suffer from periodic intestinal disturbance or from symptoms referable to the gall-bladder. Typhoid bacilluria occurs in 25 per cent. of the cases of typhoid, but is as a rule quite transitory, urinary carriers being much less common than intestinal carriers. Carriers are particularly dangerous when they happen to be engaged in handling food or milk.

The endemic occurrence of typhoid in certain localities is now attributed to the influence of human carriers rather than to the persistence of infection in the soil, although it is an undoubted fact that the typhoid bacillus may persist for a time and even multiply in sewage-infected earth.

Pathology.—The most characteristic lesions are in the small intestine. In the early stages the Peyer's patches are hyperæmic and swollen, the swelling attaining its height about the tenth day of the disease. The solitary follicles of the intestine are similarly affected and a diffuse catarrh of both large and small bowel may be present. Necrosis ensues in the inflamed lymphoid masses, and yellowish-brown sloughs are formed, the separation of which occurs during the third and part of the fourth

weeks. In some cases, slow resolution may possibly take place without necrosis or sloughing. The ulcers which result from sloughing of Peyer's patches are ovoid and lie along the long axis of the bowels. Those which arise in the solitary follicles are more circular. The edges of a recent ulcer are undermined, and the floor shows smooth muscular fibres, or sometimes the peritoneal coat. As the sloughs separate, perforation or hæmorrhage may ensue. Immediately above the ileo-cæcal valve irregular sinuous tracts of ulceration may be evident. Actual ulceration of the solitary follicles of the large intestine is rare. The ulcers of typhoid heal without contraction, and regeneration of the epithelial covering takes place. A slaty pigmentation, often punctate, may persist. The time required for healing is a week or ten days. When perforation occurs it is usually in the lower ileum, where ulceration is most intense. It may, however, happen in other situations such as the pelvic colon, cæcum, appendix, or, on rare occasions, the jejunum.

The mesenteric lymph glands, particularly those of the lower ileum, are hyperæmic and swollen. They rarely suppurate. The spleen is enlarged to twice or thrice the normal size. It is softer and redder than normal, and the Malpighian tufts may be enlarged. Infarction sometimes occurs, but rupture is rare. Parenchymatous degeneration occurs in the liver, and minute opaque areas of focal necrosis are scattered through its substance. The gall-bladder may become infected and cholecystitis result. Pylephlebitis is a rare complication due to infection from the bowel. Cloudy swelling of the kidneys is the rule, occasionally a parenchymatous nephritis ensues. In chronic urinary carriers inflammation of the renal pelvis or urinary bladder may be found.

The myocardium shows fatty and granular degeneration. Endocarditis is rare, but endarteritis may affect the aorta, coronary arteries and peripheral vessels. Atheroma is a sequel. Hypostatic congestion of the lung bases is the rule with, it may be, distinct broncho-pneumonic consolidation. Lobar pneumonia is uncommon. Gangrene, abscess or infarction of the lungs is rare. Ulceration of the larnyx may occur, the ulcers being found in the neighbourhood of the arytenoid cartilages, or at the base of the epiglottis. Necrosis of the cartilages sometimes occurs. Zenker's vitreous degeneration of muscle, although not peculiar to typhoid, is particularly marked in this disease. It chiefly affects the straight muscles of the abdomen, the adductors of the thigh and the diaphragm. Rupture of muscle and hæmorrhage may ensue. Osteo-periostitis of the tibia, vertebræ and other bones may be due to primary infection with the typhoid bacillus or to secondary infections with other organisms. Superficial abscesses, degenerative changes in the central nervous system or peripheral nerves, and venous thrombosis are also sequels of typhoid infection.

Symptoms and Course.—The period of *incubation* averages from 10 to 14 days, but may be as short as 5 days or as long as 3 weeks. Symptoms are generally absent, but ill-defined malaise or, more rarely, gastro-intestinal disturbance may occur.

The *onset* of the fever is generally insidious with chilliness, lassitude, loss of appetite and muscular pains. Symptoms which are particularly suggestive are frontal headache, epistaxis, slight bronchitis and disturbing dreams. The tongue becomes furred, the mouth dry and the bowels loose or constipated. The patient may not take to bed for a day or two. The temperature

rises gradually, being a degree or more higher each succeeding night with morning remissions. By the end of the first week the patient's condition is very characteristic. The aspect is heavy and the cheeks are flushed. The lips and mouth are dry, and the dorsum of the tongue covered with a dirty white fur, the tip and edges being raw. The abdomen is slightly tumid, with gurgling in the right iliac fossa. The bowels are generally loose, several liquid motions like pea soup being passed in the 24 hours; sometimes, however, there is constipation. The spleen may be palpable. A characteristic feature is a moderately full but easily compressible pulse, the frequency of which is not increased in proportion to the temperature. The respiration is accelerated. The temperature will by now have attained a maximum of 103° to 105° F., still showing morning remissions of about 1°, and is unstable, reacting quickly to minor disturbances. The urine is high coloured and concentrated, and the skin usually dry. Thirst and headache are the chief complaints.

The rose spots usually make their appearance towards the end of the first

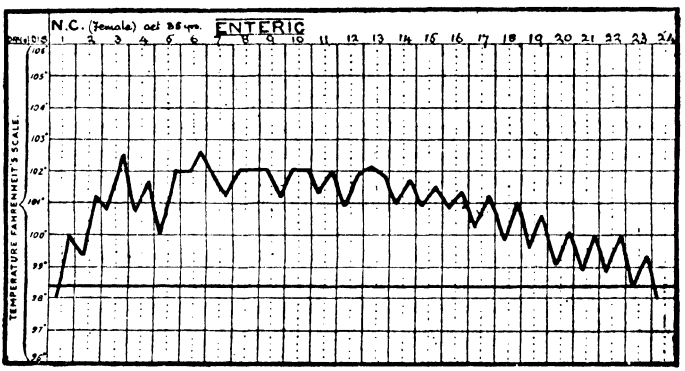

FIG. 1.—Typhoid Fever from the first day. Illustrating gradually rising temperature, a "continued" stage, and a typical lysis.

week, sometimes on the fifth day, more often between the seventh and twelfth. Each spot is a circular, slightly elevated papule of a pale pink colour from 2 to 4 mm. in diameter, disappearing on pressure. The rash should be sought for on the abdomen, the flanks, the sides of the chest and the back, which should always be scrutinised. The spots appear in successive crops, each one fading in 3 or 4 days, and leaving a transitory brownish stain. Often the eruption is scanty, a few spots only being seen; occasionally it is very profuse, and involves the limbs as well as the trunk. The face usually escapes. Minute sudaminal vesicles occasionally cap some of the spots. The eruptive period lasts from 10 days to 3 weeks. A profuse rash does not necessarily indicate a severe attack.

By the second week the fever (Fig. 1) has reached its fastigium or acme. The temperature maintains its level with slight morning remissions, the headache may abate, but prostration increases and the other symptoms are more severe. The lips become cracked, sordes accumulate on the teeth, the abdomen becomes more distended and diarrhœa is often a marked feature, the stools being liquid, yellow in colour, alkaline and foul. They may be

chocolate-coloured or red from admixed blood and small shreds of tissue, or actual sloughs may already be present. The evacuations are not accompanied by colic or tenesmus. The spleen is now larger. The pulse rate will have quickened to a frequency of 112 to 140. It is often dicrotic, and the heart sounds enfeebled. The bases of the lungs may now show signs of hypostatic congestion, and the respiration be more accelerated with slight lividity of the lips and face. Delirium of a muttering character disturbs the sleep, asthenia is very marked and muscular wasting rapid. The urine may be albuminous. Patients may succumb during this period from toxæmia, or towards the end of the first fortnight from perforation of the bowel or intestinal hæmorrhage.

During the third week improvement should occur, the temperature becoming more remittent in type, the morning reading falling more rapidly than that of the evening. The tongue cleans and appetite begins to return. During the fourth week defervescence may be completed, the temperature usually remaining at a subnormal level for some time. In severe infections, however, the third week is a period of increasing anxiety. The symptoms increase in severity and the patient may pass into the "typhoid state," lying on the back in a semi-stuporose condition, and tending to sink down into the bed. The pulse and heart sounds become more and more enfeebled, the pulmonary congestion increases, the extremities become blue and cold, subsultus tendinum appears, and the evacuations are passed unconsciously. Sometimes there is retention of urine. Extreme abdominal distension may supervene, and the occurrence of perforative peritonitis or of hæmorrhage from the bowel is more than ever to be dreaded. In such severe cases the fever may be prolonged through the fourth and fifth weeks before any signs of defervescence appear. They are not necessarily fatal.

Convalescence after a severe attack is always protracted. The temperature is at first subnormal, and remains in a very unstable state. The heart sounds remain enfeebled, and the pulse is often rather fast or easily quickened by exertion or excitement. The effort of standing and walking is difficult and painful. The appetite, however, is good, and the weight rapidly increases. The aspect gradually becomes less anæmic. Slight peeling of the skin, loss of hair, and ridging or furrowing of the nails is often noticeable. During this period the feet and ankles may show slight œdema, and cutaneous abscesses or localised bone abscesses may occur. Femoral thrombosis sometimes appears, and loss of memory may be noticeable.

Relapse.—Tendency to relapse is a marked feature, and shows itself in from 5 to 15 per cent. of the cases. The relapse may be intercurrent and occur during actual defervescence, but more commonly develops after an afebrile period of a week or a little longer. The symptoms of relapse are a repetition of those of the original attack, but generally in a mitigated form, the fever reaching its acme in a shorter time, and the whole duration being 10 days or a fortnight. The spleen enlarges again, a new crop of rose spots usually appears, and fresh ulceration of the bowel occurs. On occasions, the relapse equals or exceeds the original attack in severity, and may even prove fatal. Spurious relapses are recrudescences of fever during convalescence, of short duration, and unaccompanied by definite symptoms. Their explanation is often obscure.

The fact that typhoid fever may show great variations in its clinical characters, and in the severity and prominence of different symptoms, has

led to the description of many special types. It is noticeable, too, that different epidemics may differ much in their salient features.

Variations in onset.—The onset of febrile symptoms may be sudden, sometimes with rigors and vomiting. The temperature rises quickly, and delirium may supervene early. In such acute cases, death may occur during the second week, or the disease may gradually assume the ordinary type. In exceptional cases, pneumonia may mark and mask the onset, the attack commencing abruptly with consolidation of the lung. The true nature of the infection may be overlooked and only discovered at autopsy, or the pneumonia may subside and be replaced by the ordinary symptoms and signs of typhoid. This variety is known as *pneumo-typhoid*. The prominence of meningeal symptoms may lead to confusion with cerebro-spinal fever, and the differential diagnosis only be possible by examination of the cerebro-spinal fluid. Sometimes this is turbid and contains the typhoid bacillus, but more commonly it is under tension but clear, and the meningeal symptoms quickly subside after lumbar puncture, to be succeeded by the more typical signs of typhoid fever. The term *meningo-typhoid* is applied to such cases. Yet another occasional mode of onset is with a primary acute hæmorrhagic nephritis (*nephro-typhoid*). When acute gastro-intestinal symptoms signalise the invasion, appendicitis or irritant poisoning may be simulated.

Variations in course.—There is an ambulatory form in which febrile disturbance is generally, although not invariably, slight, and the patient continues about during the whole or the greater part of the illness. Some such cases end in recovery; but they often run a very severe course, the patient taking to bed about the end of the second week with aggravated symptoms, or succumbing to hæmorrhage from the bowel, perforation, acute delirium or myocardial failure. Mild and abortive forms of typhoid also occur in which the fever is insignificant, or, after a well-marked onset, ends in a rapid defervescence between the eighth and fourteenth day. An afebrile form is known, and is said particularly to occur in the enfeebled or those exposed to great hardships.

Variations due to age, pregnancy and other causes.—Typhoid fever is rare in infancy, but becomes more frequent in childhood, and then, generally, the symptoms are mild, the pyrexia of short duration and sometimes of a markedly intermittent or remittent type. Such complications as perforation or hæmorrhage are rare.

In the aged, particularly in those over sixty, typhoid tends to run an unfavourable course, hypostatic pneumonia and circulatory failure being common.

Abortion or premature delivery takes place in from 50 to 70 per cent. of pregnant women who contract typhoid. The fœtus is usually dead or, if born alive, usually succumbs to an acute typhoid septicæmia. The prognosis as regards the mother is not especially influenced.

In malarial patients the onset of typhoid may be sudden, with a typical rigor; but the severe symptoms proper to typhoid develop later. On the other hand, subtertian malaria may closely simulate typhoid in its commencement.

Chronic alcoholism exerts a very unfavourable influence. Pre-existing pulmonary tuberculosis is apt to advance rapidly during convalescence from the fever. In diabetes typhoid often runs a mild course.

Special Symptoms and Complications.—*Digestive system.*—Suppurative parotitis is attributed to ascending duct infection, and occasionally leads to cellulitis of the surrounding tissues. Due attention to the cleansing of the mouth goes far to prevent it. Ulcers sometimes appear on the pillars of the fauces and the pharyngeal wall (Duguet's ulcerations). Diarrhœa, although common, is not a constant feature, some patients being constipated throughout the disease. The severity of the diarrhœa does not depend on the extent of the intestinal ulceration, and it often disappears after a few days' hospital treatment.

Intestinal hæmorrhage occurs in about 7 per cent. of all cases, and is serious. It is most common at the time when the sloughs are separating, *i.e.* at the end of the second or beginning of the third week. The hæmorrhage may be slight, but more often is profuse. The evacuated blood is bright red in colour, unless it has been retained in the bowel. The signs of a severe hæmorrhage are a sharp fall in the temperature, a sensation of faintness, increased frequency of the pulse and, it may be, a transient rise in blood pressure with disappearance of dicrotism. The spleen may shrink rapidly. Sometimes the hæmorrhage is fatal before any blood is voided. There is a hæmorrhagic form of typhoid fever in which melæna may be an early sign, and is associated with petechiæ in the skin and hæmaturia.

Perforation of the bowel is responsible for one out of every 3 or 4 deaths. It is commonest towards the end of the third week, and is especially frequent in cases characterised by severe diarrhœa or by meteorism. Its onset may be preceded by intestinal hæmorrhage. The perforation generally lies within the last 12 inches of the ileum, where the ulceration is most severe and also most advanced; but perforation of the colon or the appendix may occur. Shivering, with the onset of sharp pain in the right iliac fossa, is usually the first sign. Localised tenderness, localised muscular rigidity and local immobility of the abdominal wall accompany the pain. The temperature may show a sudden drop to subnormal followed by a rise; but sometimes no variation is detected. Both pulse and respiration rates are usually increased, and the former should be watched carefully in all doubtful cases. Obliteration of the liver dullness may occur; this sign is especially valuable when occurring in a rigid and retracted belly. Another sign of some importance is the onset of irritability of the bladder with frequency of micturition. More reliance should be based on the local than on the general symptoms in making the diagnosis. After the first shock the patient may react and show deceptive signs of improvement, but before many hours the signs of spreading peritonitis will assert themselves. Unless dealt with surgically with the utmost promptness perforation is almost invariably fatal. A polynuclear leucocytosis generally accompanies perforation, but is inconstant and not of great diagnostic value.

Other causes of abdominal pain in typhoid fever are acute cholecystitis or perforation of the gall-bladder, suppurative cholangitis, portal pyæmia, suppurating mesenteric glands, appendicitis and splenic infarction, but none of these are common. Thrombosis of the iliac veins may also cause abdominal pain and tenderness, but a clue to this condition may often be found by examining the veins of the lower limbs and by looking for slight œdema of the leg or foot.

Respiratory system.—A mild bronchitis is present in most cases. In severe infections, and particularly in the later stages, hypostatic congestion of the

lung bases occurs. Lobar pneumonia is a complication which may supervene in the third or fourth weeks of the disease. Although typhoid bacilli may occur in the sputum, and be found in the lung, pneumococci are also present. Without careful physical examination the condition may be overlooked, as cough is often slight and rusty sputa absent. Embolic and pyæmic processes in the lungs during typhoid may give rise to abscess, gangrene and pneumothorax. Intra-pulmonary thrombosis, with infarction, is a very rare event.

Ulceration of the larynx is not infrequent in severe cases. It may be latent or give rise to huskiness of the voice, stridor, and toneless cough. There may be pain on deglutition and laryngeal tenderness. The slighter symptoms may abate, but sometimes the process terminates in necrosis of cartilage and œdema or stenosis of the larynx.

Blood and circulatory system.—A slight initial polynuclear leucocytosis is sometimes seen in the first week of infection. Later there is generally a marked anæmia associated with leucopenia, and a relative increase in the lymphocytes and large mononuclear cells. At the same time the eosinophils disappear, to reappear with convalescence. The appearance of a polynuclear leucocytosis indicates the onset of some inflammatory complications. An extreme degree of secondary anæmia usually persists during convalescence. A decided tendency to myocardial weakness is an important feature of the disease, and is indicated by a short and sharp first sound, feeble impulse and perhaps some increase in the area of cardiac dullness with the appearance of systolic cardiac murmurs. The blood pressure falls. In some cases the pulse becomes intermittent, irregular or alternating. During convalescence the pulse may remain rapid or become preternaturally slow. Sudden death during typhoid is usually to be attributed to the cardiac condition. Sometimes thrombosis of the cavities of the heart or of the pulmonary artery occurs. Endocarditis and pericarditis are rare events.

Femoral thrombosis is very apt to appear during early convalescence. It is usually left-sided, and sometimes appears to commence lower down in the veins of the popliteal space or calf or in the internal saphenous trunk. The complication is generally attributed to staphylococcal infection. The symptoms are pain and tenderness at the site of the thrombosis, fever and swelling of the limb, usually moderate in degree. The affected vein may often be felt as a rounded cord. In a few weeks the thrombus is absorbed, and the circulation re-established, but sometimes permanent obstruction and œdema result. The clot, if dislodged, may cause pulmonary embolism.

Arteritis, leading to occlusion, is an uncommon complication. The vessels affected are those of the lower limbs, sometimes those of the upper extremities, neck or brain.

Urinary system.—Febrile albuminuria is often present, but is transitory. Typhoid bacilluria occurs in about one-third of the cases, the urine presenting a slightly turbid, opalescent appearance; but a similar appearance may be due to the colon bacillus. Symptoms of pyelitis or of pyelo-nephritis may supervene. Urinary carriers continue to discharge typhoid bacilli for long periods. Acute nephritis is uncommon, but may occur either at the commencement or height of the disease. Retention of the urine may supervene during typhoid, but suppression is rare. During the fever the excretion of urea and of uric acid is increased, but the chlorides are diminished. Polyuria occurs at the onset of convalescence, and is of good omen.

Generative system.—Orchitis and, more rarely, prostatitis have been observed. In females acute inflammatory conditions of the vulva and also mastitis may occur.

Nervous system.—Meningeal symptoms at the onset have already been mentioned. Delirium is often present in some degree, and is usually of a quiet type. Drinkers may develop delirium tremens. Convulsions are rare. They may occur at the onset, or when occurring later may be due to cerebral thrombosis, encephalitis, or meningitis. Multiple neuritis or neuritis of such nerves as the ulnar may supervene, in the latter case often due to pressure. Acute tenderness of the toes during convalescence is also attributed to neuritis. During the course of the fever hemiplegia or aphasia may supervene. Sometimes there are signs of sclerosis of the lateral columns of the cord, the knee-jerks being increased, and an extensor plantar reflex present.

Mental disturbance is occasionally a sequel, taking the form of mania, melancholia or dementia. For many months after a severe attack the patient may remain in a fatuous condition but ultimately recover.

As regards the special senses, temporary deafness is often noticeable during the fever, and sometimes suppurative otitis occurs. Double optic neuritis is a rare complication and may lead to blindness.

Osseous and muscular systems.—During convalescence localised periostitis of the tibia, sometimes of the femur, ribs or other bones may appear. It may terminate in suppuration with limited necrosis. The inflammation is chronic and relapsing. Typhoid bacilli may persist in the discharge for long periods. A painful inflammatory affection of the ligaments and vertebral periosteum is the basis of the "typhoid spine." The lumbar and sacral regions are chiefly involved, with stiffness and pain on movement. The condition is chronic, but the ultimate outlook is said to be good. Arthritis of large joints is a rare occurrence; it may lead to dislocation of the hip.

Rupture of the rectus abdominis, sometimes of the adductors or other muscles, may take place. It is attributed to myositis and is accompanied by local hæmorrhage. The resulting fluctuating and discoloured swelling may clear up or go on to suppuration.

Cutaneous system.—Abscesses and boils may prove troublesome, particularly in children. Lineæ atrophicæ may form in the skin of the abdomen and thighs. In severe cases pressure sores may appear on the sacrum, the heels or other pressure points. These bed sores are a source of danger from septicæmia or pyæmia.

Diagnosis.—It is unnecessary to recapitulate all the symptoms already described as characteristic. Of the symptoms of onset, headache, slight epistaxis, disturbed sleep, a mild degree of bronchitis, abdominal uneasiness and some disturbance of the action of the bowels are very suggestive. Gradual daily increase in the pyrexia and its maintenance after the lapse of a week at a steady level of 103° or 104° F., with slight morning remissions, is important. Relative slowness of the pulse and the presence of dicrotism are additional diagnostic points. The dry furred tongue, slightly tumid abdomen, moderately enlarged spleen and the appearance of rose spots are confirmatory.

Special Diagnostic Methods.—1. *Blood culture.*—This is particularly valuable in the first week before the agglutinative reaction has appeared or the rose spots are evident, but is also applicable during the second and third weeks and in relapse. Ten to 20 c.c. of blood drawn aseptically from a vein

at the bend of the elbow are allowed to run directly into plenty of broth or peptone solution or, better, into a medium which contains filtered bile or bile salts.

2. *Cultures from the stools.*—Owing to the presence of other intestinal bacteria this is not always an easy process, but by improved methods bacilli have occasionally been found during the incubation stage and in over 50 per cent. of the cases examined in the first week, a percentage increased to 70 or 80 in the third week. For methods, works on bacteriology should be consulted. Stool culture is also of value for the detection of intestinal carriers, and for determining whether a convalescent is fit to mix with other members of the community. The discharge of bacilli often being intermittent, more than one examination is necessary.

3. *Cultures from the urine.*—The typhoid bacillus hardly ever appears in the urine before the tenth day, and as a rule not before the fifteenth. The infected urine is generally opalescent and slightly albuminous. Cultures are made without difficulty and are useful not only for diagnosis but also for the detection of urinary carriers.

4. *Agglutination tests.*—Towards the end of the first week of the disease the blood serum becomes capable of agglutinating the typhoid bacillus. This power usually reaches its maximum about the eighteenth or twenty-first day. Blood is obtained from the lobe of the ear or elsewhere, received into a small glass tube and sealed. The serum which separates is mixed in various dilutions with a young (18 to 24 hours) broth or agar culture of the typhoid bacillus and a hanging-drop preparation made. Controls are indispensable. Agglutination of 1 in 50 with a time limit of one hour is usually taken as the positive standard. The bacilli first lose their motility and then aggregate into small clumps. The macroscopic method of applying the test allows the bacilli to sediment in flakes at the bottom of small tubes; Dreyer's method in which standardised dead cultures are used is the best; it is quantitative.

Normal blood serum does not show an agglutinating power greater than 1 in 10 or 1 in 20. The test is complicated by the development of co-agglutinins in other infections of the typhoid group. For instance, the serum of a patient infected with a paratyphoid bacillus may exert some agglutinative power on the typhoid bacillus. In such cases agglutination should be tested at short intervals and its degree noted in the case of both organisms, but more exact information is obtained by isolation of the infecting organism by blood culture. After anti-typhoid vaccination agglutinative power is developed in varying degree and persists for months or it may be for some years. In a person already inoculated against typhoid, agglutination is only important as evidence of infection if it be obtained in a dilution of at least 1 in 100.

5. *The atropine test of Marris.*—In typhoid and paratyphoid fevers atropine has but little power of accelerating the pulse. The patient lying quietly, the normal pulse rate is ascertained, being taken every minute until steady; about 10 minutes is required. A hypodermic injection of $\frac{1}{80}$ grain of atropine is then given. After 25 minutes, to allow time for the full effect of the drug, the pulse rate is again taken and recorded minute by minute until the temporary acceleration has ceased—15 to 20 minutes may be needed. If the pulse rise more than 20 beats, typhoid or paratyphoid is unlikely, but

if the rise does not exceed 10 beats the infection is probable. The reaction is most constantly observed in the second week. When the pulse is fast, the test is not so reliable, nor is it constant in those over 50 years of age.

6. *The Diazo reaction.*—A saturated solution of sulphanilic acid in 1 in 20 hydrochloric acid and a fresh half per cent. solution of sodium nitrite are required. Equal quantities of urine and sulphanilic solution are mixed in a test tube and a couple of drops of the nitrite added. By shaking, a froth is induced and ammonia is allowed to trickle down the side of the tube. If the froth become rose pink and the liquid turn crimson, the test is positive. The reaction may sometimes be obtained as early as the fourth day, and persists during the height of the fever. Unfortunately it also occurs in measles, typhus fever, scarlet fever, pneumonia, tuberculosis and erysipelas.

DIFFERENTIAL DIAGNOSIS.—Prominence of respiratory symptoms in typhoid fever may lead to the infection being overlooked. Conversely a deep-seated or apical *pneumonia*, or, in children, broncho-pneumonia with intestinal disturbance, may simulate typhoid. Careful and repeated physical examination, blood culture and agglutinative reactions will lead to a correct diagnosis. When typhoid is prevalent, caution is necessary in arriving at a diagnosis of primary bronchitis, pneumonia or broncho-pneumonia.

Differentiation from *acute miliary tuberculosis*, from *tuberculous meningitis* and from *tuberculous peritonitis* is often difficult. Acute miliary tuberculosis may simulate typhoid in its insidious onset with malaise and headache, its rising temperature with morning remissions, its comparatively slow pulse, its bronchitis, and perhaps some enlargement of the spleen. But the temperature tends to be more irregular, sweats are present, the dyspnœa and cyanosis are suggestive, and signs of pleurisy may develop. There are no rose spots, and agglutinative tests and blood culture give negative results (tubercle bacilli are rarely found). Tuberculous meningitis is differentiated by such symptoms as vomiting, convulsions, the persistence of headache after the first week, or when delirium is established. A pulse hardly raised above the normal rate, stiffness and retraction of the neck, the presence of Kernig's sign and of retraction of the abdomen or the onset of ocular paralysis are very significant. The irritability and curled-up decubitus of meningitis contrast with the apathy and dorsal decubitus of typhoid. Lumbar puncture will clinch the diagnosis; in tuberculous meningitis lymphocytes are in excess in the cerebro-spinal fluid, and sometimes tubercle bacilli may be demonstrated. The question of meningo-typhoid has already been discussed. Tuberculous peritonitis may resemble mild typhoid fever. The presence of tuberculous masses in the abdomen or the development of peritoneal or pleural effusions is significant. In cases with indefinite symptoms and no signs of tubercle elsewhere, negative blood culture and agglutination tests afford assistance.

Suppurative and pyæmic conditions may give rise to fever and constitutional disturbance bearing some resemblance to typhoid. Among these must be mentioned appendicitis and the intraperitoneal abscesses which may result from it, perinephric abscess, cholecystitis, pelvic, or puerperal infections, infective endocarditis and deep-seated osteomyelitis. The diagnosis is made by careful attention to the history of onset and course, thorough and complete physical examination, and the frequent presence of a pronounced polynuclear

leucocytosis. Profuse sweats and rigors are more likely to occur, and the temperature chart is more irregular. The blood serum fails to agglutinate typhoid bacilli, nor can they be obtained by blood culture, which may, however, reveal the presence of other organisms.

Typhoid fever in its early stages is often mistaken for *influenza*, but in the latter the onset is generally sudden and the early symptoms are more severe. The temperature reaches its maximum much sooner. The pains in the limbs and the backache are more intense, and the headache, which has a neuralgic character, is frequently supra-orbital. Catarrh of the conjunctivæ and nose may be present, and perspirations are often marked. Defervescence usually takes place within a few days. A sharp drop of temperature after 2 or 3 days with a sudden rebound 12 or 24 hours later is very characteristic. If a supposed influenzal fever persist without definite cause, typhoid should be suspected.

A mild case of *typhus* may bear a close resemblance to typhoid, and severe typhoid with grave toxæmia, stupor and a profuse eruption may be mistaken for typhus. Points in favour of the disease being typhoid are a slower onset, the later appearance of the eruption, which is never petechial, and the presence of bowel symptoms. Typhus, on the other hand, has a sudden onset with high fever which sooner attains its maximum and does not show morning remissions. Conjunctival injection, contracted pupils and a drunken expression are the rule. The rash appears on the fourth day, becomes petechial and is accompanied by subcuticular mottling. Prostration is marked and there is a greater tendency to delirium and stupor. Crisis occurs about the fourteenth day. The Weil-Felix reaction is present, but agglutination tests for typhoid are negative.

Undulant (Malta or Mediterranean) fever is distinguished from typhoid by its relapsing character, the prominence of arthritic pains and joint swellings, and the fact that the blood agglutinates the *Micrococcus melitensis*, which organism can also be recovered by blood culture. Closely allied to this is the fever produced by *B. abortus* of cows.

When *malarial fever* assumes the continuous type, which is likely to occur with the malignant infections, the diagnosis turns on known exposure to malaria, sudden onset, the detection of malarial parasites in the blood and the reaction to quinine. Malaria and typhoid fever, however, may coexist.

The fever of *secondary syphilis* is sometimes sufficiently severe to suggest typhoid, especially when accompanied by headache, malaise and muscular pains. Diagnosis depends on the history or detection of a primary lesion, the possible presence of a secondary roseolar eruption and on laboratory tests.

Amongst other diseases at times confounded with typhoid must be mentioned glanders, trichinosis, fever due to *Ascaris lumbricoides*, scarlet fever in which pyrexia is prolonged, and especially other fevers of the enteric group, *i.e.* paratyphoid A, B or C.

Prognosis.—Taking all ages, the death-rate varies from 5 to 25 per cent. It is higher in some epidemics than in others. The average hospital death-rate in London is 17 per cent. or a little less. Age has a decided influence on the mortality, which is least in children under 10, after which there is a steady increase with advancing years. Infants are believed to stand the

infection very badly. Obesity, alcoholism, privation and fatigue are adverse factors. The influence of pregnancy has already been discussed. Indications of a grave attack are a pulse rate of 130 or 140, cyanosis with signs of myocardial weakness and hypostatic congestion of the lungs; marked delirium and subsultus or actual coma, persistent diarrhœa, tympanites, incontinence of urine and fæces. A temperature of 103° or 104° F. is not necessarily unfavourable unless it is sustained beyond the usual period or accompanied by signs of heart failure. Delayed appearance of the agglutinative reaction in some instances indicates a severe attack.

Of the complications, perforation is the most grave. Without operation it is almost invariably fatal. With operation the recovery rate is difficult to fix—some surgeons claim success in over 30 per cent., but the intervention must be immediate. The average recovery rate is very much lower. Hæmorrhage from the bowel is undoubtedly serious, especially if repeated. Such complications as meningitis, lobar pneumonia and acute nephritis are dangerous but fortunately not very common.

Sudden death sometimes occurs, either at the height of the fever or in convalescence. It may be caused by intense toxæmia and myocardial failure, cardiac or pulmonary thrombosis or pulmonary embolism. Rarely no definite cause can be assigned.

Treatment.—*Prophylaxis.*—Patients suffering from typhoid fever should be isolated. Since the bacilli are found in the fæces, the urine, the pus from abscesses, the vomit and the sputa, adequate disinfection of these is necessary. Blood discharged from the nose or bowel should also be looked upon as infectious. Equally essential is the disinfection of the bedclothes and personal linen of the patient, the feeding utensils, thermometer, bed-pan, urinal, spittoon and enema syringe. The stools and urine should be mixed with an excess of some such disinfectant as carbolic acid or corrosive sublimate, and allowed to stand for several hours before being thrown down a drain. The sputa should be received in small cloths which can be burned, or expectorated into a disinfectant solution. The clothing and bedclothes of the patient should be soaked in a 1 in 20 solution of carbolic acid before being sent to a laundry.

Nurses in attendance should submit to prophylactic inoculation and take special precautions for their own safety. Overalls will obviate soiling of the clothes. If the bath treatment be adopted, rubber aprons which can be carbolised are advisable. Rubber gloves may be worn when giving enemas or touching bed-pans and urinals, but always it should be realised that typhoid acquired by contact is a disease conveyed by unclean hands, and the danger may be obviated by washing with plenty of soap and water after touching the patient or anything which has been in contact with him. Mere splashing the fingers in a bowl of disinfectant is useless. The nurse will see that everything leaving the patient or used by him is sterilised at once. Feeding utensils should be boiled after use.

In most cases the bacilli rapidly disappear from the excreta in convalescence, only persisting for a few weeks, but bacteriological examination several times repeated affords the only reasonable proof of safety. About 5 per cent. of those attacked become carriers. In most the carrier state is temporary and an arbitrary period of 3 months is allowed before the condition is deemed chronic. Intestinal carriers are more common than urinary

carriers. In both the discharge of bacilli may be intermittent. Symptoms referable to the gall-bladder and periodic bowel disturbance occur in some intestinal carriers, and urinary carriers in like manner may suffer from kidney trouble or cystitis.

Carriers are often responsible for the endemic persistence of typhoid in certain houses or localities and are particularly dangerous when employed in the preparation of food or in dairy work. They should be prohibited from following these occupations. Since they may spread infection by contaminating their own hands during defæcation or micturition they should be scrupulous in washing after attending to the calls of nature and have towels reserved for their own use. Their soiled bed and body linen must be disinfected. Medical treatment by the use of intestinal and urinary antiseptics, surgical by excision of the gall-bladder, and treatment by autogenous vaccines have up to now alike failed to solve the problem of the chronic carrier. Preventive inoculation of contacts is the most effectual method of limiting their danger and is adopted in special circumstances. Some carriers give no history of an attack of typhoid and may themselves ultimately develop an attack of the fever or suffer from typhoid septicæmia after operations on the gall-bladder or kidney.

A pure water supply and an efficient system of drainage are important factors in the prevention of typhoid epidemics. When the disease is prevalent, drinking water and milk should always be boiled, and travellers in localities where it is endemic should adopt similar precautions. Uncooked vegetables and, in particular, radishes, salads, cress, tomatoes, cucumbers, strawberries and other fruits are liable to contamination. Oysters and other shell-fish should be avoided unless their source is known to be above suspicion. The disease has been contracted by bathing in sewage-contaminated water.

Prophylactic vaccination.—Immunity can be artificially induced by vaccination with typhoid vaccine. There are several methods of preparation of vaccine, one of which is to heat a 48-hour broth culture to 58° C., and complete the sterilisation by the addition of 0·5 per cent. lysol. Exposure to higher temperatures diminishes the potency of the vaccine. The number of bacteria in the first dose is 500 million, a double dose is given 10 days later and repeated 10 days later still. The injection is made subcutaneously and preferably not after a heavy meal or exposure to fatigue. A mild local reaction and sometimes constitutional symptoms may occur a few hours after injection, hence the patient should rest. If the patient be already infected the reaction may be more severe. The duration of the immunity conferred is said to average 1 to 2 years and to be proportional to the dosage employed. It is believed that an individual inoculated at the beginning or even in the middle of the incubation period of typhoid has a good chance of escaping the fever. For army purposes, triple or quadruple vaccines of the organisms of typhoid and paratyphoid are largely employed.

General.—In the absence of efficient sera or vaccines there is at present no specific. Skilful nursing and a suitable diet are of the first importance. The room should be kept at a temperature of 60° F., and the bed narrow and of a convenient height. A hair mattress should be covered with two folds of blanket and a waterproof sheet over which is placed a sheet, and under the hips a draw sheet. A water-bed is unnecessary. A sheet and

coverlet with a blanket over the feet are usually sufficient covering. Night and morning the patient should be sponged with tepid water, and parts exposed to pressure should be rubbed with methylated spirit and dusting-powder applied. Rucking of bedclothes should be avoided. The urinal and bed-pan should be used in the recumbent position, and the buttocks sponged, dried and powdered after each motion. The mouth should be cleansed after each meal with boroglyceride solution or a weak alkaline carbolic wash. From time to time it may be advisable to move the patient from the dorsal position to avoid hypostatic congestion of the lung bases. Stools and urine should always be reserved for inspection by the medical attendant, who should never neglect daily examination of the abdomen, and should also satisfy himself that the patient, especially if restless, has not retention of urine. The temperature and pulse should be charted 4-hourly, and more frequently should complications be suspected.

Milk is the most suitable diet for patients in the acute stages. It should be given in measured quantities at 2- or 3-hourly intervals, the patient not being disturbed at night should he be sleeping. Three pints a day is, despite theoretical considerations, quite sufficient. The milk may be diluted with barley water or lime water, and plenty of plain cold water allowed between the feeds. Aerated waters are best avoided, but tea may be allowed or lemonade made with dilute hydrochloric acid and syrup of lemons. Should intestinal discomfort occur or curds appear in the motions the milk may be citrated or whey substituted. Beef-tea and meat extracts, being laxatives, are to be avoided in diarrhœa or hæmorrhage. A pint of beef-tea is ample. Carbohydrate can be added to the diet in the form of cane sugar or maltine, or an ounce of glucose may be allowed in warm water during the day. A form of soluble casein, such as plasmon, may be used to fortify the milk.

When the temperature has been normal for 3 days, cautious additions may be made, beginning with thin custard or grated bread-crumbs and milk, and then adding a small quantity of boiled or steamed fish, thin bread and butter, and so on.

A more liberal diet during the acute stage is advocated by some, *i.e.* milk puddings, custards, eggs, vegetable or meat soups strained and thickened with arrowroot or flour, finely minced lean meat, bread crumbs and mashed potato. Such feeding is said actually to diminish the tendency to perforation and hæmorrhage, and to hasten convalescence. It is not suitable in severe attacks or for patients with profound toxæmia and deficient digestive secretions. Alcohol is rarely necessary, but it is unwise suddenly to deprive alcoholic patients of all stimulants, and a moderate allowance of brandy or good whisky is by many held to be beneficial in cases of severe prostration with weak pulse, hypostatic congestion of the lungs, delirium and tremor. There is no advantage in giving more than 4 or 6 ounces in 24 hours, and it should be given in small quantities diluted. In children it is quite unnecessary. The use of chewing-gum will encourage flow of saliva and help to keep the mouth in a healthy state.

Of special methods of treatment, three require consideration: the antipyretic, the antiseptic, and the eliminative.

The antipyretic method assumes that pyrexia itself is harmful. The cold bath is most efficient, but has never gained a great vogue in England. When-

ever the temperature rises above 102°·3 F., the patient is lifted into a bath at 65° F. and immersed for 15 minutes, shivering being disregarded. The limbs and trunk are rubbed whilst in the bath. The patient is then removed, laid on a blanket, dried and lightly covered. A little alcohol is given immediately before or after the bath. Immersion is repeated every 3 hours unless the temperature remains below the point mentioned. Contra-indications are hæmorrhage from the bowel, severe abdominal pain, venous thrombosis or great prostration. The method needs good attendants, and can hardly be applied in private, but it is said to reduce the case mortality by a half or even two-thirds. In place of the bath, tepid, cold or ice sponging may be adopted when the temperature is high or the cold pack used, especially when nervous symptoms are pronounced. The ice cradle is another useful means of refrigeration; the patient is covered with a sheet, and a cradle, in which small bags of ice are suspended, is placed over the body, the whole being covered with a thin blanket. The cradle may remain in position indefinitely, the effect on the temperature being carefully watched.

Of antipyretic drugs, the most important are quinine, phenazone, acetanilide, phenacetin and acetyl-salicylic acid. They are recommended for occasional use only.

The antiseptic mode of treatment was adopted when it was unknown that typhoid was a true septicæmia and not a local bowel infection. Antiseptics, however, by diminishing fermentation, may check diarrhœa and prevent tympanites. Many have been used, but those which have the best reputation are sulphurous acid, oil of turpentine, and a mixture of quinine and nascent chlorine as advocated by Burney Yeo. Dr. Foord Caiger strongly recommends the use of oil of cinnamon throughout the disease, the dose being 2½ to 5 minims every 2 hours in an emulsion or in cachets.

Eliminative treatment by the administration of purgatives is now rarely adopted, but during the first week of the disease the administration of calomel in 3-grain doses, followed some 7 hours later by irrigation of the colon with warm water, may be beneficial.

Constipation should be met by a simple enema every second day. *Diarrhœa*, if accompanied by curds, calls for reduction of the milk. A starch and opium enema is useful, or 10 grains of Dover's powder by the mouth. In *hæmorrhage from the bowel* the most absolute rest is essential. Food should be reduced to a minimum or withheld for 12 or 24 hours. No stimulants or beef-tea are permissible. Ten minims of laudanum or a hypodermic injection of ¼ grain of morphine should be given, and an ice bag applied to the right iliac region. A watch should be kept for signs of perforation. Intravenous saline infusion, or, better, transfusion of blood, may be necessary in severe cases. The injection of a solution containing 1 grain of chloride of calcium in 10 minims of water into the gluteal region is worth a trial. *Perforation of the bowel* calls for immediate operation, no delay is permissible. *Meteorism* may be controlled by reducing the diet, administering enemata of hot water, and inserting the rectal tube. A turpentine stupe or ice poultice may be applied to the abdomen. Turpentine by the mouth or by enema, and oil of cinnamon are useful. For *delirium*, *sleeplessness* and *headache*, the reduction of temperature by sponging or cradling and the administration of 10 or 15 grains of Dover's powder should be tried. Sometimes trional or chloralamide is effectual. *Circulatory failure* is combated by strychnine hypodermically

or by injection of camphor dissolved in oil or ether. Strophanthus and digitalis are of doubtful value. Alcohol is strongly advocated by some physicians. Adrenalin also is of use. The supervention of *femoral thrombosis* calls for strict immobility of the limb. The intravenous injection of 5 or 10 ounces of a sterile 0·5 per cent. sodium citrate solution relieves the pain, and is said to arrest the progress of the thrombosis. *Bacilluria* and *cystitis* are treated by hexamine in 10-grain doses, 3 or 4 times a day. Of the suppurative and septic complications, *periostitis* may be influenced by rest, local applications and typhoid vaccine, but suppuration calls for surgical intervention. *Parotitis* usually comes to incision. *Cholecystitis* may subside, but if it persists operation becomes necessary. Crops of *boils* call for local treatment, and the appropriate vaccine should the organism be identified. The intramuscular injection of colloidal manganese is useful in such conditions. The infectivity of the purulent discharge should be remembered.

PARATYPHOID FEVER

Ætiology.—Paratyphoid fevers are, like true typhoid, ubiquitous in their distribution, but the prevailing type is different in different countries and in different climates. Paratyphoid A is prevalent in India and other tropical countries. The experience of the Great War led to the suspicion that it may have been endemic, although unrecognised, in the Mediterranean area, and perhaps also in France, Flanders and Germany. In European countries, however, paratyphoid B is the more common type. Paratyphoid C occurs in the Balkans, and possibly there are also other varieties. *Bacillus paratyphosus* A and *B. paratyphosus* B are organisms which under natural conditions only attack man. *B. paratyphosus* C is by some considered identical with *B. suipestifer*, the hog-cholera bacillus.

The greatest incidence of paratyphoid is in the summer and early autumn, but it may occur at other seasons of the year. It is more prevalent in hot countries, and all ages are susceptible. In ordinary circumstances it affects both sexes equally.

The primary source is a patient suffering from an attack, or a carrier of the bacillus. Contagion, as with typhoid, may be direct or indirect through food, drinking water, fomites, etc. The fact that infected meat, particularly pork, may induce symptoms resembling paratyphoid fever should be borne in mind.

Symptoms.—The *clinical manifestations* of paratyphoid infections are practically indistinguishable from those of typhoid fever, but the belief is generally held that paratyphoid differs from typhoid in its milder character and shorter course. This is on the whole correct, but marked exceptions occur. Occasionally paratyphoid infection is said to produce an illness which resembles acute irritant poisoning, or so-called ptomaine poisoning. But such infections are more likely to be caused by *B. aertrycke*, which in its agglutination reactions closely resembles *B. paratyphosus* B. In true paratyphoid the subsequent course is clinically unmistakable.

The septicæmic stage of paratyphoid is of short duration, rarely lasting more than a week, hence blood cultures for diagnostic purposes should be

taken as soon after the third day as possible. The distribution of the infecting organisms in the body is similar to that of typhoid, and they are discharged in the fæces, the urine, the bronchial secretions, and the pus of suppurating foci.

The *incubation* period varies from 9 to 15 days, but may be shorter.

The *onset* is more often insidious than sudden, the invasive symptoms resembling those of typhoid, but a sudden onset is believed to be more common than in the latter disease. Shivering and vomiting are not infrequent symptoms of such invasion. Sometimes gastro-intestinal symptoms are for a time very prominent. As with typhoid; appendicitis, meningitis, or pneumonia may at first be simulated. Sometimes the disease declares itself after several weeks of premonitory diarrhœa, or it may closely resemble dysentery.

The fever attains its maximum sooner than in typhoid, and may be at its height by the third or fourth day, by which time, if not before, the patient will have taken to bed with symptoms suggesting typhoid of a week's duration. The head aches, the patient is apathetic, and the spleen is generally palpable and sometimes tender. The liver may be slightly enlarged, and the gall-bladder tender if cholecystitis be present. The abdomen is generally somewhat tumid, but marked distension is uncommon. Diarrhœa may occur at the onset, but constipation is more common. Sweating is often a more pronounced feature than in typhoid. Rose spots are present in unusual profusion in some cases. They usually appear towards the end of the first week. In size, too, they often appear larger than those seen in ordinary typhoid infection, and the rash may continue to come out after the temperature has fallen. Pulmonary complications are mild, but bronchitis and broncho-pneumonia may occur. In the more severe cases, the heart may show signs of dilatation. It is exceptional for the patient to pass into the "typhoid state." The fever has a shorter duration than in typhoid. Within a fortnight, sometimes sooner, it has generally fallen by rapid lysis to normal. The slow pulse and low blood pressure of typhoid are also seen in the paratyphoid variety. Relapse is said to be just as frequent.

Complications.—Intestinal hæmorrhage is much less common and less severe than in true typhoid. Perforation is rare. Thrombosis of the femoral or saphenous veins or their radicles is not uncommon, and broncho-pneumonia or pleural effusions may occur. Cholecystitis and catarrhal jaundice may be due to paratyphoid organisms, as also bacilluria, cystitis, pyelitis and even pyelonephritis. Orchitis is an occasional complication, and is believed to spread from the urinary tract. Other complications, which have mostly been observed in army practice, are laryngeal ulceration, parotitis, periostitis, sometimes suppurative, peritonitis without perforation of the bowel, and pylephlebitis, attributed to lesions of the appendix.

Diagnosis.—For the differentiation of paratyphoid from typhoid infections and of the varieties of paratyphoid from each other, recourse must be had to bacteriological methods, *i.e.* to blood culture, agglutinative reactions and cultures from the stools and from the urine. Of these methods, blood culture in the early stages is the most satisfactory. If agglutination occur in high dilutions with one of the paratyphoid organisms and little or not at all with the others and the organism of typhoid, the nature of the infection is evident; but in other cases the examination has to be repeated at short intervals and the results compared. A rising agglutination for one organism indicates

it as the causal agent. Some infections with paratyphoid C fail to produce agglutinins in the patient's serum.

Prognosis.—The prognosis in paratyphoid infections is better than in those due to the *B. typhosus*, the proportion of severe infections being much smaller. The causes of death are chiefly hæmorrhage, perforation, lung inflammations and toxæmia.

As regards differential diagnosis, prophylaxis and treatment, what has already been said with regard to typhoid applies.

CHARLES R. BOX.

BOTULISM (see p. 395).

BACILLUS COLI INFECTIONS

Amongst the many additions to sound medical knowledge which we owe to the rapid development of the science of bacteriology, none is more striking, or fraught with more practical results in the treatment of disease, than the information which has led to our present-day conception of the nature and extent of *Bacillus coli* infections. Our knowledge of the pathogenic effects of this group of micro-organisms has entirely remodelled our views in regard to many disease-processes which were recognised, but were formerly ill-understood. And, in addition, disease-processes which were formerly quite unrecognised have been brought to light.

The beginnings of such knowledge date from the isolation of the typhoid bacillus in 1880, and the isolation, five years later, of the *B. coli communis* from the healthy intestine. Continued and extended observations, made possible by the introduction of newer differential bacteriological methods, have resulted in the recognition of a large and important group of bacilli, called the *B. coli group*, including members which differ as widely in pathogenicity as these two originally described bacteria, but also including the organisms of bacillary dysentery, Gaertner's bacillus of food-poisoning, the paratyphoid organisms, and a number of variants of *B. coli* whose differentiation still proceeds. The group is as large and as complex as the streptococcus group in which, similarly, are recognised the virulent *S. pyogenes* at one extreme and the feebly pathogenic *S. fæcalis* at the other.

We are still, however, a long way from getting a full conception of the rôle played by *B. coli* in disease. In many cases we are quite unable to decide whether the presence of the bacillus in a situation which it does not normally inhabit is the causative factor in a patient's illness. To assume that it is, without good evidence, may involve an important fallacy, and may lead to our overlooking another, and more responsible, factor. It is certain that *B. coli* may be found in some abnormal situations, as in the urinary bladder, in persons who enjoy good health. The microbe has become, as it were, saprophytic there. But such a state of things must at least be regarded as having potential pathogenic effects.

MODES OF INFECTION.—In health, *B. coli* are confined to the intestine. The modes of infection of parts of the body other than the bowel are at times very apparent, at others obscure. Of any particular tissue there are three

possible routes of infection: (1) The *direct* route, that is, by the immediate transference from the bowel to the infected area; (2) by the *lymphatics*: and (3) by the *blood stream*. In some infections, *e.g.* of the gall-bladder, pericolic tissues, pelvic cellular tissue, etc., the direct route is no doubt the one generally followed. Of the two indirect routes, however, some doubt exists as to the more likely one in certain cases, such as infection of the urinary tract especially; in some instances of this latter important condition, it is clear that invasion takes place again, directly, through the urethra. The cystitis which still occasionally follows the use of the catheter illustrates this; and the greater frequency of *B. coli* cystitis in little girls than in little boys has been adduced in favour of this route. In the acute pyelitis complicating or following typhoid fever, it is highly probable, though not certain, that infection proceeds via the blood stream to the kidney, and thus to the pelvis. But in those acute primary infections of the urinary tract, which are so common in both sexes, the mode of entry of the bacillus to the kidney pelvis is problematical.

Sites of Infection.—The sites of infection by *B. coli* are very numerous. Mention will only be made here of those which form the basis of important disease-processes which demand recognition and treatment in practice.

1. The *bowel* itself may be the site of infection. This may take place (*a*) because the infecting strain of *B. coli* has absolute pathogenic qualities; or (*b*) because the virulence of one or more of the usually saprophytic strains is increased; or (*c*) because the resistance of the mucosa is lowered by chemical or physical changes or by infection by another pathogenic microbe. From one or more of these factors acute or chronic *enteritis*, *entero-colitis*, or *colitis* may ensue. Gaertner bacillus poisoning, the result of eating contaminated food, is an important instance of (*a*), and perhaps also of (*c*) combined with (*c*). Some cases of *cholera nostras* appear to be due to *B. coli* infection, and probably most sporadic cases of acute colitis. There is no great obscurity attaching to these infective processes. In a consideration of many cases of *chronic colitis*, however, the exact rôle of *B. coli* is very obscure indeed; and this, even when we exclude a large number of cases of bowel defect to which the name *colitis* should never be applied at all. It is probable that many of the patients said to be suffering from *intestinal intoxication* are in reality the subjects of subinfection by *B. coli*. But at present our criteria for judging accurately of such a condition are lacking. Mere qualitative bacteriological investigations of the fæces in such cases yield at most presumptive evidence, and quantitative investigations take us very little farther. We await some method of estimating tissue infection by the coliform group more constant than agglutination, which is rarely present in chronic cases, and is, therefore, of little use as a guide.

2. *Gall-bladder sepsis* is closely associated with *B. coli* infection. It is commonly held that sub-infection of the gall-bladder by this microbe is one of the important factors in the evolution of cholelithiasis. However this may be, it is certain that *B. coli* is the most frequent infecting agent in *cholecystitis*, both acute and chronic. The fact harmonises with the known frequency of gall-bladder infection during typhoid fever.

3. *Appendix inflammations, diverticulitis, pericolic suppuration* and local peritonitis complicating intestinal conditions, are all of them associated with *B. coli* infection, and in many instances with this alone.

4. The *urinary tract* is infected with great frequency, with how great frequency we are only now realising, as the result of systematic cultivation of the urine in doubtful cases of the condition, and in obscure cases of illness in which no such condition is at first suspected. It is important to note, however, that the mere presence of *B. coli* in the urine—it is assumed that catheter specimens only are being dealt with, or that, when this is not the case, there is good evidence that the bacilli actually come from the bladder—does not establish an actual urinary tract infection. *B. coli* in the urine may signify one of either of the following conditions: (*a*) The elimination of the bacilli from the body through the kidney, without infection either of this organ or of the urinary tract: this process is usually of brief duration, and may be intermittent. (*b*) The excretion of bacilli (with pus) from an infected kidney or from some focus of infection adjacent to the urinary tract (prostate, urethra, pericolic tissues). (*c*) True infection of the urinary tract (pyelitis, cystitis, pyelo-cystitis). (*d*) Bacilluria.

Concerning (*a*) and (*b*) no more need be said in this place, but (*c*) demands more consideration.

B. Coli Infection of the Urinary Tract.—The cases met with may be conveniently described as falling into three groups.

(i.) *Acute cases.*—In the majority of these cases the infection appears to arise in the pelvis of the kidney; some are undoubtedly vesical in origin; in not a few it is uncertain where the infection begins. The disease is at times quite fulminating in its acuteness, being ushered in by rigors, high fever (103° to 105°), delirium and great drowsiness. More often the symptoms are abrupt and severe, but not alarming. There may be pain and tenderness in the loin, and one or other kidney may be tender under bimanual examination. But in more cases than not there is a striking absence of both physical signs and focal symptoms, so that, unless the existence of the disease is borne in mind, and the urine is examined carefully, the patient is thought to be suffering from "influenza."

In those cases in which the bladder is, from the first, markedly affected, symptoms of *dysuria* are present—frequency, pain and strangury. Such symptoms draw attention, of course, to the nature of the process.

The *urine* shows a great range of variations in its features. There may be a fairly frank *hæmaturia*, a fact which is not so widely known as it should be: *B. coli* infection is the explanation of a large number of obscure cases of hæmaturia. The amount of pus is very variable—it may be very considerable, or it may be represented only by leucocytes seen on microscopic examination. In very severe cases portions of the bladder mucosa may be shed in the form of sloughs, but this is uncommon. Like the pus, the bacilli vary greatly in the degree to which they are present in the urine; in some cases they are so abundant as to constitute by far the greater part of the total sediment. The colour and amount of the urine depend upon the degree of pyrexia and the amount of fluid ingested. Constipation is the rule, the tongue is generally covered by a creamy fur, and anorexia is common. As in so many acute *B. coli* infections, the mental state tends to depression.

The disease is often a strikingly dramatic one in children; there is a maximum of febrile reaction with lassitude and even stupor, and a minimum of serious effect upon the vital organs. It is not very uncommon to see a temperature of 105° or 106°, with big intermissions; the child is very ill

during the pyrexial stage and comparatively well when the temperature falls.

The course of the disease varies much. Prompt recognition of its nature, leading to appropriate treatment, usually results in defervescence and the disappearance of pus and bacilli from the urine in 7 to 14 days. But some of the cases last many weeks; it is fair to say that this is not seldom due to failure to diagnose the condition, or to employ efficient measures of treatment.

Relapses are very common. Of *complications*, *prostatitis* is perhaps the one most often seen; *epididymitis* occurs less often, but is a very definite condition; *urethritis* may occur. It is interesting to record that epididymitis may be the first symptom of the disease.

(ii.) *Recurrent cases.*—A not uncommon type of case is that in which symptoms of acute or of subacute infection occur at intervals over a number of years, the condition of the patient and of the urine being natural between the attacks. Recurring hæmaturia, thought to be due to acute nephritis, to tuberculosis or to calculus, is sometimes due to this condition. The probable source of these re-infections in any individual case is the colon.

(iii.) *Chronic cases.*—These are either (*a*) the sequelæ to acute attacks that have never completely resolved; or (*b*) they arise insidiously; or (*c*) they follow instrumental procedures or operations upon the urinary tract; or (*d*) they complicate mechanical defects, such as stricture and enlarged prostate; or (*e*) they occur as secondary infections in cases of renal or vesical calculus or of tuberculosis.

The symptoms in these chronic cases vary greatly. In one group it is the general toxic state that is the main feature—a sallow complexion, loss of tone, a low blood pressure, colon dyspepsia, headache and backache. In another group the local symptoms predominate—increased frequency of micturition, which may be extremely trying, pain during or after the act, and referred pain and discomfort in the vesical zone. In a third group there is little or no interference with health, general or local; but a vivid realisation of the existence of the condition troubles the patient's mind, leading sometimes to a state of bladder neurasthenia.

The urine in chronic infections shows as much variety as do the symptoms. The characteristic "fishy" odour is rarely absent; the reaction is generally acid, the amount of pus present may be very little or may be considerable, but the degree to which the patient is troubled by no means corresponds to the degree of pyuria; mucus is in excess; bacilli are constant and, like the pus, are very variable in quantity. Hæmaturia is uncommon in chronic infections, but it is easily induced by instrumental investigation, as are also "flares-up" of the chronic state, with the production of rigors, high fever, severe malaise and relative anuria. For this reason, careful deliberation is called for in deciding whether or not the bladder should be explored in these cases; and, in regard to exploration of the pelvis of the kidney, extreme forbearance should be exercised.

Bacilluria.—This term is properly applied to a urine which is loaded with bacilli, but in which there is no pus, or, at most, a few leucocytes seen on microscopic examination. It is a state of kidney elimination of bacilli rather than a condition of bacillary infection. It is usually of short duration. The appearance of the urine is characteristic; shimmering when agitated

and viewed by transmitted light. The smell already referred to as so typical of colon bacillus urinary infections is usually present here also.

OTHER SITES OF B. COLI INFECTION.

(i.) *The uterus and Fallopian tubes* are sometimes the site of infection, as in puerperal sepsis; but the infection is then usually a mixed one, with streptococci.

(ii.) Some situations quite remote from the bowel are now and again infected by *B. coli*—the *middle ear*, the *pleura*, the *bronchial tract*, *bones* and *joints*.

B. COLI SEPTICÆMIA, unless it occur as a terminal event, in which form it is not at all uncommon, is rare. When it does occur, however, it is by no means always fatal. Infective endocarditis, due to *B. coli*, is rarer still; the only cases coming under the writer's notice have been of the nature of a terminal infection.

Treatment.—The treatment of cases of *B. coli* infection may be considered under three heads—general, local, and specific measures.

1. *General measures.*—In all acute cases the patient is kept in bed, so as to ensure rest and warmth. Both of these are essential, and even in chronic cases it is of great importance to avoid cold and fatigue. As the *bowel* is the source of nearly all the infections, attention to it is paramount. It is quite impossible to say in how many seemingly unlikely cases the intestine, and especially the colon, will be found to give the clue to treatment, provided the possibility be borne in mind. Especially is this the case in acute and subacute cases. To correct constipation is not enough—constipation may not even be present—efforts must be made to change the bowel contents in such a way that they are no longer so good a nidus for growth of the bacillus. This is best attained by a *diet* which is low in total protein content; meat, eggs and raw milk are excluded entirely; junket, whey, buttermilk and cream being allowed. The following articles of food are also allowed: macaroni, boiled rice, raw and cooked fruit, salads, and lightly cooked green vegetables, jams, marmalade, honey, cold fat bacon and ham, and chicken and white game occasionally. Wholemeal bread and oatmeal porridge are recommended. On such a diet the consistency of the stools soon improves, and they lose their ill-digested appearance; as also mucus and sandy deposit, if these were present. They also become much less offensive to the smell. Plain drinks are encouraged—preferably between meals.

If the case be acute, with considerable pyrexia, the practitioner will generally consider milk the staple food indicated—it is the English doctor's sheet anchor in every acute febrile disturbance; but even in these cases it is often possible to demonstrate rapid progress so soon as the milk is disallowed.

The choice of aperients is of great importance. In acute cases, calomel is very useful combined with salines. In chronic cases, the most helpful form of laxative is of the agar-agar type (regulin, cascagar, jubol), supplemented if necessary by a compound aloin pill. *Bowel "antiseptics"* are worth trying, and, if tried, are worth persisting in. The writer gets the best results with a cachet containing salol, grs. x, hydrarg. cum. cret., gr. ½, given with water, between meals, twice or three times daily. Izal oil in ℥iii capsules may be given with food three times daily. Cyllin and kerol may be given in the same manner.

A course of *high colonic irrigations*, following the Plombières method, is indicated if mucus persists in the stools despite the above measures. Or it may be given as a preliminary treatment, to be followed by them.

In acute cases, with pyrexia, full doses of *alkalis* (sod. bicarb. and pot. cit.) are very helpful, and should be continued until the urine has been alkaline for 3 or 4 days. The *hexamine group* will then do good in proportion as the infection is focused in the urinary tract, and in proportion as the infection is pelvic rather than vesical. In gall-bladder infection these drugs are also of service, so far as clinical experience goes. To get the greatest service from hexamine in urinary tract infections it is best to keep the urine acid. For this purpose it is considered by many that acid sod. phosph. in grs. xx doses is serviceable. It is well to change the hexamine (grs. v to xv well diluted) for one or other of its derivatives now and again, reverting to the hexamine again later: cystopurin = hexamine sod. acetate, grs. xxx; helmitol = hexamine with citrate, grs. xv to xxx. Caprokol (hexyl-resorcin), grs. ii to x, is also useful.

2. *Local measures.*—Local suppurations will, of course, be dealt with surgically. Reference has already been made to associated disabilities in some cases of urinary infection which also require surgical treatment, as also to the care which must be exercised in dealing on surgical lines with those cases of urinary tract infection which may be regarded as primary. In bowel infections a very useful adjunct in treatment is to endeavour by means of posture, massage and efficient supports to improve matters if enteroptosis be present.

3. *Specific measures.*—There remains to be discussed the use of bacillary vaccines. These should always be regarded as supplemental to, rather than substitutions for, the scheme of therapeusis outlined in (1) and (2). In acute cases vaccines should either be deferred until other measures fail, or very small doses of the vaccine should be given—0·5 to 5·0 million at most, and at intervals decided upon by close observation of the course of the disease. In chronic cases vaccines should always be given a good trial. Sometimes the good effects are very striking, at others little or nothing is achieved as the result of vaccine therapy. In cases which are of long standing, and in which constitutional symptoms are absent, vaccines prove disappointing. But their use certainly seems to assist in rendering patients less toxic, in relieving local symptoms, and in protecting against acute exacerbations. In the case of chronic urinary infections these benefits nearly always stop short of the production of a clear and sterile urine. The graduated method of dosage is the one generally adopted; a series of doses ranging from 5 to 250 million, injected at intervals of 7 to 10 days, is a favourite plan. In very chronic and intractable cases the dosage may well be extended beyond this last-named figure—even to 1000 million. *The vaccine should invariably be autogenous in nature.* If second or any subsequent series of vaccine injections be given, these should be prepared from a fresh culture of the infecting bacillus, and the first doses given should be of smaller size than those which concluded the former series.

THOMAS HORDER.

BACILLARY DYSENTERY

Definition.—An invasion of the large and sometimes the small bowel by dysentery bacilli, often occurring in epidemics.

Ætiology.—No country in the world is free. All ages and both sexes are liable. Natives suffer as well as visitors from the disease. In England the disease is common in asylums. The disease is due to bacilli of the dysentery group. Two well-marked varieties or strains are implicated, namely, Shiga's or Flexner's bacillus. (Further varieties of these are also described, Hiss, Y. Strong's bacillus, etc.) These organisms can be cultivated from the stools in acute cases, but it is a much more difficult matter to obtain them in chronic ones, on some days the organisms being present, on other days absent. Later, they tend to disappear completely, though symptoms may persist.

Pathology.—The lesions are those of a diphtheritic catarrh, the condition attacking the mucous membrane of the large bowel and sometimes spreading into the small (entero-dysentery). The first change is hyperæmia, then œdema, then necrosis, resulting in the formation of a diphtheritic membrane, generally distributed, or in patches, and often of a greenish colour. The dead tissue is then exfoliated, ulcerated areas being left behind. Many of these are superficial, their floor being formed by the submucosa, while others extend deeper, exposing the muscular layers. There is no undermining as in amœbic ulcers.

Symptoms.—Various types of intensity of the disease are met with, acute types, chronic types, the entero-dysenteric type, etc. In the acute form the incubation period varies from 24 to 48 hours or longer; the illness generally comes on suddenly, with pain in the abdomen and an increased desire to go to stool, the motions now changing from a fæculent character to mucus and blood. The temperature rises, and nausea, retching and vomiting are also common. There may be albumin in the urine. The general symptoms are due to the absorption of the toxins of the bacilli. Gangrene of the bowel may develop. In mild cases, fever and serious indisposition may be absent. As the patient recovers, the pain and tenesmus gradually diminish, the temperature falls, the motions become fæculent again, and convalescence is slowly established.

Chronic type.—This appears after an acute attack has passed away. The patient may have been quite well for a time, but then a relapse occurs with a return of the dysenteric symptoms. Further attacks succeed, and the condition passes into a chronic stage, with constant disturbance of the bowels, and the frequent passage of blood and mucus. There may be pyrexia; loss of appetite is common, sweating at nights and emaciation also occur. The stools contain fæculent matter, mixed with blood and slime; there may be as many as 6 or 7 stools a day.

Entero-dysentery.—In this type there is usually no tenesmus, and the stools are not so frequent, the blood and mucus being more intimately mixed with the fæces. It is a very serious type, and toxic symptoms are prominent. The temperature is continuously high, the mouth and tongue are covered with sordes, and the patient passes into the typhoid stage and dies.

Complications and Sequelæ.—Liver abscesses do not occur. Peritonitis may follow an attack with subsequent adhesions. Parotitis and arthritis

occur, and peripheral neuritis has been described. The arthritis is most common in the knee joints, but several joints may be affected at the same time. It is similar in some ways to gonorrhœal arthritis (see Section on Arthritis). The condition is due to toxic absorption from the bacilli in the intestine.

Diagnosis.—This has to be made from other forms of dysentery. If protozoa be absent at the first stool examinations, then cultivations must be made for the dysentery bacilli. Microscopically, if the exudate be rich in cells, a bacillary case is likely. It is important that the specimen for cultivation should be freshly passed.

Prognosis.—Bacillary dysentery is a serious disease. In some epidemics the mortality is very high. People in poor condition and semi-starved easily succumb.

Treatment.—*Prophylactic.*—A prophylactic vaccine should be adopted for those liable to infection. So far, however, such vaccines have been too toxic for general use. Besredka's vaccine by the mouth was recently used for the troops in Shanghai, and the incidence of the disease was very slight, apparently as a result (Col. MacArthur). As the disease is chiefly spread by water and food, like enteric fever, prophylactic measures similar to those indicated in that disease are indicated.

Curative.—Rest in bed, suitable diet and hot fomentations to the abdomen are indicated. Albumin water, barley water or rice water should be given at first, then later milk. Flexner or Shiga serum, depending upon the organisms present, should be given as soon as possible in all severe cases. Polyvalent sera are also prepared. Doses up to 80 c.c. or more are indicated in severe cases, and may be repeated if required. For mild cases, salines may be given, such as drachm doses of sodium sulphate every 2 hours or so, till the stools become fæculent again, then less frequently. This often suffices. Rogers' hypertonic salines may be tried in fulminating cases.

For chronic bacillary cases, the treatment is very unsatisfactory. Serum and vaccines do not do much good. Diet is all-important, and may keep the disease in abeyance in ordinary cases. Rectal lavage is valuable. It should be controlled by sigmoidoscopy. Where the whole bowel is badly ulcerated, an appendicostomy, or better, a cæcostomy, is justifiable. The latter allows the escape of fæces by the cæcostomy wound, and so gives complete rest to the affected part. The author has had several wonderful cures by this method. Unfortunately even after such operations the disease may continue. If the patient could stand the operation, removal of the whole of the colon (Arbuthnot Lane's operation) might be tried, thus removing the diseased part *in toto*. It is obvious however, to ensure success, that the small bowel and the rectum must be in a healthy condition. The magnitude of such an operation, combined with the poor physical state of the patient, puts it out of court, however.

For Amœbic Dysentery, see p. 237.

CHOLERA

Definition.—A specific disease due to a specific micro-organism, the cholera spirillum, diffused endemically throughout India, and from there, from time to time, becoming diffused to other parts of the world. The disease

is characterised by violent vomiting, purging, cramps and suppression of urine, followed by a febrile reaction.

Ætiology.—The disease exists endemically in parts of India, its principal focus being the delta of the Ganges and the alluvial plain which lies south of its confluence with the Brahmaputra. From here epidemics of the disease have started, and have spread, by the trade routes, even as far as Europe. There was cholera in the Balkans in the war with the Turks preceding the Great War, and cases are met with in Russia from time to time. All races are liable, as also both sexes and any age. The disease is due to Koch's comma bacillus or spirillum, an organism which has its habitat in the intestines. The vibrio measures 1·5 μ to 2 μ in length and rather less than 0·5 μ in breadth; a single terminal flagellum may be demonstrated. It is motile, stains readily with the ordinary aniline dyes, but loses the stain by Gram's method (Gram-negative). A very characteristic growth takes place in stab gelatine cultures, liquefaction commencing at the upper part of the stab and forming a bubble or bell of air. Indol and nitrites are formed (cholera red reaction). Special bacteriological tests must be carried out, however, before distinguishing the true cholera bacillus from other common vibrios.

Pathology.—The germ in the human subject grows principally in the mucosa of the small intestine. The question whether it produces a toxin or not has been much argued. Some authorities suppose it produces an endotoxin, and this causes the gastro-intestinal disturbances which lead to the passage of fluid from the blood to the bowel. Owing to the drain of serum the specific gravity of the blood rises to as high as 1065, or even higher; the alkalinity of the blood is decreased, and its coagulative power altered; there is also a fall in the blood pressure to 80 or lower. As convalescence is established, there is great risk from invasion of the body with secondary contaminating organisms, cocci, bacilli, etc.

A post-mortem rise of temperature is common. Rigor mortis sets in early and may be very pronounced. The blood is thick and tarry, and when the abdomen is palpated a peculiar sticky feeling is noticed; this is said to be diagnostic. The intestines are collapsed and shrunken and the mucosa is swollen and hyperæmic. The liver is congested; the kidneys swollen, ecchymotic and often in a state of acute nephritis; the spleen small and shrunken; the lungs collapsed, dry and anæmic. The general condition of the viscera, apart from the intestines, points to a severe toxæmia or poisoning.

Symptoms.—Castellani and Chalmers describe 5 types of cholera. (1) *Ambulatory cases* in which, without any signs of disease, the spirillum may be obtained from the fæces; these are genuine carriers of the disease. (2) *Choleraic diarrhœa*, a variety associated with severe purging, and yellow motions containing the specific germ. Recovery may ensue or the condition may pass into a typical attack of the disease. (3) *Cholerine*, where the patient is seized suddenly with severe abdominal pains, passes numerous fæculent motions, followed by typical rice-water stools which speedily cease, and recovery takes place without further symptoms. (4) *Cholera sicca*: the patient becomes rapidly collapsed, and dies before the typical symptoms of diarrhœa and vomiting can appear. The post-mortem and the bacteriological examination of the bowel contents reveal the true nature of the

disease. (5) *Typical cholera, cholera gravis*: the incubation period is from 2 to 5 days.

There are three more or less well-defined stages—(1) The preliminary diarrhœa; (2) the collapse stage; (3) the period of reaction.

1. *The preliminary diarrhœa.*—This stage may set in abruptly, but colic-like pains in the abdomen have usually been present for 1 or 2 days, with some looseness of the bowels. There may be headache, vomiting and depression of spirits.

2. *The collapse stage.*—Once started the diarrhœa increases, profuse liquid evacuations succeeding each other with great rapidity until all faecal and bile-colouring matter disappear, and only a material like rice-water is passed. Cramps of great severity occur in the legs and feet, thirst is excessive and vomiting also results. The patient quickly sinks into a state of collapse, the skin becomes blue, the face pinched and the skin wrinkled like that of a washerwoman's hands. The voice becomes husky, the temperature falls to subnormal and death takes place some 12 to 36 hours after the onset of the attack. The urine is diminished in amount, contains albumin and casts, and uræmia is not uncommon, and is closely associated with acidosis.

3. *The period of reaction.*—If the patient survive the collapse stage and recovery take place, the cyanosis gradually yields, warmth returns to the skin, the heart's action becomes stronger, the stools become less frequent, the urine increases in quantity and the abdominal pains disappear. Even after the appearance of these favourable symptoms, the diarrhœa may return and death take place, or in other cases, a cholera-typhoid stage develops—delirium, rapid feeble pulse, high temperature, oliguria, with subsultus tendinum and finally coma.

Complications and Sequelæ.—The most common of these are pneumonia, enteritis and nephritis. Abscesses and suppurative parotitis also occur, while troublesome cramps in the legs may still persist.

Diagnosis.—During an epidemic this is easy, but when there are only a few sporadic cases it is more difficult. A disease that can be confused with cholera is the cholera nostras or choleraic diarrhœa of temperate climes. The choleraic form of malaria also may simulate cholera closely. It is distinguished from it by the presence of malarial parasites in the blood. Certain poisons produce somewhat similar symptoms—arsenic, perchloride of mercury, ptomaine poisoning and certain fungi. To make certain, the stools must be cultivated, and if the case be true cholera, the specific germ will be found.

Prognosis.—This varies in the different epidemics. The disease is a serious one and the prognosis always uncertain. The mortality varies, from 30 to 80 per cent. As a rule it is worse at the beginning of an epidemic than later when the epidemic is waning. Intemperance, debility and old age are specially unfavourable. The more rapidly the collapse sets in the greater the danger. Cases with marked cyanosis and very low temperature, according to Osler, rarely recover.

Treatment.—*Prophylactic.*—The water supply should be pure. Surface wells and surface collections of water are always dangerous, where natives live, because of their habits of defæcating promiscuously upon the soil. Flies must also be destroyed and prevented from entering houses. All persons before going into cholera areas should have a preventive vaccine. Such inocula-

tions undoubtedly reduce the case incidence, though the case mortality does not seem to be influenced.

Contaminated foods must be avoided. The kitchen must be kept clean, flies must be excluded from the larder, and, preferably, the house should be rendered fly-proof. Milk is always dangerous because of the ease with which it becomes contaminated; it is therefore better boiled. Drinking vessels, eating utensils, plates, cups, etc., should be cleaned, after use, in boiling water only, and then dried by heating or with sterilised towels.

Curative.—During epidemics the bowels must receive careful attention. Diarrhœas and other minor maladies of the stomach and intestines, which often turn out to be cholera, should never be neglected. Salines and strong purgatives should be avoided. Any looseness of the bowels should be treated by astringents, the patient being confined to bed, if necessary. Chlorodyne and other preparations of morphine and opium are invaluable.

The treatment of the attack divides itself into three stages—(1) The invasion; (2) the collapse; (3) the reaction.

1. Antitoxic sera may be tried in this stage. The Japanese believe they have had success by such methods. The patient should be kept strictly in bed, the blinds of the room drawn down, too many bedclothes avoided, and the temperature of the room should be between 70° and 75° F. Macleod recommends for the cramps, moderate and intermittent chloroform inhalations, friction with anodyne liniments, or counter-irritation with turpentine, mustard or camphor liniment. Hypodermic injections of morphine have been tried.

2. During the collapse, failure of the pulse must be energetically met or death quickly takes place. In the early stages alcohol, ammonia or spirit of chloroform may be tried, but preparations should at once be made for intravenous injections of saline. Before this is done an intravenous injection of Rogers' alkaline solution (sodium bicarbonate, 160 grs.; sodium chloride, 90 grs.; water, 1 pint) should be given to prevent the onset of acidosis. Then after this the same authority's hypertonic solution should be employed (sodium chloride, 120 grs.; potassium chloride, 6 grs.; calcium chloride, 4 grs.; water, 1 pint), this being also given intravenously, and the amount required being determined by the specific gravity of the blood—for example, a specific gravity of 1061, 1 pint; 1062, 2 pints; 1063, 3 pints; and so on. These may have to be repeated time after time, until all signs of collapse have disappeared. Glucose or gum acacia injections might also be tried. Potassium and calcium permanganate are recommended by the mouth.

Tomb's mixture of essential oils is alleged to be very efficacious; it may obviate the use of intravenous salines and may relieve suppression of urine.

3. In the reaction stage, any tendency to suppression of urine must be suitably dealt with by poulticing the loins or cupping. For persistent diarrhœa rectal injections of tannic acid may be given. Pneumonia and other complications are to be combated on ordinary principles. The discharges must be disinfected carefully as in typhoid fever and great care must be taken to prevent flies obtaining access to them.

A simple diet should be taken during convalescence, and all over-exertion avoided. A change of air is also indicated with rest from work for a considerable period of time.

G. Carmichael Low.

DIPHTHERIA

Definition.—A disease caused by the Klebs-Loeffler bacillus (*Corynebacterium diphtheriæ*), characterised by a membranous exudate at the site of infection and distinctive sequels of toxæmic origin, the chief being circulatory failure, paralysis and albuminuria.

Ætiology.—Diphtheria is commonest in temperate climes. Human agents are commonly the carriers of the infection and the cause of its endemic prevalence; local conditions, such as dampness, exposed aspects, soil contamination and defective drainage, being merely contributory. In its seasonal prevalence diphtheria closely resembles typhoid and scarlet fever, the maximum incidence falling in the autumn and late winter months. An epidemic tendency is noticeable in years of deficient rainfall, and great epidemics have been preceded as a rule by a series of dry years. Formerly a disease of rural districts, diphtheria is now endemic in most large cities and shows a tendency to local epidemic outbursts. Its heaviest incidence is on children between the ages of 2 and 5 years. New-born infants are rarely attacked. Many cases occur in adults, and rather more females than males are affected.

Catarrhal conditions of the throat predispose to the infection; convalescents from measles and scarlet fever, and in less degree those recovering from whooping-cough and influenza, are liable to contract the disease, which in the case of recent measles or scarlet fever may assume a particularly severe form. A progressive increase in infectivity and severity is often noticed during epidemics. The immunity afforded by diphtheria is short-lived; relapses are not uncommon, and second attacks also occur.

The disease is highly contagious, and infection is by direct or indirect contact. It is seldom air-borne even over a short distance. The organisms reside in the secretions from the nose and throat, in detached shreds of false membrane, and at times in discharges from the ears, the vulva, infected wounds or skin lesions.

Direct infection may result from kissing, or the reception of droplets of fluid ejected by speaking, coughing or sneezing. Indirect infection may be caused by eating or drinking utensils, handkerchiefs, towels, throat spatulas, clinical thermometers, toy trumpets, slate pencils and the like. The diphtheria bacillus readily grows in milk and produces no suspicious changes; milk thus may serve as a vehicle for spread of the disease. There is no evidence that it is conveyed by drinking water. The diphtheria of pigeons, calves, cats and most other animals has not proved communicable to man and is due to a different organism, but virulent diphtheria bacilli have been found in nasal discharges and open sores of horses.

Outside the body, diphtheria bacilli retain their virulence for long periods if protected from sunlight and from currents of air; hence the possibility of transmission by garments, toys and other articles. Sterilisation by boiling water or in the steam chamber is quite effectual.

Carriers.—Convalescents may harbour virulent bacilli in their throats, as also may others who have been in contact with the infection. Most are free from bacilli 4 or 8 weeks after the commencement of the disease, but

in some the carrier state becomes chronic. The presence of bacilli in the throat secretions of carriers is apt to be intermittent. All carriers are not equally effective distributors of the disease; intimate contact and addiction to such habits as kissing, sneezing, spitting and pencil-sucking are important in this respect. The nasal carrier is believed to be an especial source of danger. Among school children 80 per cent. of the carriers are between 5 and 8 years of age, and male carriers are two or three times more common than female. Throat and nose operations on carriers may be followed by clinical diphtheria. In the search for carriers, pallor, unhealthy tonsils, and nasal discharge are important indications, as also a history of recent sore throat. Skin carriers are the subjects of eczematous or impetiginous lesions on various parts of the body. The discovery of bacilli which morphologically resemble diphtheria bacilli does not necessarily prove they are virulent. Bacilli recovered from the throat are rarely harmless, but those recovered from the anterior nares and the skin often prove to be non-virulent when tested on guinea-pigs.

The Klebs-Loeffler bacillus is a non-motile, Gram-positive, non-sporing organism which grows as a diplo-bacillus and shows a great tendency to become segmented or clubbed. The bacilli are slender rods, straight or slightly curved, and of varying length and thickness. In films they often show a characteristic grouping which recalls the letters of the Chinese alphabet. Both long and short forms occur, the length varying from 2 to 6 μ. The long bacilli are the more typical, and are said to be more virulent. The segmented appearance of the protoplasm is relied upon for morphological identification. A rapid diagnosis may be made from smears prepared direct from the throat, but it should be confirmed by examination of a film made from a young (6 to 18 hours) culture on blood serum or Loeffler's medium. Segmentation may be demonstrated by staining with Loeffler's (alkaline) methylene-blue or by Gram's method, but the most characteristic and easily recognised picture is obtained by the use of Neisser's stain (acid methylene-blue), whereby a dark dot is shown at each end of the bacillus and often another at the centre, contrast staining being effected by the use of Bismarck-brown. The following modification of Neisser's method may be relied upon for good and uniform results. Stain in freshly prepared Neisser's stain for 5 minutes; pour off the stain and wash rapidly in distilled water. Immerse in Gram's iodine solution for 2 minutes and again wash rapidly. Stain in Bismarck-brown for 5 minutes. Drain dry and examine with an oil-immersion lens.

Pseudo-diphtheria bacilli, which, although identical in appearance with diphtheria bacilli, are non-virulent, are frequently found in the nose and ear, more rarely in the throat. Another non-virulent organism of the same group is Hofmann's. This appears in smears as a diplo-bacillus, the elements of which are short, squat and wedge-shaped with apposed bases. It stains uniformly throughout, and is shorter than even the shortest varieties of the diphtheria bacillus. These distinctions apply only to young cultures. Hofmann's bacillus does not produce acid in glucose media, and is so further distinguished. The xerosis bacillus, obtained from the conjunctiva, also resembles the true diphtheria bacillus, but it produces acid both in glucose and in sugar media.

The crucial test of the identity of the diphtheria organism is the pre-

vention of the local or general action of an injected broth culture by the previous injection of diphtheria antitoxin into the test animal.

In the throat, diphtheria bacilli are often associated with streptococci, staphylococci, or the fusiform bacilli and spirilla described by Vincent. Of these, streptococci are most important as cases of septicæmia have been found due to them. Diphtheria bacilli themselves rarely become disseminated in the blood stream or internal organs.

Pathology.—The constitutional disturbance caused by diphtheria is toxæmic, toxins but not bacilli being absorbed from the primary lesion, probably by the lymphatics. The extent, thickness, persistence and situation of the membrane determine the degree of toxæmia produced. In the formation of membrane, epithelial necrosis first occurs and is followed by inflammatory effusion from the subjacent tissues. This gives rise to the membrane in which stratified fibrin entangles epithelial cells, blood-cells and leucocytes. Nearly the whole of the process occurs outside the basement membrane. Bacilli are found in the false membrane and necrotic material, but not in the healthy tissues beneath. Recently formed membrane is firm in texture and has a glistening or somewhat gelatinous appearance. The tonsils are the common sites of the first membrane formation, but the faucial pillars, the soft palate, the pharynx, the epiglottis and the larynx may be implicated. Extension from the larynx along the trachea and main bronchi is not uncommon, but coherent membrane is rarely found in the bronchioles. Diphtheritic membrane is much more firmly adherent to the mucous membrane of the fauces than to the epiglottis, the larynx and lower air passages. Its appearance in the cavity of the mouth, on the tongue or lips is rare, and even more rare is its occurrence in the œsophagus, stomach, or small intestine. The conjunctiva and occasionally the vulva, or a cutaneous abrasion or a surgical wound may become infected. In this connection it must be remarked that streptococci and pneumococci can also produce false membrane, but this occurrence is not common.

The secondary broncho-pneumonia of faucial and laryngeal diphtheria is more commonly streptococcal or pneumococcal than diphtheritic in origin.

Apart from the membrane, the morbid appearances in diphtheria are not distinctive. The condition, however, of the heart muscle is of peculiar interest owing to the frequency of severe circulatory failure. Even in cases in which the myocardium appears healthy to the naked eye, special staining will show extensive infiltration of the muscle fibres with minute fatty granules. More gross changes are evident in advanced cases, patches of myocardial degeneration and perivascular aggregations of leucocytes becoming apparent. In severe infections the cavities of the heart may be dilated, the muscle flaccid and friable, and intracardiac thrombi, some obviously ante-mortem, may be found in the recesses of the auricles and ventricles, particularly on the right side.

Fatty granules, similar to those which occur in the myocardium, are found in the adrenals and in the fibres of the diaphragm but not in the skeletal muscles.

The chief lesion in the kidneys is a degeneration of the epithelium of the tubules, but glomerulitis and small blood extravasations may also be present. To the naked eye these changes may not be apparent.

Broncho-pneumonia is not uncommon in extensive faucial and in

laryngeal infections. Emphysema or pulmonary collapse may occur where respiratory obstruction is severe, and massive collapse of the lung may result from paralysis of the respiratory muscles.

In the nervous system, the essential lesion is a parenchymatous degeneration of the peripheral nerves which is curiously patchy in its distribution. Chromatolytic changes are also found in the vagal nuclei and in the anterior cornual cells of the cord. The cerebro-spinal fluid is normal.

The lymphoid tissues of the body often show a reaction, Peyer's patches being swollen and the spleen slightly enlarged. The liver, too, may be swollen from venous stasis and show slight toxic degeneration of its cells

Petechial hæmorrhages in the skin, serous membranes, heart wall, and diaphragm are characteristic of hæmorrhagic diphtheria. Extensive effusions of blood sometimes occur in the subserous and submucous tissues, in the skin, and in the viscera.

Symptoms.—The incubation period may not exceed 24 hours, more commonly it is 3 or 4 days, but a carrier may harbour virulent bacilli for a considerable time before showing signs of infection. The fauces are most often the site of the disease, next in frequency come the naso-pharynx, the nasal passages, the larynx and trachea. Infection of the genital mucous membrane and of wounds is exceptional and of the skin decidedly rare.

Faucial diphtheria may occur in any degree of severity, from a mild catarrhal inflammation, the identity of which is only established by bacteriological examination, to a widespread infection in which membrane invades not only the whole throat but also the naso-pharynx, nose, larynx, and, rarely, the mouth, either simultaneously or in succession.

Invasion may be characterised by malaise, headache, anorexia and soreness of the throat. Vomiting occurs occasionally and sometimes shivering; rigor is rare. In children, the onset is particularly insidious, discovery of membrane often being the first intimation of the disease. The exudate in mild cases is often limited to a patch on one or both tonsils, sometimes on the uvula or pillar of the fauces, sometimes on the soft palate. More rarely the posterior pharyngeal wall is first attacked. Special characteristics of the membrane are its elevation above the general surface, its well-defined edge, and its glistening or pearl-grey colour. At first it is separable without bleeding, but later free oozing of blood occurs when it is forcibly detached. Multiple patches on the tonsils may, in the early stage, simulate follicular tonsillitis, but the patches tend to spread and fuse; limitation to one tonsil should always arouse suspicion.

Pyrexia is moderate or absent in mild infections, enlargement of the submandibular glands is slight, and the albuminuria so characteristic of grave attacks may be wanting.

When faucial diphtheria is severe it constitutes a very serious form of the disease with a high mortality. The grave form is more common in children than in adults and may develop very rapidly. The membrane is thick, tough, and adherent, sometimes much discoloured. It covers the swollen fauces and may extend widely over both aspects of the soft palate and on the pharyngeal wall. Nasal discharge points to implication of the naso-pharynx and nose. Rarely extension occurs along the hard palate and into the sulci at the sides of the tongue. Secondary invasion of the epiglottis and larynx is not uncommon. The cervical glands become swollen and tender, and

extend and involve the neck in a collar of cellulitis (bull neck). The subcutaneous tissues may undergo widespread necrosis and the skin become thinned and much discoloured. A brownish or bloody nasal discharge excoriates the nostrils and the upper lip. Nasal respiration is obstructed and deglutition difficult. The breath has a sickening odour, and the face is puffy or becomes ashen in colour. The skin is dry and the extremities are cold. A slight general cutaneous œdema may make its appearance. The patient is restless and sleepless but apathetic. Bleeding is easily induced by interference with the edges of the membrane, and epistaxis may occur. Fever is not proportionate to the gravity of the disease; in the worst cases the temperature is subnormal. Albuminuria is usually profuse and the quantity of urine secreted may be very small, but uræmic symptoms are rare. A steady and progressive circulatory failure, characterised by a falling blood pressure and feebleness of the heart's sounds is an ominous feature. The pulse may become soft, irregular or quite imperceptible. Respiration is rapid and shallow. Vomiting often sets in before the end. Broncho-pneumonia can rarely be recognised by physical signs, but is often present. Death may occur within a week of the onset; sometimes, however, under the influence of antitoxin the membrane clears and the faucial swelling subsides, but acute circulatory failure may still be imminent, death often occurring during the latter half of the second week. In those who escape, widespread paralysis is a common sequel.

Laryngeal diphtheria.—Infection of the larynx may be primary, but is usually a sequel of faucial infection. Essentially occurring in childhood, its frequency increases up to the fourth year of life, after which it progressively declines. The presence of membrane, even in the smallest amount, on the tonsils or fauces will afford a positive indication of the nature of the laryngitis. Failing this a diagnosis is made by swabbing, not the tonsils, but the pharynx or larynx; but treatment must not be delayed pending the result. Hoarseness and croupy cough are early symptoms, soon followed by paroxysms of inspiratory dyspnœa due to laryngeal spasm, with characteristic stridor and recession of the chest wall. During the paroxysms the patient is agitated, sweating and perhaps cyanosed. The cough is loud and croupy. With relaxation of the spasm dyspnœa may cease and the child fall asleep from exhaustion. At first the paroxysms are mainly nocturnal, later they become more frequent and more prolonged, until finally obstruction is continuous and mechanical. Extraordinary recession of the sternum and lower ribs may then accompany the efforts to respire. The body assumes a leaden hue and death occurs from slow asphyxia. In rare instances the paroxysms of dyspnœa and cough culminate in the expulsion of membranous casts of the larynx, trachea or larger bronchi. The absence of toxæmic symptoms when membrane is limited to the larnyx and lower air passages is very striking.

Laryngeal diphtheria may run its fatal course in a few days. In infants its duration may be less than 24 hours. In favourable cases the condition subsides under prompt treatment. Should obstruction persist after tracheotomy or intubation, the presence of membrane in the trachea or larger air passages should be suspected; when, however, the bronchioles are blocked, the character of the dyspnœa is quiet rather than violent. Laryngeal diphtheria in a mild chronic form is a rarity, but has been seen. The subjects may probably act as carriers of the disease.

Nasal diphtheria.—Infection of the nose may be naso-pharyngeal or purely nasal. The former is grave, as toxæmic symptoms may be pronounced, whilst localised nasal infection is more often a chronic rhinitis of benign course and low infectivity. In such cases a small patch of membrane may, perhaps, be found on the septum, or a chronic nasal discharge may contain bacilli, although no membrane is visible. Possible implication of the nasal accessory sinuses should be remembered. As already mentioned, bacilli from the nose may prove to be non-virulent. Foreign bodies in the nose have been found associated with persistent nasal diphtheria.

Conjunctival diphtheria is usually the result of direct inoculation, but may extend from the nose. It may simulate a mild, simple conjunctivitis, or membrane may form on the inner aspect of the lids. There is a grave form with extreme inflammatory infiltration of the conjunctiva which may lead to sloughing of the cornea and destruction of the eye.

Vulval, vaginal and preputial diphtheria.—Vulval infection may be secondary to diphtheria of the fauces, infection being conveyed by the fingers, or it may be primary. Sometimes it is seen in puerperal women. It is of insidious onset, and the membrane looks like a slough on the inner surface of one or both labia. The inguinal glands are enlarged, and confusion with erysipelas, chancre, or gonorrhœa is possible. Severe toxæmia may ensue. The vagina may be infected with the vulva. Preputial diphtheria may follow circumcision. Infection of the puerperal uterus and of the male urethra is rare. Infection of the umbilicus may occur in the new-born.

Diphtheritic infection of wounds is not common, and membrane formation on the infected surfaces is not invariable. The wound may merely be dry and grey and the adjacent glands swollen. Bacteriological confirmation is necessary, because streptococci and other organisms may give rise to similar appearances.

Cutaneous diphtheria.—Slight infection of the macerated skin at the margins of the nostrils and mouth is frequent and diphtheritic whitlow is not rare, the finger possibly being infected by sucking it. Sometimes the raw surfaces left by eczema, herpes, or impetigo, become secondarily infected, and membrane may form, but skin diphtheria may occur without this distinctive sign. Extensive gangrene allied to noma has also been attributed to the action of the diphtheria bacillus. Before skin cases are accepted as genuine, rigorous bacteriological proof is essential.

Septic diphtheria.—The ordinary grave case of diphtheria may be looked upon as toxæmic or malignant. The septic type of case is characterised by pulpy discoloured membrane and great inflammatory œdema at the site of infection, accompanied, it may be, by ulceration, cellulitis, or even gangrene. The adjacent lymph glands are much swollen, periadenitis is marked and suppuration may ensue. Erythematous or measly rashes may appear on the extremities. Constitutional symptoms are severe and the prognosis grave, chiefly, it is alleged, because diphtheria antitoxin has no influence on the septic element.

Hæmorrhagic diphtheria.—Hæmorrhagic symptoms supervening during the acute stage indicate an infection of a severe type. Blood may ooze from the edges of the membrane, and epistaxis occur. This in itself is not necessarily serious, but the tendency to bleed may be more widespread, bruises appearing on the body and bleeding occurring around and along the track of

the antitoxin needle. The conjunctivæ may become suffused with blood, and hæmorrhage may occur from the stomach or bowel. Hæmaturia is rare. Small cutaneous petechiæ are by themselves of most sinister omen. They are insignificant in appearance and easily escape detection on account of their smallness and tendency to occur on the neck and trunk where clothing conceals them.

Blood changes.—A polynuclear leucocytosis is common and reaches its acme at the height of the disease. Sometimes the red cells are in excess of normal and the specific gravity of the blood increased, indicating an oligæmia. Leucocytosis may be absent in very mild and also in very grave infections. The presence of myelocytes is also characteristic, and their appearance in large numbers indicates a severe toxæmia and a bad prognosis.

Complications.—The chief are circulatory failure, paralysis, albuminuria and pulmonary inflammations. Relapse sometimes occurs.

Acute circulatory failure is a justly dreaded occurrence. Apart from asphyxia and from respiratory paralysis it is responsible for all the deaths. In diphtheria, excluding the mildest cases and those in which respiratory obstruction exerts its modifying influence, there is from the first a progressive fall of blood pressure, the systolic readings being affected earlier than the diastolic. Recovery is very rare when the systolic reading falls below 65 mm. The fall in pressure is said to be accompanied by a fall in volume and increased concentration of the blood. Vascular relaxation is believed to account for the early fall in pressure, the effect of myocardial weakness appearing later. The condition culminates in attacks of acute circulatory failure. Where systematic pressure readings have not been taken, minor irregularities and intermissions of the heart's action often afford the first warning. True respiratory or sinus arrhythmia, which is so common in childhood and often is exaggerated in diphtheria, should not be confounded with the condition now under consideration. Tachycardia and bradycardia are both disquieting signs. The heart sounds become modified, the first becoming short and soft and the second somewhat accentuated. Vomiting without obvious cause is always a danger signal. The characteristics of the acute attack are great irregularity and feebleness of the pulse, præcordial or epigastric pain, restlessness, rapid shallow respiration, slight cyanosis and a sub-normal temperature. The mind remains clear. Dilatation of the heart and increase in the size of the liver may be evident. Actual dropsy is rare, but sometimes slight œdema of the face, chest and feet appears. Albuminuria may supervene or, if already present, be much increased; partial suppression of urine occurs. Death often results with great suddenness, and should the first attack be survived, which is unlikely, a second or even a third may prove fatal. Rarely recovery ensues.

Death from circulatory failure is an early sequel of severe faucial infections, occurring at the end of the first or in the course of the second week. Cardiac failure occurring at a later stage of the disease is often associated with severe paralytic phenomena, and in some cases, at all events, is believed to be of nervous rather than myogenic origin. Extra systoles, heart-block and auricular fibrillation have at times been demonstrated.

Diphtheritic paralysis occurs in from 15 to 20 per cent. of cases. It is more often localised than general, and rarely complete in degree. Children suffer more frequently and more severely than adults. As a general rule

the extent and severity of the palsy are proportional to the amount of membrane which was present. Exceptionally, paralysis of diphtheritic type occurs in the absence of recognised infection. The usual time of onset is the end of the third or beginning of the fourth week of the disease, but in grave infections it may even set in before the fauces are clear of membrane. Widespread paralysis rarely declares itself before the end of the fourth week, and paralysis of the ataxic type, which is rare, often does not appear until the second or even third month.

A distinctive feature is implication of the soft palate and the ciliary muscle of the lens. Nasal intonation with regurgitation of fluids through the nose and, a little later, paralysis of accommodation with inability to read small print or to thread a needle are the earliest symptoms. The velum palati is found to be anæsthetic and sluggish or immobile. Its reflex is lost. In the eye, the pupil reactions are generally retained. Ptosis and squint are not uncommon. The knee-jerks, after a period of exaggeration, are lost. The faucial paralysis may in severe cases extend and assume a bulbar distribution, implicating the pharyngeal constrictors and the muscles of the larynx, the patient becoming unable to swallow, phonate or clear the larynx by coughing. Great irregularity of respiration, with paroxysms of dyspnœa, vomiting, and grave circulatory failure may accompany paralysis of this type.

The more widespread form of paralysis commences, like the other, with weakness of the muscles of the throat and eye and often some implication of the larynx. Increasing weakness of the legs and arms becomes evident with numbness and tingling in feet and fingers. Slight cutaneous anæsthesia may be present and sometimes astereognosis. In severe cases the muscles of the face, neck, and spine may be involved and the patient become quite helpless. The onset of paralysis of the diaphragm or of intercostal muscles may be responsible for the occurrence of fatal broncho-pneumonia or pulmonary collapse. Sphincter paralysis is only seen in severe cases.

An ataxic paralysis sometimes occurs. Inco-ordination of the movements of the arms and legs with loss of muscular sense are its chief characteristics. It is often mistaken for cerebellar tumour in children and locomotor ataxy in adults.

The limited form of diphtheritic paralysis is transitory, its duration being measured by days or weeks, but the more widespread paralysis may last for months or the best part of a year before recovery is complete.

Hemiplegia sometimes occurs in diphtheria and is due to occlusion of the middle cerebral artery, usually by an embolus. In most cases the paralysis is more or less permanent. Much more rarely an embolus from the heart lodges in a main artery of a limb, producing gangrene.

Albuminuria is of common occurrence, but in mild or doubtful cases its absence is not sufficient to negative the diagnosis. It is most likely to be found about the tenth day, but appears earlier and in greater quantity in grave cases. In those who recover, its presence is transitory and no grave damage to the kidneys results. At times casts and a little blood may be found in the urine, particularly in toxic or asphyxial cases. Acute circulatory failure greatly increases the albuminuria and may lead to actual suppression of urine. Acetone often appears in the urine during severe attacks.

Pulmonary Complications. — Bronchitis and broncho-pneumonia may

accompany severe faucial diphtheria, but are more common when the larynx is implicated. The cause is more often a secondary infection than the diphtheria bacillus. Febrile disturbance, great dyspnœa, cough, and lividity are the signs which should suggest implication of the lung. Auscultatory signs are often equivocal, owing to laryngeal obstruction or the presence of a tracheotomy tube. Massive collapse of the lungs may occur in paralytic patients and is often mistaken for pneumonic consolidation or pleural effusion. Some degree of acute emphysema is usually present when the larynx is obstructed, and surgical emphysema of the mediastinal and subcutaneous tissues may follow a difficult tracheotomy. As sequels of diphtheria, lobar pneumonia, pleural effusion and empyema are rare.

Otitis media is exceptional and seldom serious. In this respect it stands in sharp contrast to the otitis of scarlet fever. Diphtheritic membrane is sometimes formed in the auditory meatus.

Relapse of diphtheria is rare. It occurs in little over 1 per cent. of the cases and usually is mild, the membrane being limited to the tonsils and rarely spreading to other parts.

Diagnosis.—Every inflamed throat, particularly in a child, should be regarded with suspicion, and clinical diagnosis supplemented by bacteriological examination before antiseptics are applied. Definite membrane on one or both tonsils or adjacent parts of the throat is characteristic of diphtheria. Tonsillar inflammation, if accompanied by hoarseness or rhinorrhœa or albuminuria, is highly suggestive. Although some diphtheritic throats are very œdematous and painful, as a rule pallor of the mucous membrane and absence of pronounced fever are also striking features of the disease.

The differential diagnosis between scarlet fever and diphtheria is discussed on p. 260. Simple tonsillitis is usually bilateral, and the exudate, which is soft and crumbling rather than membranous, is follicular and limited to the surface of the tonsils. Pyrexia and constitutional disturbance are more pronounced than in diphtheria, and the tongue is heavily coated.

Peritonsillar abscess is more characteristic of simple tonsillitis and the secondary tonsillitis of scarlet fever. It seldom occurs in diphtheria.

Vincent's angina may produce a greyish film of exudate on one or both tonsils, and even invade the adjacent parts of the faucial pillars and the soft palate, but the process is rather a shallow necrosis than a true membrane formation. Ulceration may be evident at the centre of the deposit; sometimes it is widespread and destructive. The mucous membrane of the gums and cheeks may also be attacked. The breath has a peculiar and offensive odour, but diagnosis should never be based on this alone. The large fusiform bacilli and spirilla described by Vincent are demonstrated by removing the necrotic film, rubbing a swab on the ulcerated patch, and making a smear which should be stained in Loeffler's methylene-blue for 10 or 15 minutes, *i.e.* at least three times as long as is necessary for the staining of diphtheria bacilli, or with an aqueous (1 : 200) solution of methyl-violet; or a portion of the exudate may be rubbed up with normal saline and examined by dark ground illumination.

Double infections with diphtheria and Vincent's organisms are not at all rare. Thrush, which produces an exudate like milk curd, is recognised by detection of the characteristic mycelium. It is a disease of infants and greatly enfeebled adults.

Syphilis.—Both in adults with the acquired and children with the inherited disease the inflamed throat of secondary syphilis is a cause of confusion. The throat is painful and full of mucous secretion. Filmy patches appear on the tonsils and pillars of the fauces. The tonsillar glands are swollen and there is little or no fever. The rapidity with which ulceration and perforation of the palate occur in some cases is striking. The diagnosis is made from the history, the presence of other signs of syphilis, failure to find diphtheria bacilli, a positive Wassermann reaction and prompt response to vigorous anti-syphilitic treatment.

Rarer conditions which simulate faucial diphtheria are erysipelatous inflammation of the throat, herpes of the soft palate and lesions due to the action of steam, boiling fluids, caustics and other irritants.

Laryngeal diphtheria.—Croupy cough and stridor in a child will always suggest diphtheritic infection. Examination may show membrane on the fauces. By forcible depression of the base of the tongue with a spatula, the epiglottis may often be seen and membrane possibly recognised on its edge or surface. Rarely fragments of membrane are ejected on coughing, or there may be a history of contact with the disease. All doubtful cases should be treated freely with antitoxin, pending confirmation by examination of a swab taken from the pharynx as near the glottic aperture as possible.

Other forms of laryngitis have to be differentiated. They are (1) the laryngitis of early measles, distinguished by history, catarrhal symptoms, and Koplik's spots. (2) Simple catarrhal laryngitis; in this bacteriological examination is most essential. The voice may be hoarse, and the cough croupy; nocturnal spasms of dyspnœa may occur. Enlarged tonsils and adenoids are often present, and sometimes the history of previous attacks is obtained. (3) The glottic spasm of laryngismus stridulus is also definitely paroxysmal, but although the child crows the voice is not hoarse nor is the stridor persistent. Rickets, tetany and convulsions are the accompaniments in many cases.

Retro-pharyngeal abscess, when low down, produces considerable laryngeal obstruction. Digital examination of the back of the pharynx reveals its presence; sometimes the bulging may be seen on inspecting the fauces.

Rarer causes of laryngeal obstruction are congenital syphilis, œdema of the glottis in renal disease, or resulting from inhalation of steam or other irritants, foreign bodies in the larynx, and papillomatous growths. These forms of obstruction are differentiated from diphtheria by the history, by careful inspection of the fauces, followed by digital examination, by general examination of the patient and by the negative results of bacteriological examination. In adults the laryngoscope will give useful information. Direct laryngoscopy is also available.

Prognosis.—The important indications yielded by determination of the extent and position of the membrane have already been mentioned: the more extensive and more persistent this is, the greater is the risk of severe toxæmia. Cases where the membrane is limited to one, or to parts of both tonsils are likely to be mild; when both tonsils are completely covered the attack is more grave, but recovery is still probable; when the fauces and naso-pharynx are extensively involved, the outlook is very serious. The great mortality of laryngeal diphtheria is due to asphyxia and broncho-pneumonia,

absorption of toxin from this region being small. Diphtheria limited to the nose and not involving the naso-pharynx has a low mortality.

Enlargement of the cervical glands is more or less proportional to the extent of the lesion in the fauces and naso-pharynx, and has the same prognostic importance. The efficiency of antitoxin treatment and the day of its first administration have a most important influence. The mortality is almost negligible when antitoxin is administered on the first day of the disease, but it increases progressively to 18 or 20 per cent. if administration is delayed to the fifth or subsequent days.

Age also has a great effect, the disease being very fatal to children in the first year of life, and much more serious in children under 5 than in those over that age. Septic attacks with much pallor, copious nasal discharge, considerable glandular enlargement and profuse albuminuria have a very bad prognosis.

Hæmorrhagic symptoms, other than slight bleeding from the edge of the membrane and possibly epistaxis, are grave; particularly so, minute cutaneous petechiæ. Cases such as these hardly ever survive. Repeated vomiting after the initial stage, and signs of acute circulatory failure are most ominous. The chief danger of paralysis, when this ensues early, is its association with acute circulatory failure, but paralysis of the bulbar type is in itself very fatal. Failure of the muscles of respiration and liability to broncho-pneumonia and pulmonary collapse constitute the chief dangers of generalised paralysis. If the patient survive, paralysis terminates in complete recovery, but hemiplegia, which is of vascular origin, may be permanent.

Treatment.—*Prophylactic.*—Convalescents should be isolated for not less than 4 weeks from the commencement of the disease, or until three negative bacteriological examinations at intervals of a week have been obtained. The presence of inflammatory conditions or discharges from the throat, nose, eyes or ears is an indication for further detention. Skin eruptions and whitlows should be carefully treated.

The period of quarantine advised is 12 days. This may be supplemented by bacteriological examinations. Children from an infected house should not be allowed to attend school. Contacts in the home or school often become carriers, and should be bacteriologically examined. Clothing and utensils which have been in contact with the sick should, of course, be disinfected.

When diphtheria breaks out in a school or ward, contacts should be examined for unhealthy conditions of throat, nose, ears or skin, and bacteriological examination made in all instances, if possible. Opinion with regard to the desirability of prophylactic injections of antitoxin is not unanimous. The *symptoms* of diphtheria may be prevented in contacts by the injection of 500 units of antitoxin, but this method fails if the subject is already incubating the disease, and only affords protection to others for some 3 or 4 weeks. It should be realised that antitoxin does not prevent *infection*, but only the toxic results of infection. It militates against active immunisation, and may produce a condition of hypersensitiveness to serum, which may have to be used subsequently.

For these reasons, the best authorities are against prophylactic injections of antitoxin in contacts and in favour of repeated examinations for signs of development of the disease, when antitoxin can be administered at once.

In the Schick test we have a means of determining whether an individual is susceptible to diphtheria. If a local inflammatory reaction follows the injection of a minute quantity of diphtheria toxin *into* the skin, susceptibility to the infection is indicated. One-fiftieth of the minimum lethal dose (M.L.D.) of toxin for a guinea-pig of 250 grammes weight, in 0·2 c.c. of normal saline is the standard dose. At the same time, but at another spot, an intradermic injection of heated, and therefore inactive, toxin is made, to discount a "pseudo" reaction due to the foreign protein in the solution of toxin. The absence of a reaction to the active toxin indicates the presence of more than one-thirtieth of a unit of antitoxin per c.c. in the blood, and is a sign of immunity. The injections are usually made into the skin of the forearms. The reaction takes 24 to 36 hours to develop, and another week to subside. Four types of reaction are possible: (1) Negative, (2) Positive, (3) Negative and Pseudo and (4) Combined Positive and Pseudo. These must be discriminated with care. The best time for reading the test is 96 hours after injection.

Individuals who react positively to the Schick test may be immunised by the injection of 0·5 or 1 c.c. of a toxin-antitoxin mixture, the antitoxin being added to prevent poisonous results from the toxin. By incubating diphtheria toxin with formalin its toxicity is destroyed, although its power of combining with antitoxin is retained. *Toxoid-antitoxin* prepared in this way is now replacing toxin-antitoxin for immunising purposes. As a rule, three immunising injections are given at intervals of 7 or, better, 14 days. The development of active immunity takes about 6 weeks. This immunity is protracted, but its exact duration cannot yet be specified.

Both for testing and for immunisation it is necessary that carefully standardised solutions should be used. These can now be obtained.

Chronic carriers are a great source of difficulty. The bacilli cannot be eradicated by local application to the throat or by the administration of antitoxin. Vaccines, intramuscular injection of diphtheria endotoxin and spraying the throat with 24-hour broth cultures of *Staphylococcus pyogenes*, or of lactic acid bacilli, have all been advocated. If the tonsils be unhealthy, they should be enucleated and any adenoids removed; this is often successful. Carriers should spend as much time in the fresh air and sunlight as possible. Before condemning a carrier to prolonged isolation, the virulence of the organisms should always be tested.

General.—The patient should be isolated and strict recumbency enjoined. Diphtheria antitoxin must be injected without delay, the result of bacteriological examination not being awaited in any case in which the diagnosis is reasonably certain. It is very important the patient should receive the first dose of serum not later than the third day of the disease; the earlier it is given the better the result, but at whatever stage the presence of membrane indicates prompt dosage. The amount required depends, not on the age, but on the duration of the disease, the extent of the membrane and the degree of toxæmia. For mild cases, on the first or second day 5000 units is sufficient; in more severe cases, the dose should be repeated in 12 hours or 10,000 units injected at once. In severe faucial and nasopharyngeal diphtheria and in infections of the larynx, 10,000 units should be the initial dose, repeated in 12 hours if the membrane still show a disposition to extend, or the laryngeal symptoms be not relieved. Cases coming under

observation after the third day of illness require larger doses than those seen earlier. In very severe infections and those complicated by pulmonary lesions, enormous doses have been recommended; the advocates of these larger doses claim a diminished mortality, a reduction of paralytic complications and a speedier convalescence.

Antitoxin should never be given by mouth or rectum. Intramuscular injection is more effectual than subcutaneous, and should replace it. In severe, advanced, and hæmorrhagic infections, the antitoxin should be given intravenously, undiluted and at blood heat. Injection should be very slow, through a fine needle. The patient is then wrapped in warm blankets, hot water bottles applied, and the foot of the bed raised, since rigor and collapse may follow. Fifty thousand or more units may be given in this way, supplemented by 20,000 units intramuscularly into the buttock or outer side of the thigh. In cases which do not respond the injection is repeated after 12 hours. Strict aseptic precautions should always be observed.

Antitoxin treatment may be followed by certain sequels due to horse serum. These are less frequent when concentrated antitoxin is used. They usually occur a week or more after injection and take the form of erythematous, morbilliform, or urticarial eruptions, appearing first in the vicinity of the puncture. Fever, vomiting, arthritic pains or slight joint effusions may accompany the rash. The tonsils may again become inflamed (angina redux) and albuminuria may occur. The rashes and other symptoms are transient but may recur. Aspirin often affords much relief, and the cutaneous irritation may be allayed by weak carbolic lotions. On rare occasions such grave symptoms as rigor, urgent dyspnœa and collapse follow the injection, and death has been known to occur from syncope. These symptoms are anaphylactic in nature and may occur if the patient has been sensitised by injection of serum a few weeks previously, or quite apart from this. Asthmatics are said to be particularly liable to them. When it is necessary to administer antitoxin in such circumstances, a preliminary injection of 5 minims should be given and the effect watched. If no untoward symptoms occur within an hour or two the full injection may be employed.

Absolute recumbency is essential in the treatment of diphtheria. For the mildest case a fortnight is not too long, in the average case at least a month, and for severe infections longer. When the patient is first allowed to sit up in bed the effect on the pulse should be carefully noted. No patient should be allowed to sit up whose pulse is irregular or who has recently vomited. The detection of paralytic symptoms is also an indication for rest.

Local applications to the fauces and nose are of minor importance. In cases characterised by fœtor the free chlorine lotion is of use. When douching is resisted it is better to omit it altogether.

In laryngeal diphtheria prompt administration of antitoxin and the use of a steam tent will generally obviate the necessity of operative interference; but tracheotomy or intubation should not be postponed, if restlessness, dyspnœa and recession of the chest wall be present, or paroxysmal dyspnœa have supervened.

Intubation is suitable for the milder type of case, but constant skilled supervision is necessary, as the tube may be ejected. As a rule, tracheotomy is preferable, especially if the fauces and naso-pharynx be much involved.

Tracheotomy as a sequel to intubation has a very high mortality on account of the class of case in which it becomes necessary. After tracheotomy or intubation the patient is usually placed in a steam tent and the arms secured by light splints or other means. Cough on swallowing is obviated by using thickened foods or by nasal feeding. A method of feeding with the head lying lower than the body is often successful in intubated patients. If all go well an attempt should be made to dispense with the tracheotomy or intubation tube on the third day, sometimes even sooner. Patients must be constantly watched when the tube is first removed. In cases where the tracheotomy is dry and no secretion occurs, an alkaline spray is useful.

Circulatory failure is treated by removing all pillows, raising the foot of the bed on blocks and applying a binder to the abdomen. The most absolute rest and perfect quietude are essential. A combination of atropine, strychnine and adrenalin has the best reputation as a circulatory stimulant in these cases (atropine sulphate, gr. $\frac{1}{100}$; strychnine sulphate, gr. $\frac{1}{100}$; adrenalin solution, 1 in 1000, ℥(v). The solution is made up to 10 minims with sterile water and injected every 4 hours or more often if necessary. At the same time, as vomiting often precludes feeding by the mouth, a 5 per cent. solution of glucose in hot normal saline should be given by the bowel. Other circulatory stimulants and brandy are also advocated. When marked acetonæmia is present, 10 grains of sodium bicarbonate dissolved in 1 ounce of water should be given by mouth or rectum every 4 hours.

Paralysis calls for careful nursing and feeding, with avoidance of muscular exertion, but patients with palatine paralysis only may be allowed up after 10 days if the condition be stationary. Massage and electricity may be useful during convalescence, but should be avoided in the early stages. Hypodermic injection of strychnine is possibly of some use. The daily administration of antitoxin in doses of 1000 to 2000 units is advocated, but is of very doubtful utility.

During the acute stage of diphtheria and also when albuminuria is present, milk is the best food. Solids may be allowed quite early in convalescence. When swallowing provokes coughing, the milk should be thickened with isinglass or cornflour. When pharyngeal paralysis is present, the patient should be fed by rectum, or better, through a large soft œsophageal tube.

The occurrence of anaphylaxis after injection is best treated by injection of morphine and atropine, or of adrenalin, and by artificial respiration.

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TETANUS

Synonym.—Lockjaw.

Definition.—An infectious disease, due to the toxins of the tetanus bacillus, and showing itself by tonic spasm of the masseter and other muscles with paroxysmal exacerbations.

Ætiology.—The bacillus of tetanus is a slender rod 4 to 5 μ in length and from 0·3 to 0·8 μ broad. It is a spore-bearing anaerobe. The vegetative forms are slightly motile, and when stained by special methods show numerous fine flagella arranged all round the bacillus. In material from

infected wounds, and usually in cultures after 24 hours' incubation at 37°·5 C., spores occur. These are terminal, giving rise to the characteristic drum-stick appearance. As cultures grow older the numerical proportion of spore-bearing forms increases, and in very old cultures only spore-bearing forms or spores are found.

Distribution.—In nature the tetanus bacillus is found in the soil of highly manured districts, and in the dejecta of various animals, especially the herbivora, in the intestines of which it exists without causing pathogenic effects. In infected wounds the bacillus occurs with other spore-bearing anaerobes associated with pyogenic cocci, and saprophytic organisms of various kinds. In consequence of its association, in nature and infected wounds, with other organisms, the bacillus is difficult of isolation, as a large proportion of the associated organisms grow with much greater rapidity. Use is made of the fact that the spores will resist a temperature of 80° C. for an hour. Suspected material is inoculated into agar or serum-agar slopes or deep tubes of glucose-agar, and incubated for 48 hours. The culture is then subjected to a temperature of 80° C. for three-quarters of an hour, and subcultures are made on agar plates which are incubated anaerobically. By this means all non-sporing bacteria, and the vegetative forms of the spore-bearers, are killed, and only spore-bearing organisms remain to be dealt with.

The disease follows *injury* to the tissues in most cases, and even when no injury is known to have occurred it is highly probable that some slight abrasion has been present. The term "idiopathic tetanus" has been given to those cases in which no discoverable injury is present. Those wounds, usually of the hands, in which the tissues have been badly damaged rather than cleanly cut, are specially liable to be followed by tetanus infection. Cases have occurred from the use of contaminated gelatin used in subcutaneous injections, and from catgut sutures similarly infected.

Tetanus is more common in tropical than in temperate zones. A special form of the disease, *tetanus neonatorum*, is peculiar to the tropics, and results from sepsis in attending to the child's navel. This variety has occurred in epidemics.

Pathology.—In nature the disease is produced by the introduction of infected material through an abrasion or wound, which may be so minute as to escape detection. Probably there is no such thing as idiopathic tetanus, but infection is possible through the bronchial or even intestinal mucosa.

If the bacilli or spores, free from toxin or from pyogenic cocci, be introduced into an animal, infection may fail to occur, the protection afforded being probably accounted for by phagocytosis, for if spores enclosed in a paper sac be introduced into a susceptible animal infection occurs, as the sac protects the spores from phagocytosis. The presence of pyogenic cocci, other micro-organisms, and the fragments of bone and foreign material incidental to compound fractures and gun-shot wounds, all conduce to the conditions favourable to growth of the tetanus bacillus.

The *period of incubation*, following infection with tetanus bacilli, varies with different animals. In man a period of from 2 to 14 days occurs, but the period may be longer, and as a rule a long incubation period means a more favourable prognosis.

Tetanus toxin.—The tetanus bacillus, like the diphtheria bacillus, produces its pathogenic effects by reason of the soluble toxin it elaborates. Bacterium-free filtrates of cultures, as shown by Kitasato, when injected subcutaneously or intravenously into mice cause tetanic spasms, at first in the neighbouring muscles and later more generally, and death has resulted.

Tetanus toxin is one of the most powerful poisons known, the fatal dose for a mouse of a probably impure toxalbumin being found by Brieger to be 0·0005 mm.

Different degrees of resistance to the toxin are shown by different animals. The horse and man are the most susceptible. On a basis of weight the horse is twelve times and the guinea-pig six times as susceptible as the mouse, while the hen is two hundred thousand times as resistant. The incubation period is shorter when toxin is intravenously injected than when introduced subcutaneously, and is shorter in smaller than in larger animals.

It has been proved that toxin is absorbed by the end plates of motor nerves. This was shown by severing the sciatic nerve of an animal near the spinal cord. The corresponding hind limb was then injected with toxin. A portion of the divided nerve was then placed in another animal and tetanus resulted, while if the nerve were cut distally, and a proximal portion thereof were transplanted, no infection occurred, though in both cases the nerves were equally bathed in lymph containing toxin. And, again, if an excess of toxin be injected into a sound limb only that portion of a nerve distal to a section in another limb shows absorption of toxin. Introduction of a lethal dose of toxin into a nerve such as the infra-orbital, containing no motor filaments, is not followed by characteristic tetanus symptoms.

The toxin passes centripetally up the nerve and affects the motor nerve cells corresponding thereto, thus accounting for the longer incubation period in larger animals. If antitoxin be injected into a mixed nerve, such as the sciatic, toxin is prevented from passing up that nerve; but toxin injected into a similar nerve will act lethally even though a large excess of antitoxin had been previously injected intravenously. In one case, indeed, it was shown that a dose of toxin injected into the sciatic nerve of a highly immunised animal caused tetanus. Possibly these results are accounted for by the now well-known difficulty of bringing antibacterial and antitoxic bodies in the blood to bear on the cells of the central nervous system, a difficulty which has been met, to a certain extent, by the introduction of intrathecal medication.

Immunology.—*Tetanus antitoxin.* Very high degrees of immunity, which persist for a long time, can be achieved, both against large doses of tetanus toxin, and against the living bacilli, by the injection of the toxin into animals. As in the case of diphtheria antitoxin, tetanus antitoxin can protect other individuals against a lethal dose of toxin, and in some cases can prevent a fatal result after symptoms of tetanus have occurred. The action of the serum, as also in diphtheria, is entirely exerted on the toxins, and does not affect the bacilli. The antitoxin is prepared by using the horse, it being the most susceptible animal available, susceptibility to the disease being proportional to the degree of immunity that can be achieved. The antitoxin is standardised by similar methods to those described in the case of diphtheria.

Symptoms.—The incubation period has already been referred to. The earliest symptom is, in the great majority of cases, the so-called *trismus* or tonic spasm of the masseter muscles. Beginning as a slight stiffness, this increases until the jaws are firmly clenched, the patient being unable to open the teeth. The stiffness may involve the muscles of the neck at the same time as the jaws, or a little later. The facial muscles are affected next, and the facies presents the *risus sardonicus* due to the tension in the frontalis and in the muscles at the angles of the mouth. The muscles of deglutition are another group early affected. There is, from these parts, a steady spread of the spasm to the trunk and then to the limbs. The tonic spasm in the muscles of the trunk may show exacerbation in paroxysms, with resulting postures termed respectively opisthotonos, emprosthotonos and pleurothotonos, according as the muscles of the back, abdomen or one side of the body are in a state of spasm. These paroxysms may be induced by divers irritants, and are agonisingly painful.

The disease is often apyrexial, but in some cases the temperature rises with the development of the early symptoms, and not infrequently then shows an ante-mortem hyperpyrexia (110° F. has been recorded).

Course.—The course of the disease is variable. Sometimes it is as short as 4 or 5 days, the patient dying of spasm of the glottis, of asphyxiation or of exhaustion. Other cases, less fulminant, last from 7 to 14 days. A few seem to deserve the term "chronic."

Diagnosis.—A relatively trivial disease which may, however, cause some anxiety from its resemblance to the trismus of tetanus, is the fixation of the jaw seen in certain cases of *septic throat* and *septic teeth*, with phlegmonous involvement of the floor of the mouth, periosteum, etc. Careful examination of the mouth nearly always suffices to determine the real nature of these cases, and the presence of enlarged and tender cervical glands assists the diagnosis.

Strychnine poisoning presents features resembling tetanus in that the spasms are very similar in both diseases. But between the spasms in strychnine poisoning the muscles are relaxed, a condition never seen in tetanus. Another point of distinction is the fact that trismus and cervical rigidity never exist alone in strychnine poisoning, whereas they frequently do in tetanus.

In any doubtful case of injury, in which there are damaged tissues, bacteriological investigation of the exudate and of material from the depths of the wound should at once be made.

Prognosis.—This is always grave. The mortality in a large series of cases appears to be nearly 60 per cent. (Hill). Infants and children rarely recover. The absence of fever and a slow development of the symptoms are favourable points. If the patient reaches the tenth day of the disease his chance of recovery is considerably increased.

Treatment.—1. *Prophylactic.*—All wounds of a suspicious character should be well curetted under a general anæsthetic, the raw surface should be thoroughly treated with antiseptic and antitoxin administered.

Antitoxin has for some time been used in connection with wounds infected with road-sweepings, or garden soil, and in America chiefly in cases of wounds connected with Independence Day celebrations, in consequence of which injections a very definite fall in the death-rate resulted.

During the Great War antitoxin has been used on a much more extensive scale. Doses of 500 units were given subcutaneously to every wounded man as soon as possible after the wounds were inflicted, and were repeated at 7 days' intervals until 4 doses had been given. As a result of this systematic use of antitoxin the incidence of tetanus in the wounded, which in the early days of the war had been 16 per 1000, was reduced to 2 per 1000 from the autumn of 1914 onwards.

2. *Curative.*—Keep the patient as quiet as possible, in a dark and noiseless room. Feeding may be impossible by mouth, in which event nasal feeding may be attempted, and if this, too, is impossible because of spasm, recourse must be had to nutrient enemata. The vapour of chloroform is the best remedy by which to control severe spasms, and a mixture of chloral and bromide in full doses should be given between the chloroform administrations. A more or less continuous use of morphine is the alternative measure.

It is profoundly important that no delay whatever should occur in the use of serum. Injections of serum may be made subcutaneously, intramuscularly, intravenously, or intrathecally. The latter method achieves much easier access to the affected nerve cells, and is certainly preferable, though it is usually, and rightly, combined with other methods, the more gradual action of the antitoxin when given by the subcutaneous or intramuscular methods tending to balance the rapid elimination of that given intrathecally. An ordinary lumbar puncture is made and 20 c.c. of cerebro-spinal fluid are replaced by an equal, or even slightly greater quantity, of a high titre antitoxin. In an acute case from 50,000 to 100,000 units may usefully be thus given in the first few days, and subsequently the intramuscular or subcutaneous methods may be resorted to.

Less success has attended the therapeutic use of tetanus antitoxin than is the case with diphtheria antitoxin. This result is largely, if not entirely, accounted for by the relative slowness in the onset of symptoms in tetanus as opposed to diphtheria. The argument for the prophylactic use of antitoxin in every case of a wound contaminated with road material or soil contaminated with animal excreta becomes correspondingly strengthened.

The following scheme of treatment for acute cases is recommended by Bruce :

	Subcutaneous.	Intramuscular.	Intrathecal.
1st day . . .	...	8000 units.	16,000 units.
2nd ,, . . .	...	8000 ,,	16,000 ,,
3rd		4000 ,,	8,000
4th		4000 ,,	8,000
5th	2000 units.		
7th	2000 ,,		
9th	2000 ,,		

ANTHRAX

Synonym.—Wool-sorter's Disease ; Splenic Fever of Animals.

Definition.—An acute infective disease caused by the *Bacillus anthracis*. There are three clinical forms of the disease, according as the lesion is in

the skin (malignant pustule), in the lung (pulmonary anthrax), or in the intestine.

Ætiology.—*B. anthracis* is a large Gram-positive bacillus possessing a capsule. On artificial media it grows in long filaments which, owing to the fact that the filaments do not readily break up into individual bacilli, tend to bend upon themselves and thus cause the outlines of the colony to assume a whorled appearance that is characteristic.

In the tissues, however, the bacilli occur in straight rods measuring from 5 to 10 μ by 1 to 1·5 μ, the longer forms generally being found in attenuated cultures, and the bacilli found in the gelatinous œdema are usually longer than those found in blood. Flagella have been described arranged regularly round the bacilli, but the organism is usually regarded as non-motile.

In the herbivora, especially sheep and cattle, the disease occurs epidemically and the infection assumes a septicæmic type. The spleen may be two or three times its normal size, and on section may be diffluent. An impression preparation from the cut surface shows enormous numbers of bacilli together with blood cells and mononuclear leucocytes. The liver and kidneys are in similar condition, and the lymphatic system is extensively involved.

The carnivora are relatively immune, especially the dog.

Man occupies an intermediate position, and the disease is always communicated to him directly or indirectly from animals. Two principal forms occur, malignant pustule, a local infection through a cut or abrasion of the skin or a hair follicle, and wool-sorter's disease, an infection starting in the trachea and bronchi from the inhalation of dust containing spores.

Infections of the intestinal tract may occur but are rare. Such infections must originate from spores, as the bacilli do not withstand the action of gastric juice.

Bacteriological Diagnosis.—In a case of suspected malignant pustule direct microscopic examination will usually show the bacilli in the fluid in the surrounding vesicles. Sometimes examination of the sections of the excised malignant pustule is necessary. Cultures on agar will show in 24 hours the characteristic wavy-outlined colonies. Blood cultures in man never show the bacilli until just before death. Putrefaction rapidly destroys anthrax bacilli, hence the recognition of the bacillus in putrefying tissues entails careful bacteriological examination and animal experiments.

A guinea-pig may be inoculated with suspected material and if anthrax be present will usually die within 2 days, and the bacilli may be demonstrated in the spleen.

Ascoli has introduced a thermo-precipitin reaction. The suspected material is boiled with five or ten times its volume of normal saline containing one-tenth of 1 per cent. acetic acid, and filtered, and, when cold, is run on to the top of an immune serum, when, if the serum be properly controlled for specificity, a white ring occurs at the junction of the fluids.

Immunity.—Pasteur, noting that one attack of anthrax immunised an animal, elaborated a method of artificial immunity. He attenuated cultures by growing at 43° C. and inoculated sheep therewith, subsequently injecting virulent living cultures. By carrying out this process of active immunity the mortality among animals was greatly lessened. Marchoux showed that the serum of such animals conferred a certain degree of passive

immunity; and Sclavo, by using a mixture of such immune serum and progressively attenuated cultures and virulent cultures, obtained very high degrees of immunity in the ass. Sclavo's serum is stable, and if given in quantities of 40 c.c. at an early enough stage in the disease is almost always successful.

Formerly the local effects of infection were considered due to the mechanical damage to the tissues by the rapid multiplication of the bacilli. Later it was considered that the tissues were injured by simple deprivation of oxygen. Now the result is considered to be a toxic phenomenon.

I. Malignant Pustule.—The site of infection is nearly always upon an exposed part of the body—face or hands or forearms. The incubation period appears to be very short, perhaps not longer than a few hours. A small red papule forms, which rapidly becomes vesicular and then incompletely pustular. By the time vesication occurs there is a surrounding zone of intensely red œdema, becoming a brawny induration by the end of the second day. By this time a ring of secondary vesicles often surrounds the initial lesion, which has now formed a dry and almost black scab, generally raised above the surface of the affected skin. A frequent associated lesion in the case of the arm is lymphangitis, spreading upwards to the lymph glands, which become enlarged and painful. There is rarely much pain at the site of the initial lesion, though there is usually a good deal of itching and tenderness. Fever is almost constant, and in severe cases may be quite high. The patient is then very ill, with intense toxic symptoms. Mild cases occur, however, and in them both the local and the general symptoms are much less marked.

The prognosis turns upon the severity of the symptoms, especially of the toxæmic state. Death is sometimes very rapid—it may occur within the first week.

In some cases the initial papule and vesicle are ill-marked, but the attendant œdema is excessive (*malignant œdema*). The mortality in this type of the disease is a good deal higher than in the type in which the pustule is well formed.

II. Pulmonary Anthrax.—In this variety of the infection the bacilli are inhaled with dust from infected hair or wool. The result is the rapid development of fever, generally ushered in by a rigor, with very intense toxic symptoms and the signs of bronchitis. Cerebral symptoms develop with great weakness. The whole course of the disease may be very short, even as brief as 24 hours. Recovery probably never takes place, even if the diagnosis has been made at an early stage.

III. Intestinal Anthrax.—This is probably the least common form of the disease. The infection is due to eating meat or drinking milk from animals suffering from splenic fever. The symptoms are those of a severe gastro-enteritis—fever, vomiting, diarrhœa and intense weakness. The spleen is enlarged. This form of the disease has been found to occur in small epidemics. The mortality is high, though not so high as in II.

Treatment.—(i.) *Prophylaxis* consists in the specific immunisation of animals subject to the disease, and in the careful disinfection of all skins, hair and wool, before these are handled in any industrial occupation.

(ii.) *Curative.*—The anthrax pustule should be excised immediately it is discovered and recognised, pure carbolic acid being then applied to the

raw surface, which is now fomented continuously. A full diet is given with stimulants, and the patient is kept in bed with complete rest. The use of anthrax serum should be as prompt as possible, in the manner already referred to. (See also p. 36).

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TUBERCULOSIS

Definition.—Infection of the body by *Bacillus tuberculosis*, leading to lesions which are characterised by tubercles, microscopic or macroscopic, themselves undergoing changes leading to caseation, necrosis, ulceration and calcification, and having in close association with them varying degrees of fibrosis. The lesions of tuberculosis form the histological and anatomical basis of a large number of diseases which differ according to the organs affected, the extent of the lesions and the degree of resistance to infection shown by the tissues.

Ætiology.—THE BACILLUS TUBERCULOSIS (Koch, 1882).—This is regarded by most bacteriologists as a member of the Streptothrix group of micro-organisms; that is to say, the bacillus found in tubercular lesions is considered to be the bacillary form of an organism allied to the Streptothricæ. The other phases in the life-history of the micro-organism are not met with in the actual disease-process, but may be demonstrated in old cultures and in certain experimental lesions. This view of the essential nature of the tubercle bacillus harmonises with our knowledge of its great power of resistance to various destructive agents; it also explains many of the tissue changes occurring in the disease, the latency seen in many cases of infection and the chronicity of many others. The bacillus measures 3 to 4 μ in length as an average, is slender, and when isolated from secretions or tissues is usually bent or curved, and tends to lie in small groups. It is "acid fast" in its staining reactions, allowing of easy recognition: but it grows very slowly outside the body, requiring special media for the purpose of culture. The bacillus is capable of living for several months in dried sputum, and may be cultivated, or may be made to cause disease in susceptible animals, when obtained from the dust of ordinary living-rooms. The gastric juice does not destroy the bacilli, nor does the process of decomposition going on in dead tissues over a period of many weeks. The clinical importance of these facts is obvious. In contrast with these examples of resistance may be mentioned the fact that direct sunlight has a rapid lethal effect upon the micro-organism; so also has a solution of carbolic acid, of strength 1 : 20.

Known differences exist between the bacillus causing tuberculosis in man, in cattle, and in birds respectively. The *avian* form appears to be of little importance. The *bovine* type would appear to cause about 10 per cent. of all cases of tuberculosis in man. In children, the bovine type is found relatively more often. The *human* type of bacillus is less virulent to cattle than is the bovine type, but—though this cannot be made the subject of experiment—the bovine type is probably as virulent to man as is the human type. Of young children dying with primary abdominal tuberculosis, the

fatal lesions, in nearly half of all cases, have been referred to the bovine bacillus. Again, in both children and adolescents suffering from tuberculous adenitis, a large proportion of the cases examined could be referred to the bovine bacillus. Lastly, in lupus, about half of all cases appear to be referable to the bovine type of *B. tuberculosis* (Royal Commission on Tuberculosis).

Sources of Infection.—There are two great *sources of infection* of tuberculosis — phthisical sputa and tuberculous milk. Sources of minor importance are urine and fæces containing the bacilli as the result of active lesions in the urinary and intestinal tracts, and the flesh of tuberculous cattle eaten as meat. But the main source of the infecting bacilli of the human type is undoubtedly dried human sputa. Nuttall found that from 2 to 4 billion bacilli were expectorated in 24 hours by a patient whose phthisis was only moderately advanced. These bacilli are scattered freely in dust when the sputa become dried, and they lie about the surface of the patient's body, or they are projected directly into the air along with particles of moisture when patients cough or sneeze or even speak loudly.

Of the *bovine* type of bacillus it is probably not an exaggerated estimate to say that some 25 per cent. of all dairy cows in this country are tuberculous. In New York, Hess found tubercle bacilli in 16 per cent. of the 107 specimens which he examined.

Modes of Entrance of the Bacillus into the Body.—Although there are some other *channels and modes of entry* that have theoretical interest, the two chief ways by which the body is infected are undoubtedly ingestion of the bacilli by the alimentary canal and inhalation of them by the respiratory organs. Compared with these two, all other avenues of infection are trivial.

1. *Ingestion.*—Infection through the *intestinal mucosa* is considered to be the most common mode of production of tuberculosis in children, the main source of the bacilli being contaminated milk. This conclusion has the confirmation of clinical and post-mortem observations, as well as the support of experimental work by Behring, Calmette and others. Of late years, however, Ghon has adduced facts which suggest that, even in little children, infection may be much more often brought about by inhalation than was formerly thought. Ghon's observations have been confirmed by Eastwood and Griffith, and by Canti.

Another channel of entry by ingestion is *the tonsils*; tubercle bacilli have been demonstrated by Hugh Washam and others to pass through the tonsillar tissue to the cervical lymph glands. The tonsils are themselves rarely affected.

2. *Inhalation.*—Primary infection by the route of the air passages is difficult of proof, and, indeed, some authorities regard it as negligible compared with (1). The great frequency of respiratory tuberculous lesions, however, and the incidence and mortality-ratio of pulmonary tuberculosis in ill-ventilated districts and buildings, are points difficult to explain satisfactorily without the assumption that in the majority of these cases infection takes place by inhalation. The statistics relative to contagiousness in tuberculosis institutions are conflicting.

3. *Inheritance.*—Inheritance of tissue-susceptibility to infection by tuberculosis is a definite fact. But inheritance of tuberculosis is problematical, if by this is meant the transmission of tubercle bacilli in the spermatozoön

or in the ovum. In the few cases of "congenital tuberculosis" that have been authentically described, the transmission has generally been from a diseased placenta to the blood of the fœtus.

4. *Skin inoculation.*—This is of little more than theoretical interest. Post-mortem warts (*Verruca necrogenica*) are occasionally of tuberculous origin. Czerny, the surgeon, reported a couple of cases of inoculation during skin transplantation.

Among *other ætiological factors* the chief is undoubtedly the *inherited tissue-susceptibility* to infection already referred to. The exact nature of this susceptibility is not known, but its existence is one of the cardinal facts of clinical medicine. *Sex* seems not to be a factor. *Racial differences* in susceptibility are noticeable, though the distinction between morbidity-incidence and mortality-incidence must be made here—the former is high in the Irish, the latter in negroes. In the Jews, though the disease is common, the mortality-incidence is low. *Trauma* is definitely known to induce pulmonary infection, or, perhaps it should be said, pulmonary spread of the disease. All *occupations* tending to inhalation of dusty particles, and those which keep the workers in ill-ventilated and badly-lighted rooms and places, increase the liability to tuberculosis, especially of the pulmonary kind. If *bad economic conditions* concur with either of these the liability is increased. *Debility*, whether the result of acute illnesses, or caused by pregnancy, parturition, prolonged lactation, or exhausting modes of life generally, increases a natural susceptibility, and gives an acquired susceptibility when no hereditary weakness is present. Tuberculosis is not infrequently a *terminal infection* in such diseases as diabetes, cirrhosis of the liver, leukæmia and chronic nerve affections such as tabes dorsalis, etc. *Recurring and chronic respiratory catarrhs* seem at times to lower the local resistance to tuberculosis, though it is often matter for comment that so many patients with emphysema, asthma and chronic bronchial catarrh live for many years without developing pulmonary tuberculosis, provided they inherit no special tissue tendency to infection by the bacillus.

Incidence and Mortality.—The healthy human body is considered to be relatively immune to infection by the bacillus of tuberculosis. Against this statement, however, it must be said that, whether from the ubiquity of the causative germ, or from one or more of several factors enumerated in the preceding paragraph, some 70 to 80 per cent. of all adult cadavers carefully examined in Western countries show lesions due to the bacillus. It is said, too, that one-seventh of the whole race dies as the direct result of tuberculosis. The disease is one of "low resistance," this being the result either of inherited predisposition or of acquired loss of resistance, or of both of these.

The results of infection are of great variety and of all grades of intensity. The variety depends upon the tissues affected, and the route of spread of the infection. The intensity depends upon the degree of relative virulence shown by the bacillus, and the amount of resistance shown by the patient. Tuberculosis may exist without appreciable disturbance to health, and the lesions produced may be commensurate almost with the whole length of a patient's life. On the other hand, the infection may cause an illness of the most severe character, killing the patient in a few weeks. The results of infection are described elsewhere in this book under appro-

priate headings, but *general infection* leading to the condition termed general tuberculosis is included in this article.

Diagnosis. The Isolation and Recognition of the Bacillus.—In all doubtful cases of tuberculosis this is a point of vital importance. Clinical evidence of the existence of the disease, however complete it may seem to be, must never lack the confirmation of bacteriological proof, whenever this is possible. ("Physical signs are the signs of conditions, not of diseases.') Seeing that the only radical proof of the existence of the disease is the demonstration of the bacillus in material derived from the patient, attention must first of all be directed to this investigation. By comparison with this demonstration, even the most definite "reaction" to one or other of the tuberculin tests, or the most strikingly positive result with the complement-fixation method, or an abnormally low opsonic index, is untrustworthy. It behoves the practitioner, therefore, to watch jealously for any material that may be available for bacteriological use, and to be quite certain that such material is not obtainable before falling back upon indirect clinico-pathological evidence (see below) to support the diagnosis.

In cases of suspected phthisis, every effort must be made to secure sputa, and it may be necessary to check a habit of swallowing expectorated material. The single, isolated plug of mucus, which is often expectorated in the early morning, should not escape attention. In little children sputa, as such, are usually absent, but if vomiting occurs in association with lung disease the vomit should be searched for fragments of sputa. In suspected disease of the kidney or urinary tract, the urine must be collected carefully and submitted to examination. Cases of *albuminuria* or of *hæmaturia*, in which there is not clear evidence of diffuse nephritis, should raise the question of tuberculous disease of the kidney. The fæces should be scrutinised in doubtful tuberculosis of the peritoneum or bowel. If any *puncture-fluid* is obtainable—as from the pleura, the spinal theca, or a joint—this is valuable for investigation in any patient suspected of tuberculosis.

The methods of dealing with these materials are not difficult, though they require thoroughness and patience when the bacilli are present in scanty numbers. The very different significance to be attached to a positive as against a negative result must never be lost sight of; the former affords proof of the existence of a tuberculous lesion, the latter gives at most a presumptive evidence against it.

In dealing with *sputa*, the original carbol-fuchsin method of Ziehl-Neelsen should first be tried. If the results, after carefully searching 3 or 4 films for half an hour, are negative, the sputa should be shaken up thoroughly with ten times its bulk of carbolic acid, of strength 1 : 20, allowed to sediment, the supernatant fluid run off, and films made of the residue. If the sputa are seen to be thin and watery, this method is likely to give a negative result. If so, one of the recently introduced digestion methods may be used—either pepsin and hydrochloric acid, or "anti-formin." The use of the last-named substance, consisting of a mixture of equal parts of bleaching powder solution and a 15 per cent. solution of caustic soda, is found by some workers to give excellent results. An amount of this fluid, equivalent to about one-fifth of the bulk of the sputum, is mixed with it, allowed to act for 3 to 4 hours, the mixture centrifugalised, and the deposit dealt with by one of the staining

methods in ordinary use. The bacilli are, by the disintegrating action of the "anti-formin," isolated from the albuminous vehicle and concentrated in the deposit.

Urine is best dealt with by the carbolic acid method (*v.s.*), subsequent centrifugalisation, and staining of the deposit. The smegma bacillus (also acid-fast), which may be present if the specimen has not been obtained by catheter, is differentiated by allowing the stained films to remain in alcohol for ten minutes; the tubercle bacillus is not decolorised. In *pus*, the search is much facilitated by the use of "anti-formin," and this is a useful adjunct in the examination of fæces also. A patient suspected of tuberculosis of the bowel often suffers from diarrhœa; when this is the case, Emery's suggestion of giving sufficient opium to cause a solid stool is useful. The superficial parts of the motion are most likely to yield the bacillus, and are dealt with accordingly.

Puncture-fluids very frequently give negative results to ordinary microscopic examination, on account of the scantiness of the bacilli in them. However, the clot (if such occur), or the centrifugalised deposit, should always be searched thoroughly, as the demonstration of even a few bacilli of undoubted morphological characters is decisive. Failing this demonstration, the fluid must be used for inoculation purposes, a guinea-pig receiving a liberal amount (not less than 10 c.c. if possible). The inoculation method of diagnosis is, of course, available for the above materials also, as a final test.

The demonstration of tubercle bacilli in *the blood* has received attention of late years, but with widely different results in different hands. Reputable authorities state that bacilli can be seen in stained films in a very high percentage of all cases of tuberculosis, wherever the lesion may be. Others fail to confirm these results. There is nothing *a priori* against the possibility of such findings, seeing that we know tuberculous patients excrete bacilli in their urine even when the kidney is not itself involved, showing that the bacilli pass through the circulating blood. But it may be that the number of positive results on blood examination is directly dependent upon the time employed in searching the slides, in which case the search and its results may have a scientific interest only. Unless some simple method can be devised, which will obviate the needle-in-a-haystack conditions imposed by the examination, it is not likely to prove of practical value. It must be remembered that the medium is a difficult one to work with, and that the sight of a single bacillus never carries utter conviction to the critical eye. Unfortunately, in general tuberculosis, in which form of the disease an examination of 5 c.c. of blood from a vein often yields several bacilli of unquestionable character, we are dealing with (at present) an incurable condition.

Indirect Methods of Diagnosis.—These depend upon the presence in the tissues of certain sensitising and immunising substances. They are indicated in doubtful cases of tuberculosis in which no material is available for investigation by direct methods (see above). The relative values of these methods are still under assessment; at present their values are probably in the order of their description here.

1. THE TUBERCULIN TEST.—The test depends upon the fact that infection by the tubercle bacillus renders the tissues supersensitive to the

toxins of the bacillus, if these be introduced into it artificially. This supersensitiveness is shown by the production of certain "reactions" which are recognisable and are regarded as more or less "specific" in their nature. The test is performed in three ways.

(*a*) *The subcutaneous test* (Koch's test).—A series of three doses of "old tuberculin" is prepared, 0·0025, 0·005 and 0·01 c.c. (0·25, 0·5 and 1·0 mgrm.), respectively. These are injected at successive intervals of 48 hours, the patient being kept in bed and with 4-hourly temperature records. If any reaction follows the initial dose, the second dose is halved; so also for the second and third doses. The most certain positive result consists in obtaining an increased reaction to a second dose of the same size as the preceding one. A "focal" reaction, *i.e.* some exacerbation at the site of the suspected lesion, is of greater diagnostic value than a mere "general" reaction, *i.e.* pyrexia and malaise.

(*b*) *The skin test* (Pirquet's test).—This is best employed quantitatively. Three or more strengths (*e.g.* 25. 50 and 100 per cent.) of a solution of old tuberculin are rubbed lightly into the skin of the arm, which has been previously scarified. The appearance of papules and erythema at the site of vaccination constitutes a positive reaction.

(*c*) *The eye test* (Calmette's test).—A drop of a 1 per cent. solution of old tuberculin is introduced into the conjunctival sac. A positive reaction consists of congestion and more or less exudate, the caruncle being specially affected.

Of these tests there is little doubt that the subcutaneous is the least equivocal in its results. Its great disadvantage is that it cannot well be undertaken in febrile patients. But it is more likely than either of the two other tests to indicate an active as against a "quiescent" or "arrested" focus. It must be confessed that in actual practice none of these tests is very helpful. In some cases of undoubted tuberculosis, especially of the acute and generalised kind, all three tests may be negative. But the chief fallacy appears to be concerned with the fact that the supersensitiveness upon which the tests depend may exist in patients who have had tuberculous disease many years previously (*e.g.* adenitis in childhood), but in whom the disease now under diagnosis is not tuberculous.

2. The Complement-Fixation Test.—This test is analogous to the Wassermann test for syphilis. It is claimed by some workers that it is positive in over 90 per cent. of cases of tuberculosis. The difficulty seems to be that it cannot be relied upon to distinguish an active lesion from one that is not active. Seeing that old and caseous tuberculous lesions exist in such a large proportion of all persons likely to be tested, and that these old lesions still suffice to give the complement-fixation test, its value is quite doubtful unless undertaken in a quantitative manner.

3. The Tuberculo-Opsonic Index.—An abnormally low, or an abnormally high, opsonic index to the tubercle bacillus is considered by many authorities to be strong presumptive evidence that the person tested is tuberculous. The limits outside which this probability exists are 0·8 and 1·2. Daily variations in the index, and changes in it as the result of exercise, increase the probability that active tuberculosis is present.

4. Cytological Evidence of Tuberculosis.—Another and very useful evidence of tuberculous infection is to be obtained in cases of pleural,

and perhaps of meningeal exudates, by estimating the relative numbers of polymorphonuclear cells and of lymphocytes. It is found that, in pure tuberculous infections, the cell exudate is largely, and often almost entirely, lymphocytic in character. In pyogenic infections it is very largely polymorphonuclear; in mixed infections (tubercle with pyogenic infection) the cell-exudate is also of a mixed character.

Treatment.—This is prophylactic and curative.

1. PROPHYLACTIC.—The widest possible view should be taken of the preventive measures which are necessary in order to stamp out the disease. If, as seems certain, the three dominant factors in the persistence of the disease are—(i.) the inherited tissue-susceptibility; (ii.) the bacillus; and (iii.) bad hygienic and economic conditions of life, it is clear that the problem is not a simple one.

(i.) Families having an inherited tendency to tuberculosis should recognise the fact earlier and more thoroughly than is usually the case. The upbringing of the children needs special care, and occupations should be chosen for them when they reach puberty which keep them in the open air. Climatic considerations are also of importance in the case of these families.

(ii.) As already stated, the two great sources of the tubercle bacillus are the dried sputa from infected pulmonary cases and tuberculous milk. The former of these is both a public and a private concern—the latter is almost entirely public. Between the position of almost entire neglect on the part of health boards with regard to the purity of the milk supply, and the elaborate precautions of faddists which, if put into operation, would kill the milk industry altogether, there lies a middle course of ordinary cleanliness and reasonable care, the following of which would probably reduce the danger of milk infection by 60 or 70 per cent.

(iii.) This resolves itself into a series of sociological questions.

2. CURATIVE.—*Non-specific measures.*—These consist in efforts at improving the patient's nutrition so as to increase the tissue-resistance to the infection—ample fresh air, plenty of good food, bodily and mental rest and exercise undertaken in graduated fashion under expert supervision. Details of all these measures are given in the article dealing with pulmonary tuberculosis (p. 1089).

Specific measures.—The use of tuberculin is considered in the article upon Immune Therapy (p. 47).

GENERAL TUBERCULOSIS

Synonym.—Acute Miliary Tuberculosis.

Definition. A disseminate form of tuberculosis, giving rise to a very severe and fatal disease analogous to the septicæmias in pyogenic infection.

There are three clinical forms of the disease, according as the symptoms are chiefly referable to the lungs (the *pulmonary form*), or to the brain (the *meningitic form*), or are those of a general infection without focal signs. This latter form is often termed the *typhoid form*. The pulmonary form is described in the section dealing with pulmonary tuberculosis. The meningitic form is described in the section on meningitis.

Symptoms.—The *general* or *typhoid form* resembles typhoid fever very

closely. There is usually a period of vague ill-health—as there is in typhoid fever—preceding the more severe illness. When the latter develops there is headache, insomnia, a soft but frequent pulse, rapid respirations, a dry tongue, slight cyanotic flush and pyrexia, which is usually less continued in character than in typhoid fever. Not infrequently the temperature curve is that of a quotidian intermittent fever. In a few cases the rise of temperature takes place in the morning instead of in the evening, a feature not infrequently seen in other pyrexias of tuberculous origin, though not confined to these. Progressive loss of flesh takes place, and also anæmia, but this latter condition may only be found by blood examination, the dusky flush of the face often masking the blood state on mere clinical examination. Towards the end of the illness suspicious signs of one or other of the more focal manifestations of the infection often arise: copious fine râles over the lungs, tumidity of the abdomen with palpable enlargement of the spleen and liver, or cerebral symptoms suggestive of meningitic involvement.

Diagnosis.—As the term "typhoid form" suggests, the disease resembling general tuberculosis most closely is typhoid fever. During the first week or even during the first two weeks diagnosis may be very difficult. In favour of typhoid fever are the persistence of headache, the presence of epistaxis, relative infrequency of the pulse-rate, diarrhœa and early tumidity of the abdomen. In favour of tuberculosis are a frequent pulse-rate, early cyanosis and intermission in the temperature curve. There is leucopenia in both diseases. A positive blood culture occurs during the first week in most severe typhoid cases, and agglutination with the patient's serum may reasonably be expected after the end of the first week.

Course and Prognosis.—The disease is invariably fatal, and usually within a period of 6 weeks from the onset of fever and symptoms directly referable to the disseminate infection. A few cases last as long as the eighth week, and the writer has seen a well-authenticated case in which the patient lived until the middle of the tenth week.

Treatment.—This is entirely palliative, there being no specific measures at present known to check the progressive nature of the infection, or its lethal issue.

THOMAS HORDER.

LEPROSY

Definition.—Leprosy (λεπρός, scaly) is a bacillary disease, peculiar to man, associated with characteristic lesions which attack either the skin and mucous membranes (nodular type) or the nerves (anæsthetic type).

Ætiology.—The disease is a widespread one, occurring in many parts of the world, Europe, Asia, Africa, West Indies, Pacific Islands, etc. All races are liable. The disease is not hereditary; it may attack any age or sex. It is now admitted that the causative agent of leprosy is the *Bacillus leprœ*, discovered by Hansen in 1874. The bacillus is non-motile, and is acid-fast, staining like tubercle by Ziehl-Neelsen's method. There have been numerous claims of success in cultivating the organism, Rost, Clegg, Williams, Bayon, etc., all having reported successes; Fraser, on the other hand, has failed, and as the successful investigators are not agreed

as to whether the bacilli cultivated by each of themselves are similar, doubt must be expressed as to all the results. It is not known how the disease is spread. Some suppose sexual connection plays a considerable part, and this is very probable. An intimate contact is at any rate necessary.

Pathology.—The lepra bacillus may be found in any of the tissues of the body, but has a marked preference for the skin, the nasal mucosa and the nerves. The type of lesion produced in the different viscera is that of an infective granuloma-like tubercle.

Symptoms.—There are three main types of the disease—(1) Nodular leprosy; (2) anæsthetic, neural or nerve leprosy; (3) mixed leprosy.

1. *Nodular leprosy.*—The incubation period is uncertain; in many instances the virus may remain latent in the body for years without giving rise to any of the symptoms of the disease. There are recorded instances, on the other hand however, of persons developing the disease a few weeks or months after coming into an infected area.

Prodromata are usually marked—irregular rises of temperature, rigors, lassitude, drowsiness, diarrhœa and profuse sweating. These may be slight, and are not absolutely pathognomonic of the disease. The first positive evidence is the primary exanthem or macular stage, which shows itself as a slightly raised, shiny, erythematous eruption. This may then disappear, leaving only a slight brownish discoloration. Fever, however, recurs with a fresh eruption, and after one or two recurrences the characteristic nodules or tubercles appear, often on the site of the old macular rash. They increase in number until the patient may be nearly covered with them. The hair is often lost from the eyebrows, the mucous membrane of the nose becomes thickened, and the larynx and the eyes may also be attacked. The face acquires what has been described as the leonine aspect—pendulous cheeks, lobes of ears enlarged, etc.

The further history of the nodules varies; they may remain almost stationary, or increase very slowly, or disappear, or more commonly break down, suppurate and form ulcers. When this occurs the destructive process may spread, large areas being affected; ulcers may form on the eyes, causing blindness, or the larynx or pharynx may be destroyed.

2. *Anæsthetic leprosy.*—Prodromata are less marked; feelings of depression, chilliness and malaise, with shooting pains in the ulnar and peroneal nerves may be encountered. In other instances, numbness of the hands and feet is the first sign. Maculæ, either beginning with erythema, or with pigmentation, or with a diminution of pigment, not raised above the surface, with loss of feeling, and hair, and sweating, giving rise to anæsthetic patches, are another method of commencement.

A quiescent stage may now set in with no further signs, but finally definite nerve lesions appear—paralysis of the muscles of the hypothenar eminence, contractions of the fingers, wasting of the interossei muscles, etc. Bullæ may arise, burst and form ulcers; the bones become necrosed, and are cast off whole or in pieces, or in other cases interstitial absorption leads to shortening of the fingers or toes, a portion of the nail being left as a horny peg at the end of the stump. In this way all the fingers and toes may disappear. The fifth and seventh cranial nerves are sometimes attacked.

3. *Mixed leprosy.*—This may start as a nodular case, and then extend to the nerve trunks, or the nervous symptoms may appear first and be

followed by the nodules, or both sets of symptoms may develop together.

Diagnosis.—The lepra bacilli can easily be demonstrated in the nodular cases, either in the nasal secretion or from the juice squeezed out from one of the tubercles; in the nerve cases they can seldom be found. *Lupus vulgaris*, tuberculosis of the skin, syphilis and yaws have all been mistaken for nodular leprosy, while syringomyelia, Morvan's disease (analgesic whitlow), progressive muscular atrophy, peripheral neuritis, ainhum and Raynaud's diseases have similarly been confused with the anæsthetic type.

The bacilli of leprosy occur principally in the lymph spaces, and the characteristic feature is the enormous masses in which they occur; giant cells are generally absent. These points help to differentiate it from tubercle.

Prognosis.—This is by no means good. As a rule the dictum "once a leper always a leper" holds good, the malady gradually going from bad to worse even in spite of treatment. Trinidad observations give an average duration of life of 6½ years for the nodular, 10 years for the nervous, and 9¾ years for the mixed form. Periods up to 20 years have even been given for nerve cases. If the larynx be attacked early, or if there be visceral involvement, the prognosis is very bad.

Treatment.—Although it is not known how the disease is spread, manifestly intimate contact with lepers must be dangerous. Lepers must be excluded from acting as cooks, waiters, and in similar employments. Segregation properly and humanely carried out is the best thing, both for those who are affected and for those who are not. The disease may be greatly diminished by such measures. As regards medicinal treatment, general hygienic measures are to be adopted first, then chaulmoogra oil (oleum chaulmoogræ, synonym oleum gynocardiæ), an oil expressed from the seeds of the *Taraktogenos Kurzii*, King (N.O. *Bixineæ*), or some of its derivatives should be tried. Recently the oils expressed from *Hydnocarpus Wightiana* and *H. anthelmintica* have been found to be as good, if not better than the former, and are being extensively used now. They seem to be of a similar composition. The crude oil can be given by the mouth, in 10-minim doses, t.i.d., and then gradually increased to 1 or 2 drms. in the 24 hours. It has also been given intramuscularly; care must, however, be taken that the needle does not penetrate a vein, as otherwise fatal fat embolism may occur. Antileprol, a purified chaulmoogra oil in ½ and 1 gr. capsules has also been tried. Better than this, however, are the ethyl esters. MacDonald and Dean in the Philippines use "Moogrol," beginning with 1 c.c. and increasing this by 1 c.c. every third injection until 6 c.c. is reached. The injections are given once a week intravenously. Another way is to combine the ethyl esters with creosote, camphorated or olive oil, and give this hypodermically once a week. Beginning with a dose of ½ c.c. this is increased by ½ c.c. each time, till 7 c.c. at a dose is reached. Iodocin—calcium iodo-ricinoleate—is also recommended. grs. iij–v, or more, t.i.d. Rogers tried the sodium salt of gynocardic acid, sodium gynocardate, and claimed good results from its use. It can be put up in 3 gr. tablets, and three or four of these are given t.i.d. by the mouth. Later he suggested giving sodium morrhuate as well, and his results from this method have been very good in several cases. The sodium morrhuate

injections are given intravenously, and are best administered in a 3 per cent. solution, ampoules of fresh solution being used each time. The initial dose is ½ c.c., increasing this by ½ c.c. each time till 3 c.c. has been attained. They are given once or twice weekly. The newest of these chaulmoogra oil derivatives is a preparation by Burroughs, Wellcome & Co. called "Alepol" (sodium hydnocarpate), a sodium salt of selected fractions of the fatty acids of *Hydnocarpus Wightiana* oil. This can be given in a 3 per cent. solution subcutaneously and intramuscularly without pain, and in a 1 per cent. solution intravenously. The dose is from 1 to 5 c.c. It must be clearly borne in mind that chaulmoogra oil and its different extractives are only palliatives in the treatment of leprosy. They are not specifics, and the extravagant and exaggerated claims lately put forward for them—in the lay press—are fallacious and do not represent the true state of affairs. Injections of Deycke's nastin, combined with benzoyl chloride, had a vogue for a time, but they have lately fallen out of favour. For skin lesions, Unna recommends ichthyol, pyrogallic acid, resorcin and chrysarobin. Radio-therapy and electricity have also been tried.

G. CARMICHAEL LOW.

GLANDERS

Definition.—An infectious disease, occurring not infrequently in the horse and in the ass, occasionally transmitted to man, and characterised by the formation of granulomatous nodules in the nose (glanders), and in the subcutaneous tissues (farcy).

Ætiology.—The *bacillus of glanders*, or *Bacillus mallei*, is a short rod, straight or slightly bent, of 3 to 4 μ in length by 0·5 to 0·75 μ in thickness. It is non-motile, and possesses no flagella, nor does it form spores.

The bacillus stains somewhat faintly with the usual aniline dyes, so that a mordant, such as carbolic acid, is usually employed, but even when deeply stained there is a tendency to decolorise rapidly. The staining is markedly irregular, this irregularity being a diagnostically helpful point. It is Gram-negative.

Pathology.—The disease chiefly affects horses, mules and asses the latter being the most susceptible. Horned cattle are immune, but goats and sheep are occasionally infected.

In the horse, infection may take place through any abrasion of the skin, but most frequently through abrasion of the nasal mucous membrane from infected water-troughs or feeding-mangers. The infection may be acute or chronic. In the acute form (glanders proper) there is fever and prostration, and in two or three days there occurs ulceration of the nasal mucosa with a sero-purulent discharge, leading on to involvement of the lungs, and death within a few weeks. In the chronic form—farcy—there is involvement of the lymphatic system associated with the original site of entry. The lymph vessels become enlarged—farcy pipes—and irregular thickenings—farcy buds—occur, which may soften and suppurate.

The disease may be latent, and can then only be diagnosed by the "mal-

lein " test. In the human being the infection is generally derived directly from the horse, and is therefore usually confined to those in close connection with horses; but the disease has been contracted in the laboratory.

The *toxin* of *B. mallei* or mallein is an endotoxin, being derived from the bacterial bodies, in which respect it differs markedly from the toxins of tetanus and diphtheria bacilli. One of its chief characteristics is its resistance, it being capable of withstanding temperatures of 120° C. and prolonged storage with but little loss of strength. It is prepared by growing cultures in glycerin broth for 3 or 4 weeks, and sterilising these by boiling or autoclaving at 115° C. The cultures are then allowed to stand, and the supernatant fluid being decanted off, this is then filtered through a Chamberland filter. The resultant filtrate, to which one-half of 1 per cent. of carbolic acid is added, constitutes *mallein*. It contains the soluble portions of the bacteria, and substances from the altered medium, and is a similar product to tuberculin. It is used in doses of 1 c.c. to detect a glanders infection in the horse. As the reaction in a " glandered " animal is severe, both locally and constitutionally, it is unsuitable for use in man.

Forms of the disease.—Both glanders and farcy have been known to occur in man in acute and in chronic forms. All forms are rare.

Symptoms.—1. *Acute glanders.*—The incubation period varies, but is in most cases 4 days. At the site of infection in the nose there occurs an inflammatory swelling surrounded by œdema and lymphangitis, with a papular eruption soon becoming pustular. In a few days other and similar swellings appear, which soften and ulcerate, so that the mucosa of the nose becomes generally infected, leading to profuse muco-purulent discharge. The whole nose swells, it may be very considerably. The ulceration extends deeply so as to involve the cartilage and bone. The cervical lymph glands are usually enlarged and may soften, forming abscesses. Constitutional symptoms are present by this time, and death, usually with pneumonia, occurs about the middle of the second week.

2. *Chronic glanders.*—This form resembles closely the disease as seen in the horse. There is a chronic profuse coryza, associated with widely scattered muscular and subcutaneous nodules. Unless the nature of the disease is suspected, it may go undiagnosed for some time.

3. *Acute farcy* is the form of the disease resulting from accidental inoculation of the skin. A local lesion of a highly inflammatory kind leads quickly to a spreading zone of lymphangitis, subcutaneous nodules (farcy buds) appearing in the track of the infection, softening and forming abscesses. The patient becomes severely ill, with symptoms of a general infection, and the course of the disease is of much the same duration as in acute glanders.

4. *Chronic farcy* only differs from acute in that the " buds " are associated with much less inflammatory reaction, the constitutional symptoms are much less severe, and the course of the disease is much longer. A few of the cases have extended over 12 months.

Diagnosis.—Acute glanders has been mistaken for small-pox, owing to the likeness of the papulo-pustular eruption to the specific eruption of this disease. The chronic forms are at times mistaken for the other infective granulomata (syphilis, tuberculosis and actinomycosis). Exact diagnosis turns upon bacteriological methods, direct or indirect.

The *bacteriological diagnosis* in man may be simple if a superficial swelling exists which may be opened. Direct cultures may be made therefrom, preferably on potato, and a rapid diagnosis made. It may be, however, that weeks elapse before such an opportunity occurs, or before some deeply situated swelling calls for operative interference. In such cases serum reactions, such as the complement deviation test and the sedimentation test, are indicated, and in a case watched by one of the authors the diagnosis was made by the opsonic test several weeks before the bacilli were cultivated from the tissues.

If material containing *B. mallei* be injected intraperitoneally into a male guinea-pig, tumefaction and suppuration occur in two or three days in the tunica vaginalis, and the bacilli can be recovered therefrom.

Treatment.—The site of inoculation, if obvious, should be excised, and the underlying tissues should be treated drastically by strong antiseptics. All abscesses should be opened promptly and efficiently drained. The general symptoms are met by treatment similar to that given in any septicæmia. The only form of immune therapy promising any help is the use of vaccine, of which doses of 5, 10 and 25 million bacilli should be given at intervals of 2 to 3 days. If no undesirable reactions occur the dose should be cautiously increased.

THOMAS HORDER.
JOHN MATTHEWS.

MELIOIDOSIS

Definition.—A disease resembling glanders, occurring in the Federated Malay States and Burma.

Ætiology.—The disease is due to a bacillus, viz., the *Bacillus whitmori*, an organism closely resembling the glanders bacillus, *B. mallei*.

Symptoms.—Stanton describes, in acute cases, diarrhœa, with collapse resembling that of cholera, this being followed by septicæmic symptoms with pulmonary lesions like tuberculosis. In chronic cases there are lesions of the nature of abscesses in the skin and subcutaneous tissues, the spleen, liver and lungs.

Treatment.—Autogenous vaccines have been tried, otherwise there is no specific treatment.

G. CARMICHAEL LOW.

INFLUENZA

Definition.—An acute infectious disease, existing in pandemic and epidemic form, with sporadic outbreaks. The nature of the causative virus is not yet established, but *Bacillus influenzæ* (Pfeiffer) is found in very close association with the morbid lesions, especially those of the respiratory system, which the disease is specially prone to attack.

Ætiology.—Are the protean features of disease which are at present included in our conception of influenza all manifestations of the same *materies morbi*? Are there influenzas rather than influenza? What causative factors determine the pandemics of the disease during which the case-incidence

rises so rapidly and so enormously ? What is the association between benign influenzal catarrhs of endemic and sporadic occurrence and the pandemics which decimate whole races of mankind ? These are questions which have baffled epidemiologists and bacteriologists for many years, nor have the exceptional opportunities for observation and research afforded by the pandemic of 1918–19 served to answer them.

We are ignorant of the reasons why a state of relative quiescence in regard to the incidence of the disease—scattered sporadic cases and mild epidemics—suddenly blazes up into a devastating pandemic. We know that when this conflagration arrives the disease becomes very highly infectious in character, that its virulence is enormously increased and that the usual close association with catarrhs and seasons and latitudes and lowered general resistance is no longer observed. Age gives no security at such times; witness both the high case-incidence and high case-mortality in young adults during the pandemic of 1918–19.

A previous attack of the disease gives little or no protection; according to some authorities the reverse is the case.

In the matter of its relation to other catarrhal states the absence of definite criteria makes it impossible to be precise in diagnosis. It is only in the presence of a severe and widespread outbreak that the guide of probability is of assistance in this respect.

By some the claims made on behalf of Pfeiffer's bacillus, that it is the essential virus of the disease, are considered to be overwhelming. By others this micro-organism is regarded as being at the most the commonest secondary invader of the infected tissues. The primary microbic factor is thought by the writer and others to be of the filter-passing variety; indeed, it is probable that a minute organism quite recently isolated by American workers, using the Noguchi method of culture, is the actual causative virus. Next to Pfeiffer's bacillus the micro-organisms most commonly found in association with the disease are streptococci of the hæmolytic kind, pneumococci, *M. catarrhalis* and *Staphylococcus aureus*. It seems certain that many of the most serious and fatal cases owe their lethal character to virulent streptococci.

Pfeiffer's bacillus occurs in cases of disease quite other than clinical influenza—infective endocarditis, sinusitis and meningitis. And if we add to these, catarrhal processes which, again, either from their chronicity or other features, differ markedly from epidemic influenza, it is clear that this micro-organism, if it really be the causative microbic agent in the last-named disease, must at times undergo great variations in virulence. The bacillus is of very small size, is Gram-negative in staining reaction, grows with difficulty on ordinary media and has low vitality outside the human body. A special feature seen in regard to it is the fact that, when present in acute cases of influenza, it usually occurs in enormous numbers in the infected tissues and their secretions.

Symptoms.—So far as can be judged the incubation period is, with considerable constancy, something from 24 to 48 hours. A marked feature of the disease is the abruptness of the onset. So abrupt is it at times that the victim is stricken down, as it were, in the street, and, from being quite well he is, within a few hours, prostrated and already suffering the maximum discomforts of the disease. The temperature rises rapidly; there is often a rigor. The chief symptoms are racking headache, intolerable aching pains

in the loins and limbs, dryness and irritable redness of the mouth and fauces, and a distressing cough. An erythematous rash is not uncommon.

Although the symptoms are protean, it is customary to describe certain types of case that are frequently met with, dependent largely upon the particular tissues and functions which suffer the chief results of the infection.

1. *The febrile type.*—In this variety of the disease the chief features are pyrexia, with associated malaise, headache, pains in the back and limbs and a moderate degree of catarrh of the upper air-passages. In many cases this type differs only from the "common cold" in its more abrupt onset, its higher degree of pyrexia, its disproportionately severe prostration and its relatively "dry" form of catarrh. The eyeballs are often painful, with some conjunctivitis, and the fauces are often red and slightly œdematous. Cough is often present, with few or no associated pulmonary signs. The pyrexia lasts for a variable time, usually 4 to 6 days; it is unusual to see the fever prolonged past the eighth day without some focal complication, generally pulmonary. Defervescence is quite frequently by crisis, but this is by no means the rule.

2. *The respiratory type.*—This is the form of the disease which is most prevalent in pandemics, and, when severe, it is the form to which the mortality is chiefly due. Somewhere about the fourth day of the disease it becomes obvious that the catarrhal process is growing troublesome, with more definite involvement of the larynx, trachea and bronchial tract. In many cases the temperature falls about the third or fourth day, to rise again concurrently with a definite exacerbation and extension of the catarrh. The respiratory involvement does not tend to remain localised as a bronchitis, but involves the lung tissue, leading to a bronchiolitis and, in many cases, an alveolitis also. Then ensue the signs of acute pulmonary congestion which are so characteristic of the disease, and cause so much anxiety for fear of untoward developments. The respiratory manifestations of influenza infection extend from laryngitis and tracheitis through bronchitis to lobular and lobar pneumonia and pleurisy, both "dry" and with serous or purulent effusion. But the dominant feature, rarely absent in any really severe case, is a condition of capillary bronchitis with intense pulmonary congestion. This may be unilateral or bilateral, is more often basal than apical, but is not seldom universal. The physical signs are copious fine râles (crepitation), with impaired vesicular sound, and, less often, impaired percussion tone. This condition may well be termed the essential lesion of the disease, for even when actual consolidation of the lung is present, this is quite often an incident by comparison, and if the patient dies, he dies with the consolidation rather than of it.

Cough is usually a very troublesome symptom in this type of the disease, and is often quite independent of the need to expectorate. The sputa vary considerably. They may be quite absent, even in cases where there is widespread lung congestion. When present they are generally of a kind that corresponds with the nature of the chief lesion, whether tracheitis, bronchitis or pneumonia. Two special kinds of sputa are very typical of influenza, and they are seen frequently during epidemics. (*a*) Bright, pink, frothy mucus, sometimes produced in large amount, it may be as much as a pint in 24 hours. This rose-red mucus results from acute inflammatory œdema of the lung. It may be expelled involuntarily during cough and sometimes

it spurts from the nostrils. (*b*) Tenacious mucus, less viscid than in lobar pneumonia, and more copious, differing also in colour which is of several hues—red, brown, saffron and various shades of green, all of these being occasionally present at the same time. Seen in a white earthenware vessel these sputa are very striking and in a high degree diagnostic.

3. *The malignant type.*—This severe and very fatal form is almost confined to pandemic or to epidemic periods. The patient is gravely ill from the onset, or soon after, with intensely toxic symptoms, cyanosis of a peculiar character ("heliotrope cyanosis") and rapid development of heart failure before focal manifestations have time to show themselves—unless it be the presence of fine copious râles of the kind referred to in (2). The duration of this type of case varies from 48 hours up to a week, and no measures of treatment, however prompt, serve to avert the almost certain issue.

4. *The gastro-intestinal type.* — More strictly, perhaps, gastric and intestinal types. These types are less common in pandemics and epidemics than in small endemics and in sporadic cases. The gastric cases are quite common, and some of the milder endemics seem to "breed true" to a remarkable degree in this respect, leading to a very constant clinical picture of an illness with acute, even abrupt, onset, vomiting, marked anorexia, epigastric and umbilical tenderness and general prostration. Considerable difficulty often arises in diagnosis (see p. 126), even when there are several cases of a similar kind prevalent.

Jaundice of the catarrhal kind is not very uncommon as a complication. Some of the intestinal cases give no less difficulty, and when severe the likeness to typhoid fever is sometimes very close indeed. Tympanites, diarrhœa and enterorrhagia, associated with continued high fever and a leucopenia, may deceive the very elect.

5. *A nervous type* has been described, but it is perhaps more correct to say that a variety of nerve symptoms may arise both during and after the acute infection, rather than that a recognisable clinical picture is produced (see p. 126).

Complications and Sequelæ. -These are both numerous and important. Indeed, if we except the malignant cases and the very severe respiratory cases occurring during pan- and epidemic periods, it may be said that the importance of the disease lies more in its complications, and perhaps still more in its sequels, than in the stage of infection proper. For convenience these disabilities may be grouped as follows:

1. *Respiratory.*—The main extensions of the catarrhal process have been already referred to, as also has the occurrence of pleurisy. Sinusitis may be mentioned here; it is both common and troublesome. Otitis media also occurs. Asthma sometimes appears for the first time in a patient's life after influenza, and the age of the sufferer may be much more advanced than is usual with asthma generally. Pulmonary tuberculosis not seldom shows itself also for the first time in the same association. The most frequent sequel of all, however, is the maintenance of a state of chronic congestion or bronchiolitis at one base or both bases of the lung. This condition may persist for years, ebbing and flowing with the seasons and with the occurrence of intercurrent catarrhal infections.

2. *Circulatory.*—Perhaps the most serious complication and sequel is referable to the heart. Some degree of dilatation is very common during a

severe attack of the respiratory type, and this condition is apt to prolong convalescence in a very tedious fashion. But a much more common form of heart disability is that which arises insidiously after the patient begins to resume his usual routine of life. He is the subject of palpitation, præcordial distress and a sense of undue fatigue with slight effort. In women this state of things is complicated often by nervous symptoms, and attacks of breathlessness and a sense of impending collapse are quite common. As there is frequently in addition a considerable degree of true nervous prostration with mental depression it becomes exceedingly difficult to decide to what extent the heart is really affected. Physical signs in these cases are wholly inadequate; quite often they are absent altogether. Although, with care and encouragement, many of these cases get quite well after a time, a large number unfortunately become more or less permanent "heart invalids." It is not clear what is the exact pathology of the "influenzal heart," but it is perhaps near the truth to consider it in the main a toxic myocarditis; though to what degree it is the nervous mechanism, and to what degree the heart muscle, that suffers we cannot say.

Vasomotor troubles are not uncommon and often complicate the heart condition. Phlebitis may occur.

3. *Nervous.*—The most common complication is the intense depression from which the patients so frequently suffer. In a few cases this leads to actual mental instability and, in fewer still, to suicide. The depression may continue for a long time after the acute illness is over. So common a symptom is it that patients themselves often consider the nature of a recent febrile illness to be definitely established as influenza because of this resultant depression. And they are probably in most cases correct. The headache, which is another very constant accompaniment of the illness, may be so severe as to raise the question of meningitis; it quite commonly leads to some delirium in patients whose nervous system is, in health, none too stable.

A true meningitis occurs now and again with *B. pfeiffer* in the cerebrospinal fluid and a clinical picture that is unequivocal. Encephalitis and myelitis are described, but here, again, the diagnosis—from epidemic encephalitis—must always be a difficult matter.

Many other nerve conditions are described by authors. Perhaps neuritis, of both single and multiple types, is the most common. The writer has seen a condition indistinguishable from paralysis agitans follow a severe attack, which ended in complete recovery after several months.

Diagnosis.—During pan- and epi-demics the diagnosis is, as a rule, not difficult, especially when the case is very severe. "Filming" the sputa in a case of the respiratory type is a most valuable aid to diagnosis. If the highly characteristic condition of bronchiolitis with copious fine râles referred to on p. 124 be present in a febrile illness with nerve prostration and general toxæmia, the diagnosis is fairly certain.

The gastric and intestinal cases, and especially the latter, present more difficulty than do the respiratory cases. The gastric cases resemble food-poisoning not a little, and appendicitis may require careful consideration in patients with abdominal tenderness, pain and vomiting, of acute onset. From typhoid fever a severe intestinal case with hæmorrhage and enlarged spleen can only be distinguished by absence of agglutination and negative blood culture. A leucopenia is present in both diseases.

The diagnosis of milder cases of influenza, if occurring in sporadic fashion, is frequently a frank admission that it is well to give the patient and his friends a label to his disease. There are so many causes of an acute febrile illness with malaise and slight catarrh that exact diagnosis may not be possible.

A word of warning is perhaps necessary in respect of diseases known to be prevalent coincidentally with outbreaks of influenza. Thus, true pneumococcus pneumonia, whether lobular or lobar, is not infrequently called influenzal when this latter disease is epidemic. Of greater importance is the fact that waves of incidence of influenza and poliomyelitis and encephalitis sometimes concur. If the practitioner's attention is bent only upon the former disease he is apt to put down to it certain serious nerve lesions that really belong to the latter.

Prophylaxis.—As we do not know the factors leading to the production of influenza epidemics we do not know how to prevent them. When they arrive we can, to some extent, control them by efficient quarantine, by early diagnosis and notification and by a proper system of hospitalisation, adequate to the peculiar features presented by the disease. In regard to individual prophylaxis it was formerly held that to keep generally "fit" was a good protection against infection. But recent experience does not confirm this view: influenza attacked the strong as well as the weak; indeed, the robust young adult fell a victim by preference, though this may have been partly because he was more open to infection by virtue of the conditions of his life. The age-mortality as well as the age-morbidity during the 1918–19 pandemic seemed to make it clear that some method of specific immunisation is essential before we can hope to protect against infection. But in the absence of exact knowledge of the causative agent, specific prophylaxis of a convincing kind is scarcely practicable. The available vaccines for protective inoculation perhaps aim as much at raising resistance against the secondary infections which are frequently so harmful as against the primary invader. Regarded in this light they are rational; but it is still too soon to give a proper judgment upon the question of their therapeutic efficacy.

Treatment.—1. General Measures.—With the onset of symptoms the patient is put to bed and is kept there until the temperature has reached normal and has remained there for at least 24 hours. He is only allowed up if examination of the heart and lungs, and a review of his general condition, reveal nothing abnormal. If the attack has been more than a mild one, it is well to induce the patient to remain in bed for 4 days after the temperature is normal, so as to be on the safe side, because relapses are common, and are often more dangerous than the original attack. This rule of practice should certainly have no exception in the case of patients over 50 years of age.

The largest available room is chosen and the bed is placed well away from the walls. Blinds, curtains and screens are dispensed with, and the windows are kept open day and night. The room temperature is kept as near to 60° F. as possible. If the ideal of free ventilation with warmth cannot be secured, then warmth must be sacrificed rather than ventilation. Neglect of fresh air not only seriously prejudices recovery in the event of pulmonary complications, it undoubtedly tends much to induce them. It is probably the most important point in the treatment of all cases. The bedclothes are adjusted to the patient's temperature, only using sheets and blankets.

The diet is confined to hot fluids, given frequently in all severe cases, but easily digested solids are allowed if the stomach tolerates them; efforts at "feeding up" the patient are to be deprecated. Unless the patient is elderly, alcohol is not needed in the early stages of the disease when there are no complications. The bowels are made to act thoroughly by a double dose of the patient's customary aperient. If he has none, he is given ½-grain doses of calomel every hour for 4 doses, and this is followed by a saline draught. The patient is sponged all over with warm water twice daily.

2. DRUGS.—There is probably no drug which acts as a specific. Aspirin and Dover's powder in 10-grain doses may be given together as early as possible and may be repeated once or twice after 6 or 8 hours. This may be followed by a simple diaphoretic mixture.

3. TREATMENT OF SYMPTOMS.—If the headache is severe, phenacetin gr. x with caffeine gr. ij, may be given 4-hourly for 4 doses. If the stomach gives trouble and the tongue is foul, sod. bicarb. and sod. sulphocarb., of each gr. x, with glyc. acid. carbol. ℥x, may be given 6-hourly with the feeds, well diluted. For vomiting, all feeds are reduced to a minimum, or omitted entirely for 48 hours, giving sips of hot water only, with minim doses of tinct. iod. in 1 drm. of water hourly for 6 or 8 doses, injecting 1 pint of normal saline into the bowel two or three times during the period of starvation.

Distressing and persistent cough is often the most difficult problem. Local applications to the chest are often of service. If the origin of the cough is irritability of the upper-air passages inhalations of tinct. benzoini co. 4 parts, with menthol or eucalpytus 1 part, are useful. Failing this a spray, containing chloretone and menthol, 2 per cent. of each in liquid paraffin, may be used to the nose and throat. In the "essential cough" of the disease, syr. cocillanæ co., syr. codeinæ and tinct. terp-heroin co. are of some value. In intractable cases relief may follow syr. chloral ʒss, ammon. brom. grs. x, with ext. glycyrrhiz. liq. ℥xx, etc., in 4-hourly doses for 4 doses.

Insomnia calls for a general review of the whole programme—ventilation, control of pyrexia, posture, food, stimulants, etc. Failing attention to these things, a sedative draught of ammon. brom. grs. xx and tinct. valerian. ℥xx may be tried. If not successful, ʒij-doses of paraldehyde, with tinct. quillaiæ and tinct. aurantii to cover its unpleasant taste. Failing this, again, chloral and bromide may be given, since drugs of the veronal group are better avoided.

4. TREATMENT OF MORE SEVERE CASES AND OF COMPLICATIONS.—(*a*) *Intensely toxic cases, with hyperpyrexia.*—Attention to good ventilation should be redoubled. The thermometer and not the patient's sensations must be the guide to the amount of bedclothes. "Cradling" is often very useful, as also is tepid or spirit sponging. In cases in which the temperature is even then resistant, the cold pack should be used and repeated if necessary. Febrifuge drugs are to be avoided in such cases. Stimulants are now advisable to counteract circulatory failure.

(*b*) *Pulmonary cases.*—Linseed and mustard poultices are of service here, or antiphlogistin, applying these to the most "congested" parts. Volatile stimulants, sedative expectorants and diaphoretics are the most useful drugs: sp. ætheris co., the iodides in small amounts, bromide and chloride of ammonium, tinct. senegæ, tinct. belladonnæ and liq. ammon. acetatis. Ammon. carb. should only be used where sputa are present, and large doses

are of doubtful value at any time. Oxygen passed through warm alcohol is useful in all severe cases with cyanosis.

(*c*) *Heart failure*, to be estimated more by the general state of the patient (facies, cyanosis, dyspnœa, delirium, posture) than by pulse-frequency or physical signs, is met by alcohol, strychnine injections, camphor in oil (3 grains in 15 minims) intramuscularly, and, as a measure supplementary to these, strophanthin $\frac{1}{100}$ grain in 20 minims of sterile saline solution, injected slowly into a vein of the arm and repeated, if indications are still present, in 8 or 12 hours.

(*d*) The *post-febrile stage*, often a stage of cardiac and nervous exhaustion in severe cases, requires some caution. Strict recumbency should be enjoined, with careful feeding, stimulants and tonics.

5. Immune Therapy.—There is even greater diversity of opinion as to the value of specific measures of treatment for the disease than there is for prophylaxis. If it be decided to adopt such measures it seems clear that they should be tried as early as possible after the onset. But this means that autogenous vaccines cannot be employed. The stock formulæ recommended for use vary considerably, but all of them are based upon the principle of "mixed" infection by *B. pfeiffer*, streptococcus, pneumococcus and *M. catarrhalis*. Seeing that so many of the fatal cases appear to be so because of virulent streptococcus toxæmia some authorities give anti-streptococcus serum early in the disease in all bad cases, and the writer favours this practice. Liberal doses should be given, such as 100 c.c. intravenously in very severe cases, and 25 c.c. repeated two or three times at intervals of 12 hours subcutaneously in cases in which the infection seems less intense.

6. Many experimental methods of treatment were exploited during the pandemic 1918-19, including a large range of antiseptics by the intravenous route. But no remedy emerged from all the trials thus undertaken with sufficient credit to merit a reference here.

Thomas Horder.

WHOOPING-COUGH

Synonym.—Pertussis.

Definition.—An acute specific disease of high infectivity, characterised by catarrh of the respiratory tract, combined with periodically recurring laryngeal spasms of distinctive type and other signs of nervous disturbance.

Ætiology.—Whooping-cough is mainly a disease of temperate climates, being rarer and less severe in hot countries. Spring and autumn are the seasons of its maximum prevalence, and also of its greatest mortality, chiefly owing to respiratory complications; but the disease may also occur in the warmer months, even in epidemic form. It is more prevalent in cities and industrial centres than in the population of rural districts. Persons of all ages, if unprotected by a previous attack, are susceptible to the infection; but whooping-cough is essentially a disease of childhood, and, moreover, shows a stronger tendency to attack young infants than does any other specific disease. Most attacks occur between the ages of 1 and 10 years. Infants under the age of 12 months often succumb. The fœtus *in utero* has been known to contract the infection from its mother, and to show the characteristic

symptoms soon after birth. As regards sex, more females than males are attacked. The frequency with which whooping-cough follows an attack of measles is noteworthy. A second attack of whooping-cough is very rare. Infectivity is greatest during the catarrhal and early paroxysmal stages; but its exact duration is a matter of dispute. On rare occasions convalescents are said to have acted as carriers of the disease.

The infection is usually direct, being conveyed by the mucous droplets in the expectoration. Since the virus can resist drying for several weeks the disease may also be conveyed by fomites, but this is uncommon. One attack almost invariably confers lifelong immunity.

Bacteriology.—Of the various organisms which have been alleged to be the causal agents, the bacillus of Bordet and Gengou has the strongest claims to acceptance. This is a minute, slender rod closely allied to the bacilli of the influenza group. It is Gram-negative, and only flourishes on artificial media which contain blood or serum. It grows best at blood heat. Cultures are most easily obtained from the small pellets of viscid mucus which are expectorated at the end of a paroxysm of coughing. The blood of convalescents agglutinates the bacilli.

There are no post-mortem appearances which are distinctive, the changes found after death being due to complications. Of these, congestion of the air-passages and broncho-pneumonia are the most common, and are accompanied by general acute vesicular emphysema. The tracheo-bronchial lymph glands are usually soft and swollen.

The paroxysmal cough is attributed to the action of the virus in producing hyperæsthesia of the respiratory mucous membrane and to heightened excitability of the vagus nerve, but toxic influence on the nerve centres is probably widespread.

Symptoms.—The incubation period is difficult to fix with accuracy, owing to the insidious nature of the onset and the delayed appearance of the characteristic whoop, but it is most probably 13 to 15 days. Extremes of 4 days and 3 weeks have been claimed. During a typical attack three stages may be recognised—the catarrhal, the paroxysmal, and the convalescent.

The catarrhal stage lasts from seven days to a fortnight—it is febrile, and in many ways resembles a somewhat severe respiratory catarrh; but the cough is more troublesome and generally accompanied by some sonorous and sibilant rhonchi. Recognition of the disease at this stage is difficult unless the patient is known to have been exposed to the infection. Suggestive signs towards the end of the period are a tendency of the cough to assume a paroxysmal character, with greater severity at night and occasional culmination in vomiting.

When the paroxysmal stage is reached the disease is unmistakable. Fever will usually have subsided; but the cough occurs in paroxysmal bouts, often spontaneous, but frequently the result of external stimuli, such as excitement, draughts, the ingestion of food or examination of the throat. Several paroxysms may occur in quick succession with longer or shorter intervening periods of freedom. The victim knows when the cough is impending, and may for a time attempt to suppress it. If lying in bed a child will sit up, if about he may run to his mother or nurse. A brief, deep inspiration is followed by a rapid succession of short coughs, with open mouth and protruded tongue,

which are continued until the chest is almost emptied of air. The face becomes congested or livid, the superficial veins are engorged, and the eyes fill with tears. The eyeballs protrude, the skin is bathed in sweat, and suffocation appears imminent; but relief is suddenly afforded by relaxation of the laryngeal spasm and the occurrence of the whoop, a long-drawn crowing inspiration, which refills the lungs with air. The paroxysm then recurs, and may be repeated several times, leaving the child perspiring and exhausted. The bout often terminates with the discharge from the air-passages of a pellet of viscid, transparent mucus. A quantity of thin sticky secretion, which is sometimes blood-stained, may also flow from the mouth and nose. During the fits of coughing, which often last for 2 or 3 minutes, the child may faint or become convulsed and insensible. The contents of the stomach are often ejected, and the urine may be voided; in some instances incontinence of fæces occurs. Epistaxis is not uncommon in the more severe attacks. Subconjunctival hæmorrhage may occur, and petechiæ appear in the skin of the eyelids and other parts. Rarely the membrana tympani is ruptured, and blood escapes from the ear. In infants asphyxia may occur and call for artificial respiration.

In the early paroxysmal stage the cough is only occasional, but its frequency soon increases, and in a case of moderate severity from 15 to 20 paroxysms occur in the 24 hours; in some attacks, however, they are much more numerous. They are characteristically most frequent and most severe at night.

Physical examination of the chest at this stage will still reveal signs of diffuse bronchitis; but this is now accompanied by a greater or less degree of acute emphysema and a moderate degree of abdominal distension is not uncommon. The forcible protrusion of the tongue over the lower incisor teeth often produces a shallow ulcer on the frænum linguæ.

The duration of the paroxysmal stage is from 3 to 10 weeks, and after this convalescence begins. Whooping-cough is more prolonged in winter than in summer, and its duration is increased if complications ensue. After the whoop has ceased a fresh attack of respiratory catarrh may cause it to reappear; but this should not properly be regarded as a relapse, and does not render the patient again infectious.

The blood shows a leucocytosis even in the early catarrhal stage. Both polymorphonuclear cells and lymphocytes share in the increase; but the lymphocytes are increased out of proportion to the other cells and may constitute 66 per cent. of the total count; myelocytes may also make their appearance. The leucocytosis is said to be increased after each paroxysm of coughing, and the highest counts to be found during convulsions. The supervention of pneumonia increases the polymorphonuclear cells.

Course.—Attacks vary in their severity and duration. Mild infections may run their whole course in a week or two, whilst severe ones may last several months. As mentioned above, the number of paroxysms in 24 hours is some measure of the severity. The danger of supervention of complications is broadly proportional to the severity of the attack. When whooping-cough occurs in the adult the whoop is much less conspicuous, and may be entirely absent, but the cough retains its paroxysmal character and nocturnal severity. In infants, too, the whoop may be very imperfectly developed.

Complications.—These belong mainly to the paroxysmal stage of the

disease—they are partly mechanical and partly inflammatory in nature. The most serious are excessive vomiting, broncho-pneumonia and convulsions.

When the paroxysms of coughing are frequent and severe, excessive vomiting may lead to great emaciation and exhaustion. Diarrhœa and ileo-colitis may also occur, mainly in younger children, and during the summer months.

Pulmonary complications are frequent, and are more common during the winter. A mild general bronchitis with general, but temporary, acute emphysema is the rule, and is of but little moment. Capillary bronchitis or broncho-pneumonia, with patchy pulmonary collapse, is much more serious. It usually occurs at the height of the paroxysmal stage, and is responsible for two-thirds of the deaths. Interstitial emphysema of the lung may result from rupture of an air cell during coughing, but is only likely to be recognised when it overflows into the root of the neck and the connective tissue of the chest wall. Bronchiolectasis is an occasional sequel of the disease.

Convulsions may occur in infants and younger children, and prolonged attacks of glottic spasm may induce asphyxial fits. Aphasia, coma, hemiplegia, paralysis of ocular nerves and defects of sight, hearing, and intelligence sometimes supervene. Bulbar paralysis and polyneuritis have also been described. Cerebral congestion and meningeal hæmorrhages account for some of these complications; others, such as polyneuritis, are probably due to toxæmia. Defect in vision is sometimes found to be due to retinal hæmorrhage or detachment.

The strain of the recurrent paroxysms of coughing may induce dilatation of the right ventricle of the heart, subconjunctival hæmorrhages, epistaxis, bleeding from the mouth or ears, hæmoptysis, and hæmorrhage on the surface or less commonly in the substance of the brain. Other results are the appearances of herniæ and prolapse of the rectum.

True nephritis is rare, but albuminuria may appear. Glycosuria is occasionally seen.

An unhealthy condition of the naso-pharynx may persist after the cough has subsided, and no other disease except measles has such a bad reputation as whooping-cough as a forerunner of tuberculous manifestations.

Diagnosis.—In the absence of known exposure to infection, diagnosis may be impossible until the whoop is heard; but the significance of a paroxysmal cough, worse at night and terminating in vomiting, should not be overlooked. The disproportion between the violence of the cough and the accompanying physical signs in the chest is also noteworthy. When broncho-pneumonia does supervene the whoop may cease. In infants the cough may be paroxysmal and asphyxiating, but the whoop not developed; in such cases, as also in adults when the whoop is absent, the diagnosis may be cleared up by the occurrence of infection in contacts.

The spasmodic cough of bronchial gland irritation and of adenoids is apt to be paroxysmal, but the whoop is wanting. The same observation applies to the obstinately recurrent coughs of influenza and bronchiolectasis. In children, laryngeal inflammation of catarrhal or of syphilitic origin may induce paroxysms of cough and laryngeal spasms, but the tone of the cough at once indicates its laryngeal origin. Conversely, whooping-cough in its early

stages, if accompanied by an unusual amount of laryngeal catarrh, may be confused with the laryngitis of measles or of diphtheria.

In the catarrhal stage the malaise, cough, pyrexia and slight fullness of the abdomen with perhaps some irregularity of the bowels, may arouse unfounded suspicions of early general tuberculosis.

The leucocytosis of whooping-cough, which is considerable in the early stages, may prove of assistance in the early diagnosis of the disease. An authentic history of a previous attack puts whooping-cough for all practical purposes out of court, second attacks being excessively rare.

The presence of the sublingual ulcer is only to be expected after the incisors have appeared. Occasionally it is seen in other conditions of persistent cough.

Prognosis.—Whooping-cough is a much more serious malady among the children of the poor, and in those suffering from malnutrition, rickets, tuberculosis, or a predisposition to chest troubles, than it is to healthy children in comfortable circumstances. Apart from this, age constitutes the most important prognostic factor. Infants and children under 3 years of age suffer a considerable mortality, which for the first 12 months of life is estimated at 25 per cent. The mortality decreases rapidly after the third year, and after 10 years of age is insignificant. Hence it is found that more than two-thirds of the deaths from whooping-cough occur during the first year of life, the younger the infant the worse being the outlook. Of complications, broncho-pneumonia causes most of the deaths, occurring chiefly in the winter months. In the summer, ileo-colitis comes into prominence.

Convulsions, especially if repeated, are of grave omen. Death at times occurs suddenly from asphyxia due to sustained laryngeal spasm, or from heart failure or intracranial hæmorrhage. When tuberculous lesions are present these may be stirred into activity by the infection, and especial care is necessary.

A cautious prognosis should be given with regard to paralytic sequels, since in a number of cases these prove permanent.

Treatment.—Isolation should be enforced, but free ventilation with abundance of fresh air is desirable, and gives better results than confinement in a close room and the inhalation of medicated vapours. In the absence of fever, patients may be allowed up and out as much as possible, provided isolation can be maintained. In suitable weather continuous open-air treatment may be adopted even for those patients who are confined to their beds. A light binder should support the abdomen, and the clothing be loose and not too heavy. When lung complications are present a jacket of gauze tissue should be worn. The diet should be light and digestible, excess of starchy and saccharine food being avoided. When vomiting is persistent it is a good rule to administer food in small quantities immediately after the paroxysms of coughing. Overloading the stomach may aggravate the cough. A diet of milk or whey may be necessary in some instances. Rectal feeding is very unsatisfactory. The chest may be rubbed as a routine with some stimulating liniment.

As regards drugs, there is no specific, although quinine or euquinine in large doses have been regarded as such. During the catarrhal stage simp expectorant mixtures are sufficient, and later the paroxysms may be mo

by such sedatives as bromide, belladonna, antipyrine, bromoform, chloral, paregoric and heroin, all of which have their advocates. Perhaps belladonna in increasing doses and antipyrine are the most generally useful; the latter may be given to a child in doses of 2 or 3 grains with small doses of iodide of potassium and expectorants every 4 or 6 hours. Bromoform is insoluble and difficult to suspend in mixtures; the dose is 3 to 5 minims. Great care is necessary to avoid accidents. Benzyl benzoate has lately been highly recommended—from 5 to 40 drops of a 20 per cent. alcoholic solution being given 3 or 4 times a day according to age and the severity of the disease. Syrup of garlic is also advocated. It is claimed that intramuscular injections of ether in doses of 1 or 2 c.c. given every 2 days reduce the number of paroxysms. The method is painful. Vaccine treatment with the Bordet-Gengou bacillus is still on its trial. The results appear contradictory. Attention should be paid to the condition of the nose and throat, and adenoids removed as soon as possible, since they tend to maintain the cough. During convalescence, quinine and nux vomica are useful tonics, and a change to the seaside is advisable.

Radio-therapy, consisting in one or two exposures of the tracheo-bronchial glands to ¼–¾ pastille dose of X-rays applied to the back through a suitable filter is said to mitigate the severity of the disease and reduce the mortality. The injection of the serum of convalescents, on the same lines as in measles (*q.v.*) has been recommended.

Complications should be treated on general lines. Obstinate vomiting needs careful management as regards feeding, and hydrochloride of cocaine in quarter-grain doses 3 times a day has been recommended. Asphyxial attacks may be treated by pushing forward the lower jaw and applying artificial respiration. Intubation has been practised in some very severe cases.

Although the infectivity of the paroxysmal stage, especially of its latter part, is problematical, patients should be isolated for 5 weeks from the commencement of the whoop, provided the paroxysmal cough and whoop have ceased for a fortnight. The quarantine period for non-immune contacts is 21 days. Disinfection of rooms and clothing is desirable.

CHARLES R. BOX.

ACUTE ANTERIOR POLIOMYELITIS

Definition.—Acute poliomyelitis—an acute, specific, infectious, febrile disease, occurring sporadically and sometimes epidemically—is incident chiefly upon young children, though no age is exempt. It is due to the infection of the respiratory passages with a minute micro-organism, which can be cultivated, and, when injected into monkeys, reproduces the disease, and can again be recovered from the diseased nervous tissue of the infected animals. The clinical aspect of the malady is that of an acute febrile illness of short duration, accompanied or followed by severe nervous symptoms indicative of damage to the grey matter of the spinal cord, brain stem, cerebrum or cerebellum, or any combination of involvement of these structures. The lesion of the spinal cord produces acute atrophic paralysis (infantile atrophic palsy), that of the cerebrum produces most commonly hemiplegia (infantile hemiplegia), that of the brain

stem produces paralysis of cranial nerves and nuclei (most commonly ophthalmoplegia), and that of the cerebellum, ataxy.

It is probable that the disease frequently occurs without nervous manifestations, as a short febrile illness with complete recovery. Carriers of the disease, who do not themselves suffer, but from whose respiratory passages the organism of the disease can be recovered, are probably common, and these are important agents in the propagation of the disease.

Ætiology.—A most constant feature of the disease is its incidence in young children. During the first year of life, children seem almost immune; but during the second and third years they are most often affected. As age advances after the third year, the incidence rapidly declines, and while cases occurring in early adult life are common enough, the disease becomes very uncommon after middle life. It would appear that the immunity during the first year is acquired from the parent, and that the rarity of the malady in adult life is due either to all the susceptibles having been picked out by the disease in childhood, or to the majority of the community having been protected by the occurrence in early life of an abortive form of the disease without nervous manifestations. The sexes are equally affected, and heredity is not a factor. The disease is much more prevalent during the hotter months of the summer, usually the months of August and September in the northern hemisphere, and the months of March and April in the southern hemisphere. The experimental incubation period in monkeys is from 10 to 20 days. In man it seems to be much briefer, and may certainly be as short as 72 hours from a carrier infection. Since a subject may provedly first carry and then succumb to the infection, the incubation period may be several or many days. There is no satisfactory evidence that the infection can be transmitted by one who is suffering from the disease, since no case admitted into the children's ward of a hospital has ever infected others. The virus seems only transmissible when existing in the purely saprophytic state, namely, upon the mucous membranes of carriers and of those in the incubation stage of the infection.

Though usually sporadic, the disease may become epidemic. The first important epidemic was described by Medin at Stockholm in 1887. Another occurred in Rutland, Massachusetts, in 1894, and in Sweden and Norway in 1899 a very large epidemic investigated by Wickman occurred, and since this time many other epidemics have been reported from all parts of the world. These epidemics have proved that the disease spreads along the paths of human intercourse only, and that it is spread by individuals who are carriers of the micro-organism. No other factors in the spread of the malady are definitely known, although Aycock has collected some evidence of the conveyance of the infection by milk. There seems to be little or no tendency for the disease to occur in institutions, or to spread through the inhabitants of an institution.

Pathology.—In 1909 Landsteiner and Popper and several other investigators succeeded in transmitting acute poliomyelitis to monkeys, by the intraperitoneal injection of an emulsion of the spinal cord from a case of that disease. In the following year Flexner and Lewis, by intracerebral injection of a similar emulsion, were able to transmit the disease through a series of monkeys. In 1913 Flexner and Noguchi succeeded in cultivating the organism of poliomyelitis under anaerobic conditions upon a mixture of ascitic

fluid and fresh kidney. The micro-organism consists of minute globoid bodies, measuring 0·15 μ to 0·3 μ in diameter, which are arranged in pairs, chains or masses. They resist the action of glycerin, are capable of passing through the Berkefeld filter, and can be detected in sections of the infected nervous tissue. On inoculation the organism reproduces the experimental disease in monkeys, from which animals it can be recovered in pure culture. Infection either by means of the virus obtained from an infected spinal cord, or by means of the cultivated organism, is most easily produced by direct injection into the brain; but injections into the peritoneal cavity, the anterior chamber of the eye, the subcutaneous tissue, the intrathecal space and the nerve trunks, have all been successful in producing the disease with varying degrees of certainty. Injection into the blood nearly always fails, as the blood seems to have a definite destroying influence upon the organisms. It has been shown that the disease can be communicated to monkeys by applying the virus to the uninjured nasal or intestinal mucous membrane. In living patients during the acute stage, and in those who have died of the disease, the presence of the microbe has been detected in the secretions of the mucous membranes of either the mouth, the nose, the upper air passages or the intestine of so large a proportion of the cases, as to justify the conclusion that the virus is always present upon these mucous surfaces in patients suffering from poliomyelitis during the acute stage, and it is probable that the disease is conveyed from one subject to another by means of the secretion of these mucous membranes. Similarly the presence of the virus has been proved in patients suffering from the abortive form of the disease without nervous symptoms, and in apparently healthy contacts who thus serve as virus carriers.

From the remarkable difficulty in infecting animals with poliomyelitis by means of the blood stream, and from the fact that these can be infected by local injection of the virus into a nerve trunk, and that severance of the nerve trunk upon the proximal side prevents infection, it seems certain that the virus reaches the central nervous system by means of the perineural lymphatics, as is the case also in rabies, tetanus and diphtheria. The virus is never found in the cerebro-spinal fluid. Infection seems to take place directly from one individual to another, by droplet infection from the breath, and the evidence is against the transference of the disease by means of fomites or vermin.

After recovery from poliomyelitis, both natural and experimental, active immunity is developed, and Netter and Levaditi have shown that this immunity is associated with active principles occurring in the blood, which neutralise the virus. Artificial immunity can be produced in monkeys, both by the injection of emulsions of dried spinal cords from cases of the disease, as in rabies, and also by the injection of much-diluted virus. In whatever way infection arrives, the virus is conveyed to the nervous system by means of the perineural lymphatics, and is there fixed in the grey matter, and especially in the grey matter of the spinal cord. It may be found in the fluid of the subarachnoid space very soon after infection; but it rapidly disappears from the cerebro-spinal fluid.

The essential pathological change which occurs in the nervous system is an acute inflammation of the interstitial tissue, especially of the grey matter, with local destruction of the nerve elements according to the severity

of the inflammation, and also a general toxic affection of the nerve cells. In the acute stage the pia mater of the affected region is infiltrated with small round cells some of which escape into the cerebro-spinal fluid, giving rise to the lymphocytosis of that fluid characteristic of poliomyelitis early in the acute stage. All the vessels of the affected region are engorged, and small hæmorrhages are not uncommon. The vessels are surrounded by very numerous small round cells which produce a remarkable appearance termed "cuffing" or "muffing" of the vessels. A similar condition of the vessels occurs in rabies, in lethargic encephalitis and in syphilis, but poliomyelitis is distinguished from these by the occurrence of a considerable number of polymorphonuclear cells among the lymphocytes in the perivascular exudation. Sometimes thrombosis occurs in the vessels and this, in addition to the acute inflammation and subsequent necrosis, is the cause of the softening of the affected region which is often present. In the grey matter, in addition to the vascular changes above described, many of the nerve cells are seen to be surrounded by small round cells, and neurophages derived from the glia elements are seen adherent to the nerve cells, and actively destroying them. When the stage of acute inflammation subsides, it leaves a local necrosis which, according to the severity of the initial inflammation, may be so extensive as completely to destroy the affected region, or so slight as to allow of almost complete recovery of function. Subsequently the affected region becomes reduced in size and sclerosed from neuroglial proliferation.

The muscles which are innervated from the affected region waste completely or partially, according to the degree of destruction of the nerve cells. Some of the muscles, such as the biceps, seem always to undergo fibrous degeneration, while others, such as the gastrocnemius, undergo fatty degeneration. The muscle fibres of the muscle spindles do not degenerate, and contain a normal nerve fibre.

Cerebro-spinal fluid.—In the early days of the disease there is usually a pleocytosis, from a moderate to a very large increase of cells: the cells are usually lymphocytes, but sometimes polymorphonuclear cells predominate, both early and late during the pyrexial period; the albumin content is increased; the chlorides are present in normal amount, and the reduction of Fehling's solution is normal. The fluid is clear and under abnormally high pressure. The lymphocytosis is however evanescent, and the cell count usually drops to normal at the end of a fortnight. In a few cases in which the diagnosis was indubitable we have found the cerebro-spinal fluid normal throughout.

Blood.—In the early stages of the disease there is a constant and very marked polymorphonuclear leucocytosis which may reach as high as 30,000, with lymphocytic leucopenia. This leucocytosis soon disappears when the fever abates.

Lymphoid tissues.—All cases of poliomyelitis examined by necropsy show striking hyperplasia of the lymphoid tissues, including the tonsils, the thymus, the lymphoid tissue of the intestine, and the superficial and deep lymphatic glands. The spleen is enlarged and the Malpighian bodies prominent.

Symptoms.—The general febrile symptoms of poliomyelitis are much the same in all the cases and vary only as regards degree of severity. The nervous lesions are, however, local, and, according to their situation and

severity, or their absence, as the case may be, the various types of poliomyelitis have been excellently grouped by Wickman on an anatomical basis as follows: (1) The spinal form; (2) the brain stem form; (3) the cerebellar form; (4) the cerebral form; (5) the meningitic form; (6) the neuritic form; (7) the abortive form. Obviously any combination of the first six forms may occur. Of these varieties only the spinal and the cerebral forms are common.

The onset is abrupt and is usually accompanied by fever, which develops rapidly and lasts but a few days, and rarely longer than 7 days. The fever may be ushered in by a chill in adults, and by convulsions in children, and especially in infants. General malaise, headache and pains in the limbs are complained of by patients who are old enough to describe their symptoms. Very important among the early symptoms and in slight cases are nystagmus, diplopia, and short, jerky, involuntary movements in the outstretched hands. Gastro-intestinal disturbances, such as anorexia, vomiting and diarrhœa are common. When the onset is severe, there may be delirium and stupor with head retraction, pain and rigidity on passive movement of the neck and back, Kernig's sign and incontinence. Usually the skin is flushed and the expression bright, the latter point contrasting with the expression of many forms of meningitis. The muscles are often tender to pressure and the joints painful on movement, and these signs, with the spontaneous pains, may persist for many weeks. In a minority of the cases, the general symptoms are absent or so slight as to escape notice, and the nervous symptoms are the first evidence of illness. This absence of general symptoms and of fever seems to occur only in the spinal form of the disease, and in children.

1. Spinal Form.—In young children, the paralysis is often not apparent until the second or third day after the onset. In older children and in adults, the paralysis is usually present within 24 hours of the onset. The paralysis is always of the complete flaccid variety, with loss of the deep reflexes in the region of the paralysis, and subsequent atrophy of the muscles; it develops very rapidly in most of the cases, and seems to have its full limit of distribution at the moment of its appearance. In those cases, however, commencing in the legs, the paralysis spreads slowly upwards and gradually affects trunk and arms successively (ascending or Landry type); or, conversely, it may commence in the arms and spread to trunk and legs afterwards (descending type). In rare cases, after remaining stationary for from 2 days to a fortnight, it may suddenly spread to other regions. This sudden extension, after the lapse of days, has been observed in experimental poliomyelitis in monkeys.

The paralysis is generally much more widely spread at the onset than it is destined to be permanently. Thus all four limbs may be at first completely helpless, and there may be later complete recovery in all but one limb. Here the widely spread temporary paralysis must be due to a toxic and recoverable affection of the nerve cells, whereas the permanent palsy is the result of an actual destruction of the cells by a necrotic lesion. The paralysis may affect any of the muscles of the body, but those of the legs are by far the most commonly involved. The trunk muscles may be affected alone giving rise to marked spinal deformity, usually of a scoliotic or kypho-scoliotic type. The narrowing down of the initial, widely spread paralysis begins to

show itself after the end of the first week, and any muscle which will recover useful power will have done so before the end of the third month. It will occasionally be noticed that the deep reflexes are not lost in the paralysed region in the early days of the disease, and, where this obtains, recovery is always complete. The paralysed muscles undergo atrophy, which is more rapid and complete in those which are to show no subsequent recovery: they show a reaction of degeneration. They are flaccid from the first and in the course of time tend to develop a degree of fibrotic contracture. Any muscles which show response to faradism three weeks after the onset will completely recover. There is usually a considerable degree of vasomotor palsy when a limb is paralysed, and there may be some retardation of growth. Considerable deformities of the body and limbs may arise as the result of the loss of support which results from the paralysis, from the action of unopposed muscles, and from the occurrence of contractures. Such deformities may involve actual dislocation of joints, as in the shoulder-joint, where the deltoid is paralysed and the pectorals escape.

In rare cases, the local lesion of the spinal cord is not confined to the grey matter, but involves also the contiguous white matter of the lateral column, giving rise to signs of lesion of the pyramidal tract and perhaps also of other neighbouring tracts. Obviously, such an extension of the lesion to the white matter neighbouring upon the ventral horn may give rise to loss of pain and temperature sensibility below the level of the lesion upon the whole of the opposite side (Brown Séquard's syndrome).

Paralysis of the cervical sympathetic is not infrequently met with in those cases where the lower cervical and first dorsal segments are involved, with the usual signs of a small pupil and narrow palpebral aperture on the affected side. It is generally a transient phenomenon. When the limbs are affected, paralysis of the blood vessels, most marked at the periphery, is the rule, and there is permanent coldness to touch and pinkness or blueness of the skin, greatly increased by exposure to cold.

In the course of time, the bones of the affected limb may show conspicuous smallness from retardation of growth, if the disease has been incident during the period of growth. They become unduly fragile from a rarefying process, their ridges and bony prominences atrophy and do not further develop, but there is never the same degree of arrest of growth of a limb as is sometimes seen in infantile hemiplegia.

Disturbances of sensibility of an objective kind are rare and are almost always transient, and amount to blunting of pain and temperature sensibility, doubtless from involvement of the spino-thalamic tracts which are contiguous to the ventral horns. Subjective disturbances are common and may consist of severe local pains in the limbs, back or neck. Tenderness of the muscles and pain on moving the joints are sometimes very prominent, and may persist for many weeks. Sphincter paralysis is quite common in the early stages where the lumbo-sacral enlargement is affected, but it is always transient and lasts but a short time.

The reflexes, both superficial and deep, are at first lost in the affected region, and indeed are generally absent throughout the body in the early stages of a severe case, from the general toxic effect upon the nervous system. In the later stages, they return or remain permanently absent, according as the muscles recover or not. Any sign of a returning reflex, either deep

or superficial, in the early days of the illness is a most useful prognostic indication that the muscles concerned with the reflex will entirely recover.

It has been customary to divide the clinical aspect of poliomyelitis into four periods, namely—(1) The period of general febrile symptoms; (2) the period of development of the paralysis; (3) the period of rapid regression of the paralysis; and (4) the period of atrophy and deformities. Such a division, though useful for the purposes of memorising, is largely artificial, the true clinical periods being, before the nervous system is involved and after the especial nervous manifestations have developed.

Course.—The febrile stage with general symptoms may be so little marked as to escape notice, and this is most often seen in young children, but rarely if ever in adults; or it may be exceedingly severe, with convulsions or delirium and stupor. Usually the temperature abates upon the third day, and the entire febrile movement does not last more than a week. The paralysis most often appears on the second or third day in children, and in adults upon the second day. When first apparent, the paralysis is usually complete and does not subsequently spread. In rarer cases, it is slight when first noticed and it rapidly deepens to its full extent. Still less frequently, it begins locally and spreads, constituting an ascending or descending type, and this has been most often met with in epidemics, such as occurred in Scandinavia in 1905. Sensory disturbances and sphincter trouble are often absent, and, when present, usually pass off within a few days of the onset of the paralysis; but in some cases much pain, tenderness of the muscles, and pain on moving the joints may persist for many weeks.

Most commonly within a few days of the onset of the paralysis a very considerable remission occurs, and the paralysis becomes much narrowed down in its limits; thus, with an initial paralysis of all four limbs and trunk, the limbs recovered rapidly, leaving a permanent partial paralysis of the trunk, and in a case where both legs were paralysed, the one recovered power within the first week, leaving the other permanently crippled. Sometimes, however, there is no rapid improvement or narrowing of the region of paralysis whatever. These results are to be explained pathologically in that those regions where the paralysis is due to a toxic effect upon the nerve cells, which is a recoverable lesion, rapidly recover, whereas this does not take place where the nerve cells have been destroyed by necrosis following the inflammatory lesion.

The paralysis remaining after the rapid improvement is final, and admits of such improvement only as may occur from the recovery of a few cells which have escaped destruction upon the confines of the inflammatory lesions, and such recovery is very slow and never reaches more than a slight degree. A certain slow improvement in those paralysed muscles which retain some voluntary power is often observable, and is referable to hypertrophy of function in those elements which remain and to the acquisition of the aptitude which necessity produces. On the other hand, children afflicted with this disease during the period of active growth will often show what seems to be a progressive diminution of power in the weak muscles, and which is, in reality, a relative failure of these muscles under the strain of the increasing weight and length of the body and limbs.

Death is uncommon at any stage in the spinal form of poliomyelitis

except during epidemics, when severe general symptoms are followed by widely spread paralysis, involving all the respiratory muscles, and in these cases it takes place on the first day of appearance of the paralysis. Weakness of the respiratory muscles and especially total intercostal palsy is not infrequently an indirect cause of death, even at long periods after the onset, if bronchitis or broncho-pneumonia occur.

Diagnosis.—During the stage of general pyrexial symptoms and before the nervous manifestations appear, a definite diagnosis can hardly be made; but it may be suggested by the time of year, by the prevalence of an epidemic, and by the combination of a polymorphonuclear leucocytosis in the blood with a lymphocytosis in the cerebro-spinal fluid. When the paralysis first sets in, the diagnosis has to be made from acute rheumatism, in which the painful joints may cause an appearance of severe paralysis. An examination of the reflexes will at once distinguish the two conditions, for both the superficial and the deep reflexes are brisk in rheumatism and lost in poliomyelitis. In the same way, syphilitic pseudo-paralysis (acute syphilitic epiphysitis) may be diagnosed from poliomyelitis. From acute polyneuritis and Landry's paralysis, both of which maladies may have a pyrexial onset with similar general symptoms, poliomyelitis can generally be distinguished by the sudden onset of the paralysis and by the absence of any spreading tendency, and probably by the lymphocytosis in the cerebro-spinal fluid, and later on, by the permanent atrophic paralysis. In the rare spreading types of poliomyelitis, the latter two points alone serve to make the diagnosis.

From almost all of the local lesions of the spinal cord, membranes and roots, whether these are of rapid onset, as for example hæmatomyelia and acute myelitis, or of slow onset, such as tumour, inflammation and pressure, poliomyelitis is at once distinguished by the absence of the conspicuous sensory loss and sphincter trouble which accompany the former diseases. In the final stage of permanent muscular paralysis and atrophy, deformities and contractures, poliomyelitis presents little difficulty of diagnosis, but it should be borne in mind how frequently deformities of the trunk and especially lateral curvature of the spine have their origin in slight attacks of this malady where the lesions are confined to the dorsal region.

Prognosis.—It is doubtful whether complete recovery occurs in any case of poliomyelitis in which paralysis has once set in. Though in some cases recovery may be nearly complete, yet there seems always to be some region in which permanent muscular atrophy persists, and in cases which otherwise clear up, this is frequently in the spinal muscles, giving rise to a lateral curvature. From this condition of nearly complete recovery to one in which there is not the slightest recovery from the initial paralysis, there is every gradation. The prognosis is not influenced by the severity or otherwise of the general symptoms, for the paralysis may be slight where the general symptoms are severe, and vice versa. Incomplete paralysis or the presence of reflex action, either superficial or deep, in any region at the end of the first week after the paralysis has set in, is a sure indication that useful recovery will occur in that region. Those regions which remain completely paralysed for several weeks after the onset are certain to remain permanently disabled. The prognosis as to the eventual usefulness of disabled limbs, or as to eventual power of walking, depends upon a consideration of the muscles which are permanently paralysed, as to whether they are essential muscles or not, and

whether they can be assisted or supplanted by any mechanical apparatus which is light enough for the weak limbs to carry.

Second attacks of poliomyelitis are exceedingly rare, but two such cases have been recorded by Eshner and by Sanz. The occurrence of progressive muscular atrophy in subjects who have in early life been afflicted with poliomyelitis is not very rare, and it is usual for the progressive atrophy to commence in the region originally affected by the poliomyelitis. Potts has recorded a series of 28 such cases, and several others are to be found among the records of the National Hospital.

Treatment.—In the acute stage, the patient should be kept at rest upon a soft bed and fed upon a diet suitable to the febrile condition. Since the malady is an infectious, specific fever, and since the virus is known to exist upon the nasal, buccal and respiratory mucous membranes, and is presumably spread therefrom, bed and utensil isolation is necessary, with sterilisation of any contamination from the mucous membranes and mild daily disinfection of the mouth and nose. Lumbar puncture should be performed at once and repeated daily for 4 days, and the fluid freely drawn. This operation by itself often relieves the most acute symptoms, and is to be used not only as a method of diagnosis but also as a means of treatment. Salicylates, especially in the form of aspirin, will relieve the pain and fever, and seem to be decidedly beneficial. If pain be very severe there is no contra-indication to the use of morphine. On experimental grounds it is advisable to administer hexamethylamin in large doses, 10 grains (0·6 grm.) 4-hourly, even to young children, the only disadvantage being that this drug occasionally gives rise to hæmaturia. If the respiratory muscles are seriously involved, belladonna or atropine is of great service both in stimulating the respiratory mechanism and in checking accumulation of bronchial secretions. There is conclusive evidence, both experimental and clinical, that the serum of those who have recently recovered from the disease will protect from infection, and if administered early in a developed case will mitigate its severity and lessen or prevent the development of paralysis. Such a serum is to be obtained from the Ministry of Public Health.

Rest and posture.—It is all-important to secure as complete physiological rest as is possible for the weak or paralysed muscles for some time after the onset. Even in the slightest cases, the patient should be kept in bed for at least 3 weeks, during which time attempts at volitional movements should be discouraged. The posture of the paralysed region should be such as to secure the relaxation of the paralysed muscles; for if they are kept stretched by the action of opponent muscles which are not paralysed, recovery is greatly hindered. Appropriate postures can be secured by pillows, sandbags, splints and other devices. After a few weeks have elapsed, massage and passive movements should be regularly employed and re-educationary exercises commenced, where there is sufficient power. Electrical treatment in any form is of very doubtful value. Re-education should be assisted by every appropriate mechanical device, but it must be carefully borne in mind that every mechanical apparatus which overweights the weak limb places a millstone around the neck of recovery. The lightest possible shoes should be worn, and if splints are indicated the excellent and almost weightless, moulded, celluloid splints should be employed, to the absolute exclusion of all heavier varieties. In the re-education of the legs for walking,

a walking-machine on wheels is a necessity. Contractures and deformities, which hinder useful action, should be dealt with by passive movements, splinting, tenotomies and other surgical procedures.

2. The Brain-stem Form.—In this type, the incidence of the lesions is upon the grey matter of the brain stem from the medulla to the region of the red nucleus. The general symptoms of the onset are as in the spinal form, but there is likely to be in addition head retraction and stiffness of the neck muscles. In place of the paralysis of trunk and limbs there is bulbar, facial, trigeminal or ocular paralysis, according to the situation of the lesions. There may be nystagmus, if any of the cerebellar connections are involved, and tremors, if the red nuclei are affected. An extensive lesion of the medulla itself proves very rapidly fatal. Lesions of the upper brain stem are more commonly survived, and the resulting clinical pictures are, in order of frequency of occurrence, facial paralysis, spastic tremulousness from involvement of the upper part of the brain stem, and lastly ocular paralysis with nystagmus. Any combination of these forms may occur with one another and with the spinal, cerebellar and cerebral forms of the disease.

It is likely that many of the cases of acquired strabismus following convulsion or febrile illness in children are of this nature. Special mention is necessary of the facial paralysis which is usually attributed to a lesion of the facial nucleus. When occurring in conjunction with the spinal or with the cerebral form of the disease its cause is obvious, but when it arises as an isolated event, its origin in poliomyelitis is difficult to determine. It is by no means proved that the commonly occurring facial paralysis in poliomyelitis is due to a pontine lesion at all, and there is very good evidence that it is due to a lesion of the trunk of the facial nerve, for in the cases of facial paralysis which we have seen, associated with well-marked poliomyelitis in other regions and therefore incontrovertible, the facial paralysis has always been of the peripheral and not of the nuclear type; it has always been unilateral and has always completely recovered. Moreover, the well-known association of herpes zoster (which is a peripheral nervous-system lesion) with poliomyelitis, both as a symptom and in the same seasonal prevalence, and its common association with facial paralysis, are evidence that lesions of the peripheral nerve trunks do actually occur in poliomyelitis.

3. The Cerebellar or Ataxic Form.— Here the incidence of the lesion is upon the cerebellum, and the clinical aspect is the acute onset of cerebellar ataxy with vomiting, head retraction, rigidity of the neck and spinal lymphocytosis. Curiously there is often no nystagmus. The nature of such cases of cerebellar ataxy of acute onset in childhood has been proved by the pathological findings, by the coincident appearance of the usual signs of spinal poliomyelitis in some cases, and by the recorded instances of one child of a family being seized with an ordinary type of poliomyelitis and another at the same time with the ataxic form. The cerebellum being an organ in which very great or complete compensation occurs for partial destruction, provided that the damage be not too extensive, it is not surprising to find that many of the cases of cerebellar poliomyelitis make a rapid and complete recovery, while others in which the destruction is presumably much more severe make a slow and gradual improvement.

In the diagnosis of this condition acute symmetrical vestibulitis must be carefully separated. The latter disease resembles the former closely, in that

a pyrexial attack is followed by the acute onset of severe cerebellar ataxy, but in acute vestibulitis the patient becomes rapidly and permanently stone deaf, and all the other symptoms soon disappear. Many of the cases of acute vestibulitis have been diagnosed as cerebellar poliomyelitis with brain stem involvement affecting the auditory paths, but a moment's consideration will make it clear that no gross lesion of the nervous system can produce permanent and complete bilateral deafness as the sole result.

4. THE CEREBRAL FORM.—The characteristic clinical features of this type are usually very distinct. After a period of pyrexia and general symptoms of variable severity and length, the patient is seized with convulsions which are remarkable for their severity and duration, it being no uncommon thing for the convulsions to recur frequently for the space of a dozen or more hours. When the convulsions cease, the patient remains in a subconscious state for many hours, often for several days, and at the end of this time he gradually rouses to reveal the physical signs—motor, sensory, psychic, or some combination of these—of the cerebral lesion. The lesion may be unilateral, when the commonest result is a hemiplegia, or may be bilateral, giving rise to a double hemiplegia, and in some cases the central regions of the brain escape, while other regions are seriously involved, giving rise to marked mental defect which may be so great as to amount to complete restless idiocy. Local incidence of the lesions upon the various regions of the brain may cause a very varied clinical aspect. In one case under the care of one of us, a hemiplegia was associated with hemianopia of the opposite side. Not very infrequently the basal ganglia are the seat of destructive lesions with the appearance of spontaneous, involuntary movements, which may be of an athetoid, choreic, myoclonic or tremulous type. Of these, athetosis is by far the most commonly met with.

Notwithstanding what has been said to the contrary by many writers, it seems certain that cerebral poliomyelitis is by far the most common cause of infantile hemiplegia. It is my opinion that infantile hemiplegia due to any cause other than poliomyelitis is very rare. It is the rule for one-third of all cases of cerebral poliomyelitis to develop recurring epilepsy at a later age.

5. THE MENINGITIC FORM.—One of the most interesting types of poliomyelitis, which frequently gives considerable difficulty in diagnosis, is the meningitic form of the disease. The onset is sudden and is occasionally attended by convulsion and coma. The temperature is raised and may remain high for days, and the usual symptoms of meningitis are present. Headache and vomiting occur. The neck is stiff and the head may be retracted; there may be opisthotonos and rigidity of the legs, and Kernig's sign is commonly present. Lumbar puncture reveals a cerebro-spinal fluid, clear and under pressure, which on cytological examination may at first show no abnormality, but as the days elapse will contain an increasing number of lymphocytes, an increased amount of albumin and diminished sugar reaction.

There are certain clinical points which will sometimes serve to distinguish this type of the disease from other conditions of lymphocytic meningitis. In many of the recorded cases and in many which we have seen, careful examination has revealed a local, flaccid palsy of some part of a limb, and, if such a palsy is present, it should go far to settle the diagnosis. Again, a flushed face and bright expression are characteristic of poliomyelitis and contrast strongly with the pale, dull facies of tuberculous meningitis. Lastly, it is the rule

for the meningitic form of poliomyelitis to recover and leave no intracranial sequelæ, and this will distinguish it from the invariably fatal tuberculous meningitis.

The other common forms of lymphocytic meningitis are those due to tubercle, sinus thrombosis, mumps, measles, lethargic encephalitis and syphilis. In any questionable case, the discovery of the tubercle bacillus in the spinal fluid will settle the diagnosis, and a mixed polymorphonuclear and lymphocyte count with high lymphocytes is characteristic of tubercle. The history in the case of mumps and measles, and the Wassermann reaction in the case of syphilis, are important guides in the diagnosis. The treatment is that of poliomyelitis and meningitis in general.

6. The Neuritic Form.—It has been shown in the foregoing pages that the poison of poliomyelitis does cause a widely spread temporary abolition of function of the lower motor neurons, quite apart from the destruction of these same neurons by the local inflammatory lesions, and that the rapid improvement which occurs early, is due to a passing off of this toxic effect. The question then arises as to whether this same virus can cause the toxic effect, without giving rise to any local inflammatory lesions. In other words: can the virus of poliomyelitis produce a polyneuritis? Wickman and other investigators of epidemics of poliomyelitis affirm that it can and does do so, and have recorded many examples. While the truth of their contention is probable, yet the only infallible proof that such cases, even though occurring in an epidemic of poliomyelitis, were really examples of that disease, the recovery of the virus from the patients was not established; the reason being that all these patients recovered.

7. The Abortive Form.—This type of poliomyelitis may be described as corresponding with the initial stage of febrile and general symptoms before the appearance of the paralysis. The general bodily infection with the virus occurs, but it does not reach the nervous system, or affects it so little as to cause no characteristic symptoms. The attack as a rule is acute, with fever, headache and malaise, and in some cases slight nervous symptoms such as rigidity of the neck, pain in the neck and back and limbs. Paræsthesias occur. These symptoms are not followed by paralysis and recovery occurs within a few days. Except when poliomyelitis becomes epidemic, it is hardly possible to detect the abortive forms of the disease. Nevertheless, since an epidemic of this disease among a population seems to immunise the whole population and remove all susceptibles, so that in a subsequent epidemic only those born since the previous epidemic are affected, it seems clear that affection with the slight abortive form of the disease was the cause of the immunity.

Doubtless in a country such as England, where poliomyelitis never has been epidemic, the abortive form occurs frequently enough among the commonly occurring short febrile illnesses of children, which at present do not admit of definite diagnosis.

LETHARGIC ENCEPHALITIS

Early in the year 1917 an epidemic disease was recognised in Vienna, characterised by signs of general intoxication, bilateral ophthalmoplegia and marked drowsiness, to which Economo gave the name "Encephalitis

lethargica." In the following year cases appeared in France and in England in increasing number, and Netter, who investigated many of the French cases, drew attention to an epidemic of an apparently similar condition which appeared in Northern Italy in 1890, to which the name "Nona" had been given, cases of which seemed to have occurred in various parts of Europe during the years 1891–92. Mauthner made a pathological research upon "nona" in 1890, and was of opinion that the disease was of the nature of an acute hæmorrhagic poliomyelitis superior. It is suggested that the epidemic disease occurring in the fifteenth century and known as the "Sleeping Sickness of Tübingen," and that of the middle of the nineteenth century occurring in Northern Italy known as "Dubini's Electrical Chorea," were examples of lethargic encephalitis. It seems certain from the investigation of end cases still living that a few cases of lethargic encephalitis were occurring in England as early as 1914. The disease has subsequently become scattered world-wide.

Ætiology.—The disease seems to occur both sporadically and epidemically with no centre of spread. There is no evidence as yet to show that the disease is infective in the sense that it may be conveyed from one human being to another, the cases being for the most part widely and sparsely scattered through the country. It is more prevalent in the cold season of the year. No age appears to be exempt from the disease, and cases have occurred in the seventh decade of life, but the malady is rare in young children and seems to be most common in the first half of adult life.

Pathology.—The malady has no relation with botulism, as was at first thought by some observers, for it has no known association with food, and the *Bacillus botulinus* has never been present. Nor is it an aberrant type of poliomyelitis as was at first argued, for its age incidence, seasonal prevalence, morbid anatomy and symptomatology are quite different from those of the Heine-Medin disease. Neither does it seem to have any relation to influenza, although the height of its epidemic incidence has twice coincided with a severe epidemic of influenza. Straus, Cleland and others have claimed successful transference of the disease to monkeys by the intra-cerebral inoculation of monkeys with an emulsion of nervous tissue from a human case. Loewe and Strauss have recently claimed to have grown in pure culture on Noguchi's medium an organism (globoid) resembling that discovered by Flexner in poliomyelitis, and that subcultures carried through several generations have reproduced the disease and its histological picture in animals. They have obtained the organism from the nervous tissue, cerebro-spinal fluid, blood and nasal mucous membrane in human cases. These results appear to have been subsequently fully confirmed by Thalhimer.

Cerebro-spinal fluid.—In at least one-third of the cases the cell count is normal. In the rest, there is a leucocytosis consisting entirely of lymphocytes which may reach to over 100 per c.mm. The presence or absence of lymphocytes, and their number when present, seems to have no bearing upon the severity or prognosis of the case, nor upon the post-mortem picture, for we have several times seen persistent absence of lymphocytes when autopsy showed intense meningeal congestion.

The globulin content is hardly increased, and the reducing bodies do not disappear. Lange's colloidal gold reaction shows definite abnormalities, and the positive curves are said to be of the luetic and paretic types. Blood may occur in quantity from surface hæmorrhages.

Naked-eye examination of the brain shows a characteristic change from the colour of a normal brain, which varies from a faint rosy flush to a deep salmon-pink. It has been termed the "rose-coloured" brain. When hardened in formalin, the colour becomes a dusky purple-grey. On section, the grey matter throughout the cortex, basal ganglia and brain stem presents the same curious colour, and thus the usual distinction between grey and white matter becomes very much more conspicuous. It must be remembered, however, that in some cases, and even in severe and rapidly fatal cases, this characteristic colour may be little marked. The brain seems to be generally more full of blood than normal. Subdural hæmorrhages may be present, and these may be of considerable size. Deeply seated hæmorrhages may also occur, especially in the region of the basal ganglia and brain stem, and when large these may be confused with the hæmorrhages of apoplexy.

The microscopic appearance is that of vascular congestion with conspicuous lymphocyte "cuffing" round the small vessels. Microscopic hæmorrhages are rare. The nerve cells show the different stages of toxic degeneration with neuronophagia, they become swollen, chromatolysis occurs and the nucleus becomes eccentric. The degeneration of the cells is often very local; one group of cells may be severely affected and a neighbouring group intact, or some cells of one group may be affected and others intact. The distribution of the lesions varies greatly; and while there is no part of the nervous system which may not be affected, there is an especial selective incidence upon the grey matter of the basal ganglia and brain stem, and this corresponds with the more commonly occurring clinical symptoms of the disease, which indicate lesions in these regions. Of importance in connection with the paralyses of single peripheral nerve trunks in the clinical picture of this disease, are the perivascular and diffuse infiltrations with round cells, sometimes accompanied by small hæmorrhages, which are found around the cranial and spinal nerve roots. In cases which run a chronic course with remissions, scattered inflammatory lesions may be found at every stage of their development, from the earliest changes to the healed lesion.

Symptoms.—Considering that the pathology of the disease is one of multiple and widely disseminated patches of infection of simultaneous origin, it is to be expected that the clinical manifestations of the disease will show wide variations as to their nature, acuity and duration.

The onset is in many cases insidious, and it may take a few days to 2 weeks before the symptoms become sufficiently pronounced to allow of correct diagnosis. In other cases, however, the onset of general symptoms is sufficiently rapid to have given rise to a diagnosis of influenza. The nervous symptoms, too, follow upon the general symptoms insidiously, as a rule, but these may be in some cases startlingly rapid or even sudden in their appearance. Though lethargy, nuclear ophthalmoplegia, paralysis agitans-like rigidity and aspect, spontaneous involuntary movements and obstinate constipation dominate the clinical picture in 70 per cent. of the cases, yet any or all of these signs may be absent, and other signs be prominent, the nervous symptomatology depending upon the position of the lesions. The clinical aspect may be conveniently considered under two divisions of manifestations, the general and the nervous.

General Signs.—The general signs are those of general toxic infection, and consist of fever sometimes accompanied by rigor. Sometimes the pyrexia

is severe, and this usually marks a rapid and fatal case, but often the fever is so slight as to escape notice. Headache, bodily pains and malaise are common. Gastro-intestinal symptoms are frequently met with in the form of a thickly coated white tongue, vomiting and hiccough, and obstinate constipation is highly characteristic of the malady. Cutaneous eruptions of an erythematous nature may be seen. The severity of the general symptoms of intoxication is extremely variable, but there is no parallelism between this and the degree of involvement of the nervous system, though severity of initial general symptoms renders the immediate prognosis as regards life grave. The pyrexia does not usually last longer than a week.

The Nervous Signs.—*Mental symptoms.*—An increasing lethargy, which often becomes very deep, is present in many of the cases. In this condition the patient will lie for days without stirring a muscle, taking no heed of his surroundings and passing the dejecta under him unheeding. Yet when roused by command and vigorous bodily stirring, he will wake up and hold a very intelligent conversation, lapsing back at once when he is left alone, even though his mouth be half full of unswallowed food. In this condition, flexibilitas cerea may often be demonstrated in the limbs. The lethargy may last for 3 weeks or longer even in patients who completely recover. It passes away gradually. Unrousable coma is invariably a sign of impending dissolution. Subsequent memory of events during the early days of the lethargy may be remarkably retained. Insomnia may be a troublesome early symptom, and even when the patients are markedly lethargic they will complain that they cannot sleep. Lethargy, however, may be completely absent and the early mental state be that of vivacious excitement and talkativeness. Irritability and restlessness may be present. In some cases the first nervous sign may be delirium or mental aberration, which may rapidly develop into acute and violent mania; such cases are rapidly fatal. In cases which recover after severe symptoms, considerable mental reduction and self-obvious mental change may persist, but I have not seen any case in which insanity resulted. Indeed, it has been said that no sufferer from this disease ever regains his original mentality, and it is a common experience to find personality very seriously changed in the way of mental reduction. Complete incapacity for any sustained work, entire change of character, anti-social tendencies, moral perversion and depressed neurasthenic states are not uncommon sequels of the disease. (See also page 1710.)

Convulsions are rare, but they may undoubtedly occur as in other forms of encephalitis. Indeed, the initial clinical picture may be dominated by convulsion, and closely resemble "status epilepticus" from other causes.

Ophthalmoplegia and other paralyses in the region of the cranial nerves are most often nuclear in type, but peripheral paralysis of any cranial nerve may be met with, most commonly unilateral paralysis of the facial nerve. The pupils may show every abnormality which a lesion of the nervous system can produce. Inequality, unroundness, eccentricity and Argyll Robertson pupil and ciliary paralysis may occur. The Argyll Robertson pupil may be unilateral. The external ophthalmoplegia, being nuclear in origin, involves both eyes in terms of their conjugate movements, and the upward and downward movements are as a rule more severely impaired than are the lateral movements. Bilateral ptosis is very usual, and is a most important and valuable early indication of the disease. The common error is to consider it part

of the sleepy state. The nuclear ophthalmoplegia is often irregular, giving rise to strabismus and diplopia. Either in addition to the above or existing alone, there may be peripheral paralysis of any of the oculo-motor nerve trunks. The degree of the ophthalmoplegia varies in different cases from slight diplopia with hardly noticeable strabismus to complete paralysis of both eyes. It may be rapidly transient or permanently severe. In severe cases which survive, there is always some improvement in the degree of paralysis in the course of time.

Vision.—The diplopia and loss of accommodation cause much defect of vision, but many of the patients complain of a loss of vision in each eye, which is too great for any such explanation, the cause of which is not yet explicable. Papilloedema has been reported in a few cases, in one of which at least meningeal hæmorrhage had occurred. It is transient and never reaches a high degree.

Oculogyric Crises.—This term is applied to recurring attacks of tonic conjugate deviation of the eyes, most commonly upwards, sometimes upwards and to one side, less commonly downwards, or downwards and to one side. We have not seen any case with pure lateral deviation. The spasm is met with in the chronic stage of the malady, and there is always some degree of Parkinsonism. The attacks may last from a few seconds to 4 hours or more, and may occur frequently or at intervals of several days, and as the eyes are commonly fixed in an upward direction, they are peculiarly incapacitating. They have not been reported in any other disease than lethargic encephalitis, and may constitute, with some slight facial Parkinsonism, the sole sequela of this malady. We have not found any treatment which influences the frequency or severity of the attacks.

Bilateral nuclear facial paralysis and bulbar paralysis are not uncommon. Paralysis of any individual cranial nerve may occur, and also of any individual spinal root. Such paralyses always completely recover in the course of time.

Symptoms indicative of lesion of the basal ganglia are among the most common features of the disease, and they are often the most persistent. These consist of weakness of movement, rigidity with slowness of movement, and spontaneous involuntary movements. The weakness, rigidity and slowness of movement give rise to a peculiar immobility of facial and bodily expression and movement. The face is mask-like, the neck stiff and the head moved little and slowly, the trunk bent forward and stiff, the arms held away from the trunk, the whole appearance of the patient closely resembling that of paralysis agitans. Rapid fluttering of the eyelids when gently closed is characteristic of this condition. The spontaneous involuntary movements may be of a rhythmic tremulous nature, as in paralysis agitans, or there may be slow rhythmic choreiform, athetoid, myoclonic, irregular or highly complicated movements: these may be met with at any stage of the malady, but most commonly appear some little time after the acute stage has passed away. Fibrillation and fascicular twitching of the muscles is very common in the acute stage. In cases where bulbar symptoms, either of a spastic or flaccid kind, are present, hypersalivation of the nature of a true sialorrhœa is often a most troublesome, though transient, symptom.

In addition to the above common symptoms and signs, other indications of involvement of the cerebral hemispheres may occur. Bilateral spasticity with signs of involvement of the pyramidal systems, increased jerks, lost

abdominal reflexes and extensor plantar responses are common. Hemiplegia, aphasia and hemianopia may occur, presumably as the result of local subcortical hæmorrhages. Meningeal symptoms may be very marked in the early stages, such as suboccipital headache, painful stiffness of the neck, head retraction, vomiting and Kernig's sign. Indeed, we have seen rapidly fatal cases in which the clinical picture throughout was hardly distinguishable from that of acute meningitis, but none of these cases showed any leucocytosis in the cerebro-spinal fluid. A major incidence of the lesions upon the cerebellum gives rise to the picture of acute cerebellar ataxy following a lethargic onset, and the end result may be a condition closely resembling a usual type of disseminate sclerosis. Such cases make a good recovery in the course of time.

Peripheral pains are sometimes very severe and are usually quite local. They may be the first signs of the illness, and several of my patients had been treated for trigeminal neuralgia, brachial neuritis or sciatica before any other sign of the malady appeared. These pains may persist for months after recovery. They are obviously due to the lesion around the nerve roots which has been already referred to.

Spinal symptoms.—Since the lesions have been found in the spinal cord, it is only to be expected that focal spinal lesions should be met with in rare cases. These are usually acute atrophic paralyses similar to those of poliomyelitis. Those that we have seen have completely recovered. It has been argued, however, that this atrophic palsy is due to a lesion of the spinal roots. More severe lesions may apparently give rise to a condition resembling acute transverse myelitis.

Sphincters.—The incontinence which is almost constantly present, even when the lethargy is far from deep, is the result of the lethargy. Transient conscious dysuria is however not infrequent in the early stages of the disease. The deep reflexes may be lost in severe cases during the acute stages, and they are usually absent in pre-mortal conditions. Otherwise they tend to be exaggerated, especially if involvement of the pyramidal system be present. The condition of the abdominal and plantar reflexes depends upon the presence or absence of lesions affecting the pyramidal tracts. In the former case, the abdominal reflexes will be absent and the plantar reflexes of the extensor type.

Attention must be drawn to a group of cases in which the initial manifestations of the disease are so slight as not even to interfere with the daily work or to call for medical attention, and yet in the course of months, or it may be even years, the most serious and completely incapacitating paralysis appears. A patient of ours noticed that he saw double, and did not feel very well for a few weeks. He recovered, but 2 years later, had to give up work, by reason of a slowly oncoming Parkinsonism, which became extreme. A similar result in the slow and late development of grievous symptoms may follow any attack of lethargic encephalitis and make the prognosis in this malady very difficult.

Sequelæ.—The disabilities which this malady may leave in its wake seem endless and ever increasing as clinical experience widens. The mental, paralytic and Parkinsonian end-results have already been referred to, but special mention must be made of involuntary spontaneous movements, recurring rhythmic movements, spasms and altered respiratory rhythm.

Ceaseless rhythmic pulsatile movements may occur in any muscle, movements like those of convulsive tic may incapacitate the patients. Hideous recurring spasms may appear, sometimes local, sometimes general. Torticollis may occur. An unduly rapid respiratory rhythm may be established. (See also p. 1563.)

Course.—The course of the disease is extremely variable. It may be a slight transient illness lasting but a few days, and leaving no sequelæ after a few weeks; or a most malignant disease, fatal in a few days. Some patients, apparently recovering at the end of a fortnight, succumb to meningeal or deeply seated hæmorrhage. In others, symptoms indicative of fresh lesions may occur repeatedly, weeks and even months after the onset.

Diagnosis.—In typical cases the diagnosis presents no difficulty, the rousable lethargy, incontinence, ophthalmoplegia and negative, lymphocytic, or blood-containing cerebro-spinal fluid being so characteristic as to preclude possibility of error. The less usual forms of the malady, and especially those with very gradual onset and slight symptoms, often present great difficulty and require much care and full knowledge of the possible symptomatology of the disease for their recognition. There is no specific laboratory test for the malady, and the diagnosis must be based upon clinical grounds. Where meningeal symptoms are prominent, distinction has to be made from other forms of meningitis and from poliomyelitis. Here, the cerebro-spinal fluid is of the highest importance, as no polymorphonuclear leucocytes occur in lethargic encephalitis. In cases commencing with peripheral pains, excitement, maniacal symptoms or convulsions, careful look out should be kept for the advent of ptosis, ophthalmoplegia, or lethargy, the appearance of which, following such symptoms, should at once suggest the diagnosis. It must be borne in mind that the clinical picture of the disease may be dominated by a hemiplegic condition, and that an apoplexy may occur during the acute stage of the disease. Slight cases of the disease are frequently unrecognised, or are indeed unrecognisable in the early stages, but here the diagnosis can often be made with certainty from the end results; the peculiar ophthalmoplegia, the spontaneous involuntary movements, and the paralysis agitans-like syndrome being almost pathognomonic of the malady.

Prognosis.—A rapid onset and quick development of severe symptoms, marked pyrexia, delirium and maniacal excitement are bad prognostic signs and indicate a rapidly fatal issue. After the third week of the disease, the probabilities are all in favour of survival. The prognosis however as to how much permanent damage to the nervous system will eventually remain is hardly possible, since slow improvement may go on for months and even years. The spontaneous movements, even when very marked, may clear up in from 3 months to a year. The weakness, rigidity and tremors, which form the paralysis agitans-like picture in many of the cases, persist indefinitely.

Treatment.—Nothing being known of the infectivity and mode of spread of the disease, isolation and disinfection are not usually employed. Each case must in England be immediately notified to the public health authorities. No treatment is known which has any specific influence upon the disease. Intravenous injection of collosol iodine solution (150 c.c. for a dose), repeated on the second and fourth days, has been advocated, and is certainly without harmful effects. Intravenous salicylate of soda, in 15-grain doses in normal

saline daily, certainly seems to clear up the symptoms in some cases and may do permanent good. It remains therefore to use those measures which will help to keep the patient alive and those which relieve symptoms. Relief of the constipation is most important and is often followed by striking improvement in the symptoms. The presence of blood in the cerebro-spinal fluid, or symptoms indicative of intracranial hæmorrhage, should call for the exhibition of opium, turpentine and calcium salts, and lumbar puncture should be repeatedly performed. After the acute stage, treatment is concerned with combating the physical and mental listlessness and depression, removing the rigidity with massage, passive movements and exercise, and withal brightening the days of a convalescence which is often long, tedious and hard to bear.

JAMES COLLIER.
W. J. ADIE.

CEREBRO-SPINAL FEVER

Synonyms.—The name here chosen seems least open to objection. "Cerebro-spinal meningitis" is the best alternative, but cerebro-spinal meningitis may be caused by other micro-organisms than the meningococcus, and meningitis may not be present at all, or may not constitute the chief lesion, in some cases of meningococcus infection. "Epidemic cerebro-spinal meningitis" is much less desirable, because it suggests that there is an essential difference between the epidemic and the sporadic cases of meningococcus infection, which difference does not in fact exist. "Meningococcus infection" brings the various pathogenic possibilities of the micro-organism into line with those of the pneumococcus, with which it has close analogies, but the term does not connote a disease.

Definition.—A specific disease, due to infection of the body by the meningococcus, occurring both in epidemic and in sporadic form, and most often manifesting itself as an acute meningitis tending to involve the whole cerebro-spinal axis.

Epidemics of cerebro-spinal fever are marked by several features peculiar to the disease, offering a striking contrast with other epidemic diseases. For a long time these features were very difficult of explanation, until the existence of "carriers" became recognised, and supplied the solution to much of the epidemiological problem. Amongst these curious features may be mentioned the erratic nature of the outbreaks, the inability to trace the connection between one epidemic and another, the relative or even total escape of certain localities close to others in which the disease was rife, and the small proportion of persons affected in any one district.

On clinical, bacteriological and epidemiological grounds there is no distinction to be drawn between sporadic and epidemic cases of cerebro-spinal fever. But it is not entirely by means of the sporadic cases that the infecting agent persists, but by "carriers" also. There is little doubt, however, that from the sporadic cases, as from a smouldering infection, new epidemics light up. The present conception of the disease, from an epidemiological point of view, is that of a very widespread infection, with a total morbidity that is very low, but with foci of more intense virulence here and there. These foci of more intense virulence appear and disappear, being

preceded and followed by a somewhat higher level of permanent incidence in the districts concerned.

Ætiology.—The geographical distribution of the disease is very wide—world-wide, in fact. A certain affinity is shown for the north temperate zone.

Epidemic cerebro-spinal meningitis is a disease of winter and spring. This seasonal incidence is borne out by all observers, and is a very important feature of the disease. It compares markedly with the seasonal incidence of poliomyelitis epidemics, which are at their height in the summer months.

Epidemics of cerebro-spinal fever are prone to coincide in time with recrudescences of influenza, pneumonia, measles and scarlet fever. It is doubtful if this is more than a fortuitous observation. The naso-pharynx is liable to catarrhal inflammation in all these diseases, and pneumonia and influenza have the same seasonal incidence as cerebro-spinal fever.

The question whether cerebro-spinal fever is contagious or not has been a matter of much dispute. The facts would appear to indicate that the disease is contagious, but that the degree to which it is so is very slight. The proofs of the contagiousness of the disease are, briefly, these—(1) the occasional transmission of the disease to doctors and nurses; (2) the occurrence of a succession of cases in one family and in the same house; (3) the importation of the disease into a new country or locality; (4) the mode of spread in any locality; (5) the immunity enjoyed by collections of persons living under the same conditions as those affected by the disease, but unable for some reason to come into contact with them (Netter and Debré). Although direct contagion is uncommon, plenty of authentic instances of its occurrence have been reported.

The Meningococcus.—The meningococcus (*Diplococcus meningitidis intracellularis* of Weichselbaum) is rather smaller than the *M. catarrhalis* and larger than the gonococcus—the other two pathogenic diplococci which are Gram-negative in staining reaction. It is an obligatory anaerobe, requiring the addition of some animal protein to ordinary culture media to ensure growth. After cultivation for three or four generations it will grow on ordinary agar, but sub-cultures die rather suddenly. Optimum growth takes place at 36° to 37° C., and growth ceases at 42° C. and at 25° C. Vitality is low, especially to drying; sunlight kills in less than 12 hours.

Serum Reactions.—1. *Agglutination.*—Great difficulties are presented by the nature of the micro-organisms (having inherent tendencies to clumping). But the existence of different strains, differing in serum reactions, is rendered certain by the use of "absorption" methods.

2. *Fixation of complement.*—This method is perhaps less reliable for diagnostic purposes than (1).

Types of the Meningococcus.—By employing the agglutination test, controlled by the absorption test, M. H. Gordon has differentiated four separate types of meningococci occurring in the cerebro-spinal fluid of actual cases.

Immune Sera.—These were proved by Jochmann and by Flexner to possess potent immune substances when prepared from the horse by the usual technique. Standardisation is still, as in the case of nearly all bactericidal sera, almost impracticable. The great advance of the past few years has been the preparation of type-sera, following Gordon's researches. By the use of these the results of serum treatment, hitherto somewhat disappointing in this country, promise to be much more successful.

The primary habitat of the meningococcus, both in actual cases of the disease and in "carriers," is the upper part of the naso-pharynx and the posterior nares. West has devised a special sheathed swab for obtaining mucus from this region.

Symptoms and Course.—Cerebro-spinal fever is protean in its features and especially in its modes of onset. Out of the large number of different manifestations that occur, certain cases repeat themselves with sufficient constancy to constitute clinical "types," capable of description and of recognition.

1. THE ORDINARY OR ACUTE TYPE.—The incubation period is difficult to estimate with accuracy; there are reasons for considering it to be 4 or 5 days. The illness begins with the usual symptoms of an acute specific fever, and for the first day or two, or for longer than this if the possibility of the disease under consideration is not borne in mind so as to lead to a special examination, there may be nothing to distinguish the illness from one or other of several acute febrile infections.

The onset is usually sudden, with fever, headache, general malaise and vomiting. The temperature usually rises rapidly and attains a fairly high degree on the first day (102° to 104°).

The headache is usually very intense, is often referred to the occiput, and shows little or no response to the customary palliative drugs given to relieve it.

There is frequently a rigor in the adult, or a convulsion in the infant or child. Vomiting is more often met with in children than in infants, and is quite common in young adults.

In addition to the three cardinal symptoms at the onset—headache, fever, and vomiting—the following are quite common, but are not nearly so constant: delirium, pains in the neck and limbs, and some degree of catarrh either of the nose, naso-pharynx, conjunctiva, or ear. In some cases there is considerable bronchial catarrh and in others definite enteritis. In addition to the pains referred to the limbs there may be pain and swelling of the joints.

After some 2 to 4 days of these initial symptoms evidence of meningeal irritation begins to show itself in more or fewer of the following developments. The vomiting is repeated, despite the fact that the invasion symptoms are past. The pulse is irregular in rhythm, and in older children and in adults it is often relatively infrequent when compared with the height of the temperature. The respirations are irregular. The vasomotor system is unstable, leading to periodic flushing of the face and to the presence of *tâches cérébrales*. The patient lies on his side with legs drawn up and prefers the shelter of the bed-clothes. The pupils are dilated and the light reflex is sluggish. There is photophobia, with intolerance of noise and of all kinds of interference. Examination of the neck reveals a stiffness of the muscles, which cannot be overcome without pain. The hamstrings are found to be taut, so that the knees cannot readily be extended if the hips are flexed (Kernig's sign). The abdomen is retracted and the superficial reflexes are abolished. The mental state is one of restlessness and mild delirium with troublesome insomnia. The headache may become quite intolerable and may require morphine for its reduction. In a considerable number of cases a rash appears during the first week—either a number of large rose spots about the trunk and limbs, or a macular eruption like that of measles, or a

few small petechiæ scattered over the trunk, neck and extremities. Herpes is common, and is generally situated at the usual places—the angle of the mouth, the chin and the nose. There is a leucocytosis of considerable degree (20,000 to 40,000).

Towards the end of the first week the mental state changes to a condition which may perhaps best be described as one of resistant stupor: the patient can be roused by an effort at examination, or by a change of position; but either proceeding is resented, and he quickly resumes his huddled posture. The headache is less constantly severe, but shows sudden and marked exacerbations, often nocturnal, with complete insomnia. The neck rigidity increases, and the head is retracted. The back also becomes stiff. Flesh is lost rapidly. Polyuria is common, with polydipsia. The temperature generally remains fairly high, and, although this is by no means invariable, the fever approximates to the continued type.

Assuming that the course of the disease is not interrupted by lumbar puncture or by specific therapy, the condition of the patient remains much the same during the second, and perhaps during the third, week of the illness. But the wasting continues. The temperature often becomes intermittent in type. One of the three modes of termination will be followed.

(*a*) *Recovery*.—This is gradual when it occurs, and is often interrupted by sudden recrudescences, throwing the patient back into a state which leads to renewed anxiety. The temperature chart is often interrupted in its defervescence by sudden rises, with or without a corresponding recrudescence of the meningitic symptoms. Ultimately the fever completely subsides, the patient ceases losing flesh, the headache and stupor pass off, and the rigidities slowly disappear. The pulse-rate remains high for some time in a good number of cases, and some authors regard this as a sign that the patient is not yet free from the possibility of relapse, and therefore as an indication for caution in treatment. The actual stage of convalescence, once it is established, is rarely interrupted. If the temperature and pulse-rate have remained normal for fourteen days, the risk of relapse may be considered to be passed. It may be some weeks, however, before the patient is free from stiffness.

(*b*) *Death*.—The ordinary type of the disease is not often fatal during the first 2 weeks. When it is, the stupor passes into true coma, the pulse and respiration rise in frequency, and the temperature often shows a sudden ante-mortem rise.

(*c*) *Becoming chronic*.—More often, if the ordinary type terminates fatally, it is by passing into a subacute or chronic stage. If the "crises" already referred to continue, or if, despite the fall of temperature, there is no corresponding improvement in the general condition, a state of progressive emaciation supervenes, with a tendency to chronic hydrocephalus. The wasting is sometimes extreme, so that bedsores are unavoidable. The rigidity becomes marked, and approaches, even in adults, that degree termed cervical opisthotonos in infants. Feeding becomes difficult, and this adds to the wasting due to trophic disturbances. The sphincters usually relax, leading to incontinence. Papilloedema develops. The patient may continue in this unsatisfactory state for several weeks, or even months, and yet may eventually recover, and without any residual defects. More often, however, he gradually succumbs to the disease, or, if he eventually survives

its ravages, it is to be left with mental defect, deafness, blindness, hemiplegia, or diplegia.

Opinions differ as to the frequency of true relapses in cerebro-spinal fever. This is probably due to the fact that what some authorities term relapses others consider to be merely recrudescences. It is certain that the latter are very common; indeed, they are a characteristic feature of the disease.

2. The Superacute Type.—This form of the disease is common at the height of an epidemic. The invasion symptoms are abrupt, and the patient is from the first very ill. Delirium is marked, with most tiresome insomnia, and the headache may drive the patient to a state of acute mania. The temperature is usually very high (104° to 106°), and intermits. Skin eruptions are more constantly present than in the ordinary type; but are by no means necessarily petechial in character. Discharges are apt to occur from the nose and conjunctival sac. The tongue is dry and tremulous. The meningococcus can generally be grown from the blood by culture, and may even be demonstrated in cover-slip preparations made from the blood direct. The leucocytosis is high (30,000 to 40,000). After 3 or 4 days the active mental state changes to stupor; if the cerebral pressure is not now relieved by lumbar puncture this stupor passes into coma. Even if the pressure is relieved by this procedure there is a great tendency for the patient to slip back into a comatose state; then, with pulse, respirations and temperature all rising, with insensitive pupils and absence of corneal reflex, the surface of the body becomes livid, the lungs congested, and death occurs.

3. The Fulminating or Malignant Type.—This form is prone to occur during the evolution of an epidemic. But it is by no means rare as a sporadic manifestation of the disease. It is more often seen in older children, adolescents, and adults than in infants and younger children. The abrupt appearance of fever, headache and active delirium, rapidly passing into coma, and the whole course of the disease may not exceed 12 hours.

In all fulminating cases of cerebro-spinal fever there is a rapid development of septicæmia. In some of them the septicæmia covers the whole of the disease, symptoms of meningitis being absent, and the meninges being free from gross lesions on examination post mortem. Even more constantly than in the superacute type is a blood culture positive; but the course of the disease is too rapid to admit of a diagnosis by this method during life.

4. Mild Types.—These cases are said to be common during the decline of an epidemic. It is at present quite impossible to say with what frequency they occur, because it is certain that many of them are overlooked. They are often treated as cases of "influenza," owing to the resemblance they bear to that disease. Many cases of acute fever with headache and pains in the back and limbs are regarded as "influenza" from a diagnosis by exclusion. They are not subjected to a lumbar puncture because the condition does not seem sufficiently grave. And if they recover from an illness of a few days' duration this is thought to be confirmatory of the diagnosis. In the presence of an epidemic of cerebro-spinal fever, however, a very close scrutiny of these cases should be made, and if there is even doubtful neck-rigidity or Kernig's sign, the cerebro-spinal fluid should be examined. Even when lumbar puncture is not at first decided upon a swab from the naso-pharynx should be investigated for the meningococcus.

During an epidemic a patient who presents the symptom-complex of headache, malaise, pains in the back and limbs, slight fever, and some stiffness of the neck is probably suffering from a mild grade of meningococcus infection, and should be treated as such, by a lumbar puncture and the administration of serum. Subsequent measures will be determined by (*a*) the course of the disease; (*b*) the result of the examination of the cerebro-spinal fluid; and (*c*) the result of the examination of the naso-pharyngeal swab. The value of these cautionary measures is sometimes made apparent by the patient becoming rather suddenly worse after a few days, when it may be quite obvious that the nature of the disease is what was originally suspected.

5. Post-basic Meningitis of Infants (Cervical Opisthotonos of Infants).—These cases were first described (1878) by Gee and Barlow. These observers recognised that they were dealing with a specific disease which had no causative association with tuberculosis, syphilis, or rickets. At the time of these authors' observations no epidemic of this type of meningitis had been described, and the cases were thought, even by much later writers, to be met with in sporadic fashion only. Of recent years, however, it has been recognised that this clinical manifestation of meningococcus infection may occur in epidemics.

The characters of the micro-organisms present in these cases were originally thought by some workers to differ from those of the micro-organisms found in the acuter cases occurring in epidemics. This distinction has disappeared of late, and there is more or less consensus of opinion that, although the strain may vary, the causative diplococcus is essentially the same in the acute as in the chronic, and in the epidemic as in the sporadic cases.

Seeing that the clinical features, again, do not differ materially in this type of meningitis from those often seen in cases occurring in older children, and occasionally even in adults, nor from those often seen in infants at times of an epidemic, it follows from these considerations that the inclusion of cases of post-basic meningitis in a general account of cerebro-spinal fever is amply justified.

Post-basic meningitis occurs chiefly in infants between the ages of 6 months and 2½ years. The same type of the disease may, however, be seen in children up to the age of 4 or 5 years. The onset is usually sudden, with a convulsion in many cases, and very frequently vomiting. The temperature rises abruptly, but does not, as a rule, remain high. In most cases the fever has become slight, or is absent, by the end of the first week of the illness. A large number of the patients suffering from the disease are therefore without fever when they come under observation.

The main and characteristic sign of the disease, the retraction of the head, becomes marked about the third or fourth day. It usually persists, with increasing severity, throughout the whole course of the disease. With it the back becomes arched, so that in extreme instances the occiput and the sacrum may meet. The extremities are usually in a condition resembling tetany, the stiffness being persistent rather than paroxysmal. Progressive wasting is another constant feature, and the degree of emaciation is often very considerable and very rapid. Of the other symptoms vomiting is one of the most common, and may be very troublesome. The pulse and respirations are usually frequent, and may be irregular.

The disease in most cases quickly enters upon a chronic course. The

infant lies motionless in its characteristic attitude for hours at a time, but is not usually comatose. Feeding is not as a rule difficult. The pupils are fully dilated. Blindness is present sooner or later in 30 per cent. of the cases (Langmead), the origin of the condition being central, since papilloedema of any magnitude is quite uncommon. Blindness is rare in the cerebrospinal meningitis of older children and adults.

Lumbar puncture yields similar results to those found in the ordinary type of the disease; but, as the condition progresses, it is found that the meningococcus fails to appear in the fluid, and the polymorphonuclear cell-content changes to lymphocytosis, indicating the chronic stage of the infection. Dry punctures are not uncommon, indicating the probable closure of the foramen of Magendie by the plastic exudate at the region of the bulb and fourth ventricle. Fluid removed from the ventricles during life, or the examination of fluid found in the ventricles post mortem at this stage, often reveals the meningococcus, showing that the disease is still, in its chronic phase, to be regarded as a persisting infection. Indeed, *the post-basic meningitis of infants is probably to be considered as a meningococcus infection of the pia-arachnoid system with a special tendency to involve the cerebral ventricles by ependymitis.* The peculiar symptoms and course of the disease are thus explained.

Owing to the early development of hydrocephalus in this type of the disease, and the elastic nature of the infant's skull, the head enlarges in all directions, with bulging of the fontanelles and opening of the sutures between the bones. The shape of the skull thus approximates to that of congenital hydrocephalus. The eyes are turned downwards, and the sclerotics above the cornea are exposed by retraction of the upper lid. If this condition of acquired hydrocephalus has lasted for some weeks, there may be enlargement of the superficial veins about the nose and orbits, and running over the temporal regions to the vertex.

The mortality in this type of the disease is very high, probably over 80 per cent. Some of the cases linger for many weeks, and a few very gradually recover, with, all too often, residual blindness and also perhaps deafness. But the majority succumb to the intracranial pressure effects produced by the distended ventricles, in from 4 to 6 weeks from the onset of the disease.

Complications.—1. HYDROCEPHALUS may arise soon after the onset of the disease, or it may develop, and often rather suddenly, during its course, or it may be the final anatomical expression of the infective process, the counterpart of the symptom-complex seen in the chronic state of the disease. Certain symptoms are specially suggestive of the condition: pallor, cyanosis, increased frequency of the pulse with diminution in its tension and volume, shallow respirations, and stupor or coma supervening rather suddenly upon a previous state of consciousness.

If hydrocephalus arise at a later period of the disease than the end of the first week it may show itself with surprising suddenness, and sometimes in patients who seem to have been improving satisfactorily. In addition to the symptoms just enumerated, there is a recrudescence of the headache, vomiting and fever, which may have to a large extent subsided. More often it appears gradually and concomitantly with the progressive cachexia of the chronic type of infection. A valuable sign of its presence in children and adults is the presence of a resonant note to percussion over the anterior

horn of the lateral ventricle (Macewen). This sign is best obtained by placing the head in an upright position and inclining it to one side. The sign is not present in infants in whom the fontanelles are still open.

Hydrocephalus of the chronic stage of the disease is seen very constantly in infants suffering from the post-basic type of infection. Emaciation is a constant feature. The child lies for hours without stirring. There may be reiterated automatic acts, such as the biting of nails or the loosening and pulling out of teeth. The patients are rarely comatose. Vomiting and convulsions may occur.

2. Psychic Disturbances.—These are not very common, if the delirium and stupor are excluded. But the delirium may develop into mania, urged thereto by the violence of the headache. During convalescence it is not very uncommon to observe temperamental changes, such as puerility or emotionalism, which rarely persist for very long. Secondary dementia is, however, not unknown.

3. Motor Defects.—Cranial nerve palsies are very uncommon. There are three groups of paralytic complications, but none of them is common.

(*a*) *Hemiplegia* and, less often, *monoplegia* of cortical type. This usually appears at the height of the disease, and is generally of temporary duration.

(*b*) *Flaccid paralysis* localised to one extremity or to a part of one extremity. The tendon-jerks are lost. Muscular atrophy may ensue, and R.D. may develop. The prognosis for the limb is by no means bad, and complete, or almost complete, recovery is probable.

(*c*) *Spastic ataxia.*—It is not uncommon to find convalescent patients very unsteady on their legs when they first begin to walk. Little children often refuse to walk at all for a time, even if they had learnt to do so before the illness began. Older children sprawl about the floor. Adults tend to topple over in an indiscriminate manner. In the majority of these cases there are no signs of organic disease, and the return to a normal gait is usually only a matter of time. In a few of the cases, however, the ataxia is accompanied by exaggerated knee-jerks, true ankle-clonus and extensor plantar response: a state of spasticity. The sphincters are intact, and there is no anæsthesia or analgesia. According to Sophian, who drew attention to these cases, the pupils often remain dilated, with a sluggish light reflex. Recovery, though slow, is the rule.

4. Special Senses.—Complications involving the eye are very variable, and yet, in relation to the essentially nervous character of the main lesions of the disease, they are not very common. Fortunately, with the single exception of that form of blindness so often seen in the recovered cases of the post-basic type of the disease, very few of the eye complications are permanent. Inflammatory lesions include conjunctivitis, keratitis, iridocyclitis and (rarely) cellulitis of the orbit. Nervous lesions include extrinsic ocular defects which are not uncommon, but are generally transitory (*i.e.* spasmodic). Amaurosis is relatively common in the post-basic infection of infants; it is fortunately unusual in the more acute infection of children and adults. It is in most cases unaccompanied by any changes in the optic disc, and is therefore to be attributed to cortical changes associated with hydrocephalus. In some cases, however, a state of secondary optic atrophy is present. Optic neuritis is not a common complication; but papillitis, or a lesser degree of change even than this, is said by French authors to be extremely common.

The chief complication affecting the ear is meningitic deafness. This is a common and very serious complication, serious because when it occurs it is apt to be permanent. The auditory defect generally begins early in the course of the disease, and usually before the end of the first week. It is usually bilateral, which adds to the seriousness of the trouble in the event of its becoming permanent.

5. Arthropathies.—A certain degree of painful stiffness, and even swelling of the joints, is not at all uncommon as a transitory symptom in cerebro-spinal fever. Occasionally, however, one joint shows evidence of much more intense infection, becoming red, swollen and very painful with the slightest movement. It may suppurate, and secondary infection may occur.

6. Other complications are the broncho-pneumonia already referred to in little children; occasionally pneumonia in adults; and enteritis.

Lumbar Puncture.—In any suspected case of meningitis a lumbar puncture is as clearly indicated as is puncture of the chest in a suspected case of pleuritic effusion, or a blood-count in a suspected case of leukæmia.

If the patient is an infant, it can easily be held in the position about to be described by the nurse or assistant. In an adult free from delirium a local anæsthetic (novocain and adrenalin injection or, less suitably, ethyl chloride spray) is indicated. In stuporose or comatose patients the question of anæsthesia does not, of course, arise. In all other types of patient than these three a general anæsthetic is advisable.

Special apparatus is unnecessary. A long, stout needle with a syringe may be used. But nothing is quite so useful as a "Barker's needle," which is strongly made, and is fitted with a stylet, the point of which is bevelled off flush with the point of the needle, whilst the other end of the stylet terminates in a broad expansion to fit against the palm of the hand. The needles—it is advisable to have a duplicate one handy—are sterilised by boiling, whilst the patient is being prepared.

The puncture should be made with the patient in the recumbent position; even in adults who are not acutely ill no exception should be made to this rule. If the operator is right-handed, the patient lies most conveniently on his right side, and close to the edge of the bed. *A good light upon the back, without shadow from the operator's hand, is imperative.* The shoulder is on the bed and not on a pillow, so that the spine lies straight in its long axis. The knees are drawn well up to the abdomen, and the head and shoulders are bent forward; the trunk is thus arched with its convexity backwards. This position is best secured in an infant by one arm of the nurse or assistant being placed round the neck and the other arm under the knees. By clasping hands the infant's body can be brought into the desired posture. The skin in the situation of the sacrum and lumbar spine is now rubbed thoroughly with acetone or alcohol, or is swabbed with tincture of iodine.

The space between the third and fourth lumbar vertebræ is the most convenient one for the puncture. (But the interspace above or below the third may be utilised with almost equal advantage.) This space is cut by a straight line joining the summits of the iliac crests. The most useful landmark is the spine of the fourth lumbar vertebra, which is the one lying nearest to this intercristal line. The puncture is made between this spine and the one lying next above it, which is felt at a distance of a ½ to 1½ inch

according to the patient's age. *It is essential to success to outline the two spines beyond any doubt.*

The puncture is made in the middle line and directly forwards. In adults it is sometimes found better to direct the needle slightly upwards. If obstruction be encountered this is probably by bone. The needle should be withdrawn a very little way and redirected slightly, with a view to correcting any fault which may be suggested by a revision of the surface markings. As soon as it is judged from the "feel" of the needle that it has entered the sub-arachnoid space, it is advisable to test its position before pushing it further forward. In this way the operator avoids piercing the venous plexus which lies at the opposite side of the canal, and which forms the common source of the blood that occasionally flows and obscures the result of the puncture. If such an accident happens it will often be found that slight traction on the needle in the direction of its handle will result in a flow of fluid free from blood; in this case the fluid should now be collected in a separate vessel.

If a "dry" puncture results, it is because the needle has not entered the canal at all, or has struck a nerve root which blocks its orifice, or because the inflammatory exudate is too thick to flow through it. The first possibility is the most probable, especially with an operator who is not very experienced.

Assuming Barker's type of needle to be used, the first 3 or 4 c.c. of fluid are allowed to run into an ordinary clean test-tube and are utilised afterwards for chemical tests which will go far to establish the diagnosis by the bedside. A sterile bottle or test-tube is then placed to receive the rest of the fluid, care being taken to avoid contaminations from the air, hands, etc. The bottle or tube is carefully sealed and is sent forthwith to the pathologist. If it cannot be dealt with in the laboratory within two hours some arrangement must be made for keeping the tubes warm, as by wrapping them in cotton-wool and placing them in proximity to a hot-water bottle. In general it may be said that *the fluid may be allowed to run away until the rate of flow is reduced to one drop to each three or four seconds.* The needle is now withdrawn by a quick movement, the skin being supported by firm pressure with the thumb of the left hand. The minute hole is sealed by a small piece of gauze soaked in collodion.

THE CEREBRO-SPINAL FLUID IN MENINGOCOCCUS MENINGITIS.—1. *The pressure and the amount of the fluid.*—These are both increased. The amount of fluid which flows away before the normal pressure is re-established depends upon the pressure and the consistency of the fluid; it averages about 30 c.c.

2. *The naked-eye appearance of the fluid.*—Various grades of turbidity are met with, from very slight opalescence to a highly purulent exudate. The degree of turbidity varies with the stage of the disease at which the lumbar puncture is undertaken. In the invasion stage the fluid may be almost clear; in the acute meningitic stage the fluid shows marked turbidity; later, again, as the inflammatory phase passes, the fluid becomes clearer. The presence of blood probably always means that a vessel has been punctured by the needle. Some degree of clotting often takes place when the fluid is allowed to stand, filaments of fibrin appearing at the bottom of the tube.

3. *Chemistry of the fluid.*—The albumin is increased in amount: instead of the faint opalescence which appears on boiling and adding dilute acetic acid to the normal fluid, a definite coagulum is produced, and an opaque

ring appears when the fluid is poured gently on to the surface of strong cold nitric acid. A quantitative estimation of the albumin shows that it may be present to the extent of 0·2 or 0·3 per cent. The globulin is also increased, as demonstrated by adding one part of the fluid to five parts of a 10 per cent. solution of butyric acid in normal saline, boiling, adding one part of normal caustic soda, and boiling again : a heavy white coagulum is obtained (Noguchi's test).

4. *Cytology of the fluid.*—In the early or invasion stage of the disease there is a quantitative increase in the lymphocytic content, a fact which often escapes observation if the lumbar puncture be delayed. With the arrival of the acute meningitic inflammation the chief cell present is the polymorphonuclear, usually in large numbers. At the stage, therefore, at which most lumbar punctures are undertaken, the cell content is chiefly polymorphous (70 per cent. to 80 per cent.). Later, when the stage of chronic hydrocephalus ensues, the lymphocyte again becomes the dominant cell, and in a much greater number than in healthy fluid. Most observers, however, describe cases of undoubted meningococcus meningitis in which the cell content is chiefly lymphocytic throughout. In the post-basic type of the disease the cells are most often lymphocytes for the greater part, and the same may be said of cases which are in a chronic stage whilst under investigation, whether the chief seat of the effusion be at the root of the bulb or elsewhere.

5. *Bacteriology of the fluid.*—Films made direct from the cerebro-spinal fluid, or, better still, from the centrifugalised deposit, show intra- and extra-cellular meningococci in the great majority of cases at some time or other in their course. If a careful search be made and no cocci are discovered, it must not be assumed that none are present until the device of incubating the fluid as a whole is undertaken, and until cultures made upon suitable media are found to be sterile. The number of cocci seen, and their disposition with regard to the cells of the exudate, are matters of great variability. These things depend in the main upon (*a*) the stage of the disease, (*b*) the intensity of the infection, and (*c*) the influence of specific serum treatment.

Diagnosis.—*The chief difficulty lies in not suspecting the presence of the disease.* It is, of course, much more easy to bear in mind the possibility of cerebro-spinal fever during the presence of an epidemic than at other times. Cases which go undiagnosed, at least during the first part of their course, are those sporadic cases which generally happen to be atypical.

The reason why it may not be possible to decide on clinical grounds whether meningitis is present or not is because several infective processes, other than that due to the meningococcus, are apt to produce symptoms highly suggestive of meningeal irritation. This state of meningeal irritation, when due to toxæmia and not due to actual meningitis, has been termed *meningism* or *meningismus*. The question whether such a state is entirely toxic, or whether it is due to definite though slight changes in the meningeal tissues which just stop short of an inflammatory exudate, is problematical.

The diagnosis of cerebro-spinal fever may be conveniently considered under three heads—(1) from various acute infective processes with toxæmia, leading to "cerebral" symptoms ; (2) from certain acute cerebral diseases of primary origin ; (3) from other forms of meningitis.

1. THE DIAGNOSIS OF MENINGITIS FROM TOXÆMIA MERELY.—The question is settled partly by the clinical data and partly by an examination of the cerebro-spinal fluid. In a case of fever with "head symptoms," the following differential points should be borne in mind:

(1) *If headache and delirium synchronise, meningitis is probably present, and not merely toxæmia.*—Contrast an ordinary case of typhoid fever (toxæmia), in which headache and delirium alternate, the patient being free from pain when he is delirious, with cerebro-spinal fever (meningitis), in which the patient's headache and delirium are both present at the same moment.

(2) *Vomiting.*—If this occurs not merely at the onset of the fever, but on subsequent days also, at a time when the invasion period of the infection may be said to be passed, it is evidence of meningitis.

(3) *Pulse and respirations.*—Irregularities in rhythm are in favour of meningitis, and so is a relatively low pulse rate in comparison with the height of the temperature, provided typhoid fever can be eliminated.

(4) *Stiffness of the neck* without signs of otitis, enlarged glands, or of other local inflammation, even though it only exists in slight degree, is strongly in favour of meningitis. If the stiffness increases, rather than diminishes, with prolongation of the examination, the presumption is still greater.

(5) *Kernig's sign*, provided the patient is over 2 years of age, may be taken as being of equal significance with stiffness of the neck.

(6) *Papilloedema*, though its presence is much in favour of meningitis as against toxæmia merely, is not of much value in this connection, because it is usually absent at the early stage of the disease when the diagnostic problem requires urgent solution.

These six points are worthy of the most critical investigation. All other clinical features that may be present are equivocal—they may be produced by a toxic state of the brain or meninges. This statement refers to the state of the pupils, whether contracted or dilated; the presence of *tâches cérébrales*; the absence of the superficial or of the deep reflexes; the "peevish" state of the patient with a resistant attitude; marked insomnia or persistent stupor.

(*a*) *Influenza.*—This probably gives most difficulty in actual practice. *It should be noted that cerebro-spinal fever is very often mistaken for influenza, whereas influenza is rarely mistaken for cerebro-spinal fever.* The reason for this lies in the fact that the diagnosis of influenza is too often by exclusion. Fever prolonged past the seventh day, in the absence of an inflammatory focus (bronchitis, pneumonia, pleurisy, sinusitis, etc.), is unlikely to be due to influenza, and should therefore lead to a critical revision of the diagnosis.

(*b*) *Typhoid fever.*—The onset of the illness is nearly always a gradual one, and the evolution of the toxic symptoms is much more deliberate than in cerebro-spinal fever. This is perhaps the most significant differential point clinically. The leucocyte count is very helpful, and may prove of great diagnostic assistance before Widal's test is available: the count is low in typhoid (2000 to 7000), but it is high in cerebro-spinal fever (15,000 to 40,000). The rose spots of typhoid do not appear until the eighth or tenth day, whereas the rash of cerebro-spinal fever which might be confused with these usually appears much earlier. If the spleen is palpable in cerebro-spinal fever this is the case early, whilst the disease is at its "septicæmic" stage; in typhoid

the spleen can rarely be felt before the end of the first week. The dissociation of headache and delirium in toxæmia already referred to is strikingly seen in typhoid fever. Moreover, the disappearance of the headache altogether, which occurs so frequently in typhoid fever after the tenth day, is another point of distinction; although its severity may diminish, it is rarely absent so early in the course of cerebro-spinal fever. As soon as a positive Widal test is obtained (usually about the seventh to tenth day), this finding, together with a leucopenia, may be relied upon as decisive in favour of typhoid. A positive blood culture may often be obtained before the agglutination test is available.

(c) *Pneumonia.*—Acute pneumococcus infection is the most common cause of a toxæmic state leading to meningism; the patient is usually a child, but not always. The symptoms of meningeal irritation may precede the signs of pulmonary disease, in which case the diagnosis can only be settled by lumbar puncture, or they may concur with such signs, in which case some care must be exercised lest the case be one of cerebro-spinal fever ushered in by pneumonia. Here the leucocyte count is of no help, for there is a high leucocytosis in pneumonia as in cerebro-spinal fever. A blood culture may reveal pneumococci, or a lung puncture may yield direct evidence of the nature of the infection; but if the diagnosis is considered in serious doubt, it will probably be deemed wise to perform lumbar puncture.

(d) *Measles.*—The differential diagnosis between this disease and cerebro-spinal meningitis does not appear to be a matter of practical difficulty. But in the writer's experience, although no reference is made to the fact by authors, it is sometimes necessary to decide whether or not a mixed infection is present. There is good evidence that acute encephalitis may occur as an immediate sequel to measles.

(e) *Malignant small-pox,* on the authority of Milligan, simulates cerebro-spinal fever very closely, on account of the sudden onset, headache, vomiting and pain in the back. But as the eruption occurs on the third or fourth day the diagnosis is not left long in doubt.

(f) *Rheumatic fever.*—If cerebro-spinal fever begins with arthritis and profuse acid sweats, if the patient is an adolescent, and if the pains are specially referred to the joints, the diagnosis of rheumatic fever is at first pardonable. The addition of an erythema makes the simulation all the closer. The failure of salicylates to relieve the pain, or to reduce the fever, should at once arouse suspicion. The important distinction between early rigidity of the neck in meningitis and rheumatic stiffness – that the former tends to increase with examination, and the latter tends to decrease – should be remembered in this connection.

2. Differential Diagnosis of Cerebro-spinal Fever from certain Diseases of the Central Nervous System.—The most important of these diseases sometimes introducing a difficulty is—

Poliomyelitis (*infantile paralysis*).—This disease, like cerebro-spinal fever, exists in epidemic and in sporadic forms. Of recent years there have been several small epidemics in England. Sporadic cases are very common. If the type of the disease is the usual one, little or no difficulty is introduced in diagnosis from cerebro-spinal fever, because the invasion or febrile stage is short and the degree of illness it involves is not great; it is quickly followed by the paralytic stage, and the real nature of the malady becomes manifest.

In the cerebral type of poliomyelitis, however—acute polioencephalitis—there may be considerable resemblance to cerebro-spinal fever, in that the patient often lies in a state of semi-stupor, and vomiting may occur and may persist for 2 or 3 days. It is, however, in the meningitic form of the disease that a real difficulty presents itself. There may be added to the headache and vomiting, pain and stiffness in the neck and spine, and even some degree of opisthotonos. Careful study of the cerebro-spinal fluid usually serves to differentiate the two diseases.

Meningism may occur in a child as the result of acute gastric or intestinal irritation, and especially as the result of *ascaris lumbricoides*.

3. Differential Diagnosis of Meningococcus from other Forms of Meningitis.—(1) *Pneumococcus meningitis* is rarely primary; almost always it complicates consolidation of the lung, or pleurisy, or otitis media, or infection of the nasal sinuses. But when it occurs it is apt to be extremely acute, running a rapid course and nearly always a fatal one.

(2) *Streptococcus meningitis* usually complicates some infective process about the skull, and most often this is middle-ear disease or sinusitis. In the majority of cases some surgical procedure has been attempted for the relief of the primary condition.

(3) "*Influenzal*" *meningitis* is a term applied somewhat loosely. Recent knowledge imparted by lumbar puncture makes the diagnosis of influenzal meningitis impossible from clinical grounds alone. And it is a striking fact that those cases in which Pfeiffer's bacillus is isolated from the lumbar puncture fluid, with the exudate of an acute meningitis, and definite symptoms, are not usually cases in which influenza has been suspected, still less diagnosed.

(4) *Typhoid meningitis*.—A true infection of the meninges may occur in typhoid fever, but it must not be inferred that a patient necessarily has typhoid meningitis because the bacillus is grown from the lumbar puncture fluid. This may occur without clinical evidence of meningitis and without histological and chemical changes in the cerebro-spinal fluid characteristic of meningeal inflammation.

(5) *Tuberculous meningitis*.—This is by far the commonest form of acute meningitis and therefore deserves fuller mention. The most helpful points in a differential diagnosis from meningococcus meningitis are the following. Tuberculous meningitis is rarely so sudden in its onset, the meningitis symptoms being preceded by a longer period of malaise, which begins less abruptly than the invasion symptoms of cerebro-spinal fever. The temperature is seldom high, except as an ante-mortem event, the usual range being 99° to 101°. Retraction of the head is transient and ill-marked, or is absent. Photophobia is more common than it is in cerebro-spinal fever. In adults aphasia is often a common and an early symptom. True (paralytic) squint is common. The "peevish" condition in children is much more marked during the first week. In both children and adults the depth of the stupor after about the tenth day is much greater. The discovery of tubercles in the choroid is pathognomonic, but these lesions rarely appear before the third week of the disease, and are therefore not of much service for diagnosis. Some authors lay stress upon the presence of signs of tuberculous disease elsewhere in the body as assisting in the diagnosis, but this is, of course, not true. Except in the case of adults, and by no means always then, there are rarely any such signs. The leucocyte count affords no

differential help as from cerebro-spinal fever, a leucocytosis of considerable size (15,000 to 30,000) being present in tuberculous meningitis.

However high a degree of probability that a patient is suffering from meningitis may result from a general examination, confirmation of this view rests entirely upon the results of lumbar puncture. For three reasons it should not be deferred: it establishes the diagnosis that meningitis is present; it decides the nature of the infection; it is a valuable aid to treatment in the event of a positive result.

Prognosis.—The mortality in cerebro-spinal fever is undoubtedly higher in the epidemic than in the sporadic cases, if the post-basic meningitis of infants, in which the mortality is very high, be excluded. There are, however, no good figures upon which to base an estimate of mortality in the sporadic cases. In epidemics the mortality prior to the introduction of serum treatment was about 70 to 80 per cent. It has certainly been much reduced of late, though the efficacy of sera varies greatly in different epidemics.

The influence of age is noteworthy. The disease is extraordinarily fatal in infants (patients under 2 years of age). This statement holds good both for the post-basic cases which are so often subacute or chronic in character, and for the acute cases. The mortality is lowest between the ages of 5 and 10 years.

A fulminating form of onset is invariably bad, and the mortality in these cases is very high, if indeed it is not 100 per cent. In the cases with less vicious invasion symptoms, one or more of the following symptoms betoken a grave issue: early loss of consciousness, wild delirium, persistent insomnia, extensive hæmorrhagic eruption, cyanosis. Later in the course of the disease the worst sign is the appearance of hydrocephalus.

The degree of fever, the intensity of the headache, the amount of rigidity, the presence of marked emaciation, frequency and irregularity of the pulse, rhythmical respirations, the presence of herpes—none of these things yields any information of value in predicting the issue of the disease. *In few other diseases, if in any, is it possible for the patient to be so ill and yet to recover completely, as in cerebro-spinal fever.*

The state of the cerebro-spinal fluid in relation to prognosis is to a high degree equivocal. No reliance must be placed upon it except for purposes of diagnosis. It may be almost clear and may contain very few meningococci, and yet the patient may be desperately ill and likely to die. On the contrary, it may be highly purulent and crowded with meningococci, and yet the patient may get rapidly well.

According to Netter and Debré, the most important fact bearing upon prognosis is the stage in the disease at which serum treatment is begun. Flexner found that if serum was given between the first and third days, the mortality of the disease was reduced to 18·1 per cent.; if it was delayed until the seventh day the mortality rose to 36·5 per cent.

Treatment.—1. PROPHYLACTIC.—The principles governing prophylaxis are those applicable to infectious diseases in general. Although it would appear that the healthy carrier is more responsible for the spread of the disease than the patient himself, it is none the less important to isolate every case of the disease and to exercise all precautions against further contact with healthy persons. Whenever possible the patient should be transferred to a hospital, and preferably to an institution where the staff is accustomed to deal with infectious diseases.

All contacts who are found to be carriers should be placed under quarantine, and should be kept there until the naso-pharynx is free from meningococci. The carrier should live as far as possible in the open air. For lavage of the naso-pharynx, and for a gargle, a weak solution of izal may be used, or peroxide of hydrogen, or a 1 : 1000 solution of permanganate of potash, adding 1·5 per cent. of sodium sulphate to assist penetration (Gordon). For spraying the nose or fauces, a 1 per cent. solution of iodine with 2 per cent. of menthol in parolein may be used.

The use of a meningococcus vaccine for the purpose of clearing the throat has not proved to be successful.

2. CURATIVE.—(1) *Serum treatment.*—Cerebro-spinal fever is not only a specific disease in regard to its ætiology, it is specific also in regard to its therapeutics. Given that treatment by an appropriate anti-meningococcus serum is early and thorough, the disease is curable in the large majority of cases.

It is of vital importance that the first dose of serum be given at the earliest possible moment after the disease is diagnosed or is strongly suspected. Nothing in the treatment of the patient should take precedence of this first serum administration. If the result of using one brand of serum in a particular case is unsatisfactory, a different brand should be tried, and even a third, if necessary. It may even be advisable to prepare a special serum for the case of a particular epidemic.

The serum must be given by the intraspinal route; it has much less therapeutic value in the ordinary type of case if given intravenously, and perhaps little or none if given subcutaneously.

The serum may be allowed to flow into the spinal theca by gravity, or it may be injected by means of a serum syringe. The rapid injection of serum is harmful and may even lead to a fatal result; but it is doubtful if the injection method is prejudicial, provided due care be exercised to warm the serum and to inject it very slowly.

With regard to repetition of the serum, Flexner laid down an arbitrary rule for guidance on this matter, recommending the use of serum daily for 4 or 5 doses, and advising that after this the practitioner should be influenced by the subsequent clinical condition of the patient and by the state of the lumbar puncture fluid at successive operations. Some such custom as this remains the usual one in the ordinary type of the disease. It is desirable to vary this rule in individual cases.

If the case is of the superacute type, it is well to repeat the dose of serum in 8 to 12 hours and again after the same interval. In this way an effort is made, consistent with the precautions already referred to, to get as much serum as possible into the cerebro-spinal sac during the early stages of the disease. After these initial 3 doses an interval of 24 hours may be allowed to pass before the next dose is given.

If the case is a mild one the original serum administration need not be repeated for 24 hours, and the second interval may be 48 hours, provided the course of the disease is satisfactory. Although in very mild cases one administration of serum with the drainage it entails is often sufficient to establish a definite and lasting improvement, this must never be depended upon, as recrudescences are common and are certainly preventable by adequate use of the serum.

No doubt the best indication for the repetition of the serum is the condition of the meningitic exudate as seen at successive punctures. The lumbar puncture fluid should always be examined by a competent observer whenever this is possible. The indication for further serum is proportionate to the number of meningococci still present in the extracellular form. But it is not often practicable to prepare a stained film of the fluid straightway so as to be guided by the result. The decision whether to use serum or not must in most cases be determined by a consideration of the clinical condition together with the naked-eye characters of the fluid. In regard to the latter it may be said that if the fluid is still turbid (indicating the presence of polymorphous cells), it is well to give more serum. If serum is not given upon the occasion of any puncture, and the pathologist reports extracellular cocci in the specimen examined from that particular puncture, this should decide the practitioner to give serum at the puncture next undertaken, whatever the naked-eye features of the fluid may be.

(2) *General management.*—The diet is to be adjusted to the patient's condition. The disease is an exhausting one, and as full a dietary as is consistent with the state of the digestive secretions is to be allowed. If the fever is a conspicuous feature, and the patient is drowsy or delirious, the mouth is usually dry; the diet is then necessarily restricted to fluids, which should be given in the form of diluted milk, and freshly prepared meat essences, in small quantities at frequent intervals. Water should be given freely. If the patient is in a state of stupor the act of swallowing must not be relied upon; feeding must then be by the passage of a nasal tube three or four times in the 24 hours. According to the age of the patient, from 5 to 10 ounces of citrated milk and water (equal parts), or of peptonised milk, or of beef essence are allowed to run into the stomach from a funnel attached to the tube and held at the necessary height above the bed. A raw egg may be beaten up in the milk and a little brandy may be added if the state of the heart indicates the use of alcohol. If vomiting is troublesome, peptonised milk should only be used, or whey or albumin water. If this symptom is persistent, it may be advisable to put no food at all into the stomach for 24 to 48 hours, relying upon saline injections (5 to 20 ounces according to age) per rectum every 6 hours, supplementing these, if thought desirable, by the subcutaneous use of a 10 per cent. solution of dextrose in normal saline.

The bowels are usually constipated; it is therefore frequently necessary to use purgatives: castor-oil or calomel followed by a saline, or compound liquorice powder. If the patient is comatose early in the disease, when treatment is beginning, it may be advisable to give 2 minims of croton oil in butter or moist sugar.

Urinary difficulties do not usually occur unless the patient is unconscious, in which case it is important to bear in mind the possibility of retention, which may lead to "overflow incontinence." This condition indicates the use of the catheter, with the customary care in the matter of asepsis.

(3) *Drugs.*—It is exceedingly doubtful if any drug exercises a beneficial influence upon the infection, but urotropin, in full doses (60 grains daily), has been recommended, and has experimental evidence in its favour.

(4) *The treatment of certain symptoms.*—Headache is usually the most distressing symptom calling for special treatment. In all but the mildest cases of the disease it is a good thing to shave the scalp and to apply an

icebag or Leiter's tubes. A leech over each mastoid is sometimes followed by relief for several hours. If, as is often the case, the pain is referred to one particular spot, the leech should be applied there. Drugs are not of much use in controlling the very severe headaches, but antipyrine, caffeine, and aspirin may all be tried in full doses. Morphine may be imperative in some cases, because nothing else may be of any service. Restlessness, delirium and insomnia,—if these symptoms are troublesome a trial should be given to some such combination as the following :—

℞ Ammon. bromid., grs. x-xxx.
Tr. valerian. ammon., ℥x-xxx.
Syr. chloralis, ℥xx ℥ij.
Aquam ad ℥i.
S.—Secundis horis ad doses iv-vi.

The pains and the stiffness are best treated by warm baths at a temperature of 102° to 104° F.

If the delirium is exhausting or the condition verges upon mania, vapour of chloroform may be used, or morphine with atropine may be given. Hyoscine should be avoided.

Arthritis.—The affected joint is best treated by fixation, by the application of hot stupes, and by aspirin internally. If the fluid effusion becomes considerable, or does not quickly yield to these measures, the joint should be aspirated and 5 to 10 c.c. of serum should be injected into it if the meningococcus is demonstrated in the fluid.

(5) *The repetition of the lumbar puncture.*—A lumbar puncture of necessity precedes each intraspinal dose of serum. But there arises in many cases an indication for continuing the lumbar punctures over a longer period than that covered by the serum administrations. Any further untoward event in the course of the disease, or any undue prolongation of it, is best met by repeating the puncture. The amount of fluid withdrawn is determined by the amount present, and its characters. Too much is not likely to be withdrawn. If the temperature rises after having settled for 2 or 3 or more days ; if there is an exacerbation or a recurrence of the headache, restlessness, delirium, or insomnia ; if rigidity returns after an initial subsidence—in either of these instances it is advisable to investigate the pressure and the characters of the cerebro-spinal fluid. There are reasons for thinking that further drainage at certain intervals tends to prevent the development of the most serious of the complications of the disease, a state of hydrocephalus. It may therefore be necessary to repeat the puncture several times, especially in the most chronic cases and in the group of post-basic cases in infants.

(6) *Treatment of hydrocephalus.*—If a condition of hydrocephalus has been diagnosed, it is advisable to tap the lateral ventricles and to inject serum. This procedure is not so difficult nor so dangerous as may be supposed.

(*a*) The patient is usually an infant with open fontanelles. The region of the anterior fontanelle is shaved and the skin is sterilised. A stout needle, to which a syringe can be attached, is inserted at the lateral angle of the fontanelle, and is gently pushed towards the mesial line for a distance of an inch or an inch and a half. The fluid is usually under considerable

pressure, so that it becomes quickly known when the needle reaches it. It is not necessary or advisable to attempt to withdraw more fluid than comes into the syringe with very gentle aspiration. With great care, an amount of serum less in bulk than the fluid withdrawn is now introduced into the ventricle.

(*b*) In older children and adults the operation of decompression becomes necessary; and here again, though a much more serious procedure, the practitioner should not hesitate to give the patient the benefit of the operation and of the use of serum by this special route.

THOMAS HORDER.

PLAGUE

Definition.—Plague is an acute infectious disease, running a rapid course, associated with high fever, high mortality, generally with enlargement of the lymphatic glands, and due to a specific micro-organism—the *Bacillus pestis*.

Ætiology.—The disease may occur anywhere, but is more common in subtropical regions. Towards the equator it tends to die out. All races and ages are subject to it. It is due to a bacillus, a short rod, often distinctly oval-shaped, and with somewhat rounded ends. It is non-motile, Gram-negative, and when suitably stained shows characteristic bipolar staining. The bacilli measure from 1 μ to 1·5 μ in length. Growth takes place easily on all the ordinary culture media. The disease is common in the rat, and epidemics amongst these rodents often precede the human cases. The germ is spread from rat to man, in ordinary bubonic cases, by the common rat flea (*Xenopsylla cheopis*); but in pneumonic cases the transference is direct by droplets of sputum, and persons suffering from chronic pulmonary troubles are specially liable to the pneumonic form, which is intensely infectious from person to person—doctors and nurses often acquiring the disease.

Pathology.—The mild forms may be due to attentuated brands of bacilli. The plague bacillus gives off a toxin, and this is responsible for many of the lesions present. The severity of the toxæmia is seen in the hæmorrhages and the general changes in the viscera. In bubonic plague the bubo is apparent. Marked features are met with in the lymphatic system—all the glands of the body being more or less affected. Even in pneumonic and septicæmic plague, where there is no primary bubo, enlargement of the glands is evident at autopsy. The primary bubo is characterised by its marked hæmorrhagic nature, the individual glands being matted together and the periglandular tissue infiltrated with a blood-stained gelatinous fluid. Bacilli are present in the necrosed tissue in enormous numbers. In the secondary glands, the periglandular infiltration is absent, and the hæmorrhagic character is not so marked. On section, these glands appear greyish-red. Bacilli are no more numerous in them than in the blood and spleen.

The heart often shows dilatation of the right side, with its muscle soft and fatty, and petechial spots on the epicardium; the liver is enlarged and congested with cloudy swelling and fatty changes of the parenchymatous

cells; the spleen is also enlarged, the pulp soft and hyperæmic; the kidneys are congested with cloudy swelling and early fatty changes.

Hæmorrhages, varying from petechial spots to larger collections of blood, are always present; they are seen under the skin, in the subcutaneous tissues, and on the serousmembranes. The name "black death" was derived from these hæmorrhages.

In pneumonic plague the lesion is that of a broncho-pneumonia, areas of consolidation with hæmorrhagic effusions being scattered throughout the substance of the lungs. Bacilli are present in the lesions in large numbers.

Recently Norman White has suggested that the plague bacillus alone does not cause epidemics of pneumonic plague. He believes there is an additional organism at work, working in symbiosis with the plague bacillus, and that pneumonic plague is a disease *sui generis*. This idea has been criticised by C. A. Gill and others.

Symptoms.—Plague may be differentiated clinically into seven types—(1) Bubonic; (2) Septicæmic; (3) Pneumonic; (4) Intestinal; (5) Cerebral; (6) Cellulo-cutaneous; (7) Abortive or ambulatory (*Pestis minor*).

1. *Bubonic.*—The incubation varies from 2 to 5 days. The onset is sudden, with high fever, often ushered in with one or more rigors; the pulse is rapid, and severe constitutional disturbances are present—severe frontal headache, giddiness, nausea, vomiting, diarrhœa, with pronounced bodily weakness and mental terror. The patient may, on walking, reel like a drunken man.

The bubo appears on the second or third day, the glands rapidly enlarging till they reach the size of a hen's egg. Pain may be severe. As a rule only one group of glands is affected, and 80 to 90 per cent. of these suppurate, the abscesses maturing during the course of the second week. Buboes occur in order of frequency in the inguinal, axillary, submaxillary and cervical groups.

The urine contains albumin, and the blood shows a polymorphonuclear leucocytosis. Death may take place at any time, but is commonest on or about the third or fifth day. If recovery take place, the severity of the symptoms gradually lessens; but convalescence is somewhat protracted. Sequelæ are common, such as sepsis, carbuncles, etc.

2. *Septicæmic.*—The disease runs a very rapid course, the symptoms being those of a severe septicæmia. The glands are usually slightly enlarged and tender; but no definite bubo is seen. The patient sinks rapidly and quickly dies. Blood may be passed per rectum towards the end.

3. *Pneumonic.*—The onset in this type is ushered in by a chill, followed by a rapid rise of temperature, with headache, dizziness, pains in the limbs, accompanied by pain and tightness in the chest, with cough and expectoration of a thin, sanguineous, watery fluid. The respirations are increased, with cyanosis, diminished resonance over one or more areas and rhonchi (Childe). Herpes labialis is said not to occur. Multitudes of plague bacilli, either in pure culture, or mixed with different cocci, are present. The condition resembles the severe types of influenzal broncho-pneumonia. Why some epidemics take on this form almost entirely is not clear, *e.g.* the Manchurian epidemic 1910–11.

4. *Intestinal.*—A rare form. Wilm described it in the Hong-Kong

epidemic of 1896 as follows: It runs its course without buboes; its predominant features being disorders of the intestinal canal, vomiting, incessant purging, liquid stools, bile-stained, with an offensive odour and often mixed with blood. Definite pathological lesions are seen in the intestine at autopsy.

5. *Cerebral.*—In this type the patient dies with cerebral symptoms closely resembling those of malignant malaria—delirium, convulsions and then a gradually deepening coma. Definite plague meningitis has also been described.

6. *Cellulo-cutaneous.*—Carbuncles due to the plague bacillus are sometimes encountered, and have to be distinguished from ordinary coccic carbuncles. The latter may, however, appear as a sequela in the disease. The plague carbuncles have a necrosed and ulcerated centre with a hard edge, from which a red areola spreads, sometimes covered by minute vesicles. Plague bacilli are demonstrable.

7. *Abortive or ambulatory* (*Pestis minor*).—Cases of this sort are met with in all epidemics. The disease may be acute or chronic, during which—without serious indisposition or without fever—buboes develop, and these may suppurate or be absorbed (Scheube). Other abortive types have also been described—the glands of an area swell and become painful, there may be headache, fever, giddiness and indefinite pains, then everything clears up and the patient quickly recovers.

Prognosis.—The disease is a serious one, the mortality being as high as 80 to 90 per cent. in some epidemics.

Treatment.—The aim for the future sanitarian is to make houses, grain-sheds, and all other buildings rat-proof. If the rat can be kept from intimate contact with man, plague can be controlled. Destruction of rats should be carried out where possible. Ships and steamers can be disinfected by the Clayton process—sulphur gas. Vaccination should be urged upon those entering plague areas (Haffkine's method). The general treatment of the disease is symptomatic, no drug being of special value. Good results have been reported after large doses of perchloride of mercury and carbolic acid, and intravenous injections of tincture of iodine have also been given a trial. Stimulants should be used early. Buboes and carbuncles should be treated with hot fomentations of carbolic acid and sublimate. It is better not to excise them or open them before ripe, for fear of a general infection.

Serums have been tried (Anti-plague, Yersin's, and Lustig's). The general opinion is that these lower the death-rate in bubonic, but are useless in septicæmic and pneumonic cases.

UNDULANT FEVER

Synonyms.—Malta Fever; Mediterranean Fever; Gibraltar Fever; Rock Fever; Neapolitan, Cretan, Cyprus, Danube, Levant Fever.

Definition.—An endemic specific fever, sometimes becoming epidemic, of long duration, with a tendency to long wavy relapses, due to the *Micrococcus melitensis*. The disease is common in the goat, and man generally acquires the infection by drinking milk from such animals.

Ætiology.—The fever is common on all the Mediterranean littoral; it

is also met with on the Red Sea, in Zanzibar, Uganda, Nigeria, and South Africa. In the East it is found in India, Assam, Hong-Kong and China; in the West, in the West Indies, Porto Rico, etc. Its distribution is probably even much more extensive. The indigenous population seems to have a certain immunity to the disease, *e.g.* Malta, the Maltese not suffering so much as the English soldiers and sailors. All ages and both sexes are equally affected.

The germ of the disease is a minute coccus, the *Micrococcus melitensis*, which is distributed throughout the body, in the blood, bile, fæces, urine and milk. Inoculations of the germ produce the disease, and there have been numerous instances of workers with the organism becoming infected. The disease is primarily one of goats, in which it apparently causes few symptoms; though the coccus is excreted in large numbers in their milk. When the infection is a severe one the milk may be of poor quality. Cases of undulant fever in South Africa have lately been shown to be caused by the *Bacillus abortus*, an organism closely resembling the *Micrococcus melitensis*. A *Micrococcus para-melitensis* is now also described.

Pathology.—The changes found at autopsy are those associated with high temperature and the circulation of toxins in the blood. There is no specific inflammation of Peyer's patches or the other glands of the intestine. The spleen is always enlarged, averaging about 20 ounces in weight. The mesenteric glands are slightly swollen. The lungs are congested at their bases and œdematous—pneumonia may also be present.

Symptoms.—The incubation period is usually stated at 14 days, but may last a longer or shorter period. Subcutaneous inoculation of monkeys gives an incubation period of 5 days, whereas if the disease result from ingestion this is lengthened to about 15 days.

Four varieties are usually described: (1) Ambulatory; (2) Ordinary; (3) Intermittent; (4) Malignant.

(1) *Ambulatory.*—Sometimes the symptoms are so slight that a patient can go on with his work. Out of 525 dock hands examined by Shaw in Malta, 79 gave positive serum reactions, whilst out of 22 of those specially tested 9 showed the organism, either in the blood or urine, or in both. These cases then approximate to definite carriers. In other cases there is slight fever, and other symptoms which quickly disappear. Serum tests show, however, these cases have been infected.

(2) *Ordinary or undulant type.*—The symptoms resemble those seen in other fevers; but the temperature chart is characteristic. Bouts of fever of 20 days' duration or so are followed by remissions, these alternating with each other and producing a series of undulations on the temperature chart. The total duration of the pyrexia is 90 to 120 days, or even longer; some cases of a year have been described, and Bruce has even noted one of three years. In addition to the peculiar temperature, constipation is a prominent symptom, also pain and swellings in the joints. Neuritis and orchitis occur, the latter usually passing away quickly, but the former may persist and cause severe crippling. Sweating is seen during the remissions. The spleen is enlarged and painful. Bronchitis, congestion and œdema of the lungs with slight hæmoptysis are seen in some cases. Secondary anæmia eventually develops.

After running a more or less prolonged course, the remissions become more prolonged, the febrile exacerbations less high, and gradual con-

valescence is established. The neuritis and anæmia may persist for a considerable period of time. Marked debility is also common.

(3) *Intermittent type.*—Here the temperature swings up and down like a benign tertian malaria. Often about normal in the morning, it rises suddenly in the afternoon to 105° F. or higher, accompanied with chilliness or a definite rigor. By evening, the temperature falls again, associated with drenching sweat.

(4) *The malignant type of Hughes.*—The patient is attacked suddenly with high fever—severe pains all over the body, with signs of diarrhœa and pneumonia. Vomiting then sets in, and the patient gradually passes into the typhoid state; the temperature rises still higher, hyperpyrexia develops and the patient dies.

Diagnosis.—This has to be made from the other specific fevers. Clinically, undulant differs from typhoid and the paratyphoid fevers in its longer duration, the patient does not look so ill, rose spots are absent, constipation is the rule, and in the frequent occurrence of painful arthritic or neuralgic symptoms. The surest method for determining a diagnosis is by blood culture for the specific germ and by the melitin test. The agglutination test is also useful. Dilutions of 1–20, 1–100, and 1–500 should be used. It has lately been shown, however, that 20 per cent. of genuine cases of undulant fever do not agglutinate. Agglutinins, when present, may persist in the blood for long periods after the patient has recovered. If a suspicious case does not react to the ordinary *M. melitensis*, then tests should be tried with the *M. para-melitensis* as well.

Prognosis.—This is quite favourable as regards life and ultimate recovery, the death-rate being only from 2 to 3 per cent. Death occurs as a rule in the first week or two of the disease and is preceded by continued high temperatures, a tendency to hyperpyrexia, delirium, dry tongue and diarrhœa. In the chronic cases, there may be great debility, anæmia and emaciation. Neuritis is often troublesome and very difficult to remove.

Treatment.—Goat's milk should be rigidly excluded as an article of diet in places where the disease is rife. By this simple procedure, the disease has been stamped out of the Navy and Army in Malta, and cases are now of excessive rarity amongst the troops. If goat's milk has to be used, the agglutination test should be performed to determine if the goat be infected or not. Boiling the milk for 20 minutes renders it safe. Destruction of infected goats is also indicated. There is no specific drug. Symptoms have to be treated on ordinary principles. The tendency to hyperpyrexia in severe attacks must be borne in mind, and if it threatens sponging with ice water or cold baths will be required.

Sleeplessness, headache, arthritis and orchitis are all treated on general principles. The patient should be kept strictly in bed at first, but later on—especially if the weather be warm—it may be advantageous for him to sit in a bath-chair or even to go out of doors. This tends to prevent congestion and œdema of the lungs.

As regards food, the diet must not be too meagre, as the fever is a prolonged one. When the temperature is high, the diet may be restricted to fluids, but when normal, solids of a nourishing nature may be given, milk puddings, eggs and even fish. Vaccines have been tried, but so far have not given any very definite results.

G. Carmichael Low.

TULARÆMIA

Definition.—A plague-like general infection of rodents, hitherto confined to North America, communicable to man. The disease has the peculiarity, in which it resembles Malta Fever, of being extremely infective to laboratory workers handling the causative organism, *Bacterium tularense*, and attention to this aspect has been drawn by an important paper by Professor J. C. G. Ledingham and Dr. F. R. Fraser, in the *Quarterly Journal of Medicine*, vol. xvii., describing three cases occurring at the Lister Institute.

Ætiology.—In 1911 M'Coy, during plague work among ground squirrels in California, discovered a plague-like disease not due to *Bacillus pestis*, and in 1912 M'Coy and Chapin isolated the specific organism from the blood of infected animals, and it was named *Bacterium tularense*. Subsequently the organism was found in various rodents, and endemic centres of the infection have been recognised in many areas of North America. The first human case of infection appears to have been reported by Pearse in 1910, but bacteriological proof connecting it with *B. tularense* was provided by Francis subsequently. Where the infection is endemic among rodents, human cases are not uncommon, and possibly some have recovered unrecognised. The infection is conveyed from animal to animal by various blood-sucking parasites. The fæces of infected bugs have been shown to be infective. There is thus no difficulty in understanding how endemic centres of infection are kept up, and human infections in the field are readily understood. But it is difficult to explain the cases of infection in laboratory workers. It is suggested that a possibility is respiratory infection during the anæsthetising of experimental animals, when coughing is not uncommon, and the virus is certainly contained in bronchial secretions, as well as the excreta generally. The question appears to be parallel to the difficulty of explaining the great liability of laboratory infections with Melitensis.

B. tularense is a minute, Gram-negative, cocco-bacillus, measuring, according to M'Coy and Chapin, 0·3, 0·7 and 0·2 μ. It is not easily stained by the ordinary dyes, unless a mordant, such as carbolic or aniline, is added. It is refractory to growth on ordinary media, the original cultures being obtained on a medium composed of egg-yolk. It will grow readily on serum and blood agar, and glucose agar if a piece of rabbit spleen be added thereto.

Pathology.—In animals, nothing characteristic is found. At the site of inoculation some diffuse necrosis may be seen, and occasionally swelling of the corresponding lymph glands. The spleen, liver, lungs, and kidneys may show small necrosis areas. Human cases contracted in the field, probably from some blood-sucking fly, will show a local ulceration at the site of the bite, with swelling, and possibly suppuration, of the local lymph glands. Cases contracted in the laboratory provide no pathological data, for there is no evidence of the portal of infection, and the blood shows no characteristic changes.

Symptoms.—Sudden onset of fever, up to 103°, with marked malaise and no localising symptoms, in the case of laboratory workers with *B. tularense*, suggest the initiation of serological tests with specific antigen. The temperature subsided at the end of 3 weeks in the American series of cases, but it remained up for a longer period in the London series, and in one case there were irregular rises of temperature for a period of a year. The marked

features of the majority of the cases were the malaise, the recurrent nature of the fever, and the prolonged inability to work.

Diagnosis.—In endemic areas people handling rabbits and other rodents, who develop fever, with or without localising signs of insect bites, should be under suspicion. In this country, only laboratory workers could possibly be infected. In either case, the diagnosis depends upon specific agglutination to *B. tularense* antigen. Very definite agglutinations were noted towards the end of the second week after the commencement of the disease, and the titre rose rapidly and remained high during the long convalescence.

Prognosis.—This appears to be of about the same order as that in Malta Fever. The disease is not fatal, but causes a long period of inability to work.

Treatment.—No account is given of any attempts to confer immunity, either prophylactic or phylactic, and the treatment would appear to be one aiming at rest, with measures to counteract the anæmia that tends to supervene.

JOHN MATTHEWS.
THOMAS HORDER.

B. THE MYCOSES

Numerous fungi are pathogenic to man, and the lesions caused thereby are conveniently described as the mycoses. The classification of these fungi is as yet somewhat confused, though five main families may be recognised. These with their chief genera and the lesions caused thereby are indicated in the subjoined table.

TABLE OF FUNGI PATHOGENIC TO MAN
(MODIFIED FROM BESSON)

Family.	Genera.	Causing
I. HYPOMYCETIDÆ	1. Discomyces. (Nocardia.)	(*a*) Actinomycosis (*b*) Mycetoma.
	2. Malassezia.	Tinea versicolor.
	3. Trichosporum.	Trichosporosis.
	4. Coccidioides.	Dermatitis.
	5. Sporotrichum.	Sporotrichosis.
	6. Oidium.	(Thrush.)
II. MUCORACIDÆ	1. Mucor mucedo.	Pulmonary mucormycosis.
	2. Mucor corymbifer.	Auricular and pulmonary mucormycosis.
	3. Rhizo mucor.	Pulmonary rhizo-mucormycosis.
	4. Rhizopus nigricans.	Mouldy-food poisoning.
III. GYMNOASCIDÆ	1. Trichophyton.	The ringworms.
	2. Epidermophyton.	Tinea cruris.
	3. Microsporum.	Juvenile ringworm.
	4. Achorion.	Favus.
IV. PERISPORACIDÆ	1. Aspergillus.	Aspergillosis "Pinta."
	2. Sterygmatocystis.	Otomycosis.
	3. Penicillium.	Otitis.
	4. Lepidophyton.	Tinea imbricata.
V. SACCHAROMYCETIDÆ	1. Endomyces.	Thrush.
	2. Saccharomyces	Myxomatous tumours.
	3. Cryptococcus.	(*a*) Blastomycosis. (*b*) Histoplasmosis.

Some of the diseases mentioned in this table, for example the ringworms, are described in other sections. Six of them will be described here—actinomycosis, mycetoma, sporotrichosis, aspergillosis, blastomycosis and histoplasmosis, the lesions of which are of the nature of infective granulomata.

ACTINOMYCOSIS

Synonym.—Ray-fungus Disease.

Definition.—A local infection, tending to become general, due to the *Streptothrix actinomyces*, producing granulomatous lesions chiefly in the jaw, skin, lung and digestive tract.

Ætiology.—*Actinomyces bovis* was first described by Böllinger in 1877 as the micro-organism producing large, hard, sarcomatous masses occurring about the jawbones of cattle, and in the following year Isaack and Wolff found the same organism in human cases.

The characteristic of the disease is a suppurative lesion, the pus from which contains visible granules which, examined microscopically, are seen to have a centre of a closely meshed filamentous network, with a border of radially arranged striations, often ending in club-shaped bodies. Formerly these club-shaped bodies were thought to be spores, but they are now regarded as hyaline thickenings of the sheaths of the threads. The clubs are only found in preparations made from pus from active lesions, or in cultures on media in which serum or blood is employed.

It is essential in examining suspected pus to isolate a granule. If granules be not readily detected in the wound or in the pus, Colebrook has pointed out that if pus be vigorously shaken in a tube of water the granules, not being emulsified, will sink to the bottom and may be removed by a pipette. Microscopical examination is very much facilitated by crushing the granules between two slides. The mycelial filaments retain Gram's stain, while the clubs lose it and take the counter-stain. Culture is in any case difficult, depending to a large extent on the amount of secondary infection. To eliminate this as far as possible the granules should be well shaken in a sterile saline solution, and then after crushing between sterile slides should be sown on to glucose agar plates which are incubated anaerobically, or crushed granules may be shaken up into melted glucose agar which is aspirated into long sterile tubes according to the method of Vignal. Numerous subcultures may be necessary to complete the isolation of the organism.

Mode of invasion.—Till recently the view has been held that actinomycosis was conveyed to cattle and man from vegetable sources. Colebrook, in a review of 28 cases coming under his observation, brings forward strong reasons for believing that the fungus may be present under normal conditions in the alimentary tract. He quotes Lord as finding similar organisms in carious teeth and tonsillar crypts, and himself found not dissimilar filamentous organisms in each of six carious teeth examined. He has also shown that the serum of heavily infected patients causes agglutination of suspensions of actinomyces, as also does the serum of inoculated rabbits. The same observer supports the observation of Klinger as to the frequent association with actinomyces bovis in actinomycotic lesions of a minute Gram-negative cocco-bacillus, to which Klinger gave the name of *Bacillus*

actinomycelium comitans. The significance of the association is not known.

Symptoms.—These depend upon the anatomical distribution of the granulomata.

1. *The jaw and adjacent structures.*—When the infection occurs in these parts the patient presents a swelling very like a sarcoma, generally about the angle or ramus of the mandible. The swelling may, however, affect the submandibular tissues and lymph glands rather more than the jaw itself, and one of the writers has recently seen a case in which the lesion was confined to the glands. The swelling is tender, somewhat painful, and not generally so hard as in sarcoma. It may show one or more spots of softer consistency than the rest of the lump. In most cases there is no obvious source of infection inside the mouth; the assumption is—in the light of observations quoted above—that the avenue of invasion is a carious tooth, or the gums and peri-odontal membrane.

2. *The intestines; appendicitis.*—The favourite site of infection is the cæcum and appendix region. The disease manifests itself either as an attack of appendicitis, most often acute, in which case the diagnosis is made only at the time of laparotomy; or as a slowly growing lump in the right iliac fossa, with some pain, tenderness, and constitutional disturbance, in which case suspicion may be aroused as to its nature, if it be remembered that this region is a site of election for the ray fungus. There is a tendency for the infection to spread from the ileo-cæcal region—(*a*) to the adjacent *peritoneum*; (*b*) to the *abdominal wall*; (*c*) to the *liver*. For this reason it is rare to find the lesion confined to the appendix by the time operation takes place. For this reason, too, the first evidence of cæcal infection may be the involvement of the parietes in the lower right quadrant of the abdomen, in which case there is always a probability that the infection has spread from the bowel. The *liver* is sometimes involved alone, that is, without obvious intestinal infection. The disease is only to be distinguished from abscess by puncture or by free incision.

3. *The pleura and lung.*—Actinomyosis in these tissues is by no means rare (see section on Respiratory System, pp. 1114, 1163), and the disease should constantly be borne in mind by the practitioner when faced with an obscure case in which indefinite physical signs appear at one base, with cough, fever and (not seldom) hæmoptysis. In some cases a fairly frank pleuritic effusion appears, and the bacteriological examination of the exudate reveals the nature of the disease. In other cases the clinical picture resembles a basal tuberculosis. As the disease progresses the differential diagnosis lies between ray fungus, bronchiectasis and new growth. Hæmoptysis which recurs in the absence of any evidence of tuberculosis in an obscure case of pulmonary disease, is highly suggestive of actinomycosis of the lung. The later stages of the disease still resemble pulmonary tuberculosis: wasting, intermittent fever, purulent expectoration, cough and physical signs of progressive lung infiltration with destruction.

4. *The skin.*—Granulomata sometimes appear in the skin and subcutaneous tissues (*a*) alone, or (*b*) complicating the disease in deeper structures.

(*a*) The neck and scalp are the parts most often affected. The initial lesion is a rounded swelling, not very acute, and therefore resembling a tuberculoma rather than the result of a pyogenic infection, but usually firmer

in texture and larger than the lesion seen in tuberculosis of the skin. It has therefore to be distinguished from sarcoma and from gumma. As the lesion progresses it involves the subcutaneous tissue and tends to ulcerate, after the appearance of one or more soft and dusky-red areas on it. When ulceration occurs at these points, pus escapes, and this contains the tell-tale granules characteristic of the infection. At this stage the appearance is not unlike that of a chronic carbuncle or a suppurating gumma. Ultimately the skin "breaks down" over a considerable area of the swelling, and a chronic ulcer forms, which discharges freely.

(*b*) Similar skin lesions appear not seldom in association with primary infections of deeper structures, these superficial deposits having the significance of metastatic pyæmic deposits.

5. *The brain.*—The brain, like the skin, may be infected by direct spread from an adjacent lesion, or it may suffer by way of a general pyæmic process. In a case under the observation of C. E. West and one of the writers a chronic otitis media was complicated by granulomata in the scalp, from which the streptothrix was demonstrated in films and grown in tubes of blood-broth. Cerebral symptoms developed, and the patient died comatose. At the post-mortem examination a large abscess was found in the centrum ovale of one hemisphere, and the mycelial threads were found in the pus in considerable numbers.

Diagnosis.—Hints have been given in the preceding account relative to the differential diagnosis from tuberculoma, sarcoma, pyogenic infection and gumma. *The chief reason why actinomycosis goes unrecognised is that the possibility of its existence is overlooked.* All materials from a suspected case (pus, pleural exudate, sputa, material from liver puncture, excised lymph glands, etc.) should be carefully examined for mycelium, and the bacteriologist should have his attention drawn to the possibility of its presence. Sputa from a case of recurring hæmoptysis, in which a negative report in respect of tubercle bacilli has been returned on several occasions, have been found to contain threads of actinomyces when the necessary investigation has been specially asked for.

Course and Prognosis.—Although these vary much, there is, as may be inferred from remarks already made, a tendency for ray-fungus infection to become pyæmic in character. It is this feature which gives the serious note to prognosis in all cases. In lesions about the jaw and in skin infections that are primary and not associated with visceral infection, the outlook is not nearly so bad as when the lungs, liver or intestinal tract are involved, and when the skin lesions are multiple and secondary. Early diagnosis, if possible before secondary infection (usually staphylococcus) has taken place, adds greatly to the chance of recovery. One of the most important points in connection with prognosis is the uncertainty as to the complete extirpation of the fungus after treatment has been apparently successful. Recurrences are common, and must be allowed for in any thorough programme of treatment.

Treatment.—So soon as the diagnosis is made, the question should be raised whether or not radical surgical measures are practicable. If they are they should be pursued without delay; any abscess or infected area should be drained, or incised and freely curetted; infected lymph glands should be excised; doubtful teeth should be sacrificed. The exhibition of

potassium iodide in full doses should follow these surgical measures, or should take their place in all cases in which they are for some reason impracticable. In some cases it is reasonable to try the patient's response to iodine before planning operative measures. The drug should be given freely diluted with water, and it should be gradually increased from an initial dose of 30 grains in the day to 60 grains, or even to 120 grains if this amount can be tolerated. *If recovery takes place the iodine treatment should be renewed for certain periods now and again to guard against relapses.*

Vaccine therapy has been attempted in a few cases; the nature of the infecting agent imposes great practical difficulties; if secondary infection by staphylococcus be present inoculation against this microbe should certainly be adopted as a supplementary measure. (See Immune Therapy, p. 42.)

THOMAS HORDER.
JOHN MATTHEWS.

MYCETOMA

Synonyms.—Fungus Foot; Madura Foot.

Definition.—A chronic granulomatous condition affecting the feet, hands, face and sometimes the limbs and internal organs, characterised by swelling of the parts, with the presence of fistulous openings from which an oily, purulent fluid exudes.

Ætiology.—The disease is endemic in different parts of India, but has also been met with in the Sudan, Egypt, Cochin-China, Senegambia, the United States and South America. It is found in country districts, not in towns, and chiefly attacks those who go barefooted. It is thus generally confined to natives, and all ages and both sexes are liable. It is caused by a fungus, the old *Streptothrix maduræ*. Brumpt has now, however, divided up the mycetomas into 8 different varieties, under different generic names. Some of these are due to species of *Discomyces* (*Nocardia*), others to *Aspergillus* itself or to sub-divisions of it, namely, *Madurella* and *Indiella*. White, red, and black varieties occur clinically.

Pathology.—On section of the affected part the tissues are found to be soft like jelly, and oily. These greyish-yellow, or greyish-red jelly-like masses contain cystic dilatations from which fistulous tracts pass, either into the tissues, or externally, and open through the skin. Both the cysts and sinuses are full of the fungus, which macroscopically appears as white masses like fish's roe, or in other cases as black agglomerations or grains, while in yet another variety the bodies are of a pinkish colour. The bones, fasciæ, tendons and muscles are ultimately destroyed. Microscopically, the mycelial structure is easily recognised in the white masses.

Symptoms.—The invasion of the fungus takes place through small cuts or abrasions. Once inoculated, the parasites proceed to grow, forming one or several hard nodules in the subcutaneous tissues, usually on the sole of the foot. After several months they ulcerate through the skin and discharge the characteristic contents described above. More nodules then appear in other regions of the affected part, which begins to enlarge permanently, and finally becomes studded with discharging sinuses, out of which an oily, foul-smelling, semi-purulent fluid exudes. There is no special pain, but

if the foot be affected, locomotion is restricted or greatly impeded. Though the foot is the usual site of the lesion, the hand and other parts of the body may also be attacked. The general health remains good at first, but finally anæmia and cachexia appear.

Diagnosis.—This can easily be made by finding the characteristic fungus. The differentiation of the different genera and species requires laboratory facilities.

Prognosis.—This is bad, and if the disease be untreated it will finally kill the patient.

Treatment.—The parasite in nature evidently lives on grasses or other plants, therefore walking with bare feet should be avoided. If one or two nodules only be present, these should be freely removed. When the foot is seriously affected it should be amputated, remembering to make the incision well away from any diseased tissue, as otherwise recurrence is sure to take place. Potassium iodide may be tried internally, and should be pushed.

Recently Audrain claims to have cured a case with intravenous injections of mercurochrome (10 c.c. of a 1 per cent. solution) and neo-arsphenamin 0·75 gramme, these being given on alternate weeks—the course consisted of 18 injections of each. There is no definite proof, however, that the case was a genuine one of Mycetoma.

G. CARMICHAEL LOW.

SPOROTRICHOSIS

In this disease, which is much less common than actinomycosis, lesions (granulomata) appear in the skin and rarely in the muscles and bones.

Ætiology.—The *causative microbe* was first described by Schenk in 1898. Two varieties, *Sporotrichum schenki* and *S. beurmanni*, were originally described, but are now generally regarded as identical. The organisms occur in pus as oval or fusiform spores, and grow in culture as colourless branching septate mycelium, with clusters of brown fusiform spores on the ends of the filaments—occasionally the spores are arranged round the filaments. They stain well with the aniline dyes, but irregularly with Gram's stain. Growth occurs under aerobic conditions only, and on ordinary laboratory media. Cultures are best made from closed lesions, which should be punctured with a wide-bored needle, and the material aspirated should be thickly sown on glucose agar plates, which should be kept at laboratory temperature. The colonies, which appear in from 4 to 10 days, are very characteristic. At first white, thick and leathery, they later become convoluted and coffee-coloured, and still later may become black. Laboratory animals, especially mice and rats, are susceptible, the lesions resembling those in man; but the disease is seldom fatal. The serum of infected individuals agglutinates the spores of the organism, and specific immune bodies can be demonstrated by complement-fixation tests.

Symptoms and Diagnosis.—See p. 1340.

Treatment is on the same lines as described for Actinomycosis.

ASPERGILLOSIS

Infections with aspergillus, usually *A. fumigatus*, have been observed in the middle ear, and on abraded corneæ, as well as in the lung. The organism of the group of Ascomycetes, grows on ordinary laboratory media, and frequently occurs as a contamination.

The cases of *lung infection* are not very rare (see p. 1115). They resemble cases of chronic pulmonary tuberculosis very closely; indeed, they are generally mistaken for this disease until investigation of the sputa reveals their true character. In most of the cases described there has been a history of previous bronchial or pulmonary disease of a chronic kind; the fungus infection is therefore to be regarded as secondary. The *course* and the *treatment* of pulmonary aspergillosis are those of the disease it so closely resembles.

THOMAS HORDER.
JOHN MATTHEWS.

BLASTOMYCOSIS

Definition.—Invasion of the tissues by yeast-like organisms either locally or in a generalised form.

Quite a large number of peculiar pathological conditions have recently been listed, as due to yeast-like bodies or blastomycetes. The parasites multiply in and destroy the tissues, in many instances leading to the death of the host. The fungi implicated have been ascribed to the genera *Saccharomyces*, *Coccidioides*, *Oidium*, *Monilia* and *Cryptococcus*. Warty growths, minute abscess formation and ulceration are the commoner types of lesion observed.

Symptoms.—Clinically the following types have been described. 1. *Cutaneous type.*—This may attack the lips or nose, and may remain local, with no great inclination to spread. 2. *Oral blastomycosis.*—Here the infection attacks the mouth, and spreads gradually to the hard and soft palate, and then to the pharynx, nose and larynx. The lesions, at first verrucous and papillomatous in type, eventually ulcerate, and when extensive cause the death of the patient. 3. *Coccidioidal granuloma.*—As a rule, the lesions of this form appear on the skin surfaces first, or in the subcutaneous tissues, small warty growths appearing with small epidermal or subdermal abscesses, and then the parasites spread to the inner viscera, the infection becoming general. In the affected tissues the parasites can easily be demonstrated. 4. *Gluteal blastomycosis.*—The fully developed condition shows a diffuse brawny thickening of the skin of the buttocks, with sinuses leading into the deeper tissues, some of these communicating with each other and passing deeply inwards. A thin pus exudes from the openings with no grain-like bodies in it, as in actinomycosis. Maxwell's fistulous disease of the buttocks is probably this disease. 5. *Pulmonary blastomycosis.*—Darling has described a series of cases in Panama of a blastomycotic condition of the lung, under the name of histoplasmosis. Post mortem the lungs were studded with nodules like miliary tubercles. These areas contained many yeast-like bodies named by Darling *Histoplasma capsulatum*. The symptoms clinically were anæmia, enlargement of the spleen and fever.

Diagnosis.—This is made by finding the specific organism, and also in some instances by a process of exclusion. The lesions, at the onset, are generally mistaken for tubercle or syphilis, and these conditions must be excluded by clinical and other tests. Oral blastomycosis can easily be mistaken for Espundia or Uta conditions due to *Leishmania americana*. The presence of the Leishmania will settle the point.

Prognosis.—This, on the whole, is bad. All the forms are very chronic and little influenced by treatment. The coccidioidal granuloma and pulmonary blastomycosis are always fatal.

Treatment.—Iodide of potassium in large doses is usually recommended. X-rays have been tried, and for local foci of infection, antiseptics of various sorts. Surgical removal, if the lesions are seen early, and strictly limited, may suffice. Small cuts and abrasions should always be attended to, and carefully cleaned, with carbolic or other antiseptic.

HISTOPLASMOSIS

Definition.—A peculiar condition, probably a blastomycosis, found in natives in Panama.

Ætiology.—The parasite named by Darling, its discoverer, *Histoplasma capsulatum*, is now generally supposed to be a yeast akin to a *Cryptococcus*.

Symptoms.—Darling observed the disease in a Chinaman and two negroes in Panama. The malady was associated with an irregular temperature, wasting, anæmia and enlargement of the spleen.

Pathology.—The lungs were studded with small nodules like tubercle. No tubercle bacilli were, however, found, but instead small bodies about half the size of a red blood corpuscle, with what appeared to be a small nucleus. They resembled Leishmanial parasites in some ways, but had no definite kinetonucleus. As already stated, they are now considered to be yeasts, and the disease really to be an internal blastomycosis.

Prognosis.—All the cases seen died.

Treatment.—This would be on the lines of blastomycosis generally. Potassium iodide might be tried.

G. Carmichael Low.

C. SPIROCHÆTAL INFECTIONS

SPIROCHÆTOSIS ICTERO-HÆMORRHAGICA

This form of jaundice was first differentiated by two Japanese workers, Inada and Ido, in November 1914, who made a full investigation into the ætiology, symptomatology and pathology of the disease. In September 1916, Capt. A. Stokes, R.A.M.C., and Capt. J. A. Ryle, R.A.M.C., published an account of several cases which they carefully investigated amongst our troops in Flanders, and later, in January 1917, they published a further account of their work. Lord Dawson, Lieut.-Col. Hume, R.A.M.C., and Capt. S. P. Bedson, working independently, published in September 1917 a very

complete account of their observations on cases occurring in the army in France. During the past six years this form of jaundice has been closely studied in various parts of the world, and most careful investigations have been made. Thus, in the French army, the disease was found by Martin and Pettit, who published an account of it in October 1916, and have made several further contributions. Investigations on similar lines were made in the Belgian and Italian armies.

Definition.—An acute febrile disease in which jaundice usually appears about the fourth or fifth day, and associated in severe cases with hæmorrhages from the nose, lungs, stomach or bowel, or a purpuric rash. It is caused by a specific spirochæte.

Ætiology.—*Infection.*—The occurrence of the disease in rats has also been closely studied on the Continent, in Japan, America, etc.; and in March 1918, Dr. A. E. Coles found on examination of rats at Bournemouth that 9 per cent. were infected with the specific spirochæte—Spirochæta (Leptospira) ictero-hæmorrhagica. It seems probable that infected rats by means of their infected urine contaminate the soil and water in the locality, and by this means infection is conveyed to man. During the Great War the disease appeared endemic in rat-infested wet trenches. Dogs are susceptible to infection with the spirochæte, causing jaundice, and it has been stated that this organism is the common cause of Canine Jaundice. It has not been proved that the disease is conveyed by the consumption of infected food or water, and infection from patient to patient in hospital does not usually occur. Any race may be infected. The disease does not appear to occur in tropical countries, but is associated with temperate climatic conditions and damp.

Pathology.—In three cases described by Dawson, marked evidence of duodenitis and intense inflammation in the area round the ampulla of Vater were found. Stokes did not mention the occurrence of duodenitis in his fatal cases. Both observers describe the bile-duct as being free from inflammatory changes to the naked eye. The liver showed usually few abnormal changes macroscopically, but on microscopical examination some cases showed evidence of cellular degenerative changes. In one case described by Dawson, the liver was diminished in size, its capsule wrinkled, and microscopically there were numerous areas of cell necrosis; in other words, a condition of acute yellow atrophy was found. The condition of acute yellow atrophy in fatal cases of spirochætosis ictero-hæmorrhagica is apparently uncommon, death usually resulting from the toxæmia of the disease rather than from auto-intoxication consequent on acute yellow atrophy. The kidneys showed in all cases some degenerative changes of the epithelial cells. In some, there was evidence of a nephritis which in a certain number was hæmorrhagic in character. In none of Dawson's or Stokes' cases was any enlargement of the spleen found.

The scarcity in number of organisms present in infected patients makes it necessary frequently to resort to guinea-pig experiments in order to discover the spirochæte. The guinea-pig is extremely susceptible to the disease, and the introduction of infected material into the intraperitoneal cavity is followed, after an incubation period, by a rapid development of typical symptoms, associated with a heavy infection, so that it is easy to demonstrate the spirochæte. In man the blood infection is of short duration, and after the fifth day of the disease, the chances of a positive result diminish.

The infection, as already mentioned, is not a heavy one, so that blood film examinations are usually negative. Introduction of some of the blood (3 c.c.) into a guinea-pig intraperitoneally is likely to give a positive result up to the seventh day of the illness.

The urine, from the tenth day to the fifth week, usually contains spirochætes, and the centrifugalised deposit may yield a positive result on microscopical examination, or a portion injected into a guinea-pig may reproduce the disease in it. The spirochæte obtained from the urine is agglutinated by the blood of the patient after the fourteenth day of the disease. After the fourteenth day of the disease, protective substances conferring immunity are found in the blood, and an immunity test with guinea-pigs was described by the Japanese workers.

Symptoms and Course.—Dawson gives the following account: "The disease has more often a sudden than a gradual onset, and manifests itself by shivering, head and body pains, great prostration, vomiting and diarrhœa. The temperature rises quickly to 102° or higher. During the succeeding 3 or 4 days the conjunctivæ become injected, and herpes, which is liable to become hæmorrhagic, appears on the lips in about 40 per cent. of the patients. Bleeding occurs in most of the severe cases, but uncommonly in the mild cases. It may come from the nose, lungs, stomach, bowel, or as a purpuric rash. Early in the illness a slight hæmoptysis is a valuable diagnostic sign. It is to be noted that hæmorrhage often precedes jaundice in order of appearance.

"The jaundice usually appears on the fourth or fifth day, but may be as early as the second, and as late as the seventh day. It reaches its height about the tenth to twelfth day. In some cases it is intense, and the skin takes the greenish hue met with in complete obstruction of the common bile-duct. Constipation is marked. The stools may become clay-coloured, though in most cases a small quantity of bile gives them a light brown coloration. Tenderness in the upper abdomen is usual. The tongue is furred and brown. The liver is frequently enlarged to the extent of two or three fingers' breadth below the costal margin. The spleen is not palpable. The glands in the axillæ and groins are sometimes enlarged and shotty. In severe cases there are evidences of an acute bronchitis. The respiration rate may rise to 28 or 30, and when a fatal result is impending may resemble that met with in uræmia. The pulse is slow in proportion to the pyrexia, a rate of 75 to 85 being quite usual. In this respect the disease resembles enteric fever, though differing from the latter in that the heart does not block with atropine. The systolic blood pressure is about 120 mm. Hg, being higher than that of enteric fever. The early weakness and prostration are characteristic of the disease. Frontal headache and aching behind the eyeballs are distressing symptoms of the commencement, but diminish as the days pass. The muscular pains last longer, and are at times intense. Twitchings and convulsions may precede or accompany the coma of the fatal cases.

"The urine contains bile in abundance, which may persist for 4 to 5 weeks. Albumin is usually present, and may reach a sixth; casts—hyaline, epithelial and granular—are common. Some French authors lay stress on the evidence of renal insufficiency.

"The course of the illness varies with the severity of the disease. In the acute case an irregular type of pyrexia persists for 10 to 14 days and ends by

lysis. In some instances there is a secondary rise of fever about the beginning of the third week which is difficult to explain, since there is no accompanying exacerbation of symptoms or increase of jaundice. The jaundice will reach its height about the tenth day, and this often coincides with the fall of the temperature. In other cases the temperature will fall earlier while the jaundice is still deepening. Convalescence is slow but recovery is complete."

It is interesting to note that spirochætosis ictero-hæmorrhagica may occur without jaundice. Stokes stated that in 100 cases examined by him, jaundice occurred in only 60 per cent.

Diagnosis.—A comparison of the symptoms of spirochætosis icterohæmorrhagica with those of epidemic catarrhal jaundice renders it perfectly clear that the two diseases are quite distinct. In epidemic catarrhal jaundice, the low mortality, the premonitory period of several days before the onset of pyrexia, the absence of herpes and hæmorrhagic symptoms, the absence of symptoms of severe toxæmia, and the common occurrence of splenic enlargement are prominent distinguishing features.

Prognosis.—The Japanese workers found a high mortality in their cases —about 30 per cent. Stokes [1] put the mortality figure of his cases as less than 6 per cent. Dawson estimates the mortality as not more than 4 to 5 per cent. in his series.

Treatment.—This is on the lines of epidemic catarrhal jaundice (p. 311). No specific treatment appears to be of value.

W. H. Willcox.

RELAPSING FEVER

Synonyms.—Spirochætosis; Febris Recurrens; Spirillum Fever; Famine Fever; Seven-day Fever.

Definition.—A specific fever, characterised by relapses, due to a spirochæte (spironema) and spread by lice.

Ætiology.—The disease occurs in many parts of the world; it is rare in England, but common in parts of the Continent. In India, Algiers, Cochin-China and in the United States it also occurs freely. All ages are liable and both sexes. The cause of the disease is a spirochæte, and it is customary at the present day to divide the infection into a number of varieties. (1) European relapsing fever, due to the *Treponema recurrentis* (the old spirillum of Obermeier). (2) Asiatic relapsing fever, to *T. carteri*. (3) American relapsing fever, to *T. novyi*. (4) North African relapsing fever, to *T. berberum*. (5) Central African relapsing fever (Tick fever), to *T. duttoni*.

In addition to these human varieties there is a fowl spirochætosis due to *T. gallinarum*, this disease, as is also African tick fever, being spread by ticks, while the other varieties are all spread by lice.

Pathology.—The treponemata evidently give off toxins, which, acting on the cells of the organs, produce changes similar to those resulting from other toxins. There are no very characteristic appearances met with after death in uncomplicated cases. If this has taken place during the paroxysm, the spleen is enlarged and soft, and the heart muscle, liver and kidneys show cloudy swelling. Infarcts may be found in the kidneys and spleen, and ecchymoses in various parts of the body.

[1] *Lancet*, January 27, 1917.

European Form.—**Symptoms.**—The incubation period varies between 2 and 12 days. In accidental inoculations 7 days has been the rule. During this period slight prodromata may occur. The invasion is sudden, with a rigor, and intense pains in the back and limbs. In young persons especially, there may be nausea, vomiting and convulsions. The temperature rises rapidly, reaching 104° F. on the evening of the first day; the pulse is rapid; there may be delirium and sweating; the spleen is enlarged, and, in some epidemics, jaundice is a marked symptom. After the fever has persisted for 5 or 7 days the crisis occurs, the temperature in a few hours falling to normal, accompanied by profuse sweating and diarrhœa. Convalescence is now rapid, and the patient feels well in a few days. In a week, however (the fourteenth day from the commencement of the illness), the temperature rises and the attack is repeated. The second crisis takes place from the twentieth to the twenty-third day, and recovery is again rapid. This usually terminates the illness, but in some instances second or even third relapses are seen.

The parasites are present in the blood during the attacks, but are absent in the apyrexial intervals. Lice become infected by sucking the blood. The treponemata finally appear in the cœlomic fluid and nowhere else. During the scratching, which takes place in louse infection, some of the parasites are crushed, and the contents of their cœlomic cavities are scattered on the skin, the treponemata entering through the bites of the parasites, *e.g.* contaminative method of infection (Nicolle, Blaizot, and Conseil).

Complications and Sequelæ.—These are not specially frequent. In some epidemics hæmatemesis and hæmaturia have been noted. Pneumonia may occur. The enlarged spleen has been known to rupture. Ophthalmia and post-febrile paralysis have also been reported. Abortion usually takes place in pregnant women.

Diagnosis.—This is made by finding the specific parasite in the blood. If blood examinations have not been made, the first paroxysm might be missed, but the relapse in 7 days should then reveal the true nature of the trouble.

Prognosis.—Death is not very frequent in the European form, Murchison putting the mortality at 4 per cent. During famines, however, it is much higher, and in some of the varieties in Cochin-China and India it may reach as high as 30 to 40 per cent.

Treatment.—Avoidance of the bites of lice prevents the disease. Salvarsan or neosalvarsan (novarsenobillon) is now generally employed. It may be administered in doses of 0·4 gramme for a man, 0·3 for a woman. As a rule one injection is sufficient, though in some cases a second is required. Apart from this, the disease should be treated by ordinary nursing, diet, etc. Collapse may occur at the crisis and will require stimulants, such as ammonia, strychnine, or digitalis.

Asiatic Relapsing Fever.—This is due to the *T. carteri*. The treponema has been experimentally inoculated into man. Monkeys are also susceptible, but not rats and mice. Clinically the symptoms resemble very closely those of the European form. Rigors are, however, not so common at the commencement, collapse is more frequent at the crisis and the relapses are generally more numerous. Varieties or types have also been described by Carter. (1) A short irregular remitting fever, and (2) the so-called bilious remittent fever or icteric fever of Carter. The parasite is distinguished from *T. recurrentis* and *T. novyi* by immunisation and agglutination tests.

The mortality is high, somewhere about 18 per cent. The treatment is the same as for the European variety.

AMERICAN RELAPSING FEVER.—Due to the *T. novyi*. One relapse is usual in this form. The mortality is low, 2 to 6 per cent.

AFRICAN RELAPSING FEVER.—The fever found in Algiers, Tunis and Egypt is similar to the European, both in its symptoms and method of dissemination, namely, by lice. The form met with in the equatorial regions is different clinically in many ways, and further is transmitted by a bug-like tick, the *Ornithodorus moubata*.

CENTRAL AFRICAN RELAPSING FEVER.—**Synonyms.**—Tick Fever; Tete Disease. This form is found throughout British and Portuguese East Africa, Nyasaland, Uganda and the Congo Free State. The tick becomes infected by sucking the blood of an infected individual, and finally, according to Marchoux and Couvy, transmits the treponemata back to man by the salivary secretion. The ova become infected also, and thus the new generation hereditarily can pass on the disease.

Symptoms.—The period of incubation is usually 7 days. The bite may be accompanied by local inflammatory signs. Prodromata are present, mental heaviness, loss of activity, profuse sweating. The attack comes on gradually with malaise, vomiting and a slight rise of temperature. The temperature then increases, with headache, chilliness and severe pain in the region of the spleen. Vomiting continues, and there may be diarrhœa with streaks of blood. The spleen is enlarged, and scanty treponemata are now found in the blood. Finally, after three or four days, there is a crisis, accompanied by profuse and drenching perspiration. The patient feels weak and tired, but slowly regains his appetite and strength. The disease may end, or there may be an intermission of from 5 to 8 days, after which the first relapse appears. The temperature rises, and the original symptoms reappear. After lasting 3 or 4 days, there is another crisis, and then another period of remission. Second, third and even fourth relapses have been described. When they are prolonged, the patient is greatly weakened and becomes much emaciated.

Complications and Sequelæ.—Iritis is very common.

Diagnosis.—This has to be made from malaria, trypanosomiasis and other febrile conditions. The specific parasite should be demonstrated before diagnosing the condition.

Prognosis.—In Livingstone's time, many natives were reported to have died of the disease. Dutton and Todd also frequently saw fatal cases on the Congo, and the former of these two investigators died of it himself.

Treatment.—The Ornithodorus lives in the cracks and crevices of cow-dung houses, and it is therefore dangerous to sleep in such buildings. Destruction of all old mud rest-houses by fire and building of modern ones with cement floors would soon stamp out the disease as far as the European is concerned. The natives seem to have an immunity to the infection. Novarsenobillon injections will cut short the disease and effect a cure. Quinine is of no value.

Somaliland variety.—This form of tick fever is spread by another species of tick, the *O. savignyi*, which lives in the dust of market-places and encampments. It is therefore more difficult to avoid its bite than that of the *O. moubata*, which is bug-like in its habits and only bites by night. The form of the disease is similar to that just described.

BRONCHIAL SPIROCHÆTOSIS

Definition.—A chronic bronchitis associated with spirochætes in the expectoration.

Ætiology.—The condition is common in various parts of the tropics, cases having been reported from Ceylon, the West Indies, the Philippine Islands, West Africa and the Sudan. All races and both sexes are liable.

Castellani discovered the disease in 1905, and named the associated spirochæte the *Spirochæta bronchialis* in 1907. This organism, which is now known as the *Treponema bronchiale*, though resembling the mouth spirochæte, differs from it in several features.

Pathology.—There do not appear to be any records as yet of post-mortem examinations on the condition.

Symptoms.—Castellani describes three types of the disease—an acute, a subacute and a chronic variety.

In the first of these fever, cough, and pains all over the body are present. The expectoration is scanty and muco-purulent. In the second, the attack lasts for several weeks, there is little or no fever, while the expectoration may be pinkish in colour and contain blood. The third variety follows upon an acute or subacute attack, or the onset may be insidious and slow. There is a chronic cough, with scanty often blood-stained expectoration. True hæmoptysis is also seen. Sometimes there is no fever, but in other cases the temperature is hectic. Physical examination reveals a few dry or moist rales, with sometimes some dull areas. The sputum does not show tubercle bacilli, but plenty of spirochætes.

Diagnosis.—This must be made from tubercle and other forms of chronic bronchitis. The repeated absence of tubercle bacilli is important. The spirochætes can be found easily, the precaution of washing out the mouth carefully, always being adopted, to avoid contamination with mouth spirochætes. Paragonimiasis is distinguished by the characteristic ova in the sputum. Animal inoculations should also be performed for further exclusion of tubercle.

Prognosis.—This is good. In chronic cases there may eventually be anæmia and wasting.

Treatment.—In the acute cases the patient should be confined to bed and given some mild expectorant. Castellani reports good results from arsenic (Fowler's solution) in the subacute and chronic cases. Salvarsan or some of its derivatives, as novarsenobillon, may also be tried.

RAT-BITE FEVER

Synonyms.—Sodóku; Sokoshio; Rat-bite Disease.

Definition.—A chronic relapsing type of fever, due to a spirillum, the *Spirillum minus* (Carter), transmitted to man by bites of rats infected with the specific germ.

Ætiology.—The disease is common in Japan, and in Bombay, India; cases have also been reported from France, Italy, Spain, America, Britain

(Horder) and East Africa (Low). Any one unfortunate enough to be bitten by an infected rat is liable to acquire the infection.

The spirillum was isolated from rats in Japan, and also by the Japanese in human cases. It is almost certainly the real cause of the disease. At first described as a spirochæte by the Japanese, and known by the name of the *Spirochæta morsus muris*, it has recently been shown by Robertson to be the same as the *Spirillum minor* of Carter, the *Spirochæta muris* of Wenyon, etc., and if one corrects the gender of the specific name, should now read *Spirillum minus*.

Pathology.—The few post-mortem examinations made have not shown any significant changes.

Symptoms.—After being bitten, the wound heals up in an ordinary manner, but in from 2 to 6 weeks pain appears at the site of the old bite, and the scar breaks down. The lymphatics draining the area of the bite then swell and become inflamed, with enlargement of the glands of the area involved; a definite ulcer may now mark the site of the bite, with an angry inflammation spreading away from it, and small vesicles may break out around it. When this has continued for some time, general symptoms make their appearance; the temperature rises to 103° F. or over, there may be rigors, vomiting and nausea, with severe headaches, joint pains, diarrhœa and general malaise. A specific rash then usually appears, dusky coloured, purplish red spots or a coloured patchy erythema over the limbs, trunk and face, which lasts for some time and slowly disappears. After remaining high for 8 days or so, the temperature drops, and the symptoms generally ameliorate. In a varying period of time, however, the first relapse appears, with a return of the symptoms. This in turn disappears, only to be followed by further relapses, which in some of the reported cases have continued for months or even years. Considerable debility follows the attacks, and finally the patient may pass into a very poor state of health. A transient or permanent nephritis may result, and exophthalmos and paresis have been seen in some cases. Ultimately the infection tends slowly to disappear.

Diagnosis.—The history of the rat bite generally gives the clue to the diagnosis. Apart from that, the disease in some ways resembles syphilis, but the Wassermann reaction is negative. The relapsing nature of the disease with the specific skin lesions should clear up any difficulties in coming to a correct interpretation of the complaint.

Prognosis.—With modern treatment this is quite good. Previously it was not so, many cases continuing with chronic symptoms for years. A mortality of 10 per cent. has been given by some authors.

Treatment.—Salvarsan or some of its derivatives should be given, commencing with doses of 0·3 of a gramme. One or two injections are usually sufficient to abolish completely all the symptoms and bring about a permanent cure.

G. Carmichael Low.

SYPHILIS

A specific disease due to entry of a micro-organism (*Spirochæta pallida*) into the tissues, either by inoculation into the skin or mucous membrane (acquired syphilis), or by transmission *in utero* (congenital syphilis).

In acquired syphilis a primary sore usually develops at the site of inoculation, and may be followed after a few weeks by a succession of lesions of the skin, mucous membranes, subcutaneous tissues, arteries, muscles, bones, viscera and central nervous system, which recur again and again at varying intervals throughout the patient's life. After many years, degeneration of the parenchyma of the brain (general paresis) or of the spinal cord (tabes dorsalis) may develop. From an early stage changes in the blood serum can be detected by the Wassermann and a variety of flocculation tests. Any or all manifestations, even the primary, may be omitted. In congenital syphilis the systemic disease is the first manifestation.

Ætiology.—The specific micro-organism was discovered by Schaudinn in 1905 and named by him *Treponema pallidum*. Subsequently this was changed to *Spirochæta pallida*, but the original name still persists in some countries. *Sp. pallida* is a minute organism which in fresh specimens under dark-ground illumination appears as a bluish white, very delicate corkscrew. Its length varies from 5 to 24 μ (average 8 to 10 μ); the distance between individual coils is 1 μ, and the depth of each coil is 1 μ. It is very active in its own ground but slow in moving from place to place. It alternately contracts and expands its coils, bends into loops or forms itself into a right angle. It stains with considerable difficulty, the most usual methods employed being Leishman's or Giemsa's modification of the Romanowsky stain, which dyes it rose-pink, or some method in which silver nitrate is employed, such as Fontana's stain, by which it is stained black. It was first cultivated by Noguchi, who showed it to be an anaerobe. It has been demonstrated in every syphilitic lesion, including the brains of general paralytics, and its ætiological connection with syphilis has been proved experimentally on animals by Metchnikoff and Roux and numerous other workers. It has a life of only a few hours under natural conditions outside the body, and is killed at once by drying and by much feebler antiseptics than suffice to destroy ordinary pathogenic organisms.

The usual methods of transmission are by sexual intercourse and to the fœtus *in utero*. It does not seem necessary for a person transmitting the disease by intercourse to be suffering at the time from syphilitic lesions of the external genitals. At least, this appears to be the case when men convey the infection, and it is clear that often the semen contains the virus. The period during which a person suffering from syphilis is liable to convey the disease by sexual intercourse varies; after the second year the chances diminish, and it is unusual for infection to be passed on in this manner after the fifth year. There is no doubt, however, that infection can be transmitted to the fœtus by an infected mother up to a much later period, and there is, in fact, no limit to the length of time during which an infected mother may transmit the disease to her unborn child. Accidental infection results from contamination of any minute abrasion with secretion from a syphilitic lesion. The most dangerous from this point of view are the primary sore and the early secondaries. As the age of the infection increases, it becomes more and more difficult to discover *Sp. pallida* in the lesions, and although it is possible to infect an animal with secretion from later or tertiary syphilides, the chances of conveying the disease at this period by ordinary social intercourse are extremely slight. Even in the earlier stages, owing to the low resistance of the organism to external agencies, the risks of accidental infection by

ordinary social intercourse appear to be very slight, judging by the great prevalence of syphilis and yet the very low proportion of extragenital chancres.

Invasion of the tissues.—Although a number of days elapse before a visible lesion appears, within a very few days after infection histological examination of the tissues at the site of inoculation shows that changes are already commencing, and animal experiments have demonstrated that, by this time, the virus has spread throughout the body, infecting particularly the spleen, bone-marrow and testicles. Within the last few years, Kolle and Evers have shown that, after inoculation by scarification, the virus has reached the nearest lymph glands of a rabbit in half an hour, and those of a guinea-pig in 5 minutes.

Pathology.—Although the clinical appearances of syphilitic lesions differ with the age of the infection, the syphilitic lesion of every stage is histologically the same—a granuloma composed of an exudate of plasma cells and lymphocytes around the parasitic focus, with obliterative endarteritis of the vessels. Regarding the exudate as the reaction of the tissues to the toxins evolved by the virus, we may explain the differing clinical appearances which characterise the successive recrudescences of activity of the virus by the increasing sensitiveness of the tissues. Syphilis is characterised by alternate periods of activity and quiescence. In an uncured case the periods of quiescence are probably only apparent, as is shown by the fact that the blood serum gives the Wassermann and other characteristic serum reactions when no other signs of disease are manifest. It has to be remembered, however, that clinical examination does not by any means search all the structures in which the syphilitic organism can produce changes. Doubtless the balance of the struggle between the organism and the tissues rests in most cases with the latter, but the effect of the struggle on them is shown when the spirochætes temporarily gain the advantage in some spot (usually one where the tissues have been damaged or unduly strained). The response of the tissues is usually the greater the older the infection—*i.e.* the longer the virus has been acting on them. Thus, if secretion be obtained from —(i.) A primary sore the size of a pin's head; (ii.) a secondary papule when the infection was about 3 months old, and the same size or bigger; and (iii.) a large tertiary lesion, say 10 years old; in the first specimen a large number of syphilitic organisms would be found, in the second only a moderate number, and in the third probably none. Early in the disease, then, a large number of organisms produce only a small lesion, a little later a moderate number produce a moderate lesion, and still later a very small number produce a very large lesion. Histologically, all the lesions are the same; the difference is in their size and their subsequent course.

An important feature of the action of *Sp. pallida* is its effect on blood vessels. The pathology of syphilitic arteritis is discussed on p. 937. Here it may suffice to sketch the main general effects of syphilis on the vessels. The changes in the vessel wall may lead to aneurysmal dilatation, as in the case of the aorta and other large arteries of the body, and in the cerebral vessels. The aortic valve may be involved in syphilitic mesaortitis, with resulting regurgitation. Perhaps a more common result of syphilitic arteritis is thrombosis of the vessel, with important effects resulting from failure of the blood to reach the part supplied. Thus, endarteritis obliterans of the coronary arteries leads to myocardial degeneration; and closure of

cerebral and spinal vessels results in paralyses, varying from failure of one cranial nerve nucleus to complete hemiplegia or paraplegia, or death from failure of blood supplies to vital centres. Thrombosis of the vessels implicated in syphilitic lesions has also an important bearing on their clinical progress. Thus, in the case of primary lesions, it may result in failure of anti-syphilitic remedies to reach the parasite in the depths of the lesion, where it may reawaken months after all signs of the disease, even the blood reaction, have disappeared, and give rise to a lesion at the site of the primary sore (*recurrent chancre*). In tertiary lesions the cutting off of nutritional supplies to the centre and the action of the toxin lead to necrosis and liquefaction, but this is never so complete as in tuberculosis. This is seen in the clean-cut ulceration which often characterises tertiary syphilitic granulomata. If bone is involved in the tertiary gumma it may necrose throughout as in the flat bones, or only partially as in the long bones. Where necrosis does not occur, the granulomatous tissue of a syphilitic lesion tends to become more and more fibrous, though at the same time natural forces work towards its removal. There is, so to speak, a race between the two processes. If the amount of exudate is comparatively small, as in some primary and in practically all secondary lesions, the exuded cells may all be removed. If the exudate is a large one, a considerable proportion of it may reach the fibrous stage before the natural scavengers have had time to remove it. Thus many primary lesions are marked by scars of cartilaginous hardness for years afterwards, and gummata, their centres having liquefied, may be enclosed by dense connective tissue. Bone gummata, in fact, are often ringed by heaped up bone of ivory hardness.

Scarring from formation of fibrous tissue and its subsequent contraction may have important effects on viscera. For example, an active tertiary hepatitis may be stopped by suitable treatment, but the subsequent contraction of the scars may cripple the organ hopelessly. Similarly, the aortic valve cusps may be rendered permanently incompetent by the scarring following on stoppage of the syphilitic process.

The changes which occur when the parenchyma of the central nervous system is invaded are described elsewhere.

Incubation and early course.—The incubation period varies from a minimum of about 10 days to a maximum of about 90, with an average of 4 to 5 weeks. A small papule then appears at the site of inoculation, and quickly enlarges to a round or oval sore about the size of a threepenny bit; the centre usually becomes eroded, or perhaps more deeply ulcerated, and the broken surface is surrounded by a dull-red areola varying in width from half to 2 or 3 mm. Beyond the confines of the eroded area the tissues are infiltrated, feeling definitely tougher to the palpating finger than do the corresponding tissues on the other side of the part. With age this induration becomes more and more pronounced until, in the case of some primary sores, it feels as if there were a button embedded in the tissues. The sore does not bleed easily when scraped, but serum oozes freely from it, and this serum usually teems with syphilitic organisms. The sore is comparatively painless.

These are the main characteristics of all primary syphilitic sores, but individual features vary with the site. Thus the most indurated are those on the under-surface and mouth of the prepuce. In the case of a sore at the

reflection of the prepuce on to the *corona glandis*, when the prepuce is retracted, the lesion flicks over like a plate turning on its edge. A sore at the mouth of the prepuce often converts it to a fibrous ring. Induration is easy to elicit in sores affecting one wall of the *fossa navicularis*, which then feels as if a plate were embedded in it. In primary sores of the glans itself, induration is difficult to elicit owing to tightness of the tissues, but the sore is easy to recognise by its dull-red areola, even contour, eroded centre, and indolent progress. Primary sores of the skin are dark red, covered with a dark scab, and tough in consistency. Ulceration is usually more marked in sores affecting the mouth and under-surface of the prepuce, the skin at the penoscrotal angle, the tissues around the nails, the lips and the tonsils. Almost all primary sores are comparatively painless, but when affecting the terminal phalanx of a finger or thumb they may be exquisitely painful; this, no doubt, partly accounts for the fact that primary sores in this situation are so often diagnosed as whitlow. The primary sore affecting the prepuce, the skin of the penis, or (especially) the female labia may be accompanied by a toughly indurated œdema of the affected parts, which become somewhat livid.

The course of the primary sore varies greatly. In some cases the lesion is fleeting and apt to pass unnoticed. Such a sore is by no means an unmixed blessing, since its apparent triviality may lead to neglect of treatment, with the possible result that years later tabes or general paresis supervenes. The history of a substantial proportion of cases of tabes and general paresis is that the initial lesion was either unnoticed or was very trivial. It is possible that this may be due to the fact that the infecting organism is a spirochæte with no great capacity for causing lesions of the surface structures, but with a predilection for the parenchyma of the nervous system (neurotropic virus). On the other hand, the triviality of the sore may have led more certainly to the graver late manifestations because of neglect of treatment. The ordinary sore which remains untreated lasts for a month or longer, and long after the erosion has healed over, a button of indurated tissue may remain to mark the site. Syphilitic organisms have been found by histological examination of such scars many years later. Weeks or months after it has healed the sore may break down again, the resulting lesion approaching then more closely to the characters of a tertiary ulcer. It is probable that in these cases the syphilitic organism buried in the depths of the scar has gradually reawakened to activity. When a sore becomes infected by secondary organisms, ulceration is a more prominent feature, and in rare instances the ulceration is phagedenic. In such cases the surrounding tissues very rapidly become black and necrotic, and the resulting loss of tissue may involve large portions of the external genitals.

Shortly after the appearance of the primary sore the nearest lymph glands often become painlessly enlarged, and in the case of the penis the lymphatics running from the sore can frequently be felt below the skin. The affected glands may reach a large size, bulging out the overlying skin; and this, with the fact that there is no reddening of the skin or other sign of acute inflammation, often gives the clue to the nature of the sore on which it depends. Syphilitic buboes do not usually suppurate, but may do so if the sore has become contaminated by secondary organisms, so that suppuration should not weigh heavily against a diagnosis of syphilis. A week or so after the local lymph glands have begun to enlarge there is universal

adenitis, which can be appreciated by palpation, particularly of the epitrochlear, axillary and cervical glands. About this time, or when the sore is about 15 days old, the blood serum often for the first time gives positive Wassermann and other serum reactions, such as the Meinicke, Sachs-Georgi, Kahn, and Sigma of Dreyer and Ward. The last three depend on the flocculation which occurs after incubation for some hours of heated and diluted syphilitic serum with diluted extract of heart muscle prepared by special methods. The three flocculation tests mentioned here are, on the whole, more delicate with serum than is the Wassermann, but present indications are that the Sachs-Georgi and Sigma are less delicate with cerebro-spinal fluid. The percentage of cases in which the Wassermann and flocculation reactions are given increases with the age of the disease until the outbreak of the skin lesions which manifest the next or secondary stage. Practically 100 per cent. of patients in the secondary stage are positive.

Diagnosis of the Primary Stage.—The guiding characteristics by which primary syphilitic sores are distinguished from others are the incubation period, colour, indolence, surrounding infiltration, comparative painlessness, slighter tendency to bleed, indolent enlargement of neighbouring glands, and the presence of *Sp. pallida* in the serum exudate from the sore. The length of the incubation period is a guide only when the patient has not been exposed to infection for over 10 days.

Of sores which may appear on the genitals, herpetic lesions are multiple and fairly closely set, so that when the tops of the minute blisters have been rubbed off, a composite lesion is seen made up of a number of minute circles or of arcs of circles. Herpes is not accompanied by induration or enlargement of neighbouring glands, and is usually attended by some degree of irritation.

Chancroid has an incubation period of only a few days; the sore is of a more inflammatory nature, being undermined and more definitely ulcerated, rather than eroded; excavated, rather than worn down. The edge is much more irregular and is merely tipped with red, which is of a much brighter shade than the areola surrounding a primary syphilitic sore. A case should never be dismissed at once as chancroid, since there may be a double infection, and syphilis be incubating in the sore; unless a close watch is kept, the thickening and induration which develop later in a mixed chancre may pass unnoticed, and the physician receive a rude shock from the outbreak of a syphilitic eruption in a case which he has diagnosed as chancroid. A good rule is to continue microscopical examination at intervals until the sore heals and to test the blood for the serum reactions for 3 months. Chancroid may be accompanied by a bubo which tends to suppurate. A syphilitic bubo may, however, suppurate, so that it would be a mistake to exclude syphilis on the sole ground of suppuration. If the glands, though distinctly enlarged, showed no signs of active inflammation, it would be strong evidence in favour of syphilis.

Scabietic runs on the glans and skin of the penis are often diagnosed as syphilis. They are mound-like, not eroded, have no areola, are not indurated, and, of course, the serum exudate contains no syphilitic organisms.

Syphilitic sores in parts of the body other than the genitals are often overlooked, mainly because syphilis is not thought of in those parts. A unilateral tonsillitis should arouse suspicion, especially if associated with

painless enlargement of the submaxillary glands on one side. Similarly, the clue to the nature of a lip chancre may be given by the glands. Primary sores affecting the terminal phalanx of a thumb or finger are often extremely painful and simulate whitlows rather closely. The syphilitic sore is more brawny, and remains so considerably longer after the sore has been lanced.

In any case of doubt a specimen of serum should be taken from the sore and examined microscopically. This should be done before any antiseptics have been applied, as they kill off the organisms in the superficial layers and prejudice the success of the examination. To obtain a specimen which has to be sent away to a laboratory for examination, the sore should first be cleaned with a swab of lint and a fairly deep puncture made in its margin with the point of a scalpel or a vaccination lancet. The sore should then be squeezed and the specimen collected after the serum has oozed for a few minutes. The serum should be allowed to run into a capillary tube, only one end of which should be sealed. Alternatively a good method is to puncture the nearest enlarged gland and aspirate a little of the gland juice. A moderately stout needle is run obliquely into the gland, and a few minims of sterile saline injected into it. The gland is massaged and aspiration applied by a syringe. The fluid aspirated is forced into a watch-glass and collected in a capillary tube as above. It is always a good plan to send two or three specimens, as it often happens that the first specimen is negative, while the second or third taken some minutes later, when the serum has had an opportunity of oozing up from the deeper layers, is positive. Also it is good to remember that, just as a clinician would search longer a microscopical specimen from a sore which he believed to be syphilitic, so would the pathologist at a distance if he were told that the sore was strongly suspicious. The information cannot conjure the syphilitic organism into the microscopical field. When the necessary apparatus is at hand it is always better to examine the specimen at once by dark-ground illumination.

Spiral organisms other than *Sp. pallida* may be seen in a specimen obtained from the genitals or the mouth. They are largely eliminated by taking care to clean the surface of the lesion before collecting the specimen, but some may still be included. All coarsely spiral organisms which appear thick should be excluded at once. To the observer who has once observed *Sp. pallida* closely, only three others will cause difficulty:

A fairly fine spirochæte, with closely set spirals, often found in specimens from the genitals; it is about twice as thick as *Sp. pallida*, shines more brightly, has a slightly rusty tinge, and spirals which are by no means so cleanly cut as those of *Sp. pallida*. Two very fine spirochætes, found in the mouth, and both as fine as, or finer than, *Sp. pallida*. One is distinguished by the angularity of its turns, the other by its spirals being much more closely set, so that it looks like a piece of twisted silk.

Secondary Stage.—Usually, but by no means always, a generalised rash appears three or four weeks after the sore. The eruption generally starts on the sides of the trunk in the form of pinkish spots, varying in size from a split-pea to a little-finger nail, which deepen in colour with age to a dull-red or somewhat brownish tint. At first they may be difficult to see, requiring a good light, but become more manifest after the patient has stood stripped for a few minutes. The eruption spreads gradually over the trunk

and limbs, and fades in a few weeks, leaving little or no staining. It may recur at a later period, and the spots are then annular or ring-like.

After the fading of the first roseola, a peculiar change in the distribution of the pigment may occur, especially on the necks of brunettes. The neck becomes generally discoloured, or, more commonly, assumes a dappled appearance (syphilitic leucodermia), as if the pigment had been washed out of a number of circular areas, each about the size of the end of a finger-tip, and had collected at the margins.

The *papular* eruption follows closely on the heels of the roseolar, and takes a number of different forms. The commonest, and generally the earliest, consists of numbers of dome-shaped, dull-red, indurated papules distributed generally over the trunk, limbs and face. Most of them are about the size of a lentil, but scattered among the smaller papules may be a considerable number of others which are larger, sometimes reaching the size of a three-penny-bit. The individual papule feels indiarubbery, and when it is squeezed between finger and thumb appears glistening white, while its surface epithelium cracks slightly. Variations of the ordinary papular eruption are the papulo-squamous, squamous, papulo-pustular and pustular. In the *papulo-squamous* a large proportion of the papules are covered at their centres by loose scales. The *squamous* syphilide is a papular eruption in which scaling is a still more prominent feature. In the *papulo-pustular* syphilide the centre of the papule necroses, and the appearance is rather that of a suppurating acne spot. An extension of this is the form in which the whole papule breaks down, and the *pustular* syphilide results. When extensive, the pustular syphilide may resemble a varicellar or a variolous eruption. A more severe and malignant form is the ecthymatous type, in which the papule breaks down quickly, and the underlying tissues are eroded or ulcerated. As the destruction of tissue extends, the secretion dries to a crust. This may become heaped up by the deposit of successive layers, and the result is a blackish crust, shaped like a limpet (*rupia*).

Peculiar appearances of the papular syphilide in different situations.—Between the buttocks, on the lateral surfaces of the scrotum, and on the labia, the papular syphilide often becomes very prominent and wart-like, with a greyish-white appearance; these syphilides are called *broad condylomata*. The whole of the contiguous surfaces of the buttocks may be covered with these lesions, which may diffuse into a large, moist, wart-like plaque with a few outlying growths. On the front and back of the scrotum the papular syphilide often takes the form of glistening-white, slightly raised rings with brownish centres. These are best displayed by stretching out the scrotal skin as if it were a piece of cloth under examination. Between the toes, under the pendulant mammæ, and in almost all moist situations, papules tend to run together and, their sodden covering often becoming rubbed off, a moist, pinkish-red surface, fringed with loosened epithelium, is left. Condylomata and moist papules generally exude serum freely; the parts appear unnaturally moist, and the secretion is rich in *Sp. pallida*. On the palms and soles the papules appear as flat or slightly raised spots, varying in size from a split-pea to a sixpence. They scale easily, leaving a collar of loosened epithelium surrounding the shining papule, which feels almost corn-like. Sometimes the lesions run together into large plaques traversed by weeping fissures. The finger-nails may show characteristic

changes, more especially in the recurrent secondary stages. The end of the finger becomes pinkish-red and bulbous, and the reflection of the skin on the nail is occupied by weeping granulations. The nail becomes brittle and lustreless and is shed. The papular syphilide may be well marked on the forehead, following the margin of the hair (*corona veneris*), and it is often possible to find many papules in the hairy scalp. On other parts of the face, especially about the naso-labial fold and the chin, the papules are often set in rings. In some cases the facial lesions may be prominent, especially at a naso-labial junction, appearing as moist, fungating growths like condylomata. On account of its similarity to yaws this syphilide is called frambœsiform. When the papular eruption of the type under discussion recurs on the body it tends to be distributed in rings, as in the case of other types of recurrent syphilide.

The *follicular* or conical type of papular syphilide usually occurs at a later period than the dome-shaped variety just described. There are two main types, the small and the large follicular. The *small* follicular syphilide occurs in small clusters of minute, pin-head, brownish papules affecting the hair-follicles and often thickly distributed on the back. The affected areas, each about 1 cm. across, have a goose-skin appearance, and the part generally looks as if it had not been properly washed. The *large* follicular syphilide is usually disposed in circles the size of half a crown or larger, the centre of the circle being occupied by a particularly large papule, round which a ring of smaller satellites is ranged; this is the *corymbose* syphilide. It usually appears comparatively late, say about the end of a year or eighteen months, and its characters approach closely to those of the nodular cutaneous syphilide, to be discussed under tertiary lesions.

The syphilitic eruption in the mouth.—Before the rash appears on the body the soft palate may become erythematous, contrasting with the pallid hard palate. Other lesions of the mouth usually make their first appearance at the time of the papular syphilide of the skin. On the mucous surface of the lips and the pillars of the fauces the early syphilide is a greyish-white patch, edged with a pinkish-red areola, which marks it off from the surrounding mucous surface. On the pillars of the fauces the appearance is that of a snail-track creeping up over the pillar on to the soft palate. On the tonsil the lesion tends to ulcerate rather deeply. The mucous patch on the lip is usually round or oval and, if it crosses the angle of the mouth, is fissured. On the sides of the tongue fissuring and ulceration are more pronounced, but on the under-surface the lesion may be condylomatous in type, while on the dorsum the commonest lesions are pink, bald spots, the pile of the tongue having been rubbed off each papule. The secretion from these lesions teems with syphilitic organisms, and is very contagious.

The *hair* is shed to a varying degree in the secondary stage. In most cases there is some thinning, which is not particularly noticeable; in others it falls in a patchy manner, giving the back of the head a moth-eaten appearance; and in a few the patient may become temporarily bald. The beard and eyebrows may participate in these changes.

Joints and bursæ are not often affected in secondary syphilis, but occasionally an *acute synovitis* occurs. It is fairly painful, and usually worse at night. A more indolent form of synovitis causes swelling without pain or great limitation of movement. The tendon-sheaths may be affected

similarly, and the tendency to formation of adhesions may lead to permanent limitation of movement. Mild *periostitis* may occur in the secondary stage, but bone-affections are commoner in the tertiary.

From about the sixth month, or even earlier, the patient may develop symptoms pointing to syphilitic disease of the central nervous system, which are dealt with elsewhere. It is well to remember that in over 30 per cent. of cases in the secondary stage changes in the cerebro-spinal fluid indicate invasion of the central nervous system, though only a very small proportion of these cases show clinical signs of nervous disease.

Constitutional symptoms—Fever.—Even in the incubation period rigor followed by some degree of fever and pains in the limbs may occur. In some cases, towards the end of the primary stage, or on the outbreak of the rash, the patient's temperature may become irregular, the pyrexia being intermittent, continuous or remittent, and accompanied by some constitutional disturbance. Sometimes just before the outbreak of the eruption, and during the early part of the secondary stage, there is a feeling of aching in all the limbs, as if the patient had been taking too much exercise. In some cases at this time there may be definite lightning pains, which lends support to the idea that all these symptoms may possibly be due to meningeal involvement and irritation. In the early secondary stage also, headache may be severe, and may not improbably be due also to meningeal involvement.

Anæmia.—The organism of syphilis affects particularly the hæmopoietic organs, and it is not surprising that untreated syphilis is usually accompanied by some degree of anæmia. The anæmia is usually of the secondary type, with reduction of the red blood corpuscles to an average between 4,000,000 and 5,000,000 per c.mm. The loss is more particularly displayed in the hæmoglobin content, which is usually reduced, so that the colour index may be as low as 70 per cent. of the normal. The early stage is accompanied by a moderate leucocytosis which may reach a cell-count of 20,000 per c.mm. The increase of leucocytes is made up chiefly of lymphocytes, which is to be expected in view of the fact that the organism of syphilis stimulates a local exudate of lymphocytes and plasma-cells, of which the infiltration is largely composed. In rare cases the anæmia may be much more severe, Müller having reported one with a blood state resembling that found in pernicious anæmia. Justus, in 1895, introduced a new test based on the reduction of the hæmoglobin content which followed the first administration of mercury in a case of syphilis, but this is now of only academic interest.

Diagnosis of Secondary Eruptions.—The maculo-roseolar syphilide is fairly easy to distinguish by the history of a primary sore with indolent adenitis; by the subcuticular, deeply grounded appearance of the spots, which first appear on the flanks, very rarely itch, and are of a pinkish or dull-red rather than a bright-red tinge, and by the coincidence of positive serum reactions. Other erythemata are brighter red, more irritable, and often affect the backs of the hands. *Seborrhœa* is more superficial, not well grounded in the skin, and is more scaly, the scales being greasy. *Pityriasis rosea* is often mistaken for syphilis, but the lesions are brighter in colour and more irritable; they tend to become annular, with their centres covered by branny scales. *Ringworm* is more superficial and irritable, and the fungus can be found in scrapings from its border. *Tinea cruris* or *dhobie's itch*

affects a triangle at the upper and inner part of the thigh ; it is brighter red, more irritable, and quite superficial. *Drug rashes* are more inflammatory and irritable ; they appear more suddenly, and are associated with a history of the patient having taken such a drug as copaiba, cubebs, antipyrine, quinine or belladonna. The *eruptions of specific fevers* are usually accompanied by more pronounced constitutional symptoms.

The ordinary dome-shaped papular syphilide is usually easy to distinguish from a non-syphilitic eruption. The indurated feel of the papule, its shining appearance when pinched, its readiness to scale, and its dull or pinkish-red colour are valuable diagnostic signs, as is also the association with mouth and throat lesions. The different appearances which a papular syphilide presents in different parts of the body, such as dry papules on the trunk and most areas of the limbs, moist papules on the scrotum, between the toes and in other moist, warm parts, and wart-like condylomata on the scrotum, contrast strongly with non-syphilitic dermatoses which are true to type wherever situated. The microscopic test should always be applied in any doubtful case, and very rarely fails, even with the papulo-pustular or the pustular syphilide. *Acne spots* are more inflammatory, and tend also to affect the upper front of the chest and between the shoulders behind, rather than the flanks, loins and limbs. Pus can usually be expressed from blind acne pimples when they are pricked and squeezed. *Molluscum* spots are white and umbilicated, while caseous matter can be squeezed from their centres. *Lichen ruber planus* is characterised by flatter, smaller, polygonal spots of a violet tinge and waxy covering ; it is more irritable. *Psoriasis* is usually less indurated, more superficial, bleeds at a number of points when slightly scraped, and affects the extensor rather than the flexor surfaces of the limbs ; the scales are more silvery, and in moist situations the rash remains true to type, contrasting with the syphilide, which here becomes sodden with the secretion that freely oozes from it. *Varicellar spots* are more superficial and not associated with mouth and throat lesions. *Variola* is quicker in development and change, and tends to affect the backs of the hands and wrists. *Bromide and iodide* eruptions appear more suddenly, and are considerably more irritable. The deeper forms of pustular syphilide with considerable crusting, such as the superficial and deep ecthymatous, or the rupial, are distinguished from ordinary *impetigo* by the darker colour of the crusts, the circular rather than linear shape of the lesions, and the greater degree of tissue destruction below the crusts. *Scabies* is often mistaken for a crusted syphilide, and vice versa. The individual scabietic lesion is easy to recognise, but the tendency is to forget that scabies and syphilis often coexist.

Secondary syphilitic mouth lesions are easily diagnosed by the characters mentioned. *Vincent's angina* may cause confusion, but there is no pinkish areola, and the microscope easily settles the diagnosis.

Tertiary Lesions.—There is no sharply dividing line between the secondary stage and the tertiary, since the earliest tertiary lesion, the nodular cutaneous, is merely a collection of papules, which are more deeply embedded, and tend more to ulceration than the papules of what is called the early secondary stage.

The *nodular cutaneous syphilide* occurs in one or more isolated areas of the skin as a collection of skin gummata, each about the size of a pea, often running into one another to form a more or less continuous, brownish-red

ridge, which describes a circle, or may be made up of the arcs of a number of circles so as to produce a snake-like line of varying length. Sometimes the affected area looks as if a number of groups of concentric circles had been described on the skin; sometimes two or three very short concentric arcs are seen. The affected area may be as small as a finger-nail or larger than a hand. The individual gummata may degenerate only so slightly as to produce some scaling, or may ulcerate more deeply and become crusted. The lesion extends centrifugally, and leaves in its wake a reddish-stained area, which shows little evidence of scarring; or a supple, papery scar which shows well the concentric distribution of the lesion. Sometimes the nodules do not resolve as the lesion extends, and a red nodular plaque of indurated tissue is formed. On the palms the lesion may form the characteristic serpiginous pattern described above, or affect chiefly the folds, which become fissured. In some ulcerative cases extension is more rapid than healing, and a large patch of small skin ulcers may be left in the wake of the advancing arcs of new lesions. Very rarely, and then mostly when situated close to the angles of the mouth, or at a nasal orifice, the ulcer may become phagedenic, causing most extensive destruction of tissue. The areas of the body which are more commonly affected are the calves, about the iliac crests, over the shoulder-blades, the palms of the hands, the flexor surfaces of the joints, and the nose, forehead and mouth region. The areas chiefly affected are those exposed to injury or constant friction, and an odd distribution can usually be traced to the patient's occupation, exposing the part to much stress or injury. A similar type of lesion may affect the soft palate and lead to considerable ulceration and deformity.

Gummata of the tissues underlying the skin are usually, though by no means invariably, later than skin gummata. Those of the subcutaneous tissues and muscles grow up as indiarubbery lumps which vary in size from a shrapnel bullet to an orange, or larger. They are painless, quietly expanding growths, which tend to break down in the centre and, opening through the skin, discharge their contents, leaving clean-cut ulcers with overhanging edges, tough, wash-leather sloughs occupying the bases. Sometimes, instead of a discrete gumma forming in the affected muscles, these are diffusely infiltrated, and much deformity results when the degenerated tissue is replaced by scar.

The *joints, bursæ, and tendon-sheaths* are not often invaded in tertiary syphilis. When they are, the parts affected are, again, those most exposed to stress and strain, such as the knee-joint and the prepatellar bursa. The swelling is easy to recognise by its soft, indiarubber-like consistence, as also by the fact that it follows the lines of the joint, bursa or tendon-sheath affected, and by the absence of signs of active inflammation.

The *bones* are affected in tertiary syphilis in different ways. In the long bones the most usual manifestation in acquired syphilis is a localised gumma, which eventually necroses in the centre, while the edge becomes converted to a raised circle of ivory hard bone. The process is accompanied by boring or gnawing pain, which is particularly severe at night. The contents are discharged through the skin, leaving an intractable ulcer, at the bottom of which bare bone may be felt. If the process begins deeper, the local swelling may not be so obvious and, eventually, with discharge of the necrotic contents, one or two fistulous openings lead to the interior of the bone. Diffuse osteitis

and periostitis are not so common in acquired as in congenital syphilis. A sign of congenital syphilis in adolescents and adults is the sabre-scabbard tibia resulting from diffuse periostitis in earlier years; the bone is thickened from before backwards, and its anterior crest is curved with its convexity forwards, giving the bone the shape from which the condition derives its name. Of the long bones, the most commonly affected in acquired syphilis are the clavicle (sterno-clavicular joint), sternum, ribs, tibia and femur; but no bone is immune, and the process is particularly apt to affect those which have received a blow or other injury. Syphilitic dactylitis is very uncommon. Usually the proximal phalanx is affected, and a quiet, painless swelling results. Sometimes a sinus forms and the bone becomes rarefied. In other cases the whole bone becomes permanently thickened, and in still others absorption of the product may result in permanent shortening of the phalanx. The flat bones of the skull tend especially to undergo caries as a result of gummatous infiltration, and some of the worst mutilations which result from syphilis, and make it so dreaded, are those resulting from caries of the bones entering into the formation of the nose and palate. Here, after a period during which the patient is afflicted by ozæna, the bridge of the nose may fall in, or a large perforation of the hard palate suddenly make its appearance. In others the process may spread to the skin, and the most disfiguring ulceration of the face ensue. Gummata of the frontal and parietal bones may start in the inner or the outer table. In the latter case a swelling is followed by breaking down of the centre. Under the influence of treatment this may gradually be absorbed; otherwise a circular or perhaps a horseshoe- or trefoil-shaped ulcer, rimmed with an ivory-hard ridge, results. The ulcer may perforate the skull, but the general cavity of the cranium has usually by then become shut off from the affected area. When the gumma starts in the inner table, irritative and pressure symptoms may mark its first appearance. Gummata of the vertebræ are uncommon; according to their situation they may lead to retro-pharyngeal, lumbar or iliac abscess. Rarely they may involve the spinal canal and cause symptoms of pressure on the cord.

Tertiary syphilis of the *testicle* occurs in two forms, which are often combined, the diffuse interstitial and the nodular. In the former the testicle slowly enlarges, becomes heavy, but remains quite smooth, and the testicular sensation is lost. The nodular form, often engrafted on the diffuse, is characterised by the formation of gummata which may project like bosses from the surface of the testis. The epididymis is usually not palpable, and commonly the cord is moderately thickened. The condition may be accompanied by a hydrocele. Usually, in the end, the testicle shrinks, but the gummata may break down, giving rise to a form of *fungus testis*.

The *mouth and throat* often suffer severely in tertiary syphilis. Gumma of the tonsil is followed by severe ulceration. The soft palate may be strewn with a number of pea-like nodules which often ulcerate and result in all grades of deformity. Perforation, usually at the junction with the hard palate, is common, and sometimes the soft palate becomes adherent to the posterior pharyngeal wall. Perforation of the hard palate may result from gummata commencing on the mouth side.

The *tongue* may be the seat of discrete gummata which eventually reach the surface and cause deeply punched-out ulcers. A form analogous to the

nodular cutaneous syphilide consists of a number of pea-like nodules affecting a moderately large area of the tongue. This becomes swollen and very tender, but, unlike the diffuse glossitis mentioned below, is very amenable to treatment. A much commoner manifestation of tertiary syphilis of the tongue is diffuse glossitis, which may be deep or superficial. The affected portions are swollen and the surface is smooth, hard, inelastic and usually covered by a bluish-white pellicle (*leucoplakia*). On retrogression, the tongue becomes cut up into numerous islands by fissures of varying depth. The tongue is tender, and intolerant of spices and hot food.

The insides of the cheeks, along a line from the angle of the mouth opposite the gap between the upper and lower teeth, are often affected with leucoplakia. The area forms a bluish-white ridge cut up herring-bone fashion, which is quite characteristic. It may be the only clinical sign of syphilis which the patient may show.

In the tertiary stage, fever has been noted in a number of cases, and its dependence on syphilis has been shown by its response to anti-syphilitic treatment. The fever may simulate almost every type, and may be long-continued. It has been noted more particularly in connection with syphilis of the liver. It may be mistaken for rheumatic fever in cases where there is some arthritic pain due to periostitis in the vicinity of joints; for typhoid fever and for tuberculosis. These examples may serve to show the type of fever and its long continuance in some cases, and point to the necessity of an investigation with syphilis in view in cases of obscure pyrexia.

Diagnosis of Tertiary Lesions.—An indolent swelling, or an ulcer preceded by a swelling, the lesion being obviously deeply embedded in the tissues or breaking down in the middle (which contains a characteristically gummy material) and sclerosing at the margin, with a circular, crescentic or evenly sinuous contour, and brownish-red in colour, should always arouse a suspicion of syphilis. Denial of primary sore, or of secondary lesions, is of no importance, as they may long ago have been forgotten. The positive serum reactions may mislead, since by no means all ulcers in an old syphilitic are themselves syphilitic. On the other hand, negative serum reactions are rather strong evidence against tertiary syphilis. *Epithelioma* is perhaps more likely to be confused with tertiary syphilis when the lesion is in the mouth, but epithelioma has a considerably harder margin, and the edge is rolled, not clean-cut. A positive serum reaction may prove to be a trap, as epithelioma is often engrafted on an old syphilitic glossitis. Ulcers on the legs resulting from *varicose veins* or *impetigo* may arouse a suspicion of syphilis. They are usually much less regular in contour and associated with more inflammatory manifestations. Syphilitic orchitis is easily distinguished from other conditions by the evenly smooth hardness of the testicle, the weight and the absence of testicular feeling.

Congenital Syphilis

An infected mother can transmit syphilis to her offspring long after she has ceased to be sexually contagious. Syphilis transmitted to the fœtus during the early months or years of the mother's disease is usually fatal, and a miscarriage results. In successive pregnancies the virulence of the disease seems to become more and more mitigated, so that infants born dead

at term are succeeded by those dying shortly afterwards, by those surviving though diseased, and eventually by healthy children. The family history does not always pursue this regular course of gradual attenuation, however, since in some families an apparently healthy child may be preceded and succeeded by some miscarriages, or stillborn children. It has even happened in the case of twins that one is healthy and the other diseased.

Symptoms.—A syphilitic infant born alive may show an eruption of bullæ or pustules resting on dark-red bases. The secretion contains the organism of syphilis in large numbers. A commoner event is the maculo-roseolar eruption, coming on about 3 weeks or a month after birth. It selects chiefly the napkin area, the neighbourhood of the nose and mouth, and the palms and soles, but the whole trunk and limbs may be affected. The macules often run together into large patches which may be annular, as in the recurrent form of acquired syphilis. In moist areas, and where the rash is exposed to friction, the surrounding surface secretes serum freely and becomes red and glazed, or crusted. Condylomata and moist papules occur and ulcerative fissures or rhagades may form at the angles of the mouth. These often leave radiating scars which remain as stigmata of the disease. Syphilitic infants may retain a fairly well-nourished appearance, but often become emaciated, with yellowish, papery skin and a wizened, old-man appearance. Simultaneously with the skin eruptions, the nails may become opaque and irregular. In others there is infiltration and oozing of serum around the nail, which is loosened and shed. The hair is often shed extensively; on the other hand, syphilitic infants may grow an abundant crop of hair, which has been called the "syphilitic mop," though it occurs in other diseases. Mucous patches appear in the mouth and throat, and involvement of the mouth and larynx is marked by the well-known "snuffles" and the hoarse, raucous cry of the syphilitic infant. Suppurative otitis media is often an early manifestation, and leads to hopeless deafness.

Tertiary lesions may appear very early, or not until the ages of 7, 14, 21, or even later. Thus diffuse interstitial orchitis may occur during the first 6 months. Skin gummata may appear in the first year or two as small infiltrates which break in the centre to discharge their mucoid contents. Tertiary lesions of the mouth and throat may show themselves at any time after the first year, and result in perforation of the palate and considerable deformity of the soft palate and faucial pillars. Destruction of the nasal support results in saddle-nose, and from the age of about 11 there is a liability to sudden deafness from gummatous changes of the internal ear. The affection usually starts in one ear, but quickly follows in the other, and the child becomes permanently deaf. Choroiditis and iritis may appear as early as the age of 5 months, and, unless properly treated, lead to blindness, or considerable impairment of sight. Interstitial keratitis may begin at the age of 6 or not until the patient is between 20 and 30. Usually it starts in one eye, and the other follows suit in a few months, often in spite of treatment. The cornea of the affected eye gradually becomes opaque from the margin inwards, and this is followed by vascularisation, which results in the formation of a pink patch (*salmon patch*); then the cornea may gradually weaken and bulge before the intra-ocular pressure, or it may ulcerate. Gradually, after many months, the cornea may clear more or less completely, but the patient is often left with

permanently damaged sight owing to concomitant iritis and choroiditis. The permanent teeth may show signs of congenital syphilis in the form of notching of certain teeth, which are narrowed at their cutting bases. The two upper central incisors are much the most usually affected (*Hutchinson's teeth*), but all the incisors may be notched. These characteristics are usually lost after the age of 20. The first molars are often dome-shaped, the cusps having fallen together from failure of the central pillar to mature (*Moon's teeth*).

The long bones may be affected in various ways. During the first few months syphilitic epiphysitis may cause signs simulating paralysis (*syphilitic pseudo-paralysis*) owing to the rapid loss of movement which occurs. Movement of the limb causes severe pain, which explains the apparent paralysis. The epiphysis is swollen, and occasionally definite separation occurs. Arthritis may be associated with epiphysitis, and the joint may suppurate. Between 5 and 18 years of age chronic synovitis affecting chiefly the knees, with swelling of joints but with slight pain or interference with movement, may be puzzling to diagnose unless syphilis is remembered.

Dactylitis occurring in the second year causes fusiform swelling of the proximal phalanges of two or more fingers, or, more rarely, toes. At a later period in childhood, between the ages of 8 and 14, chronic periostitis of long bones is apt to cause characteristic deformities, best shown in the tibiæ, which become shaped like sabre-scabbards.

The visceral and nervous affections of congenital syphilis are dealt with in other sections.

Diagnosis.—Syphilitic pemphigus occurs on the palms and is earlier than ordinary *pemphigus neonatorum*, and *Sp. pallida* can be found in the secretion. Ordinary *erythemata* are brighter red, and associated with friction and moisture such as from wet napkins, while the syphilide is not necessarily accounted for by friction, or by moisture, and is associated with such signs as "snuffles" and chronic laryngitis.

Syphilitic epiphysitis is distinguished from *true paralysis* by the pain on movement and contraction of the muscles when the skin is irritated. It occurs earlier than *scurvy* or *rickets*, appearing about the third week, and is associated with the skin and mucous-membrane lesions of syphilis. It is well to remember that syphilis has been found to be responsible for many of the nutritional and mental disorders of childhood, and that it is advisable to investigate every obscure case with syphilis in view.

Treatment.—*Prophylaxis.*—In a classical experiment on man, Metchnikoff prevented the development of syphilis, after inoculation with virulent syphilitic virus, by rubbing the following ointment into the scarified area an hour after the inoculation:

Calomel	33
Lanolin	67
Vaselin	10

Probably a more effective method would be to steep the part for some minutes in 1 in 2000 iodide of potassium and mercury and then to rub in the above ointment. I have seen many failures from the use of such antiseptics as potassium permanganate and even lysol applied thoroughly a few minutes after exposure. It is well to remember in connection with prophylaxis by

disinfection that antiseptics do not act immediately, and that their effect is very considerably hampered by organic material. It is difficult, therefore, to understand how a thin film of potassium permanganate could destroy any organisms left on the surface after swabbing the parts.

During recent years prophylaxis by ingestion of Stovarsol tablets, or by injection of arsenobenzene compounds, has been advocated by many workers. Stovarsol, an arsenical preparation, is dispensed in tablets containing 0·25 gramme each. The person who has been exposed to infection takes four each morning before food for four successive mornings, and repeats the treatment in each of the following two weeks. When the injection method is employed, a short course of intravenous injections of "914" is given, much as indicated on p. 216. Considerable success from these methods has been reported, but they are opposed by a number of high authorities, chiefly on the grounds of the possibility of their merely masking symptoms. Both antiseptic applications and arsenical treatment employed as prophylactics may prevent the appearance of the primary sore but not the infection, so that those who have employed them should resort to tests afterwards, to make certain that no later sign of syphilis appears, *e.g.* a positive serum reaction.

The prevention of accidental infection of fingers, lips and other extra-genital parts resolves itself into measures to prevent the direct or almost direct contamination of abrasions with the virus from syphilitic persons who are in the earlier stages of syphilis. Such persons should be warned of the risk arising from sharing table utensils, crockery and house linen with others. They should not kiss others nor talk directly into people's faces, and articles which they have used should be dipped in very hot water. A further precaution is to keep open lesions smeared with an antiseptic ointment such as the Metchnikoff cream mentioned above.

The prevention of transmission to offspring is primarily a matter of preventing infection of mothers. A man who has contracted syphilis should be advised to wait for at least five years before marrying; by that time the risk of transmission by sexual intercourse has usually gone, whatever the treatment. The period can be shortened by treatment, but this must be prolonged and thorough. A syphilitic woman is liable to convey the disease to her offspring throughout the child-bearing period. Efficient treatment of the mother before or during pregnancy will usually prevent the disease being transmitted, or, if the latter has already occurred, will go far towards curing the infant before it is born. Naturally, the earlier this treatment is commenced the more likely the success.

Curative treatment of syphilis.—The remedies most commonly employed for the treatment of syphilis are preparations of arsenic, mercury, bismuth and iodine. The first three are believed to destroy the parasites; the last to stimulate the tissues to clear away granulomatous tissue.

"606," or dioxydiaminoarsenobenzene dihydrochloride, was produced by Ehrlich in 1909. It is now sold as Salvarsan. Arsenobenzol (Billon), Arsenobillon, Kharsivan, Diarsenol, and Arsphenamine, according to the country of origin and the manufacturing firm. It is a yellow powder which forms an acid solution when dissolved in water. Addition of an alkali to this solution causes a precipitate which redissolves on addition of more alkali. Being liable to change on exposure to air, it is sold in sealed ampoules containing weighed amounts of this compound. Owing to the complexity

of its preparation for administration and the difficulties of this, the original "606" is now very little employed, and consequently special works should be consulted for details of its injection.

In order to obviate the inconvenience of administration which attaches to the use of "606," Ehrlich experimented to discover a compound having the same therapeutic properties but simpler to administer. The result was two preparations, one called "914," which was produced shortly after "606," and is now used very extensively. The other, "*Sodium salvarsan*," is "606" already converted to the sodium compound. It is a yellow powder which requires only to be dissolved in water and can be given much more concentrated than the original preparation. It is about two-thirds the strength of salvarsan and, in equivalent doses, is a more easily tolerated preparation than the original.

"914," or dioxydiaminoarsenobenzene monomethylene sulphoxylate of soda, is now sold as Neosalvarsan, Novarsenobillon, Neokharsivan, Novarsan and Neo-arsphenamine. It is a yellow powder (containing 18 to 22 per cent. of arsenic) which is much more liable than salvarsan to become toxic on exposure to air, so that it must be administered very quickly after the ampoule has been opened and its contents dissolved. It is soluble in its own weight of water, in which it forms a neutral solution. The most usual method of administration is the intravenous. The dose, from 0·45 to 0·9 for adults (which corresponds to 0·3 to 0·6 of "606"), is dissolved in 2 to 5 c.c. of distilled water and drawn into a syringe. The syringe is armed with a fairly fine needle, and the point of the latter inserted into the vein, which should be distended as tightly as possible, by fastening an elastic band round the upper arm and making the patient grasp a roller bandage. A pull on the piston causes blood to flow back into the syringe when the needle is properly within the vein. The rubber band is released, the hand opened, and the piston pressed steadily home. "914" can also be given intramuscularly or into the deep subcutaneous tissues, the dose being dissolved in about 2 c.c. of water. Its therapeutic effect when administered in this form is undoubtedly greater than when injected intravenously. The injection may cause considerable pain, which may be immediate or come on 2 or 3 days later and last for about a week. More recently various preparations have been synthesised, which, in many respects, are similar to "914." Their great advantage is that they can be injected subcutaneously with very little discomfort to the patient. The best known in this country are Sulfarsenol, Kharsulphan, Metarsenobillon and Myosalvarsan. They are readily soluble in distilled water, and can be injected in a concentration of 0·6 gramme per c.c. of water intramuscularly or just over the fascia covering the glutei as follows. In the upper and outer quadrant of the gluteal region the skin and fat are pulled away from the underlying fascia, by grasping them with the thumb and fingers of the left hand, and a 2-inch record needle is entered obliquely at the base of the pyramid thus produced. The needle is made to underrun the fat so that its point may scrape on the fascia overlying the gluteal muscles. The charged syringe is fitted to the needle and the injection given fairly slowly. The site is then massaged with a pad of lint. A preparation known as Stabilarsan is a solution of the base of "606" in glucose. Stabilarsan is preferably given by the intravenous route.

Two preparations have been introduced by Kolle, the successor of Ehrlich. One, called Sulfoxyl-salvarsan, is a stable arsenobenzene preparation put up in ampoules already dissolved and ready for injection. The other preparation, known as Silbersalvarsan, is a combination of salvarsan and silver. It is an emery-coloured powder which forms a dark-brown solution in water. It is well to dissolve in 8 c.c. water, and, after puncturing the vein, to draw about 2 c.c. blood into the syringe. The injection should be given much more slowly than neosalvarsan, otherwise the patient may suffer from vasomotor symptoms as noted below.

Therapeutic properties of arsenobenzene preparations.—All the arsenobenzene preparations mentioned above act more rapidly than mercury or bismuth. The greater certainty of cure is shown by the fact that unequivocal second attacks of syphilis, formerly a great rarity, are now comparatively common, even in the experience of those who understand the difference between recurrent and new chancres. Kolle's silver salvarsan appears to be about twice as powerful in immediate therapeutic effect as "606," and can consequently be given in much smaller doses. Sulfoxyl-salvarsan is slower in action. It is used for old-standing cases, in courses of three injections of 8, 10 and 12 c.c. at intervals of 2 to 3 weeks. Stabilarsan appears to be slow in action as judged by the disappearance of *Sp. pallida* from open early lesions after its injection, but its effect seems to be more profound than that of "914." When the results of an intramuscular or deep subcutaneous course of neosalvarsan are compared with those of an intravenous of any compound there is little doubt that the advantage rests with the intramuscular or subcutaneous method, and it is reasonable to expect that the same will be found of the closely similar preparations sulfarsenol, kharsulphan, metarsenobillon and myosalvarsan. Sufficient is not yet known of silver salvarsan and sulfoxyl-salvarsan to indicate their position in regard to permanence of effect, but considerable evidence has been produced to show that the silver arsenobenzene preparations are valuable in syphilis of the nervous system.

Owing to convenience of administration the worker will probably choose, for consulting-room practice, "914," stabilarsan, or one of the silver preparations for intravenous, and sulfarsenol, kharsulphan, metarsenobillon or myosalvarsan for subcutaneous treatment.

Toxic effects of arsenobenzene remedies.—These compounds all tend to damage capillary endothelium. In patients who have died as a result of overdoses, or of idiosyncrasy, there have been found blockage of cerebral capillaries with small hæmorrhages around; hæmorrhagic nephritis; hæmorrhage into lung capillaries; submucous petechiæ and ecchymoses in the stomach and bowel; and, in a comparatively few cases, degeneration of liver cells amounting to a condition like that found in acute yellow atrophy.

Clinically, toxic effects are manifested by one or more of the symptoms enumerated below. The list is a comparatively long one, but most of the symptoms are so mild, infrequent, or preventable as not to preclude the routine use of these remedies. In roughly chronological order they are as follows:

1. *During or immediately after the injection.*—(1) Vasomotor disturbances, also known as anaphylactoid symptoms or minor nitritoid crises; (2) urticaria; (3) syncope; (4) pain in the gums and teeth.

2. *Following the injection usually in a few hours*, and occurring generally on the same day.—(5) Rigor, rise of temperature, and headache; (6) vomiting, diarrhœa, pain in the back and cramp in the legs; (7) herpes (labialis or zoster).

3. *At various times from a day or two to a month or longer* after a single injection or a course of injections.—(8) Albuminuria; (9) stomatitis; (10) chronic headache; lassitude; loss of appetite, weight and sleep; (11) erythema and dermatitis; (12) jaundice; (13) severe cerebral symptoms.

The *vasomotor symptoms* simulate very closely those of anaphylaxis. The face becomes flushed, and the tongue and lips may swell; there may be respiratory distress, and the patient may become unconscious. Often a severe attack is followed by more or less generalised *urticaria*. As a rule the symptoms last for about half an hour, but in rare cases recovery is not complete for a number of hours. Some patients are peculiarly susceptible. In others the symptoms may be produced by imperfect preparation of the remedy for injection or too rapid administration, as they depend on the physical state of the solution on entering the circulation. As measures of prevention, solutions of "914" should not be given concentrated if the preparation does not dissolve perfectly in practically its own weight of water; sodium salvarsan and silver salvarsan, if given in concentrated solution, and stabilarsan, should be injected slowly. The treatment usually employed is to inject 10 to 15 minims of adrenalin chloride (1 in 1000) hypodermically. A good method of prevention is that recommended by Sicard. The tourniquet is retained during the injection and may preferably be kept on the upper arm for some minutes (even 10 to 15) after removal of the needle. In the latter case a pad should be held closely to the bend of the elbow to prevent a hæmatoma. *Syncope* is usually mental, unless it precedes vomiting. *Pain in the gums and teeth* is probably vasomotor. The *peculiar taste in the mouth*, of which some patients complain during the injection, is a very common symptom when concentrated solutions are given.

Rigor, rise of temperature and *headache* are very rarely severe, but are commoner after first than after subsequent injections. *Diarrhœa* and *vomiting* are not frequent unless there has been an error in technique, or the patient has been indiscreet in his dietary. Quite often they are followed by *herpes*. Usually these symptoms have all disappeared by the next day. They are prevented to some extent by taking care that the patient has fasted for 2 hours before the injection.

Albuminuria very rarely causes any anxiety. *Stomatitis* is not often attributed to arsenobenzene remedies, but these undoubtedly seem to increase the tendency to this complication which is manifested by patients on mercurial, or bismuth treatment. *Chronic headache, lassitude*, etc., are symptoms of intolerance displayed by a few patients, and indicate the necessity of a rest from treatment.

Various *skin affections* may occur besides the urticaria and herpes mentioned above, and may be very serious. The mildest is some slight itching which quickly passes off. Some patients show a transient and limited erythema, but in a small minority a punctiform erythema quickly spreads over the body, is accompanied by most intense itching, and often then passes on to exfoliative dermatitis. The incidence of dermatitis depends largely on the intensity of the treatment. Generally speaking, a male adult of

average build will easily tolerate 4 grammes of "914" in doses of 0·45 to 0·75, or the equivalent of this in other arsenobenzene remedies, spread out over a period of 57 days, but if this period is shortened the percentage of dermatitis increases noticeably. A careful look-out for signs of skin irritation will often supply timely warning of the idiosyncrasy and, by preventing the administration of more arsenobenzene, will save the patient from a severe attack. The treatment of exfoliative dermatitis following arsenobenzene injections is often troublesome on account of the generalised exfoliation and the local pustulation and eczema. Generally, the patient should be in bed and well protected. The injection of sodium thiosulphate, which is now sold for the purpose in ampoules containing measured amounts, has proved to be very useful in aborting the toxic effects of arsenobenzene, bismuth and mercury. The dosage for general use is 0·45, 0·6, 0·75 and 0·9 gramme, dissolved in 5 to 10 c.c. water, and injected intravenously or intramuscularly every other day. On intervening days an intravenous injection of 25 c.c. of a 25 per cent. solution of glucose is valuable. The injections may be supplemented by pulv. sod. thiosulph. gr. xxx, dissolved in half a tumblerful of water, taken each morning before food. The diet should be simple, containing large quantities of bland liquids, and should not include eggs and meat. Locally, calamine lotion is soothing and an occasional bran bath is valuable, but careful precautions should be taken against chill, as these patients are very prone to pneumonia.

Jaundice following injections of arsenobenzene preparations appears to have become much more common in recent years, and a voluminous literature on its ætiology has accumulated in all countries without any definite consensus of opinion having been arrived at. In the very great majority of cases the type is mild, with clayey stools and highly coloured urine. Occasionally it is much more serious, with severe epigastric and hepatic pain, restlessness and delirium, followed by death. Broadly, the changes found in these rare cases have been extensive degeneration of liver cells with round-celled infiltration of the supporting connective tissue, multiple subserous hæmorrhages, and frequently hæmorrhages into lung alveoli. Either type may occur during a course of injections or be delayed for many months afterwards. In respect of the delay in onset, as in some other features, the fatal type of jaundice strongly resembles trinitro-toluene poisoning. The exact part played by arsenobenzene in the production of jaundice is uncertain, but the weight of evidence seems at present to favour a connection between the amount of arsenobenzene administered as routine in a given time and the proportional incidence of jaundice, the more concentrated the course the higher being the percentage of jaundice. A feature of the fatal type of jaundice which has been noted in this and other countries is its tendency to occur in limited outbreaks which bear no apparent relation to changes in technique or brand of the remedy employed. This feature lends some support to the theory, held by some, that besides arsenobenzene an extraneous agency (bacterial infection ?) plays a part in the causation.

For the *prevention* of jaundice, besides regulation of the dosage, the diet should be fairly generous in carbohydrates and somewhat restricted in fats and proteins. For treatment, besides reduction of the diet to slops, daily intravenous injections of 25 to 50 or more c.c. of a 25 per cent. solution of glucose are useful.

Severe *cerebral symptoms*, with headache followed by mental confusion, epileptiform convulsions and coma, ending in death in a large proportion of cases, are now very rare, thanks to the moderate doses with which treatment is usually commenced. One patient, whom I saw in the comatose condition, was restored within half an hour by phlebotomy to 20 ounces, the removal of 15 c.c. of cerebro-spinal fluid, and the injection of 1 c.c. of adrenalin chloride 1 in 1000. Other workers have since been equally successful by this means. The treatment should be applied at once, and the lumbar puncture should be repeated if the symptoms continue. *Thrombosis* of the injected vein is more apt to follow injections of silver salvarsan and of stabilarsan. It is usually prevented by taking the precaution to clear the needle of solution before withdrawing it, by aspirating a few c.c. of blood into the syringe.

Jarisch-Herxheimer reaction.—A temporary effect of these, as of other antisyphilitic remedies, may be to increase the intensity of the syphilitic process. This may be important when an artery supplying some vital organ is already partly blocked; then the increase in the severity of the process may result in a complete blockage which may be disastrous, as when a coronary artery becomes obstructed, or the patient develops hemiplegia, or dies of obstruction of the basilar artery. Such cases are very rare.

Neuro-recurrences.—Though not strictly a direct effect of arsenobenzene treatment, paralysis of various cranial nerves, especially the seventh and eighth, became more common shortly after its introduction. These phenomena have been proved to be syphilitic recurrences and due to the small amount of treatment given in the early days of "606." Since it has been recognised that much more than 1 or 2 doses of "606" is necessary for the cure of syphilis, neuro-recurrences have become comparatively rare.

Precautions recommended in treating patients with arsenobenzene compounds.—In the case of sufferers from advanced Addison's disease, bleeders, and those on the point of death from severe visceral disease, these remedies are contra-indicated.

In all cases where intravenous injections are employed it is advisable for the patient to fast for 2 hours beforehand. In my own centre the administration of glucose ʒxiv, sod. bicarb. gr. xv, ol. limonis ♏ j, aq. ad. ʒiii, half to 1 hour before each injection, has appeared useful in preventing jaundice. The principle is that a well-fed liver will not be poisoned so easily as a starving one, and it is remarkable how very few private patients develop jaundice. Other methods of prevention of this and other toxic effects of arsenobenzene consist in scrupulous care over technique, particularly in avoiding contact of solutions with alcohol.

In visceral disease of a less severe type than is mentioned above, in alcoholism, and when the patient is prone to such skin affections as eczema and severe seborrhœa, it is advisable to begin with a dose of 0·15 to 0·3 gramme of "914," and to increase the intervals in the outline of treatment given below. The same applies to patients suffering from syphilis of the brain, cord or viscera when there is reason to fear an exacerbation of the process. In diabetes mellitus it is necessary to be very cautious, as arsenobenzene increases the blood sugar, and the patient should be watched carefully by some one experienced in the administration of insulin.

In all cases the commencing dose should be moderate. 0·45 gramme of "914" or stabilarsan, or 0·15 gramme of silver salvarsan for an adult male

who is otherwise healthy. The intervals between doses should be spaced in a way which has proved to result in a very low proportion of toxic side-effects. I have found in the case of men that, when 6·0 grammes "914" are compressed into less than a 92 day course, the incidence of such toxic side-effects as dermatitis increases noticeably. The patient should be watched carefully through the course for signs of intolerance. This precaution may not absolutely prevent severe side-effects, but such as do develop will usually be much milder than when no notice is taken, for example, of an erythema, and the treatment is continued to the end of the course.

Mercurial preparations.—Mercury was formerly the sheet-anchor in the treatment of syphilis. Its action is much slower, however, than that of the arsenobenzene compounds, and when it is used alone relapses are frequent whilst the patient is actually under treatment. The great advantage of mercury is that it can be kept almost continuously in the circulation, so that the action is maintained after the dose of arsenobenzene has been excreted until it is safe to administer another arsenobenzene injection. To ensure the certain destruction of all the parasites, it seems to be necessary that an anti-syphilitic remedy should be present constantly in the body fluids for a period of many months.

Methods of Administration.—The *oral method* is much favoured, but is apt to cause gastro-intestinal disturbance, and is exposed to the risk of failure through the patient's forgetfulness. I employ it only in those cases where the patient cannot take injections or inunctions and also when, a large amount of arsenobenzene and mercurial treatment having been given, the patient cannot continue injections or remain under close observation. Favourite preparations are—(1) Hydrargyrum cum creta, grs. i to ij; (2) hydrargyri iodidum viride, gr. $\frac{1}{6}$ to $\frac{1}{4}$; (3) hydrargyri perchloridum, gr. $\frac{1}{6}$; (4) hydrargyrum tannicum oxydulatum, gr. i; (5) pil. hydrargyri, grs. i to iij; (6) liq. hydrargyri perchloridi, $5\frac{1}{2}$ to i, often prescribed in a mixture with potassium iodide. The first five of these are usually given in pill form, often combined with a little opium, *e.g.*, pulv. ipecacuanhae compositus grs. i to ij, or extractum opii gr. $\frac{1}{8}$, to counteract the irritant effect. It is a good plan to ring the changes on these preparations until one is found which does not upset the patient. Generally speaking, the best plan of administration is to give courses of a month or six weeks, gradually increasing the daily intake of mercury until slight signs of stomatitis appear, and then reducing the dose. After the first and second courses rests of a week are given, and at the end of the third the interval is one month, after which the series of three courses is repeated. The length of time over which this treatment is prolonged depends greatly on the amount and character of the previous treatment.

Inunction.—This is a valuable method of administering mercury, but must be carried out by a skilled rubber, and has the inconvenience of soiling the skin and clothes. On successive days 5 to 10 grammes of $33\frac{1}{3}$ per cent. mercurial ointment are rubbed for twenty minutes into thighs, calves, arms, chest and back, a bath being taken on the sixth day and the cycle restarted on the seventh. The number of rubbings varies from 60 to 200 in a course, the length of a course depending on the patient's tolerance, which is judged by the state of the gums, the weight and the general well-being.

Intravenous injections are rapid in effect, but very apt to give rise to toxic symptoms; they appear to me to have the further disadvantage that the effect is not sustained. The usual preparations employed are the cyanide and the perchloride, in doses of 1 c.c. of the 1 per cent. solution daily or on alternate days to a total of twenty or thirty.

For *intramuscular injections* both soluble and insoluble preparations are employed. Among the *soluble* preparations are the biniodide (1 per cent. solution) in doses of 1 c.c., the bibromide, the benzoate and the perchloride, the last being made up as follows:

Sod. chlor.	gr. iv.
Aq. destill.	400 ♏.
Dissolve, filter and add hydrarg. perchlor. gr. viij.	Dose, 5 to 10 ♏.

The soluble preparations are more rapid in effect, but this is not sustained. They have the further disadvantage of having to be given daily or on alternate days.

The *insoluble* preparations most commonly employed are mercury in fine subdivision, calomel and mercury salicylate. Suspensions of these remedies ready for use are sold by most chemists. The doses usually employed are: mercury, 1 to 1½ grs.; calomel, ½ to ¾ gr.; salicylate, 1½ to 2 grs. Calomel causes more pain than the other two, and my own preference is for mercury in fine subdivision. The advantages of the insoluble preparations are that, on account of the slow absorption, enough mercury can be given in one injection to last a week, and that the effect is sustained.

The technique of intramuscular injections is simple. The site usually chosen is the upper and outer quadrant of the gluteal region. A needle 2 inches long is introduced, almost to its full length, perpendicularly to the skin surface. The base is examined to see that no blood is oozing from it, the syringe is applied, the piston pulled upon to see that the needle point is still not within a vein, and the piston is then pressed home. The needle having been withdrawn, the site is well massaged with a ball of cotton-wool. Before an insoluble preparation is drawn into the syringe, the suspension should have been well mixed, either by stirring with a glass rod or by energetic shaking of the bottle.

Toxic effects of mercury.—These are stomatitis, nephritis, colitis, general malaise and dermatitis.

Stomatitis can usually be prevented by care. The patient's teeth should be set in order before starting the course, and he should brush his teeth night and morning; the tooth brush should be kept in an antiseptic solution, such as chloramine T., 0·5 to 1 per cent. Potassium chlorate is useful, and may be incorporated in the dentifrice. If the gums become sore, the mercury must be stopped and more energetic treatment applied to the mouth. Lozenges of potassium chlorate to suck, and swabbing with peroxide of hydrogen, followed by the application of collosol argentum, or of a mixture of liq. arsenicalis 1, vinum ipecacuanhæ 1, and spiritus vini rectificatus 2 parts, usually suffice to restore the gums to a healthy condition. An astringent mouth wash should be employed and injections given of sodium thiosulphate. (See p. 210.)

Nephritis rarely results from the moderate doses of mercury now em-

ployed, but the irritant effect of mercury on the kidneys should be remembered in cases where these organs are already diseased.

Colitis is extremely uncommon as the result of the ordinary mercurial course of treatment. *General malaise* is apt to result from pushing mercury too freely, and it is always advisable to keep a close watch on the patient's weight and general condition. *Dermatitis* as a result of mercurial treatment alone is very rare.

Bismuth preparations, introduced by Sazerac and Levaditi in 1921, have rapidly acquired a prominent position amongst anti-syphilitic remedies, and seem likely to supplant mercury wherever the intramuscular, or deep subcutaneous, route of administration is practicable. Bismuth is tolerated better than mercury, in doses which can be administered with at least equal safety, and acts more rapidly than the older remedy, while a course of bismuth injections goes farther towards eradicating the disease than does a corresponding course of mercurial injections. Some workers assert that bismuth is equal in effect to arsenobenzene, but the majority opinion is that it is a substitute for mercury, not arsenobenzene. The toxic effects of bismuth are somewhat similar to those of mercury. The first sign of saturation is a slaty-blue line at the margins of the gums, particularly at the incisor teeth. If the remedy is continued, the buccal mucous membrane may become stained, and aphthous stomatitis supervene. If the remedy is pushed still farther, gangrenous stomatitis may result. The early bismuth blue line may persist for many weeks after suspension of the remedy. Albuminuria may result from over-dosing, but disappears quickly if the remedy is suspended as soon as it is noted. Colitis is uncommon, but certain subjects may complain of depression of spirits and insomnia, which may easily be attributed to other causes than bismuth poisoning. Generally, however, bismuth gives rise to less trouble on account of toxic effects than does mercury. The metal can be administered in a large variety of forms, and the number of preparations on the market, each with a different trade name, is legion. The great majority resolve themselves into solutions, or suspensions, of (1) the tartro-bismuthate of potassium and sodium, which was the original preparation used by Sazerac and Levaditi and contains about 50 per cent. of metallic bismuth; (2) the hydroxide (bismuth content about 70 per cent.); (3) the oxychloride (bismuth content about 80 per cent.); (4) iodobismuthate of quinine (bismuth content about 20 per cent.); and (5) precipitated bismuth. The rapidity of action depends on the rate of absorption, and this is quickest in the case of solutions of the tartro-bismuthate. As to the others, it is at present difficult to say, but watery suspensions are more quickly absorbed than oily. The eventual effect depends very largely, as in the case of mercury, on the amount of metallic bismuth introduced into the tissues. The choice of preparations depends on these facts and on the local reaction following injections. The solution of tartro-bismuthate causes a fair amount of smarting, and appears to have been largely supplanted by kindlier preparations. The iodobismuthate is too bulky for convenience, and my own preference is for the oxychloride or the salicylate. Any one of these is usually tolerated perfectly, causing little or no pain at the site of injection. Opinions differ as to the dosage, some giving a course of 10 to 15 injections, totalling from 1·0 to 1·5 grammes of metallic bismuth; others, very much more. I have found that 0·1 gramme per week for a course

of 10 injections is usually tolerated well by the average adult male. The weekly dose can be administered in 2 or 3 injections, but I have usually found it convenient in average cases to inject once, namely, at the same time as the arsenobenzene injection is given. There are experimental grounds for believing that the presence of another metal in the circulation at the time an arsenobenzene preparation enters it assists the effect of the arsenobenzene, so that, apart from reasons of convenience, the simultaneous injection of arsenobenzene and bismuth appears likely to have the advantage of affording better results than when a course of bismuth (or mercury) precedes, or follows, one of arsenobenzene. An additional reason for administering bismuth (or mercury) at the same time as arsenobenzene is that this procedure seems to be attended by fewer neuro-recurrences.

Iodine preparations promote the resolution of syphilitic processes and are most useful in the later stages. The tissue reaction is qualitatively the same in all stages, however, and there are grounds for supposing that the syphilitic infiltrate tends to bury the parasites, making them inaccessible to anti-syphilitic remedies, so that there is a use for iodine preparations in all stages. Usually I have given them for short periods between courses of treatment by arsenobenzene and mercury or bismuth, on the principle of preparing the ground for the further action of the more definitely specific remedies. The favourite preparation is potassium iodide, in doses of 5 to 30 grains twice daily. It may cause gastro-intestinal disturbance, even when given very dilute in water, and is then better tolerated if made up in a cent. per cent. solution and the dose dropped into milk. The depressing effect of potassium iodide is overcome by giving it with nux vomica. Many proprietary preparations are advertised as superior to potassium iodide, but they should be reserved for cases where the older preparation cannot be tolerated. Sodium iodide may be given intravenously.

General management of syphilis.—The main principles to be observed in the treatment of syphilis are—(1) To begin as early as possible, before the parasite has become buried in the sclerosed primary sore or entrenched in comparatively inaccessible regions, such as the central nervous system; (2) to continue as long as experience shows that there is a possibility of the patient relapsing if treatment ceases; (3) to exploit the patient's natural resistance, by maintaining his general health in the highest possible condition.

Since the decision as to cure has to be postponed for some years after suspension of treatment, and relapse cases are particularly difficult to cure, it is better to treat all cases as if they were of the resistant type, even at the risk of overtreating some. Too much reliance is placed at present on a negative Wassermann reaction as an indication for suspension of arsenobenzene treatment, and I do not believe in continuing only with mercury after the reaction has become negative. Mercury is a slowly acting, comparatively feeble anti-syphilitic remedy, and if arsenobenzene remedies had not come into use, the two years' treatment formerly considered sufficient in this country would long ago have been prolonged to four or five as in other countries.

In all cases of primary sore it is very important to apply local treatment to destroy the organisms *in situ*; otherwise they may escape the remedies circulating in the blood. It may be possible to remove the sore by circumcision, or to destroy it with a cautery. Failing this, the sore may be rubbed

with 30 per cent. calomel ointment, or injected with a solution of "914" (say, 0·15 gramme in 0·5 c.c. water).

The programme of treatment of ordinary cases of syphilis in men of average weight without clinical manifestations of disease of the central nervous system or of any viscus which has been followed in the St. Thomas's Hospital V.D. Department from early in 1920 until a few months ago is as described below; and following it is a summary of the results which it has afforded.

For the sake of brevity the arsenobenzene preparation is referred to below as "914," but, instead of "914," stabilarsan may be given in corresponding doses intravenously, or, using one of the preparations mentioned above as suitable for the purpose, the route (which I prefer) may be deep subcutaneous or intramuscular. Another alternative to "914" is silver salvarsan, given intravenously, in doses approximately one-third, or slightly over this fraction, of those of "914." For women the dosage of the arsenobenzene preparation is reduced according to the weight of the patient, and does not ordinarily exceed 0·60 gramme "914."

The dosage of bismuth (Bi) is given in terms of metallic bismuth.

FOR SERO-NEGATIVE PRIMARY CASES.

(1) Three injections of 0·45 gramme "914" intravenously, with 1 gr. Hg in mercurial cream or 0·3 gramme Bi intramuscularly at weekly intervals.

(2) 2 weeks' rest.

(3) Two injections of 0·60 gramme "914," with Hg or Bi as above, at weekly intervals.

(4) 2 weeks' rest.

(5) Two injections of 0·75 gramme "914," with Hg or Bi as above, at weekly intervals.

(6) 3 weeks' potassium iodide, gr. v t.i.d. the first week; gr. viiss t.i.d. the second week; gr. x t.i.d. the third week.

(7) Three injections of 0·75 gramme "914," with Hg or Bi as above, at weekly intervals.

(8) No treatment for 5 weeks.

(9) 3 weeks' potassium iodide as in (6).

(10) Repeat (1) to (7).

FOR SERO-POSITIVE PRIMARY CASES.

(11) As in (1) to (10) above.

(12) No treatment for 10 weeks.

(13) Potassium iodide as in (6) for 3 weeks.

(14) Three injections of 0·60 gramme "914," with Hg or Bi as above, at weekly intervals.

(15) No treatment for 2 weeks.

(16) Two injections of 0·75 gramme "914," with Hg or Bi as above, at weekly intervals.

FOR SECONDARY CASES.

(17) As in (1) to (16) above.

(18) No treatment for 10 weeks.

(19) As in (14) to (16) above.

FOR CASES LATER THAN SECONDARY.

(20) A series of courses as in (1) to (5), with intervals of 2 to 3 months between courses, potassium iodide being taken for 3 to 4 weeks in each interval.

The results of the above forms of treatment have, on the whole, been good. In the sero-negative primary cases which received the prescribed two courses and were observed afterwards for periods ranging from three months to 7 years, there were no relapses. In similar cases which received a little less than the prescribed amount, there were approximately 10 per cent. of relapses. In sero-positive and early secondary cases, the prescribed treatment was followed by approximately 10 per cent. of relapses.

In order to improve these results the treatment was for some months intensified by increasing the total amount of arsenobenzene treatment by approximately 50 per cent. But, although every dose of "914" was dissolved in 10 c.c. of a 10 per cent. solution of sodium thiosulphate, this procedure was followed by too great an incidence of jaundice and dermatitis.

It seems clear that it is impracticable to make the individual course much more intensive than as outlined above, and the writer, like others, is testing courses on various lines to obtain better permanent results than those mentioned. It is not yet possible to report definitely on any of these courses.

Serologically intractable cases.—Even in the sero-positive primary stage a small proportion of cases occurs in which the serum reactions remain positive in spite of prolonged treatment on lines commonly practised hitherto. This intractability increases with the age of the disease, until in cases of 2 years' duration or more a very high proportion are what is commonly termed Wassermann-fast. Some of these become negative when changed over to treatment by mouth after receiving a number of courses of injections, but a more hopeful method, the practice of which is increasing, is to combine metallic treatment with pyro-therapy. It has arisen largely from the good results obtained by malarial inoculation in G.P.I. As an example of this form of treatment may be mentioned the routine practice of Finger in quite early cases which show signs of intractability. Finger gives first 3 grammes "914" in doses of 0·3 to 0·45 at 5-day intervals, then inoculates with malaria and allows 10 paroxysms to occur before stopping the malaria with quinine. After this, commencing on the day of the last paroxysm, he gives another 3-gramme course of "914." His results, as reported, are far superior to those following the ordinary methods of treatment. As a substitute for malaria, which is troublesome and debilitating, may be mentioned the use of intravenous injections of typhoid vaccine and intramuscular injections of milk and various other pyrogenic agents. These have the advantage of being more convenient and of causing less debility, but so far those employed have not proved so successful as malaria. At the time of writing there is considerable activity in this field of medicine, and the writer would recommend readers to study its progress.

The treatment of syphilis of the viscera and central nervous system is considered elsewhere.

Before suspending treatment the blood and cerebro-spinal fluid should be

negative. After suspending treatment the patient should be put under observation, being examined clinically once a month, and by blood test every 3 months for a year. At the end of the year both blood and cerebro-spinal fluid are examined a week after a provocative injection of, say, 0·45 gramme "914." During the second year the blood tests are at intervals of 6 months, the provocative injection and examination of cerebro-spinal fluid being repeated at the end. As a rule it is not advisable to allow a patient to marry until after 5 years from infection and after remaining free from all signs, clinical and serological, for at least 2 years following suspension of all treatment.

Pregnant women are treated on much the same lines, the dose not exceeding 0·6 gramme. On account of the susceptibility of the kidneys, it may be advisable to withhold mercury or bismuth for the first few injections until it is seen how the injections are tolerated. Treatment may be continued almost to the end of pregnancy, a careful watch being kept on the kidneys throughout.

Syphilitic infants.—The treatment of syphilitic infants is carried out on the same principles as that of adults. When the mother has been treated throughout pregnancy, it is still advisable to continue treatment of the infant for at least a year. When treatment commences only after birth the child is in a position analogous to that of an untreated adult many months after infection, and its treatment should continue for at least 2 years.

In most cases it will be found convenient to inject the arsenobenzene preparation intramuscularly. If the intravenous route is preferred, the vein usually chosen is the external jugular or one in the temporal region. A good commencing dose is 0·05 gramme, though Findlay recommends 0·10 to 0·15 for an infant of 1 to 2 months, increasing to 0·2 to 0·3 in older children.

Mercury is given in the form of hydrargyrum cum creta by the mouth; as mercurial cream intramuscularly in doses of $\frac{1}{6}$ to $\frac{1}{2}$ grain according to age, or by inunction. Probably the most convenient and efficacious method is by inunction. A piece of mercurial ointment the size of a pea is rubbed, as Findlay recommends, for 15 minutes on successive days, into abdomen, back, one axilla, other axilla, one groin and other groin in turn, returning to the abdomen on the seventh day. This is continued for many months. Bismuth injections are well tolerated, the dosages being calculated according to the weight of the patient.

Such a tonic as syrupus ferri jodidi should also be administered.

YAWS

Synonyms.—Framboesia; Framboesia tropica; Pian; Bubas; Parangi.

Definition.—An infectious granuloma, contagious and inoculable, due to the *Treponema pertenue* (Castellani), and characterised by fever with a peculiar eruption of raspberry-like papules.

Ætiology.—The disease is common in many parts of the tropics, especially in the West Indies, Fiji, Ceylon and Java. The natives in these parts are affected. It is very rare in Europeans. Children are specially liable. Both

sexes may be attacked. The cause is the *Treponema pertenue* (Castellani), an organism resembling closely the *Spirochæta pallida*. The disease bears many analogies to syphilis, but is generally not venereal in origin, the infection taking place through abrasions or cuts in the feet, hands, etc.

Pathology.—There are no lesions in the organs as in syphilis, and the arterial walls do not show endarteritis. The papules have the structure of an infective granuloma, a stroma of fibrous tissue with granulation cells, plasma cells, etc.

Symptoms.—Some authorities state there is a definite primary sore; but certainly in most cases this does not occur. An incubation period precedes the eruption. In this stage the patient complains of vague pains, often worse at nights, in the bones and joints, and headaches with temperature also now occur. The eruption then appears, the skin loses its gloss and becomes dull and scaly, papules, at first the size of a pin head, come out over the body, and gradually enlarge until they become the size of peas or small nuts. Coalescence of several of them may form large masses. The skin over the papules desquamates, leaving a reddish warty-like surface exposed, which closely resembles a raspberry. A whitish-yellow fluid oozes out of the papules, and this drying up forms a yellow scab or crust which if left alone becomes heaped up into a conical mass, like a syphilitic rupia. If the scabs be removed, new crusts form again and again. The face is a favourite site of the papules, as also the anus and genitals; the body is also affected and, in some instances, the mucous membranes do not escape. Successive crops may continue to come out, each new exacerbation being accompanied with a fresh rise of temperature and pains in the limbs. The number of the papules varies, they may be few in number, while in other cases the skin is covered with them. Finally, the papules dry up, shrink, and fall off, leaving a lighter coloured area than the normal skin in natives, a pigmented area in light-skinned races.

Course.—The duration of the disease varies considerably; 6 weeks may see the finish of all signs, whereas in other instances the illness may continue for a year or more.

Complications.—In long-standing cases other symptoms, which are probably due to the *T. pertenue*, may appear—periostitis, inflammation of the joints, teno-synovitis, chronic ulcers, caries of bone and ulcerations of the palate and mouth. These are looked upon as manifestations of tertiary yaws, and are frequent in the Fijian variety of the disease. Even later lesions such as tabes have been ascribed to the *T. pertenue* by Fijian observers. Such lesions very frequently occur amongst the Fijians, amongst whom syphilis is said to be absent, and this is, of course, a strong point in favour of such symptoms really being due to yaws.

Diagnosis.—This is easy, the eruption being very characteristic. Syphilis and yaws may exist together, and this complicates the diagnosis. Wassermann reactions may help. The disease is very common in young children in the West Indies, and this is to be borne in mind when diagnosing their different complaints.

Prognosis.—This, on the whole, is quite good. Children may die of it sometimes, as may also debilitated adults. Deaths, however, considering the enormous numbers of people attacked, are rare.

Treatment.—Close contact with yaws cases should be avoided, and

infected individuals, if possible, should be placed in yaws hospitals, a class of building which exists in all heavily infected yaws areas (West Indies, for example).

Salvarsan or neo-salvarsan is a specific for the disease. One injection of 0·3 gramme is often sufficient to stop the disease at once. It is comparatively rare for a second injection to be required. The treponema of yaws is more easily destroyed than that of syphilis. Recently bismuth has also been used with success and has the advantage of being cheaper than salvarsan.

G. CARMICHAEL LOW.

D. PROTOZOAN INFECTIONS

MALARIA

Definition.—A protozoal infection of man, associated in most cases with definite attacks of regular periodic fever, enlargement of the spleen and anæmia. The disease is carried by anopheline mosquitoes.

Ætiology.—Malaria occurs generally throughout the tropics and the sub-tropics, and even in temperate regions. One or two tropical islands are free from it. Barbados, which used to be free, has recently become infected. All races are liable; in endemic areas the infection is commonest in children, adults gradually acquiring a certain degree of immunity. Both sexes suffer equally. The parasite of malaria belongs to the *Sporozoa*, one of the chief groups of the Protozoa, sub-order *Hæmosporidia*, genus *Plasmodium*. There are three leading forms in man. Benign tertian, B.T., is due to the *Plasmodium vivax*, Quartan malaria to the *P. malariæ*, and malignant malaria, M.T., to the *P. falciparum* (*Laverania malariæ* or *præcox*, according to some).

These parasites undergo two cycles, one in the blood corpuscles of man, the other in the tissues of the mosquito.

Human phase (endogenous, asexual, or schizogony). The sporozoits inoculated by the mosquito pass into the blood stream and enter the red blood corpuscles, where they change into little rings (signet ring), which gradually grow, develop more protoplasm and black pigment, and finally—B.T. and Quartan—fill the corpuscular envelope. The pigment then collects in the centre and the protoplasmic mass divides into a number of spores (sporulating body, rosette or schizont). The envelope now gives way, and the spores (merozoites) are scattered in the plasma. They quickly penetrate new red corpuscles and the cycle begins again.

Mosquito phase (exogenous, sexual, or sporogony).—When the sporulation of the asexual cycle takes place, certain large forms, in benign tertian and quartan infections, which do not sporulate, are seen filling the corpuscles. These are the gametocytes or sexual forms. In malignant malaria, M.T., the gametes are crescentic. When taken up by mosquitoes of a suitable type these gametes undergo the following development. The crescents of the malignant form change into circular bodies—the gametes of the benign fevers are originally circular. From the males, flagella become detached (equals the spermatozoa of higher forms), and these, penetrating the female bodies,

fertilise them (sexual act, zygosis). The resulting body now elongates, becomes pointed at one end (travelling vermicule or ookinet), and penetrates the wall of the mosquito's stomach, where it comes to rest, again takes on a circular form, and proceeds to grow (oocyst); the oocysts become filled with numerous spindle-shaped bodies (sporozoits), and protrude from the wall of the stomach like little hernia or warts; finally, they rupture, and the sporozoits escape into the tissues and pass into the salivary glands. When the mosquito next bites man it inoculates him with the saliva, and, the sporozoits passing into the red blood corpuscles, start the infection. (See Human phase just described.)

At suitable temperatures this development takes about 10 days, and after inoculation there is an incubation period of another 10 days until the fever appears.

The mosquitoes of malaria.—It is not every anopheline mosquito which can carry malaria successfully. The chief carriers are *Anopheles maculipennis* and *A. bifurcatus* in Europe; *A. funestus* and *A. costalis* in Africa; *A. albimanus* and *A. argyrotarsis* in the West Indies; *A. culicifacies, A. turkhudi* and *A. maculipalpis* in India; *A. umbrosus, A. maculatus* and *A. minimus* in Assam, Burma and the Federated Malay States.

The sporulation of B.T. and quartan takes place in the peripheral blood as well as in the blood of the internal organs, that of M.T. practically always in the latter, the forms seen in the peripheral blood being the small rings and the gametocytes or crescents. The benign tertian parasites can easily be distinguished from the quartan by the following points. In the former the corpuscle is enlarged and pale, the pigment is in large amount, of a brownish black colour, and of a fine consistence; Schüffner's dots are present, and there are 12 to 20 spores in the sporulating body; in the latter, the corpuscle is of ordinary size, the pigment is very coarse and black, and there are only 8 to 10 spores geometrically arranged like the petals of a daisy.

Staining.—Films are made in the usual manner, and may be suitably stained by Leishman's or Giemsa's stain. These methods bring out the chromatin in the parasites and other fine points in the structure of the different species. The rings, compared to a signet ring, consist of a nucleolus (dark red), a vesicular nucleus, and the outer ring, the protoplasm (blue).

Pathology.—If the infection has lasted any length of time a certain degree of anæmia is present; the white cells are normal, or diminished in chronic cases. The large mononuclear elements are relatively increased 10 to 25 per cent. The pigment of malaria consists of black dust-like grains, or coarser particles, or agglomerations into irregular lumps. It is insoluble in strong acids, altered by potash, and dissolved by ammonium sulphide. It is formed from the hæmoglobin, and is diagnostic of malaria.

Polycholia or excess of bile is present. This is due to the conveyance of the liberated hæmoglobin, after the corpuscular destruction, to the liver, where it is converted by the liver cells into bile and other derivatives. It is specially marked in the bilious type of M.T. This explains the slight jaundice seen in malaria. The distribution of the sporulating forms in M.T.—the cause of the different clinical symptoms—in order of frequency, is as follows: Brain, lungs, spleen, bone-marrow, liver, heart and intestines.

On autopsy, the liver is plum-coloured, the spleen enlarged and of a slaty

colour (in acute cases blackish red with the pulp very soft), while the intestines and brain may show a leaden colour. These features are very characteristic and give the diagnosis at once. Malarial pigment is found in the different viscera, and parasites in large numbers, especially at the chief seat of sporulation. The cerebral capillaries in such cases may be absolutely packed with parasites, sections showing them mapped out by the contained pigment.

Symptoms.—CLINICAL TYPES.—*Quartan.*—This is a benign variety. (Benign is a term applied to those forms of malaria which do not exhibit dangerous or fatal symptoms, such as coma, etc. They may, however, produce a considerable degree of anæmia and consequent weakness, thus rendering the individual more prone to other infections, such as tuberculosis; but death primarily due to the fever is rare.) The geographical distribution is typically sub-tropical, though it does also occur in the tropics. It is difficult to eradicate completely from the system, and causes considerable anæmia if untreated, often associated with albumin in the urine. The spleen may be moderately enlarged. Single infections of the parasite give rise to fever every fourth day, every 72 hours (Monday, at 12 noon-Thursday, at 12). Double infections will cause 2 days' fever with 1 day clear (Monday, at 12-Thursday, at 12, one generation; Tuesday, say at 3, Friday, at 3, the other generation; Wednesday, clear), while treble infections occasion a rise of temperature every day. The classical features of ague are present—cold stage, hot stage, and sweating stage, the rigor corresponding in time to the sporulation in the blood. (See films taken at the time.) High temperatures are met with up to 107° F. even; 105° F. and 106° F. are quite common.

Benign tertian fever (*B.T.*).—This is chiefly met with in the sub-tropics (*e.g.* Salonika), though also fairly common in the hotter regions. If untreated it causes anæmia and weakness. The spleen and liver are often fairly large. A single infection causes fever every other day, *e.g.*, every third day, every 48 hours,—Monday, at 12, for example; Wednesday, at 12. A double infection every day, the maxima on the 2 days generally being of different heights and occurring at different times. Monday, say at 12 noon, 106° F.; Wednesday, at 12 noon, 106° F.; Tuesday, at 4 p.m., 103 F.; Thursday, at 4 p.m., 103° F. The classical signs of ague are present (see above), the rigors often being very severe with high temperatures. The temperature begins to fall when the sweating appears, and reaches the normal or sub-normal (Intermittent fever). Quinine quickly causes the parasites to disappear from the peripheral blood, and stops the fever. The infection, however, is very difficult to eradicate completely, and relapses are very frequent, even during treatment.

Malignant tertian malaria (*M.T.*). — **Synonyms.** — Æstivo-autumnal Malaria; Pernicious Malaria; Sub-tertian Malaria. It is possible there is more than one species of malignant malaria, the Italians having described two quotidian varieties and one tertian. Possibly, however, these quotidians are simply double infections of a tertian, while in other cases several generations of a tertian in the blood at one time will produce an irregular type of fever.

There are three main types of febrile disturbance associated with this form of malaria. (1) A typical tertian temperature with fever every other day, 48 hours' interval; (2) quotidian fever, with a temperature every day

at the same hour; and (3) irregular remittent fever, closely resembling an enteric fever chart. In these latter forms none of the classical features of ague may be present. Malignant fevers quickly produce anæmia, and if untreated, with fresh infections superadded, cause a profound state of cachexia. Pernicious symptoms may also appear at any moment, and are due to the sporulation in certain capillary areas. Such attacks may simulate almost any disease in medicine. They are divided into *Cerebral forms*—coma, convulsions, apoplexy, aphasia, paraplegia, hyperpyrexia, meningitis, etc. *Abdominal*—gastric, choleraic, dysenteric, hæmorrhagic pancreatitis type, appendicitis and peritoneal type, etc. *Cardiac*—Syncope and various forms of disordered action of the heart. *Sudoral. Respiratory*—bronchitic and pneumonic types. *Urinary*—albuminuric type. A speedy recognition of all these forms is necessary, as death is apt to occur with great rapidity.

Complications and Sequelæ.—Rupture of the spleen may occur, but usually only after some definite trauma. After many attacks and reinfections of malaria, especially the malignant varieties, a condition termed malarial cachexia supervenes. This is characterised by jaundice of the conjunctiva, yellow skin, great enlargement of the spleen and liver, perhaps albuminuria and periodic attacks of fever. There is then a great liability to acquire other disease, such as tuberculosis.

Diagnosis.—This is easy if quinine has *not* been taken. The diagnosis is made by examining the blood for the characteristic parasites. They are, in the large majority of cases, found within a few minutes of making the film. Occasionally they are difficult to find, but repeated examinations will eventually show them. Where quinine has been taken reliance has to be placed on blood counts, differential especially, for evidence of large mononuclear increase, and on an examination for pigment in the leucocytes. A history of periodicity in the temperature is always helpful.

Prognosis.—This is good as regards life in the benign forms, but it must always be remembered that malaria is an infection difficult to remove completely—2 to 3 years even, after good treatment. In malignant forms, the death-rate will be in proportion to the skill of the investigator in diagnosing his cases. Speedy recognition of the complaint means speedy treatment and saving of life. Pernicious forms, if not seen quickly, almost all die. Malaria is one of the chief causes of death in the tropics.

Treatment.—Destruction of the breeding grounds of anophelines, by drainage, filling in of marshes, lakes, burrow pits along railways, etc., should be carried out thoroughly, while adult mosquitoes should also, where possible, be destroyed. Residents in the tropics should sleep under mosquito nets and inhabit mosquito-proof houses; quinine as a prophylactic is advantageous. A small prophylactic dose will not prevent infection if bites from infected mosquitoes be frequent, but if they be few and far between, it may be successful. James has recently pointed out the importance of taking the prophylactic dose in the evening, if possible one dose at dinner-time of 5 grains, and another about 11 p.m. or midnight. There will thus be enough quinine in the system to kill any sporozoits inoculated that night. A happy combination of all these three methods will be found to give the best results.

There are only one or two drugs of value in malaria, quinine, arsenic and plasmoquine.

Since the Great War, much has been written regarding treatment by quinine, and difficulties have been introduced, especially as regards its administration. The matter is really quite simple. If a patient with malaria can take the drug by the mouth and absorb it, then give it by the mouth ; if he cannot, it must be given either intramuscularly or intravenously. Both these ways are perfectly easy, if ordinary care be taken. The intramuscular method causes a degree of necrosis of the muscle at the site of injection, but this is of little importance if no sepsis have been introduced. Tetanus has been described as following intramuscular injections in the tropics, the idea being that tetanus spores are already in the body, and settle down and multiply in the necrosed area. This is possible. Intravenous injections can be given, and as a matter of fact ought to be given, in all pernicious cases. Deaths have been reported as following them, but whether the death was due to the malaria or to the drug is not always clear. The risk must be taken in grave cases.

As regards dosage, opinions vary, but 10-grain doses three times a day for the first 7 days or so are generally sufficient to stop the fever in most cases. Some prefer giving 5-grain doses every 4 hours, the total for the 24 hours being the same, namely, 30 grains. After the fever has fallen, 5 grains of the drug should be given every night and morning (70 grains per week) for 2, 3 or more months at a time to prevent relapses (anti-relapse prophylaxis). The salts of quinine to be employed are of importance ; the bi-hydrochloride, on account of its solubility, is the best to use for intravenous and intramuscular injections and is administered in 10-grain doses. Smaller doses than this have been recommended, the suggestion being that these should be repeated every 2 or 3 hours, but personally I see no object in this. It can also be given by the mouth, but is more expensive than the hydrochloride, the bisulphate, sulphate and some of the other preparations.

Where there is anæmia and cachexia, quinine alone will not succeed ; arsenic must then be employed in combination with one or other of the easily assimilable salts of iron. The results of such a combined treatment are excellent. A Bayer product, "Plasmochin" or "Plasmoquine," has recently been put on the market as a cure for malaria. At first used by itself, experience has shown that better results are obtained by combining it with quinine. The plasmoquine attacks the gametocytes specially, but is not so effective for the schizonts. The drug is put up in tablet form, each tablet containing plasmoquine 0·01 gramme (grain $\frac{1}{6}$) and quinine sulphate 0·125 gramme (grain 2). Of these two are given three times a day for five full courses of 6 days for M.T. and 7 days for B.T., an interval of 4 days taking place between each course. Toxic symptoms, such as a peculiar blue colour (? cyanosis), sickness, pain over the kidneys, etc., may be met with. The drug must then either be stopped and quinine substituted, or the dose reduced. In cases that have had much quinine and still get relapses, a course of plasmoquine Co. should be tried. Relapses may occur, however, even after the latter drug. The patient must also be warned against getting wet, bathing in the sea, taking cold baths at home, or drinking in excess. Any concurrent disease must be treated at the same time, otherwise success will not be achieved. Persons from the tropics not uncommonly suffer from syphilis and malaria. Dysentery and malaria is also a common combination. Some people say they cannot take quinine. If that be really so, then they

ought not to be allowed to go to the tropics. It is a good plan to give a test dose of 10 grains before the person leaves England.

BLACKWATER FEVER

Synonyms.—Hæmoglobinuric Fever; Melanuric Fever.

Definition.—An acute disease, associated in some way with malaria, characterised by high fever, jaundice and vomiting, and by the passage of hæmoglobin or methæmoglobin in the urine.

Ætiology.—The disease occurs in many parts of the tropics, especially in parts of Africa, Nyasaland, Uganda, East Africa, West Coast colonies, some parts of India, Duars, and Terai, in the Southern States of the U.S.A., Panama, British Guiana, Brazil, etc. Natives of the endemic areas seem to be immune, while colonists, natives from other parts of the world, and chance visitors are those attacked. Both sexes are equally liable, though more cases are seen in males, no doubt owing to the fact there are more males than females in the tropics as a whole. Children also suffer. The exact cause of the disease is unknown. There are two main views as to its causation. (1) It is a disease *sui generis*, the parasitic cause being as yet undiscovered. (2) It is in some way or other connected with malaria. Chills and depressing circumstances of any kind may precipitate the attack. All authorities are pretty well agreed that malaria, in some way or other, is connected with the production of the condition. Nearly, if not actually every case gives a history of many attacks of malaria, not necessarily severe, before the blackwater fever appears. The usual type of case is the patient who takes quinine when he has fever and then neglects to do so between attacks (irregular quinine taker). One interesting point in the geographical distribution of malaria and blackwater fever is that this does not completely coincide, there being, it is true, severe malaria where there is blackwater; but, on the other hand, there being plenty of malarial areas where there is either no blackwater fever at all, or only very rare cases (most of India, for example, the Federated Malay States, and other parts of the world). Again, if natives of India, where there is malaria but no blackwater fever—Sikhs, for example—go to Uganda they take the disease in a virulent form, and many of them die from it. It is still possible there is a specific parasite, which only acts in people who have suffered from malaria.

Quinine is not the cause, but it may, if given in large doses, precipitate an attack, and the name of quinine hæmoglobinuria has been given to such cases. It is better not to use this term, as quinine will not produce hæmoglobinuria except in those with a liability to it, *e.g.* persons living in, or who have lived in, blackwater countries. A cold bath or a chill in England will precipitate an attack of blackwater fever even though the patient has never suffered from the disease previously while abroad. The patient has brought his predisposition with him and is capable of developing the disease, though no longer living in its endemic haunts. There are many interesting points still requiring elucidation in the ætiology of the disease.

Pathology.—What actually causes the hæmolysis to take place is not known; there may be some abnormal instability in individuals attacked.

The liberated hæmoglobin is carried to the liver, which deals with as much of it as it can, the residue passing to the kidneys and being excreted by them, either as methæmoglobin or hæmoglobin, in the urine. The intense yellow colour of the patient is thus also explained.

The yellow colour is very noticeable and the body may appear blanched. If malaria has recently been present, the organs will show the pigmentation of that disease; in addition, however, the liver is enlarged and soft, the spleen also may be very big and the pulp almost diffluent. The kidneys are enlarged and congested, and the tubules blocked by hæmoglobin infarction. *Definite nephritis, though not usual, may also be present. There is nothing* of importance in the brain.

Symptoms.—A pre-blackwater fever stage has been described, but it is doubtful if this can really be differentiated from the ordinary malaria cachexia seen in bad malarial districts. The patient usually, though not always, thinks an ordinary attack of malaria is impending. Rigors may start the illness. The urine is now noticed to be black, the colour of dark port wine or porter, and this indicates the nature of the disease. There may be pain and aching in the loins with vomiting and hiccough. Great restlessness supervenes, the fever keeps high, the skin begins to show the characteristic yellow colour, and there is marked tenderness and pain in the epigastric region and over the liver. The vomiting may be persistent, preventing nourishment being given by the mouth, and greatly weakening and distressing the patient. This condition lasts for from three to four days, and then the urine begins to clear; in favourable cases the temperature now drops, the hæmoglobin completely disappears, the vomiting and other symptoms subside and convalescence is established. In all cases, however, careful watch must be kept for the appearance of the following additional symptoms: (1) Syncope; (2) Suppression of urine; (3) Hyperpyrexia; (4) Post-hæmoglobinuric fever; (5) General asthenia.

1. *Syncope.*—If the hæmolysis has been excessive, the signs and symptoms resemble those of ordinary hæmorrhage, namely, sighing respiration, weak flickering pulse and the other signs of shock. Syncope, especially if any attempts at movement be made, may quickly supervene.

2. *Suppression of urine.*—The urine may quickly diminish in quantity, become thick and tarry, and finally cease, the kidneys refusing to function further owing to blocking of the tubules with hæmoglobin. If this become absolute then a fatal termination of the disease is certain.

3. *Hyperpyrexia.*—The temperature may begin to rise rapidly, quickly reaching 107° F., 108° F. to 110° F. or higher, when death takes place.

4. *Post-hæmoglobinuric fever* occurs after the urine has cleared, and is difficult in many instances to explain.

5. In some cases, again, though the hæmoglobinuria has ceased and the other symptoms have subsided, the patient may not rally, but fall into an asthenic condition from which he cannot be roused, and death takes place. The effect of the hæmolysis on the malarial parasites, which are practically always present in all cases before the onset of the disease, is interesting. This hæmolysis may result in the malarial infection being completely abolished, though this is not invariable. The parasites in the latter instance return, and cause further malarial relapses either with or without hæmoglobinuria.

Complications and Sequelæ.—Permanent damage to the kidneys may

result, albumin persisting in the urine and interstitial changes developing in the organs.

Diagnosis.—This is usually easy—the history of residence abroad in English cases gives the clue. Other hæmoglobinurias have to be excluded, and for this the Autolytic Reaction will be found of use. This consists of cooling a tube of the patient's blood on ice for 5 minutes, and then incubating at 37° C. for an hour. In paroxysmal hæmoglobinuria intense hæmolysis results, whereas in real blackwater fever there is no change. Bile in the urine has been mistaken for hæmoglobinuria, but in cases of doubt the spectroscope will quickly decide the matter.

Prognosis.—This is always grave. No disease is so treacherous as blackwater fever, and until convalescence is well established the result is always uncertain. If the case can be admitted to hospital early, the chances of a successful termination will correspondingly increase.

Treatment.—Careful nursing is everything. The patient must be watched night and day, and must not be allowed to move or raise his head from the pillow. The bowels may be opened by calomel. The urine must be measured with great care and any diminution at once noted. If signs of suppression be threatening, intravenous, subcutaneous, or rectal saline, up to 1 pint, should at once be given, and hot packs should be applied to the loins. If the pulse be failing and the blood pressure very low, saline injections intravenously are indicated, or glucose or gum injections might be tried. Blood transfusion was recently used with success in a very severe case by the author, and the possibility of such a measure should be considered in all severe cases, especially in the type of case where the blood does not begin to improve and the patient passes into an asthenic state. Hyperpyrexia requires ice, and the usual remedies. Decapsulation of the kidney has been recommended for complete suppression. It would seem to be a somewhat desperate measure. Quinine *should not be given*, as it may increase the hæmolysis. For the vomiting, Hearsey has recommended a modification of Sternberg's yellow fever mixture—Bicarbonate of soda, grs. x, liq. hydrarg. perchlor., ℥xxx, every 2 hours for the first 24 hours, and then every 3 hours till the urine clears. This is said to stop the vomiting and to produce a free diuresis. Mercurial poisoning has followed its use, so care must be taken in its administration. Owing to the vomiting the patient may have to be fed per rectum. Easily assimilable foods should be given; as a stimulant, champagne is said to be of value. Careful return to ordinary diet should be insisted on during convalescence. For the post-hæmoglobinuric fever the bowels should be opened by some laxative, the condition sometimes resulting from constipation. If malaria return, it must be treated by small doses of quinine, 1 or 2 grains at a time, to begin with, cautiously increased by 1 grain per dose till 5 grains or more are reached; the patient should not return to the endemic area, as he is specially liable to further attacks.

LEISHMANIASIS

Leishmaniasis is a name applied to a group of diseases caused by parasites of the genus *Leishmania*. Some of these are general infections, others local. Of the first, we have kala-azar, due to the *L. donovani*, and infantile

or Mediterranean kala-azar, caused by the *L. infantum*, though this is now generally supposed to be the same species as the former, and if so the name *L. donovani* holds for both. Oriental sore, due to the *L. tropica*, and American dermal Leishmaniasis, to the *L. americana*, belong to the second group.

Kala-azar

Definition.—Kala-azar, or black fever, is a specific disease associated with enlargement of the spleen and liver, anæmia, and general emaciation, caused by a protozoal parasite, the Leishman-Donovan body, *L. donovani*.

Ætiology.—The disease has definite geographical limits, being commonest in India, Assam and the Mediterranean; in addition, it has been met with in China, Indo-China, Egypt, and in other parts of the world. Natives are perhaps more prone to the disease than Europeans, but this is due no doubt to their habits of life and not to any racial reasons. Children suffer as well as adults, especially from the Mediterranean form.

Leishmanial parasites are small oval- or oat-shaped bodies, 2 to 4 μ long by 1 to 2 μ broad, with two small chromatin bodies laterally placed and lying opposite each other. One of the bodies, the larger, macronucleus or trophonucleus, is round, while the other (centrosome, micronucleus or kinetonucleus) is rod-shaped, with one end usually pointing towards the former. They can be cultivated outside the body if grown on hæmoglobin agar medium (N.N.N. medium) at 22° C., when they elongate and pass into the flagellate stage. They now measure up to 24 μ in length, with the flagellum and centrosome at one end and the macronucleus in the middle (Herpetomonas type). It is supposed this flagellate represents an intermediate host stage in some insect, and Patton has found such changes in the blood in the stomachs of bugs that had sucked kala-azar bloods. Basile in Italy believes the dog flea, *Ctenocephalus canis*, is the spreading agent for Mediterranean kala-azar, the parasites being acquired from infected dogs. Quite recently Knowles, Napier and Smith have found that *Phlebotomus argentipes*, which corresponds in its distribution with kala-azar in India, becomes infected with leptomonas forms when fed on cases of the disease. It may possibly be the vector of the parasite. Recent work has tended still further to incriminate it.

Dogs suffer severely from the disease in the Mediterranean littoral, whereas in India (Madras) they seem to be free. This is interesting, as dogs can quite easily be infected experimentally with the Indian strain of parasite in England.

Pathology.—The parasites are distributed generally throughout the body, inhabiting the endothelial type of cell. In the spleen, they are also found in the large macrophages or splenic cells, in the bone marrow, in the myelocytes, and in large cells analogous to the macrophages of the spleen. They have been found also in the lungs, the testicles, and other viscera, and in the ulcers in the intestine and the lymphatic glands draining them (Manson and Low). In the peripheral blood they occur in the leucocytes, but are often so scanty as to require cultural methods to demonstrate their presence. They act as irritants, causing enlargement of the liver and spleen.

On autopsy, the spleen is firm to the touch, hard and fibrous, with the capsule and septa much thickened; the liver is also enlarged, and a fine form of cirrhosis is sometimes seen. The yellow bone marrow becomes converted into red, and is soft and diffluent. The skin sometimes shows papules or ulcers in which the Leishmania may be demonstrated, and recently some cases have shown a heavy parasitic infection in the lower layers of the skin, though unbroken and unaltered. The ulcers in the intestine are met with either in the small or large bowel; they are small and somewhat punched out, and the lymphatic glands draining the areas are enlarged.

Symptoms and Course.—In the epidemic form of the disease, as seen in Assam, Bentley states the cases start with fever of a remittent type which lasts from 2 to 4 weeks. During this time the spleen and liver enlarge. An interval of apyrexia succeeds, followed by a repetition of the fever. After some time a low form of fever sets in, accompanied by profuse drenching sweats, with pain in the limbs, anæmia and progressive emaciation. The skin becomes of an earthy colour; petechiæ, epistaxis and bleeding from the gums are common. The duration of the disease, in the days of Bentley's observations, was from a few months in acute, to 1 or 2 years in chronic cases. Ninety-six per cent. died, usually of some intercurrent disease such as dysentery, tubercle or asthenia. Besides these epidemic forms, Bentley described ordinary forms in natives; they were characterised by general weakness, debility, loss of flesh, fever perhaps at nights and enlargement of the spleen. Such cases showed no malarial parasites, but Leishman-Donovan bodies were found when the spleen was punctured.

In Europeans the symptoms closely resemble those seen in ordinary splenic anæmia. They may be classified as follows: (1) Irregular remittent or intermittent pyrexia, not necessarily high, the curve generally showing a double daily rise (double remittent type of Rogers). (2) Cachexia with deepening colour or pigmentation of the skin—whence the name black fever. (3) Anæmia and characteristic blood changes. (4) Rapid loss of weight. (5) Enlargement of the liver and spleen. (6) Sweating at night. (7) Hæmorrhages. (8) Diarrhœa—often of a dysenteric type.

The blood changes in kala-azar are those of an anæmia and leucopenia. The red cells usually fall to about 50 per cent. of the normal, but not much below. Poikilocytosis is not specially marked, a moderate amount only being present. Irregularity in size is also not extreme, but microcytes and megalocytes occur. Nucleated red corpuscles are not common—about one in every 500 leucocytes. They are of the normoblast type. Basophilia is rare. The hæmoglobin is proportionately diminished to the red corpuscles, *e.g.* about 50 per cent.

Striking changes are seen in the white cells, their number per cubic millimetre sinking to 2000 or under. This marked leucopenia should always arouse suspicions of the disease in any one who has resided abroad. Differentially, the large mononuclear cells are increased, but not to such an extent as in malaria; 8 to 12 per cent. is a fair average. In certain cases, parasites can readily be found in the leucocytes, but in others they are rare or apparently absent.

A typical blood count in kala-azar would read as follows: Reds, 2,500,000 (50 per cent.); Whites, 1200; Hb., 50 per cent.; differentially large mononuclears, 12 per cent.

The disease has been transmitted congenitally, a baby born in England to a kala-azar mother acquiring the disease (Low and Cooke).

Complications and Sequelæ.—In addition to hæmorrhages and ascites, dysenteric diarrhœa is common, depending upon the amount of ulceration in the gut. Real amœbic dysentery may also be superadded; and phthisis not infrequently carries off the patient. Congestion of the lungs and pneumonia occur. Cancrum oris is common amongst affected children in Calcutta. The ulcers in the bowel sometimes perforate, producing purulent peritonitis.

Diagnosis.—The *Leishmania donovani* must be demonstrated before one can finally say the case is one of kala-azar. Non-Leishmanial splenomegaly is also met with in the tropics. The liver or spleen should be punctured and the parasites searched for, or attempts may be made to cultivate them from the blood on N.N.N. medium (hæmoglobin agar). Napier's "Aldehyde test," which consists of adding one drop of 30 per cent. formaldehyde to 1 c.c. of clear serum from the patient's blood, may also be employed. If positive, the serum immediately becomes solid and opaque like the white of a hard-boiled egg. Other diseases give a modified positive reaction, however. A very marked leucopenia, in a person from a kala-azar area, should always make one suspicious.

Prognosis.—This used to be very bad, but since the introduction of intravenous antimony medication is now quite good and hopeful—especially if the case be treated early.

Treatment.—Bugs should certainly be destroyed wherever possible, and no one should sleep in houses where kala-azar patients reside or have recently resided, unless it be certain the houses are scrupulously clean and free from bugs. The destruction of old bug-infested coolie lines in Assam, and building of new ones, is said (Dodds Price) to have greatly diminished the disease in these parts.

Steps must also be taken to prevent, as far as possible, the bites of *Phlebotomus argentipes*.

In the Mediterranean areas, dogs should not be allowed into the houses; those known to be infected ought to be killed, and all means to prevent flea bites should be adopted.

There is only one drug that need be mentioned, and that is antimony in the form of antimonium tartaratum or tartar emetic (potassic-tartrate of antimony), or one of its other salts. It would seem to be a real specific, and its introduction into the treatment of kala-azar has robbed the disease of most of its terrors. The drug is given intravenously in a 2 per cent. solution, or simply dissolved in 10 c.c. of normal sterile saline or distilled water as required. It is then sterilised by boiling. The solution should be freshly prepared, and must not be allowed to stand. The introduction into the vein may be made with a syringe or by the gravity method, and care must be taken the solution is passed into the vein, as if it leak into the tissues sloughing occurs. It is usual to begin with a small dose of half a grain, increased by half a grain each time, until a maximum dose of 2½ grains is reached. The injections should be given every other day, or perhaps better, bi-weekly. The total quantity required will be somewhere between 40 and 60 grains in all.

Under the injections the temperature falls, the patient gains weight, and the symptoms of the disease gradually disappear. The cure seems to be

a permanent one. The general health should also be built up by suitable food and other coincident infections—malaria, syphilis, dysentery, helminthic infections, etc.—treated. Marmite may be given at the same time to increase the leucocytes. The sodium salt, antimony sodium tartrate, is preferred by some, and is said to be less toxic. Various other preparations of antimony have recently been put on the market, some of which are said to be as good, or even better, than tartar emetic. Of those one may mention Von Heyden 471 = meta-chlor-para-acetyl-amino-phenyl-stibiate of sodium. This is put up in ampoules of 0·1, 0·2 or 0·3 gramme, and can be given intravenously every second day; Oscol stibium, a preparation containing Sb_2S_3 in true colloidal suspension—strength, 1 in 2000, dose 1 c.c. intramuscularly twice weekly; or Stibamine glucoside (Neostam) twice weekly, dose 0·1 or 0·2 gramme intravenously; Urea stibamine, dose 0·1 or 0·2 gramme twice weekly; and Stibacetin.

Oriental Sore

Synonyms.—Tropical Sore; Aleppo Sore; Bagdad Boil; Delhi Boil; Biskra Button; Bouton d'Orient; Date Boil, etc.

Definition.—An infective granuloma of the skin and subjacent tissues; the skin in some instances remaining intact, in others breaking down with the formation of chronic indolent ulceration.

Ætiology.—The condition is very common in parts of the East, notably in Bagdad, in Mesopotamia, in Lahore and Delhi in India, in Asia Minor, Arabia and Persia. It has also been noted in the Sudan and in Nigeria. It is due to a Leishmania, *L. tropica*. The parasite can be easily cultivated on N.N.N. medium; it is inoculable experimentally, and an insect, most probably a sandfly, is supposed to be its disseminator. *Phlebotomus papatasii* is now generally supposed to be the vector.

Pathology.—The lesion is that of an infective granuloma, granulation tissue with plasma cells, and large cells full of parasites. When the sore breaks the ordinary organisms of suppuration become implanted upon it, and the parasites may then be difficult to find. They can generally be recovered from the margins.

Symptoms.—The incubation period varies—it may be as long as 5 or 6 months. The sore starts as a small itching papule, which extends and gradually ulcerates the skin. The ulcer has fairly well-defined edges, and somewhat closely resembles a gumma. It is found on the exposed parts—hands, face, etc. Without treatment, the sore lasts a long time, even up to a year. They may be multiple.

Diagnosis.—This is made by finding the specific parasite. The best place to search for it is in the spreading margin of the sore. A hypodermic needle, or better, a fine glass tube should be inserted, and the juice sucked up may be inoculated into hæmoglobin tubes, smears being made at the same time for ordinary examination. The parasites may take some time to grow, and the cultures should be examined for several weeks before deciding they are negative.

Prognosis.—This is good, the sores eventually disappearing. The scars, however, if the lesion have been extensive, may be unsightly, especially on the face. As a rule, immunity follows healing of the sore.

Treatment.—Avoidance of bites from insects—a difficult procedure—is to

be advised. Many treatments have been tried: CO_2 snow, X-rays, radium, vaccines of killed cultures, methylene-blue, iodoform, salicylic acid, etc. Castellani recommends injections of oleum phosphoratum into the nodule and around it, in doses of 5 minims twice weekly. Antimony (tartar emetic) treatment is the best method to employ, the drug being administered intravenously or applied locally as a 2 per cent. ointment (Low). (See antimony treatment of kala-azar, p. 230.) In Bagdad, inoculation has been practised —somewhere on the limbs—to prevent the chance of a sore on the face with consequent disfiguration by scarring.

American Dermal Leishmaniasis

Synonyms.—Espundia; Uta; Pian Bois; Pian Cayenne; Forest Yaws; Bosch Yaws; Bubas Braziliana.

Definition.—An infective granulomatous condition either occurring locally as unbroken tumours (blind nodules) or as ulcers, these often being followed by a generalised infection which attacks and finally destroys the buccal and nasal mucosa.

Ætiology.—It is found in South America, in Brazil, Venezuela, British and Dutch Guiana, Bolivia, Peru and Paraguay. The condition is due to the *L. americana*. The disease is specially frequent amongst wood-cutters and people living in the forests. Some wood-loving insect-tick or bug is supposed to be the transmitting agent.

Symptoms.—The incubation period is variable. The sore starts as a small papule or pimple, which gradually extends, and in many instances ulcerates the skin. Without treatment, the sores last a long time, but finally may heal. The arms are very often affected, and the margin of the ear is another favourite site. At a variable time after the primary sore, small ulcers may appear, either round the margins of the mouth or nose, and by extension of a serpiginous nature gradually destroy the parts.

Diagnosis.—Finding the parasites completes the diagnosis; they will be seen, if carefully looked for, in scrapings of the ulcerated areas, or may be grown in cultures. Syphilis, rodent ulcer and malignant disease closely resemble the destructive forms.

Prognosis.—Before antimony treatment was introduced this was hopeless, death taking place in the generalised infections by gradual exhaustion and sepsis. Now, even though the buccal ulceration has commenced, it can be cured.

Treatment.—This is similar to that adopted in oriental sore and kala-azar. In view of the serious nature of the secondary lesions a full course of 30 or 40 grains—*in toto*—of tartar emetic should be given when the original sore appears.

TRYPANOSOMIASIS

Definition.—Trypanosomiasis is a term used to designate the invasion of man and other animals by flagellate parasites of the genus *Trypanosoma*. Two distinct forms are known in man, the African and the South American. Similar parasites also cause serious diseases in animals, nagana and surra being the best-known examples.

African Trypanosomiasis (Human)

This form of the disease is endemic in parts of equatorial Africa, and is due to two varieties of trypanosomes. In the initial stages the infection is characterised by irregular remitting fever, increased pulse rate and respirations, œdemas and irregular erythematous rashes—in the later stages (sleeping sickness), by gradually increasing lethargy, mental and physical degeneration, progressive emaciation, tremors, other nervous phenomena and death.

Ætiology.—The disease is limited geographically to areas where the intermediate host, the tsetse fly, occurs. The equatorial belt of Africa includes nearly the whole distribution, the Congo, Uganda, East Africa, Rhodesia, Nyasaland, etc., being the areas chiefly affected. There is no race discrimination between the whites and the natives. It occurs in children, and in both sexes equally.

1. The Central African type is due to *Trypanosoma gambiense* carried by the *Glossina palpalis*, the Rhodesian and Nyasaland to the *T. rhodesiense* carried by *G. morsitans*.

Nagana is a disease of cattle and horses due to a trypanosome, *T. brucei*. This trypanosome is found in the blood of the wild game in certain districts, and the tsetse fly, *G. morsitans*, after biting such game becomes infected. The trypanosome has now to undergo a development in the fly, and after this has taken place, forms find their way into the salivary glands and so into other animals bitten. The infection does not seem to trouble the wild game specially, but when non-immune animals are taken into tsetse-fly belts they are bitten by infected flies and develop a virulent type of the infection of which they quickly die.

As regards the form of human trypanosomiasis due to *T. gambiense*, the reservoir of the infection would appear to be in game which lives near lakes and rivers (Speke's tragelaph—the sitatunga—the reed buck, bush buck, etc.), and the *G. palpalis* receives its infection from those animals and so passes it on to man. The disease is strictly limited to the areas where this special tsetse fly lives, namely, on the banks of rivers and lakes.

2. The Rhodesian type of infection (due to *T. rhodesiense*) is quite different, for here the fly that spreads it is the *G. morsitans*, a fly which lives in dry arid country often far away from water. The reservoir for the trypanosome is again the game of the area, and it is possible, as Bruce believes, that this variety is really the same as nagana, and that it is just the animal disease occurring in man. If Bruce's contention be correct, then the name of *T. rhodesiense* would have to give way to *T. brucei*.

As the clinical symptoms and pathological details are similar in the two varieties just described, they may be considered together.

Pathology.—There is little or no doubt the lesions produced are due to toxins excreted by the trypanosomes; the parasites may, however, also produce local damage by passing through the vessels into the tissues. There is little to note macroscopically. The brain often looks like ground glass and has a fairly characteristic appearance in most cases. Sometimes a definite purulent meningitis exists. Microscopically, the changes found are those of a chronic meningo-encephalitis and meningo-myelitis. The whole pia-arachnoid is infiltrated with mononuclear cells and a similar change

spreads along the septa, and affects, in varying degree, the perivascular spaces round the blood vessels. The cerebral fluid is in excess and finally contains trypanosomes. The pressure on the vessels by the proliferation of cells in the perivascular spaces accounts for the peculiar lethargy seen in life. Small-celled infiltration round the vessels, with trypanosomes lying in the surrounding tissues, is found in the viscera. The lymphatic glands are enlarged and congested, with a proliferation of lymphocytes.

Symptoms.—For convenience of classification the African form of human trypanosomiasis may be divided into—(1) The phase of trypanosomiasis fever. (2) The phase of sleeping sickness; the latter again being subdivided into—(*a*) A stage of indefinite symptoms with some degree of drowsiness and increasing languor; (*b*) the stage of drowsiness, marked lethargy, tremors and other definite phenomena; and (*c*) the terminal stage of emaciation, intense weakness, gradually increasing coma and death. These different phases pass insensibly into each other just in the same way as the phases of syphilis.

The disease may run an acute or chronic course.

1. Trypanosomiasis Fever.—The incubation is a short one, as judged by experimental inoculations in animals—5 days or so. In several of the Rhodesian cases the infective bite was followed by cellulitis round the puncture wound. After the incubation period is over the following symptoms appear: (1) An irregular remittent or intermittent temperature. (2) An increase in the pulse rate to 100 or 120 or more. (3) An increase in the respiration rate to 20 or 30. (4) Irregular patches of a congested or erythematous character, often somewhat circinate in contour, the colour returning after pressure and distributed chiefly on the trunk. (5) Œdema of the legs, or face, or both, varying in degree from a scarcely noticeable swelling to well-marked puffiness. (6) Adenitis.

The disease, if untreated, terminates in sleeping sickness or in some intercurrent infection.

2. Sleeping Sickness.—(*a*) *First phase.*—This begins very insidiously, months or even years after the original trypanosome infection. The patient complains of indefinite pains in the chest; though previously quick and alert, he becomes dull and disinclined to work, with loss of weight, glandular enlargement, and there may be some slight tremor of the tongue. (*b*) *Second phase.*—The facial aspect gradually changes, the countenance becoming sad, apathetic and morose. The disinclination to do anything becomes more pronounced, and a tendency to doze or sleep constantly now becomes evident. The speech is mumbled and slow, the gait shuffling, tremors are marked—fine fibrillary ones in the tongue and arms—and glandular enlargement may be visible even at a distance. (*c*) *Third phase.*—All the symptoms become more pronounced, the patient takes to his bed, muscular weakness and wasting become very noticeable, the lethargy is much increased, saliva dribbles from the mouth, the skin may lose its lustre, papular eruptions and bed-sores are common, and epileptiform convulsions often occur. In young adults flexure-contractions of the limbs render the condition a miserable one. The drowsiness eventually passes into coma from which the patient cannot be roused, the temperature falls to subnormal, the body and extremities become cold and clammy, and death takes place. Anæmia in varying degrees is constant in the disease. The average number of red corpuscles is about 3,000,000 or under per c.mm. Just before death, there may be an abnormal

rise (over 6,000,000 per c.mm.), but more usually a gradual fall (under 2,000,000) takes place. The hæmoglobin is reduced proportionately, the blood showing all the characteristics of a secondary anæmia. The leucocytes are normal, or slightly diminished in number; certain cases show a well-marked terminal polymorpho-nuclear increase just before death. Differentially, the large mononuclears are increased—10 to 12 per cent. Trypanosomes are present in the blood, but may be very scanty and difficult to find.

Diagnosis.—All irregular fevers occurring in people who have been living in areas where sleeping sickness is endemic, especially if not influenced by quinine, should be viewed with suspicion. The pulse rate and respirations should be carefully studied and the skin examined for the circinate erythematous patches. Attention should also be given to any adenitis. Trypanosomes should be searched for in blood films, in the glandular juices and in the cerebro-spinal fluid. They should always be demonstrated before making a diagnosis and commencing treatment. The serum-formalin reaction, Napier's "aldehyde test" (*vide* p. 230) has lately been recommended for the diagnosis of trypanosomiasis. It is said to be positive, and to have some value.

Prognosis.—Since modern methods have been introduced this is more hopeful in the *gambiense* cases. Almost all, without exception, of the Rhodesian cases have died, as apparently this is a very much more virulent type.

Treatment.—Destruction of forest and bush round the edges of lakes and rivers will drive away the *G. palpalis*, and render the area safe. To deal with *G. morsitans* is quite a different matter, and is practically impossible. The destruction of game has been suggested; it is difficult to see how this could be done, and it is not altogether clear if such destruction would have the desired effect. We require to know more regarding the infections of the smaller mammals before attempting means of this sort. In passing through *palpalis* areas, gloves should be worn and a gauze net placed over the head. Shorts should not be allowed. When travelling in *morsitans* areas there is little chance of escape from being bitten, and then it becomes purely a matter of luck whether the bite is infectious or not. Recently two new drugs have been introduced into the treatment of the disease, namely Bayer, "205" and tryparsamide. The former is given in 1 gramme doses weekly until a total of 10 grammes in all has been taken. The drug is very efficacious in early cases, but apparently is not so good in the late stages of the disease when the central nervous system is involved. Unfortunately it produces an albuminuria and during the administration the patient should be kept in bed warm, and on a milk diet. In most cases this symptom is eventually recovered from. Failures have recently been noted with "205." In many instances, however, the drug was not administered in a proper manner, the dosage being too low.

Tryparsamide is given to begin with in 1 gramme doses, these being increased to 2 or even 3 gramme doses weekly, until a total of 20 or 30 grammes in all has been taken. Eye symptoms—affections of the optic nerve—may follow the administration. Dr. Louise Pearce speaks well of the drug and has used it extensively in the later stages of the disease, in natives in the Congo. Previous to the introduction of these new drugs treatment consisted of atoxyl injections, 2½ to 3 grs., into the buttocks, twice weekly, these being continued for 6 months to a year. At the same time long courses of tartar emetic were given intravenously, beginning with half-grain doses, bi-weekly,

and gradually increasing to 2½ grs. for a maximum single dose. As much as 60 grs. *in toto* were given for a course. After a rest a second course was undertaken, and so on, for 2 or even 3 years. Whichever method is adopted the patient's general health must be built up in every way, and all other infections, if present, be eliminated.

South American Trypanosomiasis (Human)

Synonyms.—Chagas' Disease; Coreotrypanosis.

Definition.—A trypanosome disease, with symptoms very similar to those of insufficiency of the glands with internal secretions.

Ætiology.—The disease has been recorded in Brazil, but possibly has a wider distribution, which necessarily will be limited by that of the intermediate host. Children suffer from the disease as well as adults. The disease is due to the *T. cruzi*, man becoming infected by the bite of the *Lamus megistus*, also known as *Conorhinus megistus*, which apparently can transmit the infection in the larval, nymphal and imaginal stages. The flagellates are found in the peripheral blood after infection, only for a comparatively short time (2 weeks only in many cases). They then pass into the internal organs and assume a Leishmanial form, such forms producing pathological lesions in the organs infested, where the parasites divide, and from time to time trypanosome forms are produced which may find their way back into the peripheral blood. When the larvæ of *L. megistus* absorb infected blood, the trypanosomes quickly take on the crithidial form, multiply actively, and then become trypanosomes again, which are inoculable into vertebrates.

The carrier of *T. cruzi* in Venezuela is the *Rodnius prolixus*.

Pathology.—Vianna gives the following as the post-mortem appearances. Polyorrhomenitis, with serous effusions of a yellow colour; constant swelling of the lymphatic glands of the abdominal cavity, mediastinum, neck, axilla and groins; fatty degeneration of the liver, swelling and softening of the spleen; sclerosis, hypertrophy and cyst formation, often with calcification, of the thyroid gland; frequently myocarditis and changes in the suprarenal capsules. The Leishmanial forms of the parasite are found specially in the heart muscle, voluntary muscles, brain, thyroid gland, suprarenals, ovaries and testicles. The central nervous system shows cell destruction and areas of inflammation, the meninges very marked inflammatory changes, and many of the small arteries exhibit slight perivascular changes. The pathological conditions found are those of a meningo-encephalo-myelitis.

Symptoms.—Chagas divides the disease into acute and chronic forms.

Acute.—These acute forms are very common in young children, even in the first months of life. They are subdivided into—(*a*) the encephalo-meningitic form, the mortality in which is very high owing to the brain involvement, and (*b*) where there are no nervous symptoms, the prognosis being more favourable, the disease usually passing into one of the chronic forms. The main feature of all the forms would appear to be an insufficiency of the glands with internal secretions, hypothyroidism predominating, though suprarenal inadequacy is also common.

The temperature keeps up as long as the parasites exist in the peripheral blood, the thyroid gland is enlarged, the subcutaneous tissues show an acute

mucous infiltration, the lymphatic glands are swollen, hepatomegaly is present, and the spleen moderately enlarged. If the brain be involved the symptoms of encephalo-meningitis are present as well.

Chronic.—Five clinical groups are comprised under this heading—(1) Pseudo-myxœdematous; (2) Myxœdematous; (3) Cardiac; (4) Nervous; (5) Chronic, with subacute manifestations.

In the first group, the thyroid gland is enlarged, the face is puffy, and the skin a peculiar colour like dull bronze. The lymphatic glands are enlarged, and there is a high degree of cardiac insufficiency; hypothyroidism is pronounced. Convulsions are frequent.

In the second group, the picture is one of typical myxœdema—arrest of growth, solid œdema, parchment skin, etc.

In the third group, there are various disturbances of the heart rhythm, extra systoles, heart block, and other irregularities, due, no doubt, to the presence of the parasites in the myocardium.

In the fourth group, paralysis, aphasia and idiocy are common. Owing to the occurrence of the parasites in multiple foci in the brain, different motor symptoms are met with—spastic phenomena, diplegia, athetosis and flexure contractions. In children, the mental intelligence is always below par, all transitions between complete idiocy and a simple cretinoid state existing.

In the fifth group, the fresh manifestations may either be due to fresh infection or to lighting up of some of the existing foci. The results acquired from a study of such cases has led Chagas to believe the trypanosome in its later developments in the tissues of man becomes almost exclusively a connective-tissue parasite.

Diagnosis.—In the early stages this can be made by finding the trypanosomes in the blood. In the later stages, when the parasites have disappeared, it is not so easy. Puncture of some of the voluntary muscles might reveal the Leishmanial form of the parasite, which is diagnostic.

Prognosis.—This is not good.

Treatment.—The destruction of *Lamus*-infested houses must come first in the prophylaxis of the disease. All such insects should be destroyed where possible—by fumigation or by other methods. So far no cure is known for the disease; but antimony injections should certainly be given a trial. As such injections act so well in Leishmanial infections, it is reasonable to suppose they might also do so in this disease.

AMŒBIC DYSENTERY

Definition.—An invasion of the colon of man by the *Entamœba histolytica*.

Ætiology.—This dysentery is found throughout the tropics, sub-tropics, and even in temperate regions. Both sexes and all ages are liable. The *E. histolytica* gains access to the body in its cystic form by the mouth in drinking water, or on contaminated vegetables. This passes the stomach safely, after which the wall of the cyst is dissolved by the pancreatic juice, and the young amœbulæ contained in the cyst escape, pass down the intestine and locate themselves in the mucous membrane of the colon, where they form adult amœbæ (vegetative forms) which live on the tissues; the amœbæ again form cysts, which escape in the stools, and so disseminate the infection.

Pathology.—The amœbæ histolyse the tissues with which they come in contact, and finding their way into the submucosa, form ulcers in the large bowel, which tend to extend longitudinally, the openings in the mucous membrane in consequence being narrower than the floor of the ulcer (bottle-necked ulcer). The edges of the ulcers are raised and hardened, with marked undermining. There may only be a few ulcers, or practically the whole of the mucous membrane from cæcum to rectum may be involved. Without treatment, the ulceration tends to become chronic, and though healing in some places, breaks out in others. The amœbæ are seen lying in large numbers throughout the necrosed and dead tissues. When an ulcer heals a flat pigmented scar is left.

Symptoms.—The condition may begin as a diarrhœa (amœbic diarrhœa), but later, as a rule, blood and mucus appear in the stools, the latter often consisting of nothing but pure mucus and blood, in which amœbæ are easily demonstrated. Great pain, tenesmus, griping and purging, as many as 20 stools being passed per day, are concomitant. Even without specific treatment, the tendency for amœbic dysentery is to improve temporarily, but relapses are frequent, and very characteristic of the disease.

The amœbæ may be carried from the intestine and lodge in the liver (see article Amœbic Hepatitis and Hepatic Abscess, page 629), lungs, or brain (secondary amœbiasis). In the liver their presence gives rise to hepatitis, and if this be neglected, to abscess formation. The signs of an abscess in the liver are an irregular fever, often rigors, sweating at nights, pain in the right side and in the right shoulder, leucocytosis, with an enlarged and painful liver. If untreated, a chronic cachexia, with anæmia, supervenes, and emaciation may become extreme. In the brain the symptoms are similar to those of abscesses from other causes.

Complications and Sequelæ.—Abscess formation is the most serious complication of amœbic dysentery. When in the liver the abscess may burst into the lung and be coughed up, or it may burst into the pleura, the pericardium, stomach or large bowel. An ulcer of the bowel may perforate, or may cause adhesions with subsequent obstruction to the lumen.

Course.—Once the acute signs of dysentery abate, the vegetative forms of the parasite usually disappear, their place being taken by the cystic stage. Abscesses behind the colon are also met with. The patient becomes a carrier, liable, however, to frequent relapses with acute exacerbations from time to time.

Diagnosis.—This is made by finding the characteristic parasite in the stool, *E. histolytica*—living forms or its cysts. The latter generally have 4 nuclei with a chromatoid body, and measure on an average 10 to 14 μ in diameter. They may be made to appear in increased numbers in the stools by the administration of biliary extracts, and before declaring a patient clear this procedure should be tried. Sometimes they are extremely scarce, many examinations, even up to ten or more, being required to demonstrate them. The cerebral amœbic abscesses are impossible to diagnose from ordinary brain collections of pus.

Prognosis.—With modern methods of treatment this is good, a large proportion of cases being curable. There are, however, a small percentage which resist all forms of treatment (chronic resisters). The prognosis in liver abscess varies; it must always be considered a serious condition.

Cerebral amœbic abscesses are always fatal.

Treatment.—This is carried out by means of emetine, either by the mouth or needle; it is more efficacious given by the mouth, and more cases can be completely cured by this method; it should be administered as emetine bismuth iodide grs. iij in a hard gelatine capsule every night for 12 nights. By injection, 1 grain of emetine hydrochloride is given every evening for 12 consecutive nights.

If relapse occur after one course, a second course of double the dosage must be tried, namely, E.B.I. grs. iij, every night for 24 nights if the patient can stand it. Another plan is to combine the two methods, giving an injection in the morning and a capsule of E.B.I. grs. iij, at night. This large dosage must be carefully watched, as the heart often becomes affected and the patient feels very depressed and low (emetine poisoning). One has often to stop the treatment after 8 or 10 of these double doses have been given on account of this. In addition, the patient must be kept in bed and dieted with great care, albumin water, raisin tea and milk to begin with, and after convalescence white meat diet, the staple of which should be milk. No alcohol must be allowed, and great care should be taken to avoid over exertion and chills. Another method of treatment—not so drastic as the above—is that by emetine periodide (E.P.I.). This does not produce sickness and is given in 2-grain doses, three times a day for 10 days, *e.g.* 60 grs., or ʒi in all. Willmore has had good results with this, even in cases which have failed to respond to emetine bismuth iodide. He recommends giving with each dose of the emetine periodide a 5-grain tablet of fel bovinum.

In emetine-resistant cases, stovarsol, first recommended by French observers, may be given. Though not apparently a true specific, it nevertheless improves some of the cases. It is administered by mouth, a 4-grain tablet being given once or twice a day for 10 days, then one tablet on alternate days, then one twice a week for several weeks. Yatren, a German preparation, has also been used. It is given by the mouth, in the form of a pill or a capsule, and at the same time the rectum is irrigated with a solution of it, 6 to 8 injections being given. It does good in some cases. The diet in these chronic cases must also be of the simplest nature. Abscess formation requires surgical intervention. Aspiration is the best method of treatment, this often resulting in cure after one evacuation. It prevents the secondary infection of the cavity with pyogenic germs, a contingency so often met with after the "open" or "trocar and canula" methods.

For Bacillary Dysentery, see p. 85.

G. Carmichael Low.

E. INFECTIOUS DISEASES OF DOUBTFUL OR UNKNOWN ÆTIOLOGY

MEASLES

Synonym.—Morbilli.

Definition.—A specific infectious fever, characterised by catarrh of the respiratory passages, the presence of Koplik's spots on the mucous membrane

of the cheeks, a distinctive papular eruption on the skin and a special liability to pulmonary complications.

Ætiology.—Measles is of universal geographical distribution. Both sexes are equally liable to attack. It is extremely infectious, and there is little evidence that natural immunity ever occurs. When introduced among unprotected communities it spreads with appalling rapidity to persons of all ages, and causes many deaths. More than half the attacks of measles occur in the first 5 years of life, but infants under 6 months rarely take the disease. Seven-eighths of all cases occur in children under 10. Between the ages of 20 and 30 there is a slight increase in its incidence. After 40 years it is rare. When measles occurs in a pregnant woman abortion or premature delivery often results, and the infant may also exhibit the rash, usually in the same stage as the mother (*Congenital Measles*). Malnutrition, rickets, broncho-pneumonia, whooping-cough and tuberculosis are adverse factors. Recent infection with diphtheria or scarlet fever predisposes to a severe attack. The disease is always endemic in large cities, and cases are particularly numerous in December, January and February, again increasing somewhat in May and June. Epidemics recur every two or three years, and every tenth year an especial incidence is said to be noticeable.

The virus resides in the secretions of the respiratory tract and direct infection is the rule, a very intimate contact not being essential. Infectivity may be present as long as 4 days before the appearance of the rash, and then rapidly declines. Only on rare occasions do intermediaries convey the infection, and rooms and fomites do not retain it for more than a short period. There is no evidence incriminating water, milk or other articles of food.

Pathology.—The causal agent has not been identified. A small diplococcus, which forms green colonies on blood-agar, isolated by Ruth Tunnicliff, is suspect. The disease has been reproduced in man and monkeys by inoculation with blood, bronchial secretions or tears. The eruption is an inflammatory process in the dermis, more superficially seated than that of scarlet fever. Koplik's spots are minute epithelial degenerations on the crowns of the papillæ of the buccal mucous membrane. The most striking visceral change in fatal cases is broncho-pneumonia; interstitial emphysema and areas of collapse may also be present, sometimes secondary pleurisy or empyema. Pulmonary fibrosis and saccular bronchiectasis may be sequels of an attack. Secondary infections with various organisms are common. Catarrhal or ulcerative laryngitis may be found. The bronchial glands are inflamed and swollen; the lymphoid aggregations of the small intestine may be very conspicuous. Tuberculous lesions of glands, lungs and serous membranes are not uncommon in fatal cases.

Symptoms.—The rash appears on the fourteenth day of infection, sometimes a day earlier or a day later. This interval is more constant than that which elapses between infection and the first catarrhal symptoms. Reckoning to the onset of fever and catarrh 9 or 10 days usually pass. In some cases the incubation period is slightly febrile, but generally it is silent. A polynuclear leucocytosis is characteristic of this stage. Slight enlargement of the cervical, inguinal, axillary and other glands may precede the eruption. A better recognised prodromal symptom, and one of very great value, is the appearance of Koplik's spots on the buccal mucosa; these may precede the rash by 2 or 3, sometimes by 5 days. Prodromal rashes are not un-

common; a precocious macular eruption is the commonest, but a punctate scarlatiniform erythema is the most important, since it simulates scarlet fever. It is apt to appear on the second day of invasion. An urticarial rash may also occur.

Invasion.—This is characterised by catarrh of the upper respiratory tract, fever, and the outbreak in the mouth of Koplik's spots. It culminates in the appearance of the skin eruption. Sneezing, a dry irritating cough, watery eyes and conjunctival injection are the early catarrhal signs. There is complaint of chilliness, and the temperature may reach 103° F. by the end of the first day. Photophobia and sharp diarrhœa may occur. Vomiting, marked sore throat, epistaxis, convulsion or rigor are rare. Even in the early stage of invasion slight blotchiness of the skin about the mouth and nose may be evident. The cutaneous rash usually appears on the fourth day, and a deceptive remission of symptoms and fall of temperature sometimes occur just before its appearance. In some instances laryngeal symptoms are very marked during the invasive stage, and give rise to an unfounded suspicion of diphtheria.

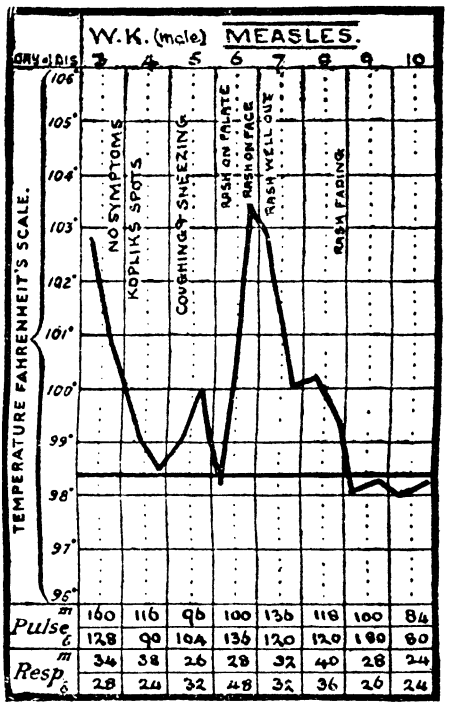

FIG. 2.—Measles. Showing the remission in invasion stage and the abrupt termination.

Koplik's spots are of great importance in the early diagnosis, since they are recognisable some 72 hours before the rash. They are minute superficial specks of a bluish-white tinge, and often show a tendency to aggregate into small clusters. Their common site is on the inner aspects of the cheeks, opposite the line of apposition of the molar teeth; but they may be more widely scattered over the buccal mucous membrane, on the inner surfaces of the lips, and even, it is said, on the conjunctivæ. They must not be confused with minute yellow nodules *in* the mucosa, which are buccal glands, or with specks of milk curd, shallow ulcers or thrush. Sometimes they are surrounded by a bright red areola. In addition, the mucous membrane of the mouth becomes congested and dusky, and a decided blotchy enanthema may precede the cutaneous rash.

Period of eruption.—With the near approach of the rash the symptoms become aggravated. The temperature (Fig. 2) rises sharply, it may be to 104° or 105° F. The hurried respiration and slight cyanosis may suggest broncho-pneumonia. Diarrhœa may persist, and sometimes urinary irritation with frequency of micturition is noticeable. The nasal and conjunctival dis-

charges become less serous and more purulent. The eruption makes its first appearance about the brow, behind and below the ears, and in the circumoral region. Rarely, it appears first on other parts, such as the buttocks, thighs or wrists. It spreads rapidly, sometimes after a short hesitation, over the face, neck, trunk and extremities, and is usually fully out on the fifth or sixth day of the attack. Small brownish macules are the first elements, but they soon become papular, and show a tendency to fuse into small groups with irregular sinuous or crescentic outlines. Profuse eruptions may become quite confluent on the face, neck, back and extensor aspects of the limbs. Petechial hæmorrhages in the rash are not uncommon. The skin is usually moist, and exhales a peculiar musty smell. Rarely, it is hot and dry. Itching or burning sensations may accompany the rash. The eruption fades in the order of its appearance, and usually disappears in the course of two or three days; but brownish staining may persist for some time, particularly on the back. Exposure or bathing may intensify it. A fine branny desquamation speedily follows. At its first appearance, the rash may fail for a time to spread; retrocession is also sometimes observed. A badly developed and retarded rash is characteristic of some severe attacks, and in asphyxial states the rash may be quite cyanotic. As the rash develops, the temperature continues to rise, reaching its maximum with the climax of the attack in from 24 to 48 hours. When the rash begins to fade, the temperature falls more or less abruptly by a crisis which is rather prolonged. The pulse-rate is increased in proportion to the fever, but the respiration is disproportionately rapid. The catarrhal symptoms also reach their greatest intensity at the height of the eruption. The edges of the eyelids are sticky, the skin about the nostrils may be excoriated, the mouth is parched, and thirst is pronounced. Headache, slight delirium, insomnia and a feeling of intense wretchedness are characteristic of this period. The throat may be sore, and the glands at the angle of the jaw tender. The tongue at first is heavily coated, but before long red papillæ are evident, and when peeling is complete a clean, red papillated tongue, very like that of scarlet fever, may often be seen. With the crisis rapid amelioration of all symptoms should occur; but slight cough and hoarseness may persist for a few days.

The blood now shows a leucopenia with a high percentage of large lymphocytes. All complications induce a polynuclear leucocytosis.

The urine presents the ordinary febrile characters. Transitory albuminuria may occur. Ehrlich's diazo-reaction is nearly always present, and is most marked when the temperature begins to fall. An acetone reaction is obtained in most cases.

VARIETIES.—Attacks may be mild or severe. Some of the mildest attacks are aberrant, the rash failing to appear, and only Koplik's spots giving a clue to the disease. Severe attacks are classified as toxic, pulmonary and hæmorrhagic. The *toxic type* includes those cases formerly termed ataxic or adynamic, in which the patient may succumb during the eruptive period without evident complication. Ill-defined rashes, high fever, muscular tremor, delirium, dyspnœa and circulatory failure are characteristic features. In the *pulmonary type* the infection falls with especial stress upon the lungs. The temperature is high, the respirations rapid and hissing, and the condition suggestive of slow asphyxia. Consolidation of the lungs cannot be detected,

but rhonchi are present everywhere, accompanied by fine crepitations. A stuporose condition may precede death or terminal convulsions may arise. The true *hæmorrhagic type* of measles is rare, but undoubtedly does occur. The patient may bleed from the different mucous membranes with hæmorrhages into the skin and subcutaneous tissues. Recovery takes place in some instances. Hæmorrhage into the rash has not the same grave significance as the hæmorrhages described above.

Complications.—These are numerous, but those involving the respiratory tract are the most important and most serious.

Laryngitis may accompany the onset, develop during the eruption, or appear early in convalescence. Arising in the invasive stage it may simulate laryngeal diphtheria, and is often responsible for the introduction of measles into diphtheria wards. Laryngitis is more common during the eruptive period, and may persist for some days—it may be complicated by laryngeal ulceration, sometimes by œdema of the glottis; but necrosis of the laryngeal cartilages and abscess formation are rare. Severe laryngitis developing during convalescence should always arouse suspicion of diphtheria.

Bronchitis is often present during the eruptive stage, but broncho-pneumonia is a much more serious complication, and is a common cause of death. Its incidence is favoured by overcrowding, and contact with other similar cases. It is attributed to secondary pneumococcal or streptococcal infection; but when occurring quite early in the infection it is by some regarded as due to measles itself. This early broncho-pneumonia is associated with a high temperature and considerable toxæmia. It is suffocative in type, and the lung signs are rather those of capillary bronchitis than of consolidation. During the eruptive stage, broncho-pneumonia should be suspected if the temperature fails to fall with subsidence of the rash, and the pulse remain quick and respiration rapid. In some cases it is possible to detect areas of consolidation by the local development of fine crackling crepitus, which is both inspiratory and expiratory in rhythm. Faint tubular breathing may occasionally be heard, but definite dull patches are the exception, and are only found when the consolidated areas become confluent. Broncho-pneumonia may clear up in a week or ten days, but often persists for weeks, or relapses. The temperature chart may show remarkable daily remissions and exacerbations which may lead to suspicions of tuberculosis. The mortality is serious, since one-third or one-half of the children attacked are said to die. Feeble infants succumb more rapidly than older children, and in those who recover convalescence is protracted. True lobar pneumonia is uncommon. Massive collapse of the lower lobe of a lung has been described; its onset is sudden with intense dyspnœa, cyanosis and cardiac failure. It is distinguished from pneumonia by the feebleness of the breath sounds, upward displacement of the diaphragm, and dislocation of the heart towards the affected side. Effusions into the pleura have been noticed in some epidemics, and empyema may follow. Fibrosis of the lung and bronchiectasis may originate in the broncho-pneumonia of measles.

Pericarditis is very rare. Endocarditis sometimes develops; it may be associated with chorea. Arthritis with rheumatic pains is sometimes pronounced.

Blepharitis and phlyctenular ulcers of the cornea are common sequels.

In cachectic children intense conjunctivitis may arise and lead to ulceration and even perforation of the cornea with destruction of the eye.

Stomatitis of catarrhal type is common. Ulcerative and gangrenous forms are occasional complications. The gangrenous form (noma) may attack the lips, cheeks, vulva or other parts. A discoloured patch appears on the mucous membrane and quickly ulcerates, extending both in depth and breadth. A zone of inflammatory induration surrounds the lesion, and a fœtid odour is given off. Noma is terribly destructive both to soft parts and bone, and is very fatal. It occurs in debilitated and feeble children, and is attributed to secondary infection. Vincent's spirilla and fusiform bacilli are often present. It is said to be sometimes due to the Klebs-Loeffler bacillus. Suppurative otitis is more common in children than in adults, and is held responsible for much chronic ear disease.

Cutaneous eruptions of eczematous, impetiginous or pustular type are common. Sometimes they are widespread, and very resistant to treatment.

Enlargement and suppuration of the cervical glands, colitis and ascites are rarer complications.

As regards the nervous system, convulsions at onset are not so serious as those occurring later. Hemiplegia, aphasia, coma or mental defect are rare, and are attributed to encephalitis. Myelitis, sometimes of the ascending form, has been known to occur; also symptoms suggestive of disseminate sclerosis. Sometimes the cranial nerves are attacked. Paralysis of extra-ocular muscles, papilloedema and optic atrophy have all been encountered. The peroneal type of muscular atrophy sometimes follows measles.

Measles especially favours the development of tuberculosis hitherto latent in the bronchial glands or lung. It may also light up tubercle in other glands in the joints or in the spine. Caseous broncho-pneumonia, miliary tuberculosis of the lungs, or general tuberculosis with meningitis may follow measles immediately or occur after a quiescent period. Measles often occurs in close association with other infectious diseases, particularly whooping-cough, diphtheria and scarlet fever.

Relapse in measles is rare. Second attacks, although uncommon, undoubtedly occur, and some unfortunate individuals never appear to acquire any lasting immunity. Fourth, and even sixth, attacks are known.

Diagnosis.—In the prodromal stage, measles may be mistaken for ordinary naso-pharyngeal catarrh. If laryngitis be pronounced, and the child croupy, diphtheria may be simulated. Mastoid operations and operations on the tonsils sometimes are performed precipitately before the true nature of the infection is recognised. Febrile symptoms and loss of weight during the incubation stage may be erroneously attributed to tuberculous infection. The prodromal scarlatiniform rash may lead to confusion with scarlet fever. These errors may be avoided by bearing in mind the possibility of measles, inquiring for possible exposure to infection, and particularly by a careful search for Koplik's spots, and shottiness of the posterior cervical glands. The pre-eruptive fall of temperature and recession of the catarrhal symptoms before the appearance of the rash should be borne in mind, and not lead to premature relaxation of precautionary isolation. In the eruptive stage, the fevers with which measles may be confused are rubella, small-pox, and perhaps typhus.

Rubella is distinguished by the trivial nature of its prodromal symptoms

—the rash on the face being often its first sign; the slightness or absence of catarrh and cough; the insignificant fever; the absence of Koplik's spots; and the presence of tender enlargement of the mastoid and occipital glands. The rash of rubella is smaller, pinker, and more discrete; but a scarlatiniform stage may supervene. The patient never feels so ill as in ordinary measles.

Small-pox may be heralded by a prodromal rash of morbilliform character, which may have a similar distribution to that of measles, save perhaps on the face. Catarrh, stomatitis and Koplik's spots, however, are absent, and the onset is more abrupt than that of measles, and more likely to be signalised by such symptoms as backache, acute shivering, vomiting and prostration.

Measles may, on the other hand, be mistaken for the early eruptive stage of small-pox, for in both an illness for a few days may precede the appearance of a papular rash on the face and upper parts of the body. Catarrh, Koplik's spots and distribution of the rash about the ears, forehead and margins of the hairy scalp are in favour of measles. The temperature, too, continues to until the maximum efflorescence, whilst that of small-pox falls with the appearance of the rash. As the rash develops, the shottiness of the small-pox papules and the peculiarities of their distribution become apparent.

Typhus fever may be simulated by measles when the rash of the latter is receding and dusky, and lung complications are present; but the rash of typhus rarely invades the face, which is always affected in measles. Koplik's spots do not occur in typhus, nor is respiratory catarrh present in its early stages. Typhus is also distinguished by the subcuticular mottling, and the tendency to the appearance of petechial hæmorrhages in the rash. The Weil-Felix reaction also is valuable.

Septic rashes in scarlet fever are often morbilliform; but their distribution does not conform to that of the measles rash. *Serum rashes, food rashes* and *drug eruptions* may assume a measly character; but these rashes often prove to be polymorphic when the whole body is examined, as it should be, and, besides, other signs of measles are wanting.

The *macular syphilide* is distinguished by the absence of respiratory catarrh and Koplik's spots. History of exposure to infection, a chancre and the accompanying throat symptoms afford a clue. The Wassermann test should be employed.

Prognosis.—In different epidemics the death-rate may vary from 1 or 2 to over 50 per cent. Measles is most fatal to infants and young children, 70 per cent. of the mortality occurring in children under 3 years of age. After the fourth year the death-rate is low. Rickets, tuberculosis, congenital syphilis, malnutrition and chronic bowel complaints are unfavourable factors, and the disease is more fatal among the poor. In the cold season of the year the tendency to respiratory complications is more marked. When the infection occurs in conjunction with whooping-cough or chronic lung disease the mortality is high. Diphtheria is an especially fatal complication. Considerable toxæmia with high fever, cyanosis, muscular tremor and diarrhœa point to a severe attack. Laryngitis, capillary bronchitis and broncho-pneumonia are serious. Cerebral symptoms, such as prolonged stupor or convulsions, are of bad augury. Remarkable recovery has been noticed in some cases of ascending myelitis.

Treatment.—*Prophylactic.*—Measles is chiefly disseminated by schools.

The difficulty in controlling outbreaks of measles arises from the fact that it is extremely infectious, and the infectivity is present in virulent form for 3 or 4 days before the rash appears. Notification and school closure have been tried with poor results. The best method is to exclude those in a class, who have not had measles previously, from school for a period covering the ninth to the fourteenth day after the occurrence of the first case.

As regards the home, when measles occurs those who have had the disease need not be excluded from school—save from infant classes; but those presumably susceptible should be excluded for over 14 days from exposure to infection.

Serum prophylaxis.—Intramuscular injection of the blood serum of healthy convalescents from measles into susceptible contacts produces a *passive* immunity, which lasts about a month. Injection during the first 5 or 6 days of the incubation period prevents measles if the dose is adequate. Injection after the sixth and before the ninth day will modify the severity of attack, and allow the development of an *active* immunity which is lasting.

Five c.c. is an average dose for a child; more is needed for adults or if the serum is injected late. In children under 3 years of age it is better to prevent the attack altogether. The most potent serum is obtained from the sixth to the ninth day after defervescence. The donor must be free from syphilis, malaria and tuberculosis, and must not be incubating any other infectious disease.

If measles follows the subcutaneous injection of immune serum the rash fails to erupt at the site of injection; this is the *Debré phenomenon.*

Systematic taking of temperatures and examination for Koplik's spots and catarrh facilitate early detection of the disease, when patients are under close observation. The wilful exposure of children to the contagion of measles is unjustifiable, as the nature of the resulting attack can never be predicted.

Fourteen days' quarantine is sufficient from the date at which exposure to infection ceased. Convalescent patients in the absence of complications are quite free from infectivity at the end of a fortnight from the appearance of the rash.

General.—Essential points are isolation and provision of ample fresh air without draughts. The patient must be confined to bed during the febrile, and also during the prodromal stage, if this be recognised in time. The sick-room should be kept at a temperature of 60° to 65° F., and ventilation effected by means of open windows; an open fire is also an advantage. The photophobia calls for the interposition of a screen between bed and window, and the avoidance of much light. Clothing should be light and consist of a flannel or woollen nightdress; this is sufficient to prevent chill, allows the respiratory muscles full play, and encourages the evaporation of perspiration. Strict attention should be paid to cleansing the mouth and teeth, and the regulation of the bowels. During the febrile stage the diet should be restricted to milk, diluted if necessary with barley water. Tea may be allowed, and lemonade or barley water given to assuage the thirst.

Twice a day during the febrile period the patient should be washed with tepid water; but should the attack assume a toxæmic form, accompanied by high fever and delirium, cold sponging or the use of the cold pack is advisable, watching carefully for any signs of collapse. Amidopyrin has also been

recommended. The hot mustard bath is useful for children when pyrexia is accompanied by such indications of circulatory failure as feeble pulse, cyanosis and cold extremities. Should convulsions ensue, the administration of chloral and bromide, or paraldehyde, by mouth or rectum, and the use of oxygen and of hot baths are valuable.

Laryngitis in the early stage is relieved by the steam tent and the use of a simple expectorant mixture, to which a sedative may be added. The croupy symptoms usually subside without necessitating tracheotomy or intubation. The possibility of the presence of diphtheria renders a bacteriological examination desirable.

Laryngitis which persists after the eruption may be alleviated by the inhalation of tincture of benzoin or lysol in the strength of 1 drachm to the pint of boiling water. The accompanying cough is relieved by a simple linctus, or one containing $\frac{1}{8}$ grain of morphine or other sedative. Late laryngitis is often diphtheritic, and needs antitoxin. Bronchitis and broncho-pneumonia call for prompt treatment. A jacket of Gamgee tissue should be applied to the chest. If the cough be dry, hard and irritating, steam often relieves. An expectorant mixture containing ipecacuanha and a small quantity of iodide of potassium is useful. Prolonged poulticing should be avoided; but sometimes a single mustard and linseed poultice gives great relief. As soon as the cough becomes looser, the steam tent should be discarded and free ventilation arranged. If possible, it is well to separate cases with broncho-pneumonia from others, as the condition is believed to be itself infectious. Treatment of the broncho-pneumonia of measles in the open air, where circumstances and weather permit, gives excellent results. Oxygen is valuable where there is much respiratory distress and cyanosis; it may be bubbled through rectified spirit, the container being immersed in hot water. Cardiac dilatation is an indication for the application of leeches. Frequent small meals are preferable to overloading the stomach.

Conjunctivitis should be met by frequent bathing of the eyes with boric lotion and the application of a little dilute nitrate of mercury ointment to the lids. In the more severe cases, drops of silver nitrate solution, 2 grains to the ounce, should be instilled night and morning, or a 2 per cent. solution of protargol used. Should the cornea ulcerate, atropine drops should be employed and ung. flav. dil. applied. Eye bandages are undesirable.

Stomatitis usually subsides quickly; the mouth should be cleansed with boroglyceride or a lotion containing chlorate of potash (10 grains to 1 ounce). The supervention of noma calls for surgical interference in the way of cauterisation or free excision. In an uncomplicated case of measles the patient may be allowed up 2 or 3 days after the temperature subsides. Supervision should be exercised during the convalescence of severe cases, and the possibility of later tuberculosis borne in mind. Ear discharges call for skilled treatment, as they may become chronic.

RUBELLA

Synonyms.—German Measles, Rötheln.

Rubella is quite distinct from ordinary measles and from scarlet fever. It protects only against itself. Amongst the exanthemata it is characterised

by its long incubation period, its short invasive stage, its benign course and its seasonal prevalence.

Ætiology.—The infectivity is less than that of measles and of short duration. Like measles it is infectious for a day or two before the eruption appears. Infection is facilitated by close contact and there is no evidence that the disease is spread by fomites. Infection through an intermediary cannot be considered proved.

Rubella is prevalent in the first half of the year. Cases increase from January to a maximum in May and June. After that an abrupt fall ensues. A series of local outbreaks usually occurs, determined by the aggregation of a number of unprotected young adults. A more or less pronounced epidemic wave occurs every third or fourth year. The maximum incidence is at a later age period than that of measles, but even the youngest infants have been known to take the disease. Its frequency much diminishes after the age of 30. Sex is without influence.

Symptoms.—The incubation period, although variously stated to be from 7 to 22 days, is usually 17 or 18 days.

Premonitory symptoms are mild or altogether absent, but a short catarrhal stage usually occurs, the rash making its appearance within 24 hours. Rarely a longer prodromal period of ill-defined illness occurs before the eruption. The characteristic adenitis of the mastoid, occipital and cervical glands can, more often than not, be detected for a day or two, exceptionally even a week or longer, before the appearance of the rash.

The rash is often dimorphic. Papular and morbilliform in its beginnings, it frequently becomes scarlatiniform in its second stage. Discrete spots first appear on the face or neck; they invade the circum-oral region and may be found behind the ears and sometimes on the scalp. Sometimes they are first found on the wrists, chest, shoulders, or even on the legs. The spots are very slightly salient and when well developed are typically papular. They are smaller than the papules of measles, pale pink in colour, and tend to cluster in small groups. The rash quickly extends to the trunk and limbs and in most cases as quickly fades. On the second day the face is no longer spotty but appears diffusely erythematous. Sometimes the outbreak of the eruption is halting in its progress. The scarlatiniform stage is not developed in all attacks; it is due to the fusion of the morbilliform elements, and is generally best marked on the trunk, especially so on the back. It becomes most apparent on the second day of the eruption. The rash rarely lasts more than 72 hours and hardly stains the skin, thus contrasting with measles.

The mucous membrane of the mouth is not inflamed, and Koplik's spots never occur. The tonsils may be slightly swollen and reddened, sometimes a follicular exudate is present. Some degree of pharyngeal catarrh is evident, and the tongue may be lightly coated. A fine vesiculation and congestion of the soft palate is often seen. The conjunctivæ are pink and the eyes slightly suffused. Photophobia is rare. Fever is slight, even when the rash is intense. Often there is no fever at all. The pulse and respiration rates are only increased in proportion to the febrile disturbance.

A tender adenitis is very distinctive. The mastoid and occipital glands may rapidly attain the size of small peas; the posterior cervical glands are also enlarged, frequently too those in the axillæ and groins. The enlarged

glands are firm, tender and discrete; suppuration never occurs. As a rule resolution takes place rapidly when the rash subsides. The urine presents no special characteristics.

Convalescence is remarkably speedy. Slight furfuraceous desquamation may occur.

Complications.—Complications and sequelæ are for all practical purposes non-existent. When they do occur they are trivial and take the form of mild recurrent sore throat, slight laryngitis, slight bronchial catarrh, rheumatic pains of a mild type, or transient albuminuria. Otitis is very rare.

On occasions, epidemics of rubella of more severe type, approximating in symptoms and sequelæ much more closely to measles, have been described.

Diagnosis.—The disease has a similarity to measles and scarlet fever, especially when the latter occurs in a mild form. In addition, the rash of rubella must be distinguished from toxic and drug rashes, from the eruption of secondary syphilis and from certain skin diseases.

Measles is differentiated by the following points. The incubation period is shorter, being 14 days from exposure to the appearance of the rash; cough and catarrhal symptoms are marked, the mucous membrane of the mouth is inflamed and Koplik's spots are present. The rash is darker, more persistent, and stains. There is no late scarlatiniform stage. Fever is more pronounced, and the mastoid and occipital glands are not especially enlarged. Pulmonary complications are much more likely to occur.

Rubella is often mistaken for scarlet fever. Distinctive points in favour of the latter are: the short incubation period; the occurrence of such initial symptoms as vomiting, marked faucial inflammation, shivering or severe headache. The fever is high at onset and the pulse disproportionately rapid. The circumoral region is free from rash and by the fourth day the tongue has peeled. The occurrence of such sequelæ as arthritis, cervical adenitis and nephritis, also typical pinhole or lamellar desquamation, will clinch the diagnosis. Even in the scarlatiniform stage of rubella, discrete measly elements may generally be detected about the edges of the rash on the forearms, wrists, legs and ankles.

Toxic, enema and drug rashes may bear a resemblance to the rash of rubella, but as a rule these rashes are very irregular in their distribution and polymorphic in character. The characteristic glandular enlargement and slight catarrh of rubella are absent.

Of skin diseases, erythema scarlatiniforme and pityriasis rosea are sometimes mistaken for rubella. The first named bears a greater resemblance to scarlet fever; unlike rubella, it avoids the face, does not give rise to swelling of the mastoid and occipital glands, and shows a great tendency to recur.

Pityriasis rosea, itself possibly an infective fever, is distinguished by the presence of a herald patch which precedes the general eruption, and the fact that it usually appears first on the upper part of the trunk. The rash often shows commingled macular and ringed lesions. The patches are slightly scaly and are decidedly larger and more persistent than the papules of rubella. There is no catarrh and no conspicuous glandular enlargement about the head. The patches desquamate in a characteristic manner from their centres towards the margins.

Secondary syphilides bear a superficial resemblance to the rash of rubella, but are distinguished by the presence of a primary sore, the characteristic

throat and the conspicuous increase in size, and shottiness of the glands in the vicinity of the chancre. The Wassermann reaction is of value.

Prognosis.—Recovery is the rule; second attacks are known, but not common, and relapse is very rare.

Treatment.—*Prophylactic.*—As the incubation period is long a quarantine of 3 weeks is necessary for contacts, or they may be isolated from the tenth to the twenty-first day from exposure to infection. Early warning of the imminence of attack may be gained by carefully watching the mastoid and occipital glands.

General.—The patient should be isolated and kept in bed until all symptoms have subsided. In 7 days all infectivity has ceased, provided there is no persistence of faucial, nasal, respiratory or other symptoms.

SCARLET FEVER

Synonym.—Scarlatina.

Definition.—An acute specific fever of sudden onset characterised by faucial inflammation, a punctate erythema of the skin, and a tongue at first furred but later raw with prominent red papillæ. Desquamation follows, and inflammatory sequelæ may occur involving especially the ears, cervical glands and kidneys.

Ætiology.—Scarlet fever is a disease of temperate climes and seldom gains a foothold in tropical or subtropical countries. It is endemic in large cities and populous centres, tending to flare up every few years in local epidemic form owing to the accumulation of susceptible material. Its general epidemic prevalence, however, is irregular, and no definite periodicity has been recognised. In the United Kingdom it is prevalent in the latter part of the summer and reaches its maximum at the end of the autumn; a fall in the number of cases then occurs, the period of least prevalence being the spring. Of late years, although the prevalence has not appreciably declined, the mortality has fallen and the type of case become less severe. Severity, however, still varies greatly in different years and in different localities.

The case mortality of scarlet fever (proportion of deaths to attacks) is not more than 1 or 2 per cent. It is greatest in the first year of life and diminishes with age. Females are more liable to infection than males, but attacks in males are rather more likely to terminate fatally.

Of predisposing causes, childhood and the absence of acquired immunity are the most important. Infants under one year of age seldom contract the disease. The maximum incidence occurs during the fifth and sixth years of life, a period slightly later than is the case with such diseases as whooping-cough and measles. Adults are not exempt, but scarlet fever is rare in the aged. As a rule, one attack protects permanently, but second attacks do undoubtedly occur. Multiple recurrences should probably be referred to some other cause than scarlet fever.

Poverty, by entailing shortage of food, overcrowding, and defective isolation, facilitates the spread of the disease and augments its death-rate.

The virus resides in the mucous secretions of the nose and throat and in the secondary suppurative lesions. The disease is infectious from its commencement, but the exact duration of infectivity cannot be determined for

any given case. Six weeks' isolation is generally sufficient if by that time the mucous membranes be healthy and the skin free from sores. Many authorities reduce this period to 4 weeks for mild and uncomplicated attacks. Late desquamation is not regarded as dangerous, and the infectivity of urine which remains albuminous has never been proved. The infectivity of scarlet fever is not nearly so great as that of measles, varicella or small-pox.

In most cases infection is derived directly from a person suffering with, or recently recovered from, the disease, but transmission by infected fomites or infected milk may also occur. It is an important fact that discharges from the nose, throat, mouth and ear may remain infectious for many weeks, and pre-existing purulent discharges also become infectious when scarlet fever is contracted. The occurrence of catarrhal infection of the nose or throat in a scarlet fever convalescent may lead to a recrudescence of infectivity.

Intermediary carriers have on occasions spread the disease without themselves showing signs of infection. On rare occasions, too, convalescents, although apparently healthy, have for months remained capable of transmitting the fever. The infectivity of carriers appears to be intermittent, and the receptivity of those exposed is increased by debilitating circumstances or acute disease of which diphtheria may be cited as an example. Attendants on scarlet fever cases, although long immune, may finally contract the disease.

Infected milk may be responsible for localised and, sometimes, for more widespread outbreaks of the fever. In most instances the milk has been infected from a human source, but possible derivation of infection from cows with ulcerated udders and teats is suggested by the well-known Hendon outbreak. Scarlet fever is not known to be transmitted by water or by sewage. Cases of wound infection are not numerous, but puerperal scarlet fever is well recognised.

Pathology.—Klein, in 1887, isolated a streptococcus from the teats and udders of cows at Hendon, and considered it the causal agent in a milk-borne epidemic of scarlet fever. It has been customary, however, to regard the streptococci found in the throats and tissues of scarlatinal cases as secondary invaders, it being impossible to grow these organisms from the blood of patients suffering from the fever in its toxic, and presumably uncomplicated form.

Drs. George and Gladys Dick, of Chicago, have now produced evidence that scarlet fever is a *local* infection of the throat by a hæmolytic streptococcus and attribute the general symptoms of the disease to toxins absorbed from the local focus. They have infected patients with scarlet fever by swabbing the fauces with a pure culture of their organism and have elaborated a test analogous to the Schick test in diphtheria. This is the *Dick test*. It is made by the intradermic injection of 0·1 c.c. of a 1 in 1000 dilution of toxic broth filtrate in saline solution. Boiled filtrate is used as a control. An erythema at the point of injection, maximal in 24 hours, indicates susceptibility to scarlet fever. The same types of reaction occur as in the Schick test (*q.v.*). During the first few days of scarlet fever a positive result may be expected. A certain number of convalescents remain positive to the test, but the majority become negative.

Susceptible persons can be immunised by subcutaneous injection of

minute but increasing doses of scarlatinal toxin at intervals of 4 to 7 days. For adults four or five injections are required, commencing with 500 "skin test" units and ending with a dose of 10,000 units. Immunity develops more slowly than in the case of diphtheria, and its duration is unknown. If the Dick test proves positive 6 months after, a further injection is recommended in the case of those nursing scarlet fever.

By immunising horses, an antitoxic serum is produced, which is said to bring about a rapid amelioration of the acute symptoms of scarlet fever.

Schultz and Charlton pointed out that intradermic injection of 1 c.c. of the serum from a patient convalescent from scarlet fever will, in a few hours, cause a local blanching of the rash of the fever. This is known as the blanching test. W. Mair suggests that the test is due to antitoxic immunity in the donor, which will account for its occasional failure, and also the fact that the serum of some donors not known to have had scarlet fever, will give the reaction. The antitoxin prepared from the Dicks' scarlatinal streptococcus possesses the same blanching property, and is now used for the test.

The post-mortem appearances in scarlet fever are not distinctive. The rash, unless hæmorrhagic, disappears after death. Such gross changes as are found in the fauces, cervical glands, lungs, kidneys and liver, together with moderate enlargement of the spleen and lymphoid structures, merely indicate an acute infective process. In severely toxic cases, early decomposition with much post-mortem staining of the tissues, fluidity of the blood and subserous ecchymoses, indicate the intensity but not the nature of the infection. In cases surviving longer, inflammations of the lungs, serous sacs, endocardium, pericardium and joints may possibly be present, and desquamation may be recognised. Scarlatinal nephritis is described as being essentially glomerular in type, but other parts of the kidney are also involved.

Symptoms.—The incubation period is short, the period which elapses between infection and the development of the first symptoms being from 2 to 4 days, with an average of 72 hours.

Invasion is abrupt, the cardinal symptoms being vomiting, headache and sore throat. In some severe cases vomiting may be so urgent as to suggest irritant poisoning, especially if accompanied by diarrhœa; in mild cases vomiting may be absent. Rigor is uncommon, convulsions occasionally occur in children. Cough and catarrhal symptoms are decidedly rare, but a mild conjunctival injection is not unknown. The skin is hot and dry, the cheeks flushed, and the eyes bright. The limbs ache, the appetite is in abeyance, and the tongue rapidly becomes coated with white fur, through which the papillæ project as red points. Slight nocturnal delirium is common. The temperature rises rapidly, and even on the first day may reach 103° or 104° F. An undue acceleration of the pulse is usually a marked characteristic, rates of 160 or more are common in young children, and rates of 120 to 140 in adults.

Very mild cases often occur, and in these the symptoms of invasion may be absent, the rash being the first indication of the disease.

Uniform injection of the tonsils, fauces, and uvula is present in the early stages of the disease. Later, the injection becomes more vivid, the tonsils are swollen, and a distinct follicular exudate often appears; inflammatory œdema of the fauces soon makes its appearance in severe cases, and may be

accompanied by free mucous secretion. The tonsils may become covered by a thin necrotic film, or a more or less coherent exudate may form which may encroach on the faucial pillars and base of the uvula, and closely simulate the membranous exudate of diphtheria. In the more severe forms of scarlet fever, the tonsillar and faucial inflammation is very intense, and both ulceration and sloughing occasionally occur; thick muco-pus trickles down from the naso-pharynx, and acrid discharge blocks the nostrils and excoriates the upper lip. The respiratory obstruction is especially severe if adenoids are present. In severe cases, inhalation broncho-pneumonia is a decided danger.

A punctate injection may often be seen on the soft palate and adjacent part of the roof of the mouth even before the appearance of rash on the skin, and is of diagnostic value. The eruption usually appears within 24 hours of the invasion, but may be delayed. It appears first on the upper part of the chest, the root of the neck and the upper arms as a finely punctate erythema; sometimes it is first seen in the axillæ. It quickly spreads to the trunk and limbs, reaching the legs last. The cheeks are merely flushed, and the existence of an area of circum-oral pallor is a well-known and striking feature. The thick skin of the palms and soles is also in most instances free from the distinctive rash. The eruption often shows a symmetrical intensification in certain regions, such as the lower abdomen and groins, the inner aspects of the thighs, the axillæ, the back, and the points and flexures of the elbows and knees.

Of the two elements of the rash, one is minutely punctate, the other erythematous. It is the former which gives it its distinctive character. On coarse skin the puncta are particularly large and may be palpable. When the erythematous element is intense the skin may actually appear œdematous and the puncta be quite obscured. In such cases, on subsidence of the rash, yellow staining may be apparent. In addition to punctation and erythema, minute petechiæ or small linear hæmorrhages are sometimes seen in the flexures of the groins, elbows, wrists and knees. These remain when the rash has faded, and together with coarse injected papules on the outer sides of the arms and legs afford valuable evidence when the rash has gone. The rash on the buttocks and extremities may assume a slightly blotchy papular appearance, and so bear a distant resemblance to that of measles. Minute sudamina sometimes accompany the rash, giving rise to the variety known as *scarlatina miliaris*. Itching is not common.

The rash may be quite transitory or may last a week or even longer. Generally speaking, it is more pronounced in severe attacks but sometimes attacks which are quite mild show rashes of considerable intensity and persistence. A dusky, blotchy, morbilliform eruption, generally limited to the convexity of the knees and elbows, but sometimes more widespread, may supervene in grave cases. It is known as the *septic rash*.

At the time of the initial faucial inflammation, the glands at the angles of the lower jaw are swollen and tender. During the eruptive period a moderate enlargement of the axillary and inguinal glands, sometimes of the posterior cervical glands as well, is often to be detected. The spleen is rarely to be felt. At times the glandular swelling leads to confusion with rubella, but the glands do not attain the size or show the marked tenderness characteristic of the latter disease.

In an average case a rapid rise of temperature (Fig. 3) marks the invasion, but the maximum may not be attained until the full development of the rash on the third or fourth evening, when readings of 103°, 104° or even 105° F. may be registered. Slight morning remissions occur. The fall is by lysis, reaching the normal by the fifth or sixth day of the disease. Termination by crisis is unusual. In bad cases of a septic type, the fever is prolonged, with increasing daily oscillations as septicæmic symptoms become prominent. In the malignant type of the disease, the fever is higher from the first and shows less remission, but occasionally is subnormal throughout. A protracted remittent fever may occur in scarlet fever without local symptoms or complications to account for it; this variety is sometimes known as the "typhoid type."

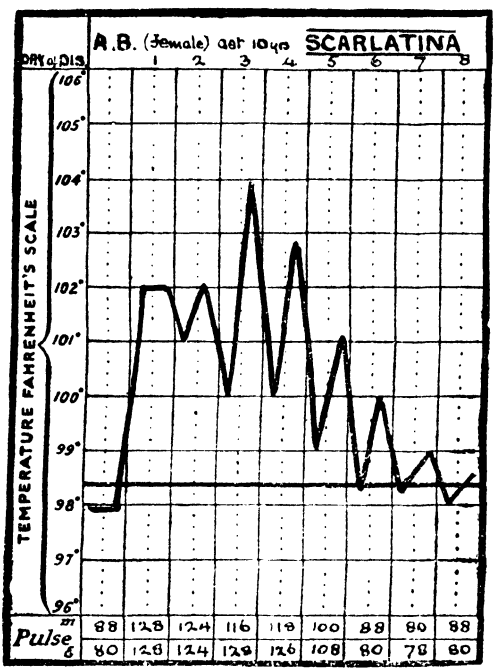

FIG. 3.—Simple scarlet fever. Showing abrupt onset and rapid lysis.

Abrupt rises of temperature during the convalescent period may signalise the onset of such complications as adenitis, otitis, nephritis, endocarditis, empyema, or a metastatic abscess. Sometimes such pyrexial attacks occur without ascertainable cause, but a thorough examination of the patient is always necessary. Very mild cases of scarlet fever without obvious febrile disturbance certainly exist.

Desquamation is a well-known characteristic, but the degree to which it occurs is very variable. The tongue peels in patches or strips, and by the fourth day is raw with prominent papillæ (*raspberry tongue*). The flushed cheeks begin to shed a fine powder during the febrile period. Fine peeling of the lobules of the ears, of the margins of the lips, and of the skin at the root of the neck, possibly also above the pubes, next makes its appearance. By the end of the first week, peeling is generally well marked on the neck, chest, inner sides of the arms and possibly on the trunk. Within a fortnight it may be seen on the hands and possibly on the feet. It may not be complete on the latter until over 6 weeks from the onset of the fever. Patrial re-desquamation often occurs on the soles and is not infectious. The characteristic of the desquamation is the pinhole or ringed form in which it commences, the horny layers of the skin being shed first over the summits of the papillæ, forming apertures which enlarge centrifugally and fuse with their neighbours. Where the skin

is thick, as on the hands and feet, it tends to separate in larger flakes, or may even be thrown off in the form of incomplete casts. A rather characteristic form of peeling is sometimes seen on the finger-tips when separation begins, as a split parallel to the free edge of the nail.

In severe cases considerable loss of hair may accompany or follow desquamation, but is temporary only, at all events in the younger patients. Furrows may also appear across the nails and take several weeks to reach the free edge.

Although desquamation typically proceeds as described above, there are cases of true scarlet fever where it is insignificant. It is unsafe to pronounce definitely against scarlet fever until 3 weeks have elapsed. In doubtful cases the hands and feet should be watched with care. A dry powdery appearance of the palms and soles sometimes is the sole indication of peeling. During desquamation the skin may appear harsh, dry, cracked or even eczematous.

A polymorphonuclear leucocytosis makes its appearance shortly after infection and reaches a maximum with the full development of the rash. It persists a variable time, and eosinophilia is generally marked during convalescence. Fluidity and slow coagulation of the blood are indications of severity, but apart from this blood examination has little prognostic value. Döhle has described certain bodies seen in the polymorphonuclear leucocytes when stained by Leishman's method as being characteristic. They appear in the acute stage as more or less definite blue spots in the cytoplasm of the cells. They are, however, not exclusively found in scarlet fever.

Varieties.—These are: (*a*) Simple or Benign; (*b*) Septic or Anginous; and (*c*) Toxic or Malignant. Surgical or Wound Scarlet fever and scarlet fever occurring during pregnancy orthe puerperium, also have special characteristics.

Simple scarlet fever is characterised by an onset of moderate severity in which the initial vomiting is not repeated and sometimes is absent. The faucial inflammation is slight, and the temperature, which may reach 102° F., has almost reached its acme in 24 hours; generally the climax is reached by the third day and amelioration of symptoms is then rapid. The urine may be normal throughout, or a trace of albumin may accompany the febrile disturbance. By the third or fourth day the tongue, at first slightly coated, has peeled, and slight powdering may be evident on the cheeks. Convalescence is rapid.

The *Septic or Anginous* variety comprises most of the severe and fatal cases. It is characterised by intense faucial inflammation and a tendency to the development of septicæmic manifestations. Repeated vomiting, sharp diarrhœa and prostration may signalise the onset. The faucial inflammation is either severe from the first or unexpectedly becomes so after a lapse of 2 or 3 days. The tonsils are much swollen and a patchy or coherent membranous exudate may form. Rapid and destructive ulceration of the tonsils, soft palate and its pillars sometimes occurs. The mucous membrane of the mouth may be excoriated and bleed at the slightest touch. The pharynx, and even the upper aperture of the larynx, may become involved in the inflammation, although, as a rule, implication of the latter is more suggestive of diphtheria than of scarlet fever. The discharges from the throat excoriate the angles of the mouth and a purulent acrid rhinorrhœa irritates

the nares and upper lip. Deglutition is painful, respiration is obstructed, and the patient often sleepless, restless and later delirious. The cervical lymph glands become swollen and tender, and peri-adenitis or extensive sloughy cellulitis of the neck may ensue. This sometimes gives rise to fatal hæmorrhage by eroding large veins or even an artery. Cyanosis and coldness of the extremities and cardiac dilatation are common. The rash is generally intense, dusky and blotchy. The temperature often reaches 104° or 105° F. in the early stages of the disease, and pyrexia may persist long beyond the ordinary period and, changing its type, assume a remittent or intermittent septicæmic form.

Death may occur in the first week; more often life is prolonged into the second week, by which time circulatory failure becomes pronounced; hypostatic congestion of the lungs or spreading broncho-pneumonia occurs. Otitis, arthritis, suppurations of the serous sacs, endocarditis, or nephritis may appear as complications.

Many patients show septic symptoms of a much milder type and make good recoveries. In grave cases which recover, improvement is very gradual and usually sets in towards the end of the second week, but may be later.

Toxic or Malignant Scarlet fever is characterised by a toxæmic condition out of all proportion to the degree of inflammatory reaction in the throat. Such cases are marked by high fever, cerebral disturbance, profound prostration and heart failure. The rash is often petechial, but in the most severe attacks the patient may die before it has time to appear, and the real nature of the disease only be revealed by the supervention of scarlet fever in contacts. The throat may be intensely injected, but the œdema, ulceration and thick purulent secretion which characterise the septic variety may be absent altogether. Sometimes convulsions precede death, but mostly delirium merges into coma. Rarely, however, the patient dies of cardiac failure with vomiting, prostration and extreme pallor, but with clear intellect, suggestive of the type of death seen in some cases of diphtheria.

Sufferers from the malignant type of scarlet fever mostly succumb within a week of the onset, sometimes within 24 hours. But, as in the septic form, cases of the toxic or malignant type are not now so common or characterised by such extreme malignancy as was formerly the case.

Rarely scarlet fever assumes a hæmorrhagic form, with bleeding into the skin and from the mucous membranes. It is possible, however, that some of the cases formerly so described were really hæmorrhagic small-pox with prodromal rashes of scarlatiniform character.

Surgical Scarlet fever may be a sequel of operations, wounds, or burns and scalds. It is more often seen after operations on the nose and throat than elsewhere. The incubation period is short, often less than 3 days, and the rash may make its first appearance round the wound. Faucial inflammation in such cases is often slight. Although the type of fever as a rule is mild, the infected wounds show a great tendency to suppurate. If the infection start from a wound or abrasion on a limb, injected lymphatic vessels are often evident which show a characteristic punctate rash. The corresponding lymph glands are enlarged and tender. When the fever follows burns or scalds the incubation period is also short and the accompanying angina may be slight. Cases of surgical and of burn scarlet fever are not highly infectious.

They are often left in general wards with impunity, but at the same time there is no doubt that occasionally they spread the infection.

Scarlet fever may arise in the pregnant woman. In early pregnancy it is rare, and is said not to lead to abortion; but occurring later it is very prone to produce abortion or premature delivery. When the infection occurs either immediately before or immediately after labour, it is apt to assume a grave form with a very high mortality from septicæmia; but there is no doubt mild attacks may occur even at this period.

Anomalous forms of scarlet fever may occur in which one or more of the cardinal symptoms are lacking. In some only sore throat is recognised (*Scarlatina sine eruptione*), and yet the patient may transmit the typical disease; in others the rash, although present, is so ephemeral or atypical that its true nature escapes recognition; in yet others, the rash is the most pronounced feature, both fever and sore throat being insignificant. In cases where the rash is very scanty or insignificant, desquamation may not be at all marked.

Complications.—These are numerous and important. They may provisionally be divided into two groups; those which arise locally in connection with the faucial and pharyngeal inflammation, and those of a general or more remote character. To the first group, in order of frequency belong otitis, cervical adenitis, rhinitis, secondary tonsillitis and stomatitis, and aspiration broncho-pneumonia. The second group includes rheumatism, albuminuria, nephritis, endocarditis, pericarditis, pleurisy and empyema.

In severe cases complications show a great tendency to occur in combination rather than singly.

Otitis.—This is met with in from 10 to 15 per cent. of the cases, and is an inflammation of the whole mucous tract of the middle ear. Its greatest frequency is in childhood, and its incidence is favoured by the presence of adenoid tissue in the naso-pharynx. It is more common in severe cases, and may show itself by the end of the first week of the fever or later. Earache with an injected and bulging tympanic membrane are the signs to be expected, but sometimes a free discharge of muco-pus or pus and blood from the ear is the earliest indication. Unexplained pyrexia not due to fresh faucial or glandular extension or to one of the distant complications should always lead to a careful examination of the ears. Perforation, which usually is rapid, generally occurs in the upper part of the tympanic membrane. A very marked degree of deafness may occur, but fortunately is transient in most cases. Pain and tenderness with slight œdema of the mastoid appear in some instances, and may be accompanied by restlessness, vomiting and fluctuating temperature. The intensity of these mastoid symptoms may vary from day to day. In children the mastoid air cells are very superficial, and pus easily makes its way beneath the covering periosteum.

Sometimes the labyrinth becomes implicated either by extension through its fenestræ or primarily. In such cases deafness, vomiting, vertigo and nystagmus may occur. Labyrinthine deafness may be permanent.

Such intracranial complications as meningitis, extradural abscess, lateral sinus thrombosis, cerebellar or tempero-sphenoidal abscess, belong to the more chronic forms of ear disease, but occasionally they arise during the acute stage of scarlet fever and need, more than ever, prompt recognition and surgical treatment. Persistence of mastoid tenderness with some local

headache and slight fever may be the only signs of inflammatory mischief invading the dura in the vicinity of the lateral sinus.

In most instances scarlatinal otitis subsides in a few weeks and the perforation of the membrane closes.

Adenitis.—A rapid and considerable swelling of the upper cervical lymph glands may occur during the convalescent stage of the fever. The swollen glands are usually those behind the angle of the mandible or higher up under the insertion of the sterno-mastoid muscle. The adenitis generally supervenes during the second, third or fourth week of the disease. It is marked by local tenderness and a sharp accession of fever. In favourable cases the temperature becomes normal in a day or two and the glandular swelling rapidly subsides, but suppuration may ensue.

Secondary tonsillitis should suggest the possibility of diphtheritic infection. Peritonsillar abscess may also occur. Ulcerative stomatitis with much fœtor of breath and sometimes even sloughing of soft tissues and necrosis of bone are also looked upon as a secondary infection. Vincent's organism and diphtheria bacilli should be sought for in such cases.

Rhinitis.—Acrid or purulent rhinorrhœa is characteristic of septic attacks. A simple rhinorrhœa which occurs in the later stages of the fever is often responsible for the transmission of infection by patients supposed to be cured. True diphtheria bacilli are more frequently found in the nasal than in the ear discharges of those suffering from scarlet fever.

Nephritis.—Slight albuminuria occurring during the eruptive stage of scarlet fever is transitory and of no great importance, but during the third week, sometimes a little earlier, sometimes a little later, a characteristic nephritis may supervene. It is to be expected in a little over 3 per cent. of the cases, and is more common in severe than in mild attacks. Chill, damp and exposure favour its incidence. The onset may be insidious or fulminant. In the insidious cases albuminuria, at first slight, and even intermittent, is the first sign. In the fulminant cases, headache, vomiting, pyrexia and even rigor may mark the onset. The urine becomes heavily loaded with albumin, casts and blood, and there is more or less suppression. The temperature may rise gradually or suddenly and show marked daily remissions. Lumbar pain is uncommon, but abdominal pain and constipation are marked features of some attacks. The amount of dropsy present is very variable. Anæmia is of rapid onset and very pronounced. The pulse tension is raised and cardiac hypertrophy is soon established, sometimes dilatation ensues. In a favourable case some improvement occurs within a week, the secretion of urine increasing, but the hæmaturia and albuminuria take much longer to clear up. In some cases albuminuria persists and chronic interstitial nephritis may ensue. The duration of an average attack may be put at 7 weeks, but is subject to much variation. Broncho-pneumonia, pulmonary œdema, œdema of the glottis, and uræmic symptoms occur in severe cases. Convulsions may be recovered from, but coma is of bad augury. In some cases of scarlet fever œdema is said to occur without nephritis, or at all events without albuminuria.

Rheumatism.—This is a common complication, and usually makes its appearance towards the end of the first week. The arthritis is fleeting and mostly involves the hands and wrists, but pains in the shoulders and elbows are not infrequent. Joint effusions are not always present. The temperature

is somewhat raised. Sometimes the endocardium and pericardium are implicated, as in ordinary rheumatism, but the profuse sweats and creamy tongue are absent. Scarlatinal rheumatism is more common in adolescents and adults than in children. A mono-articular or multiple suppurative arthritis with, it may be, pyæmic manifestations is sometimes seen. It is believed to be streptococcal in origin. Sometimes the rheumatism is gonorrhœal.

Cardiac complications.—There are three groups: those due to toxæmia; those secondary to rheumatic or pyæmic complications; and those accompanying nephritis. The toxæmic effects are cardiac dilatation and acceleration of the pulse, which is so characteristic of this fever.

Scarlatinal rheumatism is occasionally the precursor of simple or more rarely of malignant endocarditis. An unfortunate feature is the tendency to pick out the aortic valves. The influence of nephritis in producing rapid cardiac hypertrophy or inducing dilatation has already been mentioned. Pericarditis may occur quite early in some cases of the septic type. The effusion is generally purulent.

Pulmonary complications.—Neither bronchitis nor broncho-pneumonia is common, but aspiration broncho-pneumonia may complicate septic cases. Œdema of lungs may arise during the course of acute nephritis. Lateral sinus pyæmia may give rise to pyæmic infarction of the lungs, empyema and even pneumothorax. A primary empyema, often of insidious onset, occurs in some patients. Lobar pneumonia is a rare complication. Occurring early in the disease, it is streptococcal in nature and the prognosis is very grave.

Nervous complications.—If the delirium of onset, the nervous manifestations of uræmia and the cerebral complications of otitis be excluded, it may be said that nervous disturbance during the course of scarlet fever is rare. In those predisposed, epileptic fits may signalise the invasion. Hemiplegia with convulsive onset, incomplete paraplegia and peripheral neuritis have all been described. Chorea develops occasionally, usually in association with arthritis and endocarditis. Tetany sometimes occurs. Mental disturbance of a maniacal or melancholic type is an infrequent sequel, or may show itself during the acute stages.

On rare occasions gangrene of the extremities has been encountered. It is usually embolic in origin and leads to mummification, but gangrene of the legs has also been described as complicating scarlet fever in the subjects of congenital syphilis. Post-scarlatinal diphtheria was, in pre-antitoxin days, one of the gravest complications. Diphtheria may develop at the onset of the fever, but more often appears during early convalescence. It occurs more often in hospital-treated cases than in others. Every throat inflammation about the nature of which there is the slightest doubt should be subjected to bacteriological examination at once. This is a more rational procedure than the indiscriminate injection of all scarlatinal patients with diphtheria antitoxin.

Relapse.—A recurrence of the fever and rash before complete recovery from the initial attack occurs according to different authorities in from 0·5 to 7 per cent. of the cases. If the original attack were severe, the relapse is often mild, and vice versa. The sequels of a relapse are in nowise different from those of an ordinary attack.

Diagnosis.—Bacteriological identification of the *Streptococcus scarlatinæ*

is not sufficiently easy to afford much help in diagnosis. A positive Dick test before the third day of the attack is in favour of scarlet fever, since it indicates susceptibility, but a negative result does not exclude it. A positive Schultz-Charlton blanching test, made by the intradermic injection of 0·2 c.c. of a 1 in 10 dilution of immunised horse serum applied to the newly developed rash, is of more value. The reaction takes 8 hours to develop. The chief difficulty arises with mild attacks and with patients who come under observation after the initial stage. In the former the rash is evanescent, constitutional disturbance slight, and the tongue often atypical. A history of a previous attack is of great weight, but diagnosis can only be confirmed by the supervention of desquamation or of some characteristic complication. Sometimes the infection of a contact gives the clue. In days immediately following the rash significant signs are, slight staining of the trunk, faint striæ in the flexures of the elbows, knees and groins, or a triangular patch of punctate erythema over Scarpa's triangle. The submandibular glands may be enlarged, and coarse papules resembling goose-skin present on the outer aspects of the arms and legs. The tongue has usually peeled by the fourth day and remains raw and papillated for about a week. Slight albuminuria, in the absence of diphtheria, is significant.

Desquamation of the typical pinhole type rarely occurs in other conditions than scarlet fever; the character of the accompanying symptoms and the time of appearance of the peeling must be taken into consideration.

Simple tonsillitis is distinguished by the absence of punctate rash, a tongue which remains heavily coated, and absence of desquamation. But an erythema may be present, with fleeting muscular pains and sometimes otitis, and even endocarditis or nephritis occur as complications.

Careful scrutiny of the body for a rash will usually prevent confusion with *diphtheria*. When faucial exudate is present in scarlet fever, it is usually softer and less coherent than in diphtheria, and any grey ulcerated areas are depressed below the general surface. In scarlet fever, too, the faucial pillars and soft palate may show the punctate rash, whilst pallor of the throat is more distinctive of diphtheria. In scarlet fever, febrile disturbance is more marked, initial vomiting is common, and delirium may occur. The fugitive erythema which sometimes appears on the chest in diphtheria is not punctate. Bacteriological examination is decisive, but the two diseases may coexist.

When *influenza* is rife, cases of scarlet fever are apt to be overlooked; but in influenza rashes are exceptional, and careful observation of the progress of the disease will soon lead to a correct diagnosis.

Lobar pneumonia may, in children especially, by its abrupt onset, high fever, vomiting and faucial inflammation, give rise to suspicion of scarlet fever, a suspicion favoured by the flushed face and circumoral pallor which may be present. But the throat affection is trivial, the respirations are rapid and accompanied by action of the alæ nasi, and there is no punctate rash on the chest. Sooner or later consolidation of the lung may be detected, often in such obscure cases at the apex or high in the axilla.

Food, drug, serum and enema rashes often cause difficulty. Of drugs the most important rash-producers are copaiba and similar oleo-resins, quinine, antipyrine, the salicylates, aspirin and belladonna. Anomalous distribution or polymorphic character of the rash should at once arouse suspicion, especi-

ally so the discovery of urticarial wheals. The history and accompanying symptoms are of importance.

Erythema scarlatiniforme is characterised by a punctate eruption which is sometimes patchy and confined to the trunk. The rash is remarkably persistent, and desquamation may ensue whilst it is still in the florid stage. The peeling is profuse and the subjacent skin often erythematous. The characteristic sequelæ of scarlet fever are wanting. The disease is not known to be infectious and is very apt to recur, which gives a clue to its recognition. *Acute exfoliative dermatitis* is by some regarded as identical with it.

German measles in the scarlatiniform stage closely resembles scarlet fever. The diagnosis turns on the trivial character of the accompanying symptoms, which are chiefly catarrhal and the tender swelling of the mastoid and occipital glands. Even when the rash is scarlatiniform on the trunk, distinct morbilliform elements may often be recognised about the wrists and on the lower extremities, and this, with the history of an initial spotty rash on the face and around the mouth, is of great significance. The eyes are suffused and subsequent desquamation is insignificant. Sequelæ are practically unknown.

Measles is more easily distinguished. The rash is different and invades the face. Catarrhal symptoms are pronounced and Koplik's spots are present. Difficulty is only likely to arise in those cases of scarlet fever where a blotchy rash is present, or where the appearance of a septic rash may simulate intercurrent measles.

Prodromal rashes of a scarlatiniform type may appear in small-pox, chicken-pox and measles. In small-pox, the punctate rash is usually confined to the bathing-drawers area and to the axillæ. Sore throat is in favour of scarlet fever, whilst rigor and severe lumbar pain suggest small-pox. The eruption of the latter disease appears on the third day, and a doubtful case should always be isolated over that period. The initial rashes of small-pox are said to be absent in children under 10 years of age.

The eruption of chicken-pox may be preceded by a rash which is scarlatiniform, but it is more likely to be erythematous. The diagnosis turns on the condition of the fauces and tongue, the absence of the other signs of scarlet fever, and the speedy appearance of the characteristic vesicles.

As a prodromal rash in measles, a scarlatiniform eruption is decidedly rare. The marked catarrhal symptoms which accompany it will arouse suspicion, which is confirmed by the discovery of buccal inflammation and Koplik's spots.

Prognosis.—The mortality of scarlet fever varies with the type of the prevailing epidemic. Of late years, in Great Britain, a mortality of from 2 to 5 per cent. has been the rule. Of other factors, age is the most important, the mortality being greatest in infancy (21 per cent.), diminishing rapidly after the second year, and continuing to fall until puberty is reached, the least fatal period being from puberty to 36, after which age a slight rise occurs. The death-rate is slightly higher in males than in females. Tuberculous infections are likely to be lighted up by the infection, and puerperal patients run a grave risk of septicæmia. Chronic renal disease, if present, is likely to be adversely influenced.

Malignant attacks are very fatal, and the septic type of attack is also very serious, especially if broncho-pneumonia supervene. In adults, marked

sleeplessness and delirium are unfavourable signs, and in children, convulsions occurring after the initial stage. With regard to complications, nephritis in many instances clears up, especially if detected early and properly treated. Grave symptoms are uræmic convulsions, repeated vomiting and suppression of urine. Œdema of lungs often precedes the fatal issue.

Of circulatory symptoms the occurrence of pericarditis is the worst. It is often purulent and may be associated with empyema. The danger of otitis media is remote rather than immediate in most cases.

Treatment.—*Prophylactic.*—Infectivity ceases mostly within a period of six weeks. Late desquamation of the hands and feet is not a source of infection, but discharges from the nose, throat or ear are dangerous. Convalescent carriers are responsible for something less than 3 per cent. of the cases treated in fever hospitals. The dangerous carrier is often characterised by unhealthy conditions of the nose, throat or ear, discharges from which may have reappeared owing to the supervention of catarrh. Patients with persistent tonsillitis, rhinorrhœa or otitis should be isolated for at least 12 weeks from the commencement of the fever. The discharge of patients direct from wards containing others in the acute stage of the disease should be avoided; isolation for a day or two in a separate apartment is advisable. In cold weather the practice of bathing on the very day of discharge is not recommended, as a catarrh may be thus induced. Patients should not pass straight from isolation into the company of children and other susceptible persons.

Individuals in close contact with scarlet fever have at times been found to convey the infection, but a greater source of danger is the convalescent carrier, whose infectivity persists beyond the usually recognised period. The infectivity of such carriers has been known to last for weeks and even months; there is some evidence that it is intermittent.

The rules originally formulated by the Medical Officers of Schools may be taken as a safe guide in practice, *i.e.* isolation of the scarlet fever patient for not less than 6 weeks from the date of appearance of the rash, provided convalescence is complete and there is no evidence of inflamed throat or of discharge from the nose or ear, no suppurating or recently enlarged glands, and no eczematous patches about the nostrils, mouth or elsewhere. The quarantine period for contacts is 10 days, provided disinfection was efficiently carried out at the commencement of that period.

General.—Doubtful cases should be isolated until a definite diagnosis is made. Their premature transfer to a scarlet-fever ward is unjustifiable. Isolation of scarlet fever at home is most successful when a whole floor can be set apart for the patient and attendants, and there are no children of susceptible age in the house. The sick room should be large, light, freely ventilated and adequately warmed, the temperature being maintained at 55° F. to 60° F. according to the season.

The action of the skin is promoted by a daily wash and a tepid sponge every evening during the pyrexial stage. This may be replaced by a daily warm bath when defervescence is complete. The bed coverings should be adequate, but not too heavy. During convalescence, flannel or wool is the proper clothing; chill is by all means to be avoided. During the febrile stage the diet should consist of milk, barley water, or plain water and weak tea. When the temperature falls, beaten up eggs and farinaceous food may

be added and the diet gradually increased, nitrogenous food being allowed early in small amount. Most patients are fit for full diet within a week of the subsidence of the fever. Children, at all events, should be confined to bed for 3 weeks from the onset; by this means chills are avoided, the usual period of onset of nephritis passed, and the throat healed before the patient gets up. When the weather is warm, outdoor exercise may be allowed with advantage in the third or fourth week.

Special.—Attention should be paid to the mouth, teeth and gums, since oral sepsis is believed to bring its own train of local complications. The bowels should be regulated with mild aperients.

Concentrated anti-scarlatinal serum should be given early, in doses of 10 to 15 c.c., either subcutaneously or intravenously, according to the severity of the infection. To guard against anaphylaxis, a preliminary intravenous injection of $\frac{1}{10}$ c.c. in normal saline is advisable. In mild cases serum is unnecessary. The injection of 5 c.c. has been recommended for the purpose of producing a transient passive immunity in contacts.

Osman states that the incidence of nephritis is diminished if sufficient alkali is administered to keep the morning urine alkaline.

Pyrexia, with its accompanying restlessness, insomnia and delirium, may be controlled by tepid sponging and the use of acetyl-salicylic acid, chloral-amide or paraldehyde. A cold pack at 60° or 70° F. for 15 or 20 minutes is very beneficial when nervous symptoms are pronounced. After the middle of the second week, if albuminuria be present, cold sponging and cold packing should be avoided.

Persistent vomiting may be controlled by the use of diluted or citrated milk or temporary substitution of albumin water. Tincture of iodine in doses of 3 or 5 minims is often efficacious. When swallowing is painful the feeds should be small and often repeated. For the local treatment of the throat and nose, gargles are quite ineffective, and sprays have but little cleansing influence. Alkaline carbolic, permanganate or boric lotions should be applied by gentle syringing or through a douche-can under low pressure. The syringe nozzle, which should be short, is passed into the mouth behind the back teeth, the patient lying on the side with the head low. It may be necessary to envelop children in a large towel which secures the arms. For very septic and offensive throats a free chlorine lotion should be used every 2 or 3 hours. It is made by putting 200 grains of potassium chlorate in a large dry bottle, pouring on it 40 minims of strong hydrochloric acid, and setting aside, loosely corked, for 10 minutes; a pint of water is then added in 4 or 5 successive portions, shaking well. An equal quantity of water should be added to this solution before use. Great gentleness should be exercised if the nose be syringed; it is generally unnecessary. Ointment should be applied to the nares and upper lip to prevent excoriations.

Secondary tonsillitis is treated on ordinary lines, but care must be taken not to overlook secondary diphtheria. If adenoids and enlarged tonsils delay convalescence, their removal gives good results. Cervical adenitis is best treated by smearing glycerine on the neck and applying cotton wool. Poulticing is rarely called for; it appears to precipitate suppuration. Inflamed glands should only be incised when the presence of pus is assured; premature incision is to be avoided. In every case of scarlet fever care should be taken that the ears are clean. The pain of otitis may be mitigated by

syringing with water as hot as can be borne and the application of hot, dry cotton wool, or a rubber hot-water bottle, to the side of the head. By some the instillation of a few drops of glycerine or carbolic acid and the use of fomentations are recommended. Incision of the tympanic membrane is the most efficient method. Discharging ears should be cleansed frequently with hydrogen peroxide and never tightly plugged. After the fourth week of the fever, removal of adenoids and infected tonsils shortens the duration of discharge. Watch must be kept for mastoid tenderness and œdema.

Scarlatinal rheumatism is usually mild and transitory; salicylates or acetyl-salicylic acid give relief. When joint swellings persist, a mild pyæmic condition is often present or an unsuspected gonorrhœa. When the presence of pyæmic arthritis is suspected an exploratory aspiration under strict asepsis may be advisable.

Scarlatinal nephritis.—The importance of daily examination of the urine and avoidance of chill must be emphasised. No patient with albuminuria should be allowed up. During the acute stage of nephritis the diet should be limited to milk and barley water. In very acute cases, water only may be given for 24 hours or even longer. The patient should be clothed in flannel and lie in blankets. The bowels should be regulated with salines or compound jalap powder; constipation is often troublesome. Action of the skin should be encouraged by simple diaphoretics and the use of an incandescent electric bath, if available. Acetyl-salicylic acid is useful in promoting sweating. For uræmia, free purgation and sweating should be induced; venesection is useful in older patients, coupled with saline infusion. Repeated uræmic convulsions call, in addition, for chloral or chloroform. Lumbar puncture may have a good effect. Morphine if used must be given with caution.

Grave heart failure is encountered in malignant scarlet fever and during the course of septic or toxic attacks. Strict recumbency is essential. Strychnine in doses of gr. $\frac{1}{30}$ every 2 or 3 hours is often used, but even more effectual are injections of adrenalin or pituitrin. Diffusible stimulants such as ammonia and ether mixture, and brandy or champagne, are of value. Oxygen inhalation, hot saline by the bowel, or glucose enemata (5 per cent.) are useful accessories.

FOURTH DISEASE

Clement Dukes described an infectious disease which he considered distinct from scarlet fever and rubella. Its characteristics are the following:

It is most prevalent in spring and summer. Previous attacks of scarlet fever and of rubella afford no protection from it. Premonitory symptoms are generally absent or trivial, the first sign usually being a rosy red rash, slightly raised, which covers the whole body in a few hours. The temperature may range from normal to 103° or even 104° F. The fauces are red and velvety, the tongue clean or slightly furred, and the pulse only accelerated in proportion to the temperature. The posterior cervical, axillary and inguinal lymph glands are enlarged to the size of peas, hard and somewhat tender. The conjunctivæ are pink. Desquamation may ensue and is sometimes free.

The incubation period is between 9 and 21 days, and infectivity lasts for 2 or 3 weeks.

Most authorities either reserve judgment or refuse to recognise such a disease, alleging that some of the cases are rubella with scarlatiniform rash and some mild scarlet fever.

INFECTIOUS ERYTHEMA

This is a feebly infectious disease characterised by an erythematous rash which usually starts on the face, avoiding the circumoral region and then spreads to the limbs, where it assumes the form of large, rounded, slightly raised patches which spread at the periphery and fade at the centre (erythema marginatum). It has a predilection for the extensor surfaces and extends downwards. The trunk is seldom invaded.

The incubation period is 6 to 14 days, and the rash persists for a week or more. Constitutional symptoms are absent.

SMALL-POX

Synonym.—Variola.

Definition.—An acute, specific, highly infectious fever, characterised by a definite incubation period and a distinctively distributed, deep-seated eruption which passes through the stages of papule, vesicle, pustule and crust. The fever shows two phases—a remission being followed by a re-accession on the onset of the pustular stage.

Ætiology.—All races, both sexes, and persons of every age are susceptible if unprotected by a previous attack, or by efficient vaccination. This general liability is most evident when the disease is for the first time introduced into a new community; under such conditions it may decimate the population. Its present-day incidence on adults is accounted for by vaccination in infancy; in endemic centres it was, prior to the introduction of vaccination, a disease of early childhood. Small-pox has at times been epidemic in every civilised country, following trade routes and the channels of communication. It is more severe in hot climates. Coloured races are said to take it badly. Unlike scarlet fever and measles, it frequently attacks infants at the breast. When the disease occurs in severe form during pregnancy, abortion or premature delivery is inevitable, and in less severe attacks the same accident is likely. Few of the children born in these circumstances survive, sometimes they actually show the rash or its scars at birth.

In England and temperate climes most outbreaks occur during the winter and spring, and tend to die out with the commencement of summer. Small-pox protects against itself, and second attacks are rare. Vaccination gives complete immunity for some years and partial immunity usually persists afterwards. Complete natural immunity is very rare, but is reported. Inoculated small-pox affords more complete immunity than vaccination.

Infection with small-pox is, almost certainly, through the respiratory tract, and may be direct or indirect, *i.e.* by contact, which need not be very close, with a patient suffering from the disease or through the medium of objects infected by the sick person. Intermediaries may carry the contagion in their clothing or in their hair. The greater incidence in the neighbourhood of small-pox hospitals suggests the possibility of aerial convection of

the virus for considerable distances, perhaps exceeding a mile, but the influence of human carriers in these cases is hard to eliminate. Bedding, clothing and rags may retain their infectivity for considerable periods of time, especially when stored. Transmission by flies and domestic animals is regarded as a possibility. The infectivity of small-pox is slight at the time of the symptoms of onset, and is much greater when the eruption appears. It continues until all the scabs have separated. The virus is very resistant and long persists in the dry scales and crusts shed from the body. Corpses of those recently dead from small-pox can transmit the disease. Tramps are often responsible for the conveyance of infection from one locality to another.

There can be no doubt that small-pox is due to a living organism, but whether this is bacterial or protozoal cannot, with present knowledge, be decided. Minute, but characteristic, intracellular bodies are found in the epithelial cells of the pocks of small-pox and vaccinia, and also in the cornea of the rabbit, after scarification with the virus of these diseases. They are known as *Guarnieri bodies* and, although at one time thought to be protozoal (*Cytoryctes variolæ*), the trend of modern opinion is to regard them as a special degenerative reaction of the epithelial cells in the presence of the virus of small-pox or vaccinia.

Pathology.—The cutaneous lesion of small-pox lies in the deeper layers of the epidermis. Vesiculation is due to serous exudation between the cells. Loculation is caused by vertical strands of degenerated epithelial cells which radiate from the base of the pock. The tenseness of the vesicle and tethering of the covering by this reticulum cause the pock to be umbilicated. In malignant attacks, where the pocks are flaccid, and in the old and debilitated where a similar condition may obtain, umbilication is often absent. With pustulation the fibres of the reticulum are ruptured and the pock becomes dome-shaped. The suppuration is attributed to secondary infection with extraneous organisms, particularly with streptococci. On mucous membranes, owing to the absence of a resistant horny layer and maceration by the secretions, the vesicles rupture almost as soon as formed and are rapidly converted into shallow ulcers. The chief change in the blood is an increase in the mononuclear elements, which is coupled with great activity of the lymphocyte-producing tissues throughout the body. There is a great paucity of polynuclear cells. The post-mortem appearances are those usually found in acute infective processes. The rash persists, the liver is often much enlarged, and the spleen swollen. Particular attention has been drawn to the presence of local necroses in the liver, testicles and bone marrow. These are often infiltrated with mononuclear basophil cells. In hæmorrhagic small-pox, petechial and purpuric hæmorrhages are found in the skin, mucous membranes, lungs and other viscera, sometimes also in the retro-peritoneal tissues and the roots of the mesenteries.

Symptoms.—*Unmodified small-pox.*

Period of incubation.—Taking the first symptoms of invasion, this is from 10 to 14 days. The average period is 12, or counting to the appearance of the rash, 14 days. Extremes of 5 to 23 days are mentioned but are rare. In inoculated small-pox the generalised eruption appears on the eighth to the eleventh day.

Period of invasion.—In a typical attack the invasive symptoms are sudden

and of great intensity. The most prominent are severe chills or rigors, marked pyrexia, severe frontal headache and intense pain across the loins. The temperature quickly reaches a maximum of 103° to 104° F., and is accompanied by severe prostration. Giddiness and nausea are present and vomiting may occur, particularly in children. Delirium, mental symptoms and even suicidal tendencies may accompany the invasive stage. With these severe symptoms are coupled more ordinary febrile manifestations, such as anorexia, thirst, coated tongue and disturbed sleep. The breath is offensive, the skin usually hot and dry but sometimes perspiring, and the bowels constipated. There are, however, mild attacks in which the symptoms of invasion are much less severe, and even in more severe attacks pain across the loins is not always present. Mild invasive symptoms usually presage a mild eruption; with a severe invasion the attack is generally, although not invariably, grave.

Prodromal rashes.—These may precede the proper eruption for 1 or 2 days. They are not always present. There are two types, one purely erythematous, the other petechial or hæmorrhagic with or without accompanying erythema. The pure erythemas are of a bright red or dusky purplish colour and may appear on the trunk, where they are often patchy, or be limited to the bony prominences and extensor surfaces of the limbs. They may suggest the rash of scarlet fever or bear a superficial resemblance to that of measles. The hæmorrhagic or petechial rash, which often has at first a dusky erythematous background, is more characteristic. It appears in the flexures of the groins which are stippled with small petechiæ; it invades the thigh for an inch or two and extends in an ill-defined manner on to the abdomen. Sometimes it extends towards the axilla and may be found on the back of the neck and flexures of the knees. The petechial rashes are persistent and indicate a severe attack. The erythemas are fugitive and of good prognostic import; the only exception is a very brilliant universal erythema of face, trunk and limbs which sometimes ushers in hæmorrhagic small-pox.

The eruption.—On the third day the symptoms of invasion are at their maximum and the eruption appears, showing first on the forehead and temples near the edge of the hairy scalp and also on the wrists. It extends rapidly over the body but always affects most the parts usually uncovered and those most exposed to pressure, friction or other irritation. It is least profuse on the abdomen and in the groins, somewhat more marked on the chest, still more marked on the back, especially across the shoulders, thicker still on the arms, choosing their distal portions, and most profuse of all on the face, especially its upper part. It reaches the lower extremities within 24 hours of its first appearance. Meantime the lesions multiply on the parts already affected, the eruption becoming thick on the face, and perhaps in the scalp, whilst still scanty on the parts invaded later. By the third day it will have attained its full density, but the earlier lesions will be in a slightly more advanced stage of development than those which appeared later.

It conspicuously avoids depressions, flexures and protected flexor surfaces, such as the armpits, flanks, groins, orbital hollows and supra-clavicular depressions. The escape of the axillæ and scantiness of rash on the flanks is marked. Abnormal irritation by clothing, irritants or scratching may determine increased local density of the eruption. The pocks are aggregated over prominent bones and outstanding tendons, but the clavicles and

malleoli are exceptions to this rule. The rash is more or less symmetrical; one arm will not escape when the other is involved.

On the *first* day of efflorescence the rash consists of small dull-red *macules*. Within 24 hours these are becoming obvious *papules* which feel shotty when pinched up between the finger and thumb, the hardness being best marked on the face, hands and forearms. On the *third* day of eruption many of the papules have become converted into *vesicles*, but the commencement of vesiculation may be recognised on the summits of the papules at an even earlier stage. By the fourth or fifth day the eruption is completely vesicular and the early toxæmic symptoms and fever may have entirely subsided. The vesicles, which are circular in outline, slowly increase in size and become surrounded by an inflammatory areola. They are now about the size of split peas, greyish in colour, and set in the skin rather than on its surface. Umbilication is evident and loculation is proved by their failure to collapse when transfixed by a sterile needle. The contents of the vesicles remain clear for 24 hours only; they then gradually become purulent, so that by the *fifth* day *pustules* are in evidence on the face and by the eighth day are universal. With pustulation, the pocks soften, become flat-topped and lose their areolæ. Reaccession of fever with constitutional symptoms and often delirium, the *secondary suppurative fever*, accompanies the process of suppuration or maturation. Where the pustules are plentiful a marked inflammatory œdema of the skin may now appear, causing the features to become much swollen and impeding the movements of the hands and fingers. Much tenderness accompanies this œdema, and the patient may also be tormented by itching. Suppuration destroys the loculation of the vesicles and also obliterates umbilication. Adjacent lesions, particularly on the face and hands, may run together in the vesicular and pustular stage—a process which produces the *confluent rash*, and is a sign of severe infection. On the *ninth* and *tenth* day of eruption the pustules begin to *desiccate* and *scab*, some first rupture or are torn by scratching, and collapse. Brown or black crusts result which separate by the end of the thirteenth or fourteenth day, but where the skin is very thick, as on the palms and soles, the dried-up unruptured pustules may form deep-seated "seeds" which may take weeks to work their way to the surface.

To summarise: the rash is papular on the first to the third day; vesicular from the third to the fifth; pustular from the fifth to the ninth, and desiccating from the ninth to the seventeenth.

The cutaneous eruption is accompanied by an outcrop on the mucous membranes of the mouth, nose and pharynx. In severe cases the larynx, bronchi, gullet and even the stomach may also be affected. On the mucous membranes vesicles are soon transformed into shallow grey ulcers. Vesiculation may be observed on the palate, whilst the lesions are still indeterminate on the skin. In consequence of the eruption the fauces and tongue become sore, the nose is obstructed and deglutition is painful. Implication of the larynx will cause hoarseness or aphonia and even dangerous œdema. The mucous membranes of the vulva, vagina and rectum may also be involved.

The fever (Fig. 4) of invasion reaches its acme with the appearance of the rash, then it falls, but not immediately. It is generally normal by the fifth day of the eruption, often before this. It is at this stage, in the milder attacks with

scanty rash, the patient may attempt to resume his ordinary occupation, and, in modified cases, very little further febrile disturbance may ensue. Ordinarily, however, the secondary suppurative fever now sets in and reaches its acme about the ninth or tenth day of the eruption. Its duration in the more severe cases is from 10 days to a fortnight. In severe and confluent cases, the remission of temperature in the vesicular stage may be ill-marked or absent. The pulse and respirations are quickened proportionally to the degree of fever present, but in grave cases the respirations become shallow and irregular, and the pulse accelerated and feeble.

The urine is febrile in character. Some albumin may be present, and a diazo-reaction may be obtained. A foul odour may emanate from the skin in suppurative confluent cases.

Owing to the deep-seated position of the lesions in the skin, depressed scars are left, the amount of pitting depending on the degree of suppuration.

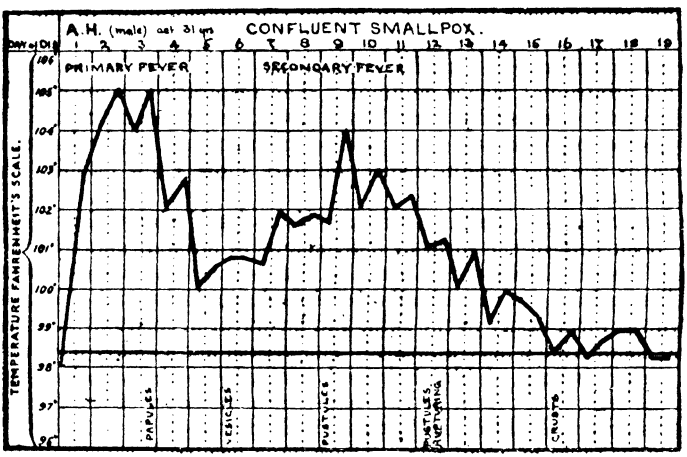

FIG. 4.—Confluent small-pox in an unvaccinated adult.

The pits show a reddish staining which may persist for months. Some desquamation may accompany the separation of the crusts, particularly on the feet and hands. The hair often falls out freely. Convalescence is, in favourable cases, rapid and complete.

Modified small-pox or varioloid.—Small-pox of a very mild type may occur both in the vaccinated and the unvaccinated. In such cases initial symptoms may be slight, and the eruption, although typical, is scanty; sometimes it altogether fails to appear. More commonly, especially in vaccinated subjects who retain but partial protection, the initial symptoms are severe, and the rash appears early, but it is generally sparse and discrete, tends to evolve quickly, and many of its elements fail to progress beyond the papular or vesicular stage, the suppurative fever being slight or absent. The lesions, which are often small, are superficial and may be unilocular, sometimes they appear fleshy and wart-like. The modification is most evident on the face. In such cases the arrest of development leading to the juxtaposition of papules,

vesicles and small pustules may cause a resemblance to chicken-pox, but the distribution remains characteristic.

Severe types of small-pox.—These comprise the confluent and hæmorrhagic varieties. *Confluent small-pox* is characterised by fusion of the lesions, particularly on the face and hands. The rash may fuse whilst still papular, but more commonly does so in the vesicular and pustular stages. In such cases the toxæmia is severe and the remission of symptoms before the stage of pustulation may be absent or ill-marked. Delirium is common, and the secondary fever high. Inflammatory œdema is very marked, the features may become quite unrecognisable and the confluent pocks may form a continuous sheet of pus. Severe conjunctivitis, salivation, cough, aphonia and diarrhœa are common. Some patients pass into a typhoid condition. An offensive odour emanates from the skin, circulatory failure is progressive, and death may occur towards the end of the second week.

Hæmorrhagic small-pox.—In the most malignant variety, purpuric flecks and patches may appear in the skin before the development of the eruption and are accompanied by subconjunctival hæmorrhages and bleeding from the mucous membranes. Initial symptoms, in particular backache, are severe, and prodromal rashes common. The respiration is hurried, but the temperature not necessarily very high. Death may occur before the outbreak of the proper eruption gives a clue to the nature of the infection, but often towards the end careful inspection may show a few papular elements struggling to appear.

In other cases the bleeding first manifests itself about the time of the eruption, occurring in the form of petechiæ or of circular spots between the lesions and also infiltrating the bases of the vesicles and staining their contents. The vesicles are often badly developed, confluent and of a violaceous hue. Bruises form easily in the skin, and hæmaturia, epistaxis, hæmatemesis or uterine hæmorrhage may appear. The breath has a sickly odour.

The mere presence of blood-stained contents in the vesicles, especially those on the legs, apart from hæmorrhages into the bases of the pocks, in the skin and elsewhere, is not of bad prognostic importance.

Anomalous types of small-pox.—There have occurred, especially in Brazil and the West Indies, but also in Africa, Australia and parts of Europe, outbreaks of an infectious disease bearing a resemblance both to small-pox and chicken-pox. This is variously known as alastrim, amaas, and varioloid varicella. The names para-variola and variola minor have also been suggested. It is now looked upon as a variety of small-pox, from the ordinary form of which it differs in its mild course and low mortality, and the fact that it attacks adults rather than children. The lesions are superficial, their appearance may be delayed and their evolution is more rapid than in small-pox, but their distribution is similar. The vesicles have a chalky appearance, are often unilocular and not umbilicated. The resulting crusts are amber-coloured. Although the invasive symptoms may be rather sharp and accompanied by vomiting, there is no secondary fever, and the protective power of vaccination is not so definite as in ordinary small-pox—indeed, it is possible to vaccinate successfully some of the victims during convalescence.

Complications.—During the later stages and in convalescence, boils and superficial abscesses often cause trouble. Septic rashes, erysipelatous or impetiginous infections may spread from the pocks. The cervical and

axillary glands may become enlarged or even suppurate. In the more severe cases, bed-sores may rapidly form over pressure points. Rarely death is due to septicæmia arising from these cutaneous affections.

Ocular complications are important. Conjunctivitis is common. Pustules may form on the palpebral or ocular conjunctiva. The eyelids often become inflamed and œdematous. A rapidly spreading keratitis may lead to sloughing of the cornea, but corneal ulcers are more common and sometimes lead to perforation and panophthalmitis. Iritis is rare. Retinal hæmorrhages sometimes cause blindness. The scars of the corneal ulcers may much impair the sight. Otitis media is comparatively common.

Laryngeal inflammation may be so severe as to necessitate tracheotomy, and may lead to perichondritis and necrosis. Bronchitis and bronchopneumonia are frequent and often accelerate death. Lobar pneumonia and purulent pleurisy are rare. Endocarditis and pericarditis are exceptional, but degenerative changes in the myocardium are not infrequent. Occasionally a destructive arthritis supervenes; it is said to be more common in childhood. Although albuminuria is often found, a true nephritis is rare.

Parotitis is looked upon as a secondary duct infection from the mouth. Orchitis sometimes occurs during the acute stage.

In rare cases paralysis of the extremities and of the bladder has been noted. Ataxy and articulatory defect may supervene, and sometimes hemiplegia occurs. The underlying lesions may be peripheral neuritis, patchy myelitis or encephalitis.

Disfigurement of the face, permanent blindness, deafness and sometimes alopecia may be the legacies of a severe attack.

Diagnosis.—The whole body should be stripped and examined in a good light. In some cases a preliminary bath is needful. Attention should first be focused on the distribution rather than on the characters of the rash. Too much reliance should not be placed on shottiness or umbilication. The condition as to vaccination should be ascertained and the nature of any prevailing epidemic borne in mind.

The initial fever may itself lead to difficulty in diagnosis; the symptoms of onset are somewhat similar to those met with in other acute diseases, particularly influenza, pneumonia and cerebro-spinal fever. Severe prostration and backache, when present, are suggestive. Often the diagnosis is not certain until the true eruption appears, but the appearance of a petechial prodromal rash in the groins may enable earlier recognition. As regards influenza, it is more common for small-pox to be at first mistaken for this disease than for the converse to occur. Lumbar puncture is available in cerebro-spinal fever. In pneumonia sooner or later lung signs appear. Precipitate certification of a supposed case of small-pox, even in a contact is unwise; it is better to await the appearance of the rash, remembering this should appear first on the forehead, near the roots of the hair, the cheekbones, sides of the nose, wrists, hands and forearms. The interior of the mouth should also be inspected and any parts of the skin which have been subjected to special irritation.

The prodromal rashes, if purpuric, may be confused with different varieties of purpura; if erythematous, with scarlet fever, measles, rubella, urticaria or other forms of erythema.

The characteristic groin incidence of the purpuric rash of small-pox should

be remembered, and is of great assistance in diagnosis. Mere widespread purpuric rashes, however, are at times misdiagnosed as febrile purpura until the occurrence of small-pox in contacts reveals their true nature. Conversely, febrile purpura and purpuric rashes occurring in ulcerative endocarditis, cerebro-spinal fever and other conditions may be mistakenly thought to indicate small-pox. The distribution of the rash and the character of accompanying symptoms should be noted. Physical examination of the organs may reveal signs which help to clear up the diagnosis, which may be very difficult.

A scarlatiniform prodromal rash is distinguished from scarlet fever by the absence of tonsillitis and of punctate redness of the soft palate. The rash on the skin is not definitely punctate and the area of circumoral pallor wanting. The tongue is not typical nor are the tonsillar lymph glands enlarged.

Morbilliform prodromal rashes bear only a very superficial resemblance to measles. The diagnosis is discussed later. Nor should rubella be confused if its characters be borne in mind. The initial erythemas may resemble those induced by antitoxic serum, by soap enemas and by drugs. The characters of these rashes are given in the article on scarlet fever.

The *true eruption of small-pox* may be confused with measles, chicken-pox, perhaps typhoid or typhus, also with various forms of papular erythema, urticaria, acne, papular and pustular syphilides, and glanders. Sometimes drug rashes, particularly those due to iodides, lead to mistakes. Measles on the face may bear a close resemblance to the papular eruption of small-pox. It is distinguished by the catarrhal symptoms, Koplik's spots, the distribution of the rash on the body, and the fact the temperature tends to rise as the eruption increases instead of falling as it does in small-pox.

The differentiation of some cases of chicken-pox is a great source of difficulty. For although chicken-pox is a disease of childhood whilst small-pox now chiefly affects adults, yet cases of chicken-pox in the adult are not infrequent, and in them the prodromal symptoms may be sharp and the rash not appear until the second or third day. Chicken-pox presents the following distinctive characters:

1. The rash of chicken-pox appears first on the trunk, and is thickest on the trunk, face, upper arms and thighs. It avoids the extremities of the limbs. It does not especially select irritated areas, nor does it avoid the axilla and groin. The presence of many lesions on the palms and soles is greatly against chicken-pox.

2. The eruption comes out in distinct crops over 3 to 5 days or more.

3. The vesicles develop much more rapidly and are mature in 24 hours.

4. The lesions are superficial and unilocular, rarely umbilicated. Their bases are not indurated. Near flexures they may assume an oval outline, sometimes they are irregular or crenated.

5. Pocks of all stages of development may be present at the same time on a given area of skin.

6. The lesions are smaller. Pustules and scabs half an inch across are almost certainly due to small-pox.

7. Successful vaccination within 5 years or revaccination within 10 years is evidence against the disease being small-pox. Chicken-pox does not protect against successful vaccination in an unprotected individual. If the

disease be small-pox, vaccination will prove unsuccessful. This rule, however, is not absolute. Vaccination may prove successful in anomalous forms of small-pox, and has been alleged to take in ordinary small-pox on rare occasions.

Confusion with typhoid and typhus is uncommon, and should be eliminated by taking into consideration the distribution of the rash and character of the other symptoms. In distinguishing other skin eruptions it should be remembered erythemas are often polymorphic. They may show occasional vesiculation which is quite superficial and are sometimes febrile. Acne affects the face, shoulders, back and chest; it is chronic, afebrile, and often associated with comedones and scars. The lesions may be pustular but are never vesicular. The lesions are not found on the forearms or hands.

If syphilis be borne in mind its eruptions are not likely to be mistaken. Reliance must be placed upon their distribution, polymorphic character, other signs of syphilis, the history and the Wassermann reaction. A patient with syphilis may also have small-pox. Glanders is rare, but when the nodules on the face suppurate and are accompanied by fever, small-pox may be suggested. There is usually a nasal discharge and a history of association with horses. Bacteriological examination will show the *Bacillus mallei*.

Certain laboratory tests have been elaborated for the detection of small-pox. Of these, Paul's test is of value. It is carried out as follows. A rabbit's eyes are cocainised. One is scarified with the contents of a suspected pock, the other is simply scarified as a control. At the end of 48 hours the rabbit is killed and the eyes are examined in a sublimate bath. In the case of small-pox or vaccinia, but not of chicken-pox or other vesicular eruption, the inoculated cornea shows opaque white elevations on a milky background. The other cornea is evenly opaque without epithelial plaques. Guarnieri bodies are present in the plaques. A more certain test and one more easy to apply and appraise is intradermal inoculation of the rabbit with material from a small-pox vesicle. After a short incubation period a characteristic inflammatory reaction ensues. This reaction remains in abeyance when serum from a rabbit hyperimmunised with vaccinia virus is mixed with the small-pox material before injection into the dermis (Ledingham, Defries and M'Kinnon). Other tests depend on the production of allergic reactions, as, *e.g.*, when small-pox material is inoculated intradermally into a rabbit which has been hyperimmunised with vaccinia virus.

Prognosis.—Natural small-pox has a mortality which varies from 25 to even 40 per cent. The prognosis may be considered under the following heads: (1) The vaccinal condition of the patient; (2) the age; (3) the nature of the attack; and (4) the character of the prevailing epidemic.

1. When a vaccinated person takes small-pox the nature of the attack usually indicates some residual immunity, the severity of the disease being less and the mortality much lower than in the unvaccinated. The presence of large, well-foveated vaccination scars renders the prognosis very favourable. After the age of 15 the protective influence of infantile vaccination will to a large extent have disappeared, but revaccination at puberty, properly performed, confers a high degree of immunity for the rest of life.

2. The death-rate in the first 5 years of life is very high and may exceed 40 per cent. After that there is a fall, at first gradual, then considerable, up to the age of 15 or 20, which is the most favourable period. Subsequently

the mortality rises steadily and may even exceed the figures given for the first quinquennium. In the vaccinated, however, the younger the patient the more certain is recovery. If revaccination has not been performed, as age increases the mortality does so also, and may reach 15 per cent. in persons over 30 years of age.

3. The nature of the symptoms is important. Mild invasion presages a mild attack. Severe invasive symptoms usually, but not invariably, mean a severe infection, but they may precede mild attacks in the vaccinated and sometimes in others. Prodromal rashes of a vivid lobster hue, especially if petechiæ be present, are the heralds of grave, often hæmorrhagic infections. Very intense backache is also an ominous invasive symptom. The more profuse the pustular rash the worse the prognosis, but the intensity of the suppurative stage is much modified by previous vaccination. Confluent eruptions mean a bad outlook, whilst patients in whom the rash remains discrete usually recover. Hæmorrhagic small-pox is always fatal.

Other unfavourable symptoms are incomplete remission between the primary and secondary fever, sleeplessness, active delirium, especially in drinkers, considerable implication of the larynx and broncho-pneumonia. The influence of pregnancy in inducing abortion and miscarriage has already been mentioned.

4. Epidemics vary much in their severity and mortality. In some the disease is so slight and the mortality so low, that doubts arise whether the epidemic is really small-pox.

Treatment.—*Prophylactic.*—Efficient vaccination and revaccination are the most powerful safeguards. The chief measures to be taken when the disease is recognised are the following: (1) Prompt removal of the patient to an isolation hospital. (2) Thorough disinfection of infected rooms and clothing. (3) Immediate vaccination or revaccination of all other members of the household and of contacts. Four or even more days after exposure vaccination may prove effectual in preventing the disease, at all events will modify it. (4) Quarantining of contacts for 16 days, or a daily inspection so that initial symptoms may be detected at once. (5) Notification of schools or institutions attended by inmates of the same house.

Inoculation with small-pox, which prior to vaccination was a method of prophylaxis, is said in some instances to have had a mortality of 2 or 3 per cent.; but even this compares favourably with a mortality of 50 per cent. as seen in some epidemics of ordinary small-pox. Inoculation, however, was found to spread the disease, and so has, in England, been made a penal offence.

General.—This is purely symptomatic. Abundance of fresh air, cool surroundings, and not too great a weight of bedclothes, fluid diet, regulation of the bowels, and tepid sponging night and morning form the regular routine. The mouth should be cleansed regularly with peroxide of hydrogen, alkaline carbolic lotion, or some other mild antiseptic, and the nose gently douched or liquid paraffin instilled. A water pillow may be necessary in some cases. Severe pain in the head and back during the invasive stage may be mitigated by the application of an ice-bag to the scalp and use of fomentations to the back; at the same time aspirin, phenacetin, or chloral and bromide may give relief; but the drug most generally useful, both in this stage and in the sleeplessness, delirium and discomfort of the secondary fever, is opium in the

form of 10 grains of Dover's powder. Sometimes paraldehyde is effectual. Delirious patients should never be left alone. The intractable vomiting of the early stage is allayed by citrating or peptonising the milk or substituting ice and champagne. Tincture of iodine in 5-minim doses is also useful. When fever continues high and is accompanied by toxæmia and delirium, tepid sponging may be replaced by hot or cold packs with advantage. Many methods have been tried of aborting the eruption and preventing the subsequent pitting. None are effectual. Evacuation of the contents of the pocks as soon as fluid appeared in them used to be recommended. Some advocate painting the face with tincture of iodine, diluted if painful, twice a day for the first 8 or 10 days, and then applying vaseline; or, better, a saturated (5 per cent.) solution of potassium permanganate may be painted over the whole body three times a day until scabbing begins, and afterwards less frequently. The application of a lint mask soaked in glycerine is useful, and glycerine may also be applied to the hands, or a dilute carbolic compress substituted. When the eruption is thick in the scalp it may be necessary to cut the hair short. The administration of salol in 10-grain doses every 4 hours is believed to modify the pustular stage. An attempt to combat the amount of suppuration by exposing the patient to red light, whereby actinic rays are cut off, is recommended by Finsen, but is said to prove too depressing. To mitigate the offensive odour which emanates from the skin, dilute carbolic lotions may be used (they also relieve the itching), or creosote may be vaporised in the sick-room. Starch poultices and alkaline washes are used for the removal of refractory crusts and zinc ointment applied. The eyes require special attention; they should be bathed with boracic lotion at frequent intervals, and dilute nitrate of mercury ointment smeared on the edges of the lids. Should keratitis threaten, an ointment of atropine with yellow oxide of mercury should be applied.

Laryngitis calls for a steam tent and inhalations of benzoin or lysol. Heart failure is combated by the usual methods, and strychnine is useful as a nervous and respiratory stimulant. During decrusting and convalescence frequent warm baths are grateful, and quinine is a useful tonic.

Patients are to be regarded as infectious until the scabs are all separated and the skin quite healed.

VACCINIA

Vaccinia or cow-pox, a disease which at one time was very prevalent among cows, but is now rare, is characterised by a vesicular eruption on the udders and teats. The vesicles, which are surrounded by an inflammatory areola, may by rupture form extensive irregular ulcers. Abrasions on the hands of milkers may be accidentally inoculated from these lesions and they, in turn, may inoculate other cows in the herd. The hands of the infected milker show vesicles with surrounding induration, the axillary glands become swollen and there is some fever. Individuals thus inoculated are protected from small-pox, and Edward Jenner made practical use of this fact by inculcating the practice of deliberate vaccination and transference of the virus from arm to arm. In addition he demonstrated that those thus inoculated were refractory to subsequent deliberate inoculation with the virus from small-pox lesions.

After long dispute, the question of the actual identity of cow-pox and small-pox has practically been settled by animal experiment in favour of Jenner's view that the two diseases are one and the same, small-pox virus being so attenuated and modified by its transmission through the cow that its inoculation results only in a local lesion, a lesion which, however, affords a high degree of protection against subsequent attacks of small-pox. Vaccinia also differs from small-pox, whether the latter be natural or deliberately inoculated, in that it has lost its infective character, and so can be used for purposes of vaccination without risk of propagating small-pox in the community. We may define vaccinia as variola which has been modified by transmission through cows or calves.

The histology of the vaccine vesicle is in every respect comparable to that of the lesion of small-pox. It goes through the stages of papule, vesicle and pustule; and loculation is produced owing to the persistence of the remnants of vacuolated epithelial cells in the form of septa.

For the purpose of vaccination vaccine lymph is prepared by the inoculation of healthy calves, the contents of the vesicles being collected and freed from pyogenic and other extraneous organisms by admixture with glycerine. This process of glycerinisation kills most of the adventitious germs, but leaves the virus of vaccinia uninjured. The lymph thus prepared is stored in capillary tubes and will remain efficacious for at least 8 months. Its use is preferable to the direct inoculation from human vaccine vesicles.

The operation of vaccination is carried out as follows: An area of skin over the insertion of the left deltoid muscle or on the outer side of the thigh is carefully cleaned with soap and water, and afterwards with ether. The contents of a tube of lymph are then ejected on to the cleansed area in 2, 3 or 4 separate portions, according to the number of insertions proposed. Scratches are made through the drops of lymph with a sterile lancet or sterile needle, care being taken to avoid drawing blood, and the lymph gently rubbed over the scratches with the instrument used. The scarified spots should be at least an inch distant from each other to avoid confluence. The lymph is given a few minutes for absorption, and any excess is removed with sterile wool. The scarified area is covered with sterile gauze. The whole procedure must be carried out with strict regard to asepsis.

If the operation be successful, inflamed areas appear at the sites of inoculation, and by the third day become distinctly papular. By the fifth day, small clear vesicles have formed which slowly increase in size and become depressed at their centres. By the eighth day the vesicles are large, sharply defined, and their inflammatory areolæ are confluent. From this time the contents become increasingly cloudy. The vesicles attain their full size by the twelfth day and collapse. By the tenth or twelfth day a brownish scab is forming. This after a time separates, leaving a depressed and pitted or foveated scar which at first is livid, but in course of time becomes dull white in colour.

Headache, malaise and fever accompany maturation of the vesicles at the beginning of the second week; the axillary glands may become enlarged and tender and the spleen palpable. Sometimes febrile disturbance is noticed as early as the fourth day.

In revaccination, the events are similar, but both the local and constitutional disturbances are less pronounced; sometimes they fail to appear at

all. The lesions may run a very rapid course, aborting at the papular or early vesicular stage. Sometimes a slight itching and glandular tenderness are all that is observed.

Natural insusceptibility to primary vaccination is excessively rare, and at least three successive attempts should be made before insusceptibility is assumed.

Although infants can be vaccinated successfully in the first few weeks of life, under ordinary circumstances the best period is from the second to the sixth month. Revaccination is advisable after the seventh year, and when small-pox is epidemic.

The degree of protection afforded against small-pox is in some degree proportional to the extent of the vaccinal lesion, and the resulting scars should, together, cover an area of not less than half a square inch. Hence the advice always to make at least two insertions and preferably four. The test of a successful scar is its depression and foveation. The period of immunity may be regarded as not less than 7 years.

Risks of Vaccination.—Fugitive erythemata, which are sometimes scarlatiniform, measly or urticarial, may appear about a week after vaccination; they resemble serum rashes. Erysipelas, septic infection and cellulitis sometimes result from the use of contaminated lymph or the lack of proper cleanliness at the operation or after. Under modern methods of glycerinisation and asepsis, these should not occur. There is no doubt, too, that syphilis has on rare occasions been conveyed by arm-to-arm vaccination. In such cases, the chancre does not appear before the fifteenth day, and is usually later. The calf being insusceptible to syphilis, the use of calf lymph has abolished this danger. Tetanus is another infection which has occasionally resulted, especially in hot climates. Tuberculosis and leprosy have also been cited as possible sequels, but with little or no proof. The addition of glycerine to the lymph kills the tubercle bacilli. The appearance of eczema and impetigo has been attributed to vaccination, as also a somewhat persistent form of anæmia. A rare sequel, to which attention has been drawn recently, is a form of encephalo-myelitis. It sets in 7 to 12 days after vaccination, with headache, vomiting and paresis. These symptoms become aggravated, and delirium may pass into coma and death, but recovery is possible. In other cases the symptoms are more suggestive of meningitis, tetanus, or lethargic encephalitis, with ocular palsies.

Quiescent infection may be brought into activity and prominence by vaccination; this is the case with congenital syphilis and tuberculosis. Hence the advisability of postponing vaccination should the infant show signs of malnutrition or ill-health.

Very rarely the course of vaccinia is characterised by the appearance of a generalised vesicular eruption, the lesions appearing in successive crops, and passing through the stages of papule, vesicle and crust. *Generalised vaccinia* of this type is usually febrile.

Accidental vaccinia is the term applied to fortuitous inoculation from a vaccinal lesion. Mothers are sometimes thus inoculated from their infants. The condition should be borne in mind. When occurring on the face, there is much œdema with swelling of the lymph glands, so that anthrax has been suspected. The vaccinated baby may also, by scratching, inoculate its own nose, cheeks or other parts of its body.

PROTECTION AFFORDED BY VACCINATION.—The immunity to small-pox which vaccination confers is not necessarily permanent. A child vaccinated in infancy should be revaccinated at the age of 7 years and again in adult life. Whatever their vaccinal condition, with the possible exception of those vaccinated within 2 years, persons coming into contact with small-pox should be revaccinated at once.

Since vaccinia has a shorter incubation period than small-pox, a person successfully vaccinated or revaccinated within 3 days of exposure to the latter disease will, in all probability, escape it. Ricketts makes the following statement: "The period of incubation of small-pox, counting to the outcrop of the rash, may be taken as 14 days. If this period be divided into three intervals comprising 7 days, 3 days and 4 days, it will be accurate, in the main, to say that a successful vaccination done in the first period will wholly prevent the attack, done in the second will have more or less effect in modifying the eruption, and done in the third, will merely add to the patient's troubles."

For a discussion of the evidence in favour of the practice of vaccination in the prevention of small-pox, the student is referred to the larger treatises.

CHICKEN-POX

Synonyms.—Varicella; Glass-pock; Water-pock.

Definition.—An acute infective disease, characterised by a rash which tends to appear in successive crops, each lesion passing rapidly through a papular stage to one of superficial vesiculation and subsequent partial pustulation. The lesions then desiccate and scab.

Ætiology.—Chicken-pox is universally prevalent and highly infectious. One attack usually affords complete protection, second attacks being extremely rare. It is mainly an affection of middle childhood, being uncommon after 10 years of age, but adults may contract it, and infants are not completely immune. Season and climate are not known to exert any influence on its incidence. It affects both sexes. Infection is in most cases direct, but articles of clothing may remain infectious for a considerable time, and the disease is sometimes carried by a healthy intermediary. The dried scabs can communicate the disease, probably by ingestion or inhalation. Like small-pox, chicken-pox is inoculable from the vesicles—but not easily. Convalescents from acute diseases, particularly from measles, diphtheria and scarlet fever, are believed to be peculiarly susceptible to chicken-pox. The disease occurs sporadically or in the form of limited outbreaks. The infective agent is unknown.

Pathology.—Micro-organisms occur in the pocks, and protozoon-like bodies have been described similar to those seen in vaccinia and small-pox. The inflammatory lesions are more superficially situated in the skin than those of small-pox; but the process of vesiculation is similar. Loculation is indistinct, and umbilication exceptional. When the clear vesicles become clouded, but rarely before this, polynuclear and mononuclear cells are found in their contents.

Symptoms.—*Incubation period.*—This is usually a fortnight or a little more; but extremes of 11 to 23 days are mentioned.

In childhood the appearance of the eruption usually constitutes the first

sign, and is taken to indicate the first day of the disease. In adults slight pyrexia and sometimes headache, shivering, and even pain in the back may precede the eruption for 48 hours. In exceptional cases, mostly in children, vomiting and convulsions have occurred.

Prodromal rashes are not very uncommon. A patchy or uniform bright red erythema, which may be punctate, sometimes precedes the eruption for some hours, and may be mistaken for scarlet fever; it avoids the face. Much less frequently the prodromal rashes are measly or urticarial in appearance.

The eruption of chicken-pox appears first on the trunk, but soon invades the face, the scalp and the proximal parts of the limbs. Sometimes it is on the face that it is first noticed. Occasionally the eruption invades the mucous membranes, especially the fauces, soft palate and the pharynx. The spread of the rash does not conform to the orderly progress of small-pox, it appears in several crops on successive days; these may come out for 2 or 3 days in mild cases, for a week or more in those which are severe. The total number of lesions may be anything from a few to some hundreds. They are thickest on the trunk, especially on the back, and next to this on the face and in the scalp. They tend to invade the limbs from above downwards, being sparse and often small on the distal portions; a few vesicles are occasionally seen on the palms and soles. The axilla does not escape as in small-pox, and it is unusual for the rash to show an especial incidence over ridges, pressure points or irritated areas.

The lesions are in turn macular, papular, vesicular and mildly pustular. The macules are very transitory, soon becoming rounded or ovoid papules of a pinkish colour and slightly salient, something like the rose spots of typhoid, or larger. Vesiculation rapidly ensues, and is complete in 24 hours or a little more. The vesicles seldom exceed a third of an inch in diameter. They look like translucent droplets, lying on rather than in the skin. An areola may or may not be present. On the scalp, forearms, hands and feet they may appear deeper, and show some hardness. Some assume oval or irregular outlines, especially when lying near creases or folds of the skin. On maturity the vesicles assume a pearly hue. When punctured, most of them collapse entirely, and umbilication is rare. Confluence of adjacent vesicles hardly ever occurs. Owing to its itchiness, the rash is often infected by scratching or rubbing, and then the lesions become larger and more inflamed. Otherwise the vesicles dry up into superficial brown scabs in a day or two, which on separating leave slight pink stains, but no appreciable pitting.

The appearance of the eruption in successive crops leads to the presence at the same time on a given area of skin of lesions in all stages of development, *i.e.* papules, vesicles, small pustules and scabs. On mucous membranes the vesicles soon rupture and leave shallow grey ulcers, often with red areolæ.

Slight pyrexia usually accompanies the appearance of the rash. Some cases are apyrexial throughout. Rarely the temperature rises as high as 103° or 104° F. Successive crops of spots may be accompanied by successive exacerbations of fever. Constitutional symptoms as a rule are absent.

Varieties.—Chicken-pox varies much in intensity. It may be so mild that only one or two pocks are recognised. As mentioned above, sharp invasive symptoms may mark its advent in the adult. There are three special varieties of the severe disease: (1) *Varicella bullosa*; (2) *Varicella gangrenosa*;

and (3) *Varicella hæmorrhagica*. In *V. bullosa* the vesicles rapidly form large blebs, which on rupture leave painful raw surfaces. *V. gangrenosa* is seen in debilitated children and those recovering from scarlet fever; large dark crusts form, and on separation reveal unhealthy ulcers which may spread on the surface and in depth with great rapidity. Constitutional disturbance is severe, and pulmonary complications often supervene. *V. hæmorrhagica* is rare; hæmorrhages occur into the vesicles and intervening skin, and bleeding sets in from the mucous membranes.

Complications.—Slight bronchitis is present in some cases. Laryngitis may occur, but is rare. Pocks on the conjunctivæ, vulva or prepuce may give rise to troublesome symptoms. Accidental septic rashes sometimes appear in the eruptive stage. Nervous complications have at times been observed, amongst them encephalitis, poliomyelitis, peripheral neuritis, papillœdema, convulsions and chorea. Exceptionally, an acute nephritis appears in the second week, and sometimes an arthritis.

Herpes zoster seems to be in some way connected with chicken-pox. Rarely an eruption of herpes is, sometimes within 24 hours, followed by the rash of chicken-pox. In other cases an eruption, from its distribution diagnosed as herpes, has given rise in contacts, after an incubation period of from 12 to 21 days, to undoubted chicken-pox.

Diagnosis.—The chief diagnostic difficulty which arises is in connection with small-pox. A mild or modified case of small-pox may erroneously be supposed to be chicken-pox, or chicken-pox with a profuse eruption and constitutional, or the rare hæmorrhagic, symptoms may be supposed to be small-pox. The differential diagnosis, in which the distribution of the rash is of primary importance, is considered in the article on small-pox. Here it may be stated that in a patient under 10 years of age, with well-foveated vaccination scars, a profuse eruption is generally chicken-pox, whilst a scanty eruption with well-marked invasive symptoms is more likely in these circumstances to be modified small-pox.

The erythematous prodromal rash may simulate scarlet fever; but the other signs of this disease are wanting, and the chicken-pox eruption appears within 24 hours. Acneiform eruptions on the trunk are distinguished by their distribution, the absence of successive crops and by chronicity.

The crusts of impetigo, when they appear on the trunk, as well as on the exposed parts, may be a cause of great difficulty. The history and duration, as well as the distribution of the lesions, will help.

Pemphigus, which has large bullæ; dermatitis herpetiformis, which is very apt to be recurrent or relapsing, with multiform lesions both on skin and mucous membranes; and herpes zoster, which on rare occasions is said to be accompanied by a generalised eruption of superficial vesicles, may all give rise to uncertainty.

A varicella-like type of syphilide is known. It has not the same distribution as chicken-pox, it usually affects the trunk, is much more persistent, and is accompanied by other evidence of its nature.

Prognosis.—Death is very rare. The gangrenous form may prove fatal to debilitated or tuberculous children, and the rare hæmorrhagic form is said by most authorities to have a very bad prognosis.

Treatment.—Although most infectious in the pre-eruptive and early eruptive stages, patients should be isolated until every scab has separated

—usually a period of 2 or 3 weeks. They should be confined to bed during the eruptive period. Skin irritation may be allayed by mild dusting powders, and it is sometimes advisable to fix the arms in light splints, so that the lesions may not be scratched and infected. It is rarely necessary to cut off the hair. Inflamed pocks may need fomentation with boric acid. Crusts which re-form may be removed by starch poultices and zinc or mercurial ointment applied. During the febrile stage light diet is advisable. Gangrenous varicella may be treated by prolonged immersion in a warm bath followed by the application of lotio hydrarg. perchlor. (1 in 2000) to the lesions. A liberal diet with tonics and stimulants is necessary.

When discharging patients particular attention should be paid to the scalp, as scabs may remain entangled in the hair. It is doubtful if lesions which have crusted several times are still infectious. The quarantine period for contacts is 3 weeks.

TYPHUS FEVER

Synonyms.—Jail Fever; Camp Fever; Ship Fever; Typhus Exanthemicus.

Definition.—A highly contagious fever characterised by sudden onset, severe prostration, a characteristic rash, and termination by crisis about the fourteenth day. The infection is conveyed by body lice, perhaps through their bites, but more probably by cutaneous inoculation of their excreta by scratching. Head lice and certain ticks are also believed to be possible vectors of the disease.

Ætiology.—Most of the factors which conduce to the spread of typhus operate by their influence on the parasites by which the disease is conveyed. The lice pass directly from the sick to the healthy, or by means of garments, bedclothes, and mattresses which have been in contact with those infected. Crowding of the sick together in dark, ill-ventilated rooms greatly favours the possibility of infection, whilst in the presence of free ventilation very close contact is necessary before the disease is contracted.

Exhalations from the lungs, emanations from the skin and the excreta are believed to be capable of conveying the infection, and the bodies of those dead of the disease have been supposed to retain their infective powers until decomposition sets in. These beliefs, in view of the part played by lice, obviously need revision. Typhus carriers are always verminous persons. Clothes which harbour infected lice have often transmitted the disease to distant parts.

Typhus is a disease of cold and temperate climates; it occurs in those months of the year when confinement within doors and overcrowding are most likely. In the tropics it is uncommon. In hot climates frequent bathing, scantiness of attire, free action of the skin, and the inimical effect of high temperatures on lice are all factors which prevent the spread of the disease.

Predisposing causes are verminous infestation, overcrowding, and destitution. Typhus is a disease of crowded insanitary towns, prisons, barracks and camps. Epidemics are particularly liable to occur in times of war and famine. Misery, bodily fatigue, alcoholism and fear also predispose to the

infection. Typhus is rare in England, but endemic foci still persist in Irish and perhaps some Scottish towns. In Russia and Eastern Europe the disease is very prevalent, and a great epidemic ravaged Serbia in the early days of the Great War. It has also been recognised in Canada, New York (Brill's disease), Mexico (where it is known as Tabardillo), Manchuria and other places.

Typhus attacks persons of all ages and both sexes. The greatest mortality is in those above middle age (at 50 years it may be 50 per cent., and between 75 and 80 years, nearly 85 per cent.); attacks in the young are less severe and very much less fatal. In populations where the disease is endemic attacks may be very mild, but when introduced into other places the type may prove excessively severe.

Pathology.—The post-mortem appearances are those common to many acute infections and are not in themselves characteristic. Decomposition is early and rigor mortis of short duration. Livid patches and petechial spots are evident in the skin. The viscera are passively congested, and the blood remains fluid. The heart is soft, and its muscle fibres granular. The liver, kidneys and other parenchymatous organs show cloudy swelling. Hypostatic congestion of the lungs and catarrh of the air-passages are common. The absence of characteristic lesions in the bowel affords a distinction from typhoid fever. Beyond occasional meningeal congestion the central nervous system appears normal. Zenker's degeneration may be found in the voluntary muscles, as in typhoid.

Microscopical examination reveals the presence of nodules of endothelial proliferation in the small arteries of the skin and of the brain, also in those of the muscles and viscera.

Of late, much importance has been attached to the discovery of Rickettsia bodies (*Rickettsia prowazeki*). These are small and bacilliform, not more than 2 by 0·3 μ in size. They stain pink by Giemsa's stain, often only at their poles. Rickettsia bodies are found sparingly in the blood taken from a patient on the seventh to the twelfth day of the disease, and also in infected lice and their excreta. Similar bodies have been described in the vascular lesions and in the endothelial cells of the liver.

An agglutinative phenomenon which goes by the name of the Weil-Felix reaction affords a valuable means of recognising the disease. The reaction is named after two observers who discovered in the urine of patients suffering from typhus an organism of the Proteus group which is agglutinated in high dilution by the serum of those infected. The strain of Proteus concerned is known as X 19, and agglutinations have been obtained with dilutions of serum up to 1 in 30,000. Reactions in controls, if occurring at all, do not take place in dilutions exceeding 1 in 50. In half the cases of typhus the reaction is found by the fifth day, and in practically all by the tenth day. There is, however, no experimental proof that Proteus X 19 is capable of producing typhus, nor does it confer immunity to the disease. It has been pointed out recently that there are at least two varieties of Proteus X 19, and that some sera react to one strain and some to the other.

The Wassermann reaction is almost always positive in typhus if the blood is examined before the crisis, but becomes negative again in convalescence (Bauer).

Symptoms.—The incubation period in most cases is about 12 days.

Eight to 10 days is a common interval when the disease is produced experimentally.

The onset is generally sudden. Distressing headache, giddiness, shivering or rigor, and frequently vomiting, mark the accession. Pains in the limbs and back may be severe, and blunting of the mental faculties with great muscular prostration is evident from the first. The tongue is large and coated, but soon becomes brown, and finally may be dark and shrivelled. Appetite is lost, thirst is great, the bowels are generally constipated, and the urine high coloured and scanty, rich in urea and uric acid, but deficient in chlorides. Albumin may appear later and the diazo-reaction is very constant. The face is flushed or dusky, the features swollen and the appearance apathetic. The conjunctivæ are injected and the pupils contracted.

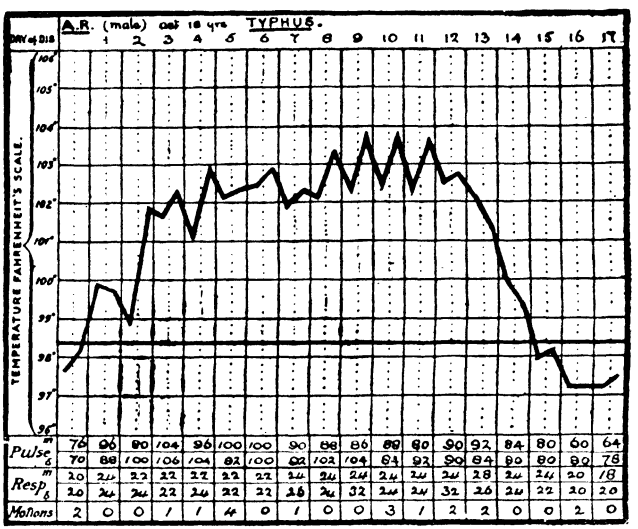

FIG. 5.—Typhus fever. Illustrating a somewhat gradual onset and abrupt termination by crisis.

Epistaxis may occur. The spleen may be palpable, but the abdomen is not distended. Even early in the disease, especially in alcoholic subjects, marked delirium, mania or stupor may be evident. Insomnia is present, or bad dreams disturb the rest. Tinnitus occurs, or deafness of nervous origin. The tongue is tremulous, and the gait tottering; if the patient have not already taken to his bed he usually does so by the third day of illness. The temperature may reach 104° F. by the first night; the acme, however, is generally attained on the third or fourth day. Associated with the fever is a rapid soft pulse. Marked rapidity of the respirations is also noticeable and may lead to an erroneous diagnosis of pneumonia.

The fever (Fig. 5), which during the invasive stage may show remissions, after attaining its maximum, which may be as high as 105° or 106° F., shows little or no daily variation. At the end of the first week or a day or two later a sudden remission, which is rarely lasting, may occur (pseudo-crisis); from

this period, however, the fever generally shows some abatement and terminates by a sudden or somewhat gradual crisis on the thirteenth to the seventeenth day of the disease.

The rash appears on the fourth or fifth day, first on the axillary folds, the sides of the chest and the abdomen. It avoids the face, which is merely flushed and congested, and does not appear on the palate, but with these exceptions it may become general all over the body, although it is most profuse on the trunk, especially on the back. The three elements of which it consists are papules, macules, and petechiæ. The papules resemble the rose spots of typhoid, being small, raised and pink in colour. At first they fade on pressure, later they become dull red or brown and indelible. They do not appear in successive crops. The macular elements of the rash generally appear before the papular elements and are much larger and blotchy; they appear to be in the skin rather than on it, hence the term subcuticular mottling which is applied to the appearance produced. The macules are best seen about the shoulders and axillæ, but often extend to the back and front of the chest, the thighs and arms. Purple petechiæ which resemble flea-bites and sometimes also purpuric patches are less constant. The latter indicate a severe infection, the hæmorrhagic character of which may be confirmed by the occurrence of hæmatemesis, melæna or hæmaturia. Profusion of the rash in typhus is an indication of a severe attack. In mild cases the eruption is scanty, and in children it is very evanescent. Leucocytosis is the rule, the chief increase being in the polynuclear cells.

The cerebro-spinal fluid may show a slight lymphocytosis, and also give a low positive Weil-Felix reaction. The globulin is increased.

About the end of the second week the patient may be considered to enter on the second stage of his disease. There is less complaint of headache; delirium, if present, is less violent and of a muttering rather than maniacal type. Prostration may be extreme and sleeplessness pronounced. The face is dusky, sordes accumulate on the teeth, and a curious mousy odour emanates from the patient. Day by day the nervous depression increases and the patient lies helpless on his back with a tendency to sink down in the bed. The pupils are contracted, the eyes half open and fixed (*coma vigil*). Although deaf and unnoticing, he mutters incoherently and can be roused with some difficulty. Tremors of the tongue and tendons, and picking at the bedclothes are apt to occur. The pulse quickens and may reach 130 per minute. It is dicrotic or almost imperceptible. The heart's impulse is feeble and the first sound faint or inaudible. The blood-pressure falls steadily. Acceleration of respiration is more than ever pronounced, 40 per minute not being unusual; the breathing is shallow, and hypostatic congestion of the lung bases occurs. The urine may be retained or passed into the bed, as also the fæces. Bed-sores are apt to form. The patient may pass away in coma from sheer exhaustion, or hyperpyrexia may precede death.

On the fourteenth day, sometimes a little earlier, sometimes later, the crisis should occur. The condition suddenly improves; the temperature falls, sometimes abruptly, perhaps more frequently by a crisis which is a little more gradual. Sleep ensues and the patient awakes from his stupor with a moist tongue and skin, a clearer intellect and perhaps a slight critical diarrhœa. Inclination for food returns, but there is still extreme weakness. Some, failing to rally after the crisis, fall into a state of collapse. In less

severe cases, where the typhoid state has not been pronounced, the crisis may occur rather earlier and recovery be much more rapid ; this is especially the case with children.

Varieties.—Typhus may occur in forms which are characterised by extreme mildness or by fulminant severity. The milder types are particularly seen among the natives of localities where the disease is endemic, and in children. Of the severe types, that known as *typhus siderans* or *blasting typhus* is the most striking. In this form death may occur within 2 or 3 days of the onset. A meningeal variety, accompanied by head retraction, ptosis, squint and other nervous symptoms, simulates meningitis. Some cases are characterised by fierce maniacal delirium. Typhus also may assume a hæmorrhagic form, but this is uncommon. Relapse in typhus is almost unknown, and authentic second attacks are excessively rare.

Complications and Sequelæ.—Respiratory complications in the form of bronchitis, broncho-pneumonia, or hypostatic congestion of the lungs are the commonest. Rarely laryngitis occurs and may lead to necrosis of the cartilages and œdema of the glottis. True lobar pneumonia is hardly ever seen. Diarrhœa is sometimes troublesome; it may be accompanied by abdominal distension and the passage of blood. Femoral thrombosis, analogous to that of typhoid fever, is common. Sometimes arterial occlusion occurs, leading to gangrene of the extremities. Septic or gangrenous infarcts may be formed in the lungs by emboli detached from clots in the heart or the vessels. Suppurative parotitis is a rather marked feature of the disease, and the inflamed gland may become gangrenous. Gangrenous bed-sores, too, are apt to form with great rapidity and pyæmic complications may ensue. When typhus is followed by hemiplegia or other forms of paralysis, thrombosis or embolism of cerebral arteries should be suspected. Mania, melancholia and dementia are occasional sequels but generally clear up, although they may take several months to do so. Amongst rarer complications may be mentioned nephritis, cystitis, orchitis and jaundice.

Diagnosis.—As compared with *typhoid*, the onset is more sudden, and prostration is earlier and more pronounced. The aspect is drunken, the face congested, the pupils contracted and the eyes suffused. Diarrhœa and abdominal symptoms are unusual. The eruption is more profuse and more widely distributed, and the spots, which are paler than those of typhoid, are accompanied by subcuticular mottling. The termination of the fever is more abrupt. Blood cultures and agglutination tests are of great value in distinguishing the two diseases, and to those acquainted with typhus the peculiar mousy odour, which is absent in typhoid, is of assistance. *Lobar pneumonia*, especially the apical form with slight meningeal symptoms, may be mistaken for typhus, but should be eliminated by careful and repeated physical examination of the lungs. The hypostatic pneumonia of typhus is bilateral and does not show frank signs of consolidation. Herpes may occur in both diseases. *Meningitis* is now easily distinguished by lumbar puncture and examination of the cerebro-spinal fluid. *Encephalitis lethargica*, with fever, headache and delirium, must be distinguished by the absence of the characteristic rash of typhus, the negative Weil-Felix reaction, and the supervention of such signs as ptosis, ophthalmoplegia, and characteristic lethargy from which the patient can be roused. The cerebro-spinal fluid may show a lymphocytosis, without globulin increase, or it may contain

blood. *Uræmia* is sometimes confused with typhus, but is distinguished by the absence of fever and rash and the condition of the urine. Difficulty occasionally arises with a fading *measles* rash, but unlike the rash of typhus this invades the face. A history of catarrhal symptoms may also be obtained in measles. The *spotted fever of the Rocky Mountains* closely resembles typhus. In hot climates and on campaigns other possible sources of error in diagnosis are small-pox, relapsing fever (epidemics of which often coincide with those of typhus), sandfly fever, and malaria. Influenza also may lead to difficulty.

Prognosis.—The mortality, which is low in childhood and adolescence then progressively increases, reaching 35 per cent. between the ages of 35 and 40. In aged patients, recovery is the exception. Clinical indications of gravity are persistent sleeplessness, marked subsultus, violent delirium or convulsions, evidence of a hæmorrhagic tendency, a profuse petechial rash and continued high fever or hyperpyrexia. Failing circulation is shown by lividity, coldness of the extremities and hypostatic congestion of the lungs. Suppression of urine and uræmic symptoms are also of grave import, as also are gangrenous bed-sores, extensive parotid suppuration and pyæmic symptoms. The disease is particularly deadly to alcoholics, and fat subjects are much less resistant than the thin.

Treatment.—*Prophylactic.*—Every effort should be made to get rid of lice. The patient should be stripped, the hair clipped short, and the body shaved and thoroughly washed before admission to a ward. The garments of attendants should be so arranged as to prevent as far as possible the risk of being bitten. The clothing of those infected, and of contacts, should at once be adequately sterilised and their living rooms and their contents disinfected. Cases of typhus are best treated in isolation hospitals, and when the disease is epidemic good results are obtained by forbidding movements of the populace in the infected areas.

A quarantine of immediate contacts for at least 15 days is usually recommended.

The *general* treatment should be on the same lines as those adopted in typhoid fever. Free ventilation, tepid sponging night and morning, careful attention to the mouth and back, and the adoption of a fluid diet, consisting of milk, beef tea, meat extracts, and plenty of water, are the essentials. The bowels are usually constipated and enemas should be used. The bladder should be watched; retention of urine may lead to great restlessness and constant overflow. When the temperature rises above 103° or 104° F., tepid or cold sponging should be repeated. In hot climates, exposure to undue heat has a very deleterious effect. For sleeplessness, paraldehyde is the most useful hypnotic, but requires to be given in large doses. Wildly delirious patients need some form of restraint, and in these cases hyoscine should be tried if other means fail. Frequent rectal salines or the administration of saline solution intravenously or subcutaneously are beneficial when toxæmia is extreme. For venous thrombosis the intravenous administration of 1 per cent. sodium citrate in saline solution and the use of sodium citrate by the mouth is recommended. The tendency to collapse after the crisis should be remembered, and patients carefully watched at this period. For further details of symptomatic treatment the article on typhoid may be consulted.

MUMPS

Synonyms.—Epidemic Parotitis ; Infectious Parotitis.

Definition.—An acute infectious disease, characterised by swelling of the parotid, and sometimes of the other salivary glands, accompanied by constitutional disturbance which is usually mild. With the exception of orchitis, complications are infrequent, and a fatal termination is exceedingly rare.

Ætiology.—Mumps is widely distributed, being endemic in most large centres of population throughout the civilised world. No climate is adverse, and no race is known to be immune. Children and young adults of both sexes are those usually attacked ; but no age is entirely exempt, although the disease is rare in infants and in the aged. The mother has transmitted the disease to the fœtus *in utero*.

The malady usually appears during the winter or spring months. Outbreaks are generally localised, and often limited to particular schools, business houses or barracks. Infection is direct from patient to patient ; but is sometimes conveyed by an apparently healthy intermediary, or by fomites. Epidemics of mumps may follow outbreaks of measles.

Pathology.—From analogy with other specific infections, mumps is attributed to a microbic invasion ; but the organism has not as yet been positively identified. Several observers have found a Gram-negative diplococcus in the blood, secretions, and fluid obtained by gland puncture ; but final proof that it is the cause of the disease is not yet forthcoming.

It is assumed that the affected salivary glands are invaded by way of their ducts. Opportunities for histological examination are rare ; but a striking feature appears to be the predominance of interstitial and periglandular rather than parenchymatous inflammation. In the case of the testicle, atrophy is said to result from a parenchymatous rather than from an interstitial inflammation, the basement membranes of the seminal tubules becoming thickened and their epithelium atrophic. An examination of an enlarged pancreas from a case of mumps is reported to have shown hypertrophy of the glandular acini with commencing cellular degeneration.

Symptoms.—The incubation period is 3 weeks ; but extremes of 14 and 25 days, or even one month, are admitted. A swelling of the parotid gland is usually the first indication of the malady, but this may be preceded for a short time by pain and stiffness in the lower jaw, or by such prodromal symptoms as feverishness, shivering, sore throat, headache, earache, drowsiness and even vomiting.

The parotid swelling is at first unilateral, and more commonly appears on the left side. It may continue to increase for 2 or 3 days, forming an ill-defined, elastic swelling, which obliterates the sulcus between the mandible and the mastoid process, lifts the auricle away from the head in a characteristic manner, and extends forwards on the surface of the masseter. Only rarely is the skin over the gland either reddened or œdematous. The swelling slowly subsides after a few days, sometimes very quickly, but a distinctive and, when present, highly diagnostic feature is the occurrence, 24 or 36 hours after onset, of swelling in the other parotid region, sometimes with fresh febrile disturbance ; or the submandibular and sublingual glands may be attacked. The interval between the invasion of the two parotid glands

may extend to 4 or 5 days, or even longer; but sometimes they are attacked simultaneously. Sometimes, too, the submandibular glands become swollen first, in which case the parotid may escape evident implication, or may swell in its turn. When bilateral glandular swellings are present the features become much distorted.

Moderate pyrexia (101° or 102° F.) may accompany the onset of mumps and persist for a day or two; but the attack is often afebrile and the pulse rate hardly quickened. On rare occasions constitutional disturbance is severe, the temperature rising to 104° or 105° F., with delirium and circulatory depression.

The swollen parotid gland may by its tenderness cause great pain on attempts to separate the teeth, to chew or to swallow. The secretion of saliva is often defective, but in some excessive salivation is noticeable. Injection of the orifices of the salivary ducts, pharyngitis, faucial congestion and even tonsillitis are sometimes observed at the height of the attack; but it may be very difficult to separate the jaws sufficiently to inspect the throat. Enlargement of the cervical lymph glands may accompany the parotid swelling. Mumps may appear in so mild a form as to be hardly noticeable. Rarely the only salivary gland affected is the submandibular (submaxillary mumps), and occasionally orchitis is the sole manifestation of the disease.

With rare exceptions the glandular swellings caused by mumps neither suppurate nor persist, although, occasionally, the parotid swelling is said to be several months in resolving.

Complications.—*Orchitis* is a well-known sequel which occurs in 15 to 30 per cent. of the cases. It tends to affect boys about the age of puberty and young male adults; in childhood it is rare. The seventh or eighth day of illness is the usual time of onset; but it may appear 2 or 3 weeks later, and is sometimes longer delayed. In some instances orchitis precedes the inflammation of the salivary glands. The onset is characterised by pain in the testis, which soon becomes swollen. The swelling is tender and elastic. Effusion in the tunica vaginalis may occur; the epididymis is not often involved. Abdominal rather than testicular pain is sometimes the first sign. Severe constitutional symptoms such as delirium, vomiting, collapse and considerable fever may accompany the testicular inflammation. The temperature may rise abruptly to 103° or 104° F. Fortunately the complication is usually one-sided. It may be accompanied by redness and œdema of the scrotum, swelling of the spermatic cord and enlargement of the inguinal glands. Exceptionally a urethritis, which is not gonorrhœal, accompanies the testicular swelling. Subsidence of the orchitis within a week is the rule, the temperature, if raised, falling rather abruptly. Suppuration is very rare; but relapse sometimes occurs. Atrophy of the testis is a sequel to be expected. When bilateral orchitis occurs before puberty the development of the individual is usually checked; but even when both testes appear atrophic sexual vigour may be retained (Osler).

In the female, corresponding complications are ovaritis, shown by ovarian pain and tenderness, inflammation and œdema of the vulva and mastitis. The latter has also occurred in the male.

Pancreatitis is a much less common complication than orchitis; it is said, however, to be a special feature of some epidemics. It should be suspected when acute abdominal pain, accompanied by vomiting and epigastric tender-

ness, occur as sequels to the parotid swelling, which under these circumstances may show a rapid subsidence. Sometimes the swollen pancreas may be felt, but often its presence is masked by abdominal rigidity. The bowels are constipated, the stools may be fatty, or even contain blood. Sometimes hæmatemesis occurs. The urine may contain sugar. Jaundice is rare. Fever and acceleration of pulse are to be expected. The onset may be accompanied by alarming collapse. Fortunately recovery has occurred in most cases.

During the course of mumps the lachrymal gland sometimes becomes swollen. In such cases orbital pain is complained of, and the eyelids become swollen. In other cases thyroiditis has been observed.

As regards the *nervous system*, meningeal symptoms, headache, photophobia, delirium and rigidity of the neck have supervened in more than a few instances. Sometimes on recovery such symptoms as aphasia, hemiplegia, monoplegia or ataxia persist; they are suggestive of the occurrence of encephalitis, or of some vascular lesion in the brain. Rarely a general paralysis of the limbs with loss of deep reflexes, attributed to peripheral neuritis, occurs. Weakness of the muscles supplied by one facial nerve sometimes accompanies the parotid swelling, sometimes succeeds it.

An excess of lymphocytes may be found in the cerebro-spinal fluid.

Acute mania and other forms of insanity are rare sequels.

Certain affections of the *organs of special sense*, although uncommon, deserve mention on account of their importance. Quite apart from deafness, due to the occasional occurrence of otitis media, true nerve deafness may occur unaccompanied by signs of middle ear disease. The deafness is of sudden onset, and when accompanied by nausea, vomiting, tinnitus and inco-ordination it is attributed to hæmorrhage or exudation within the labyrinth; but it may occur without any labyrinthine symptoms. Fortunately the deafness is usually unilateral, for it is incurable.

Papilloedema and optic atrophy with loss of vision are other important sequels. Iridocyclitis, paralysis of certain extra-ocular muscles and loss of power of accommodation may also at times ensue; these mainly terminate in recovery after a variable time.

Among other possible complications may be mentioned epistaxis, bronchitis, pneumonia, pericarditis, arthritis and nephritis. The arthritis resembles that of gonorrhœa or scarlet fever, rather than acute rheumatism. Nephritis sometimes occurs as late as 4 or 5 weeks after the salivary swellings; uræmia has been responsible for death in rare instances.

Suppuration in the parotid gland, gangrene of the gland, cellulitis of the neck and floor of the mouth, œdema of the glottis, and suppuration of the cervical lymph glands are very rare occurrences, which are generally attributed to superadded septic infection. Relapses, characterised by a recurrence of the glandular swelling after a distinct interval, are not very uncommon. Although one attack of mumps usually protects the individual for life, second attacks are not unknown.

Diagnosis.—In the presence of an epidemic this presents little or no difficulty; but the true nature of the infection may be overlooked when the parotid swelling is insignificant, or when the disease primarily affects the submandibular or sublingual glands, or again when orchitis or even pancreatitis constitutes the first symptom.

Parotitis, usually unilateral, and attributed to ascending duct infection from a dry and dirty mouth, is a well-known complication of certain fevers of the enteric group, and of some abdominal diseases. This is distinguished from mumps by the circumstances under which it occurs, and by the fact that it is not contagious. It generally ends in suppuration. It is well to bear in mind that swelling of the salivary glands may follow the administration of certain drugs, such as iodide of potassium and pilocarpine.

A painless enlargement of the parotid and lachrymal glands, characterised by great chronicity, occurs in Mikulicz's disease.

Inflammatory swelling of the higher cervical glands, especially when accompanied by peri-adenitis and œdema, may be mistaken for mumps. Swelling of this character occurs in certain cases of diphtheria, and also in scarlet fever. Careful attention to the history, proper examination of the fauces, and search for rashes should eliminate this error. Enlargement of the pre-auricular lymph gland due to lesions about the nostrils and angle of the mouth, and the swelling caused by periostitis of the lower jaw may superficially resemble inflammation of the parotid.

When the submandibular and sublingual glands alone are swollen the distinction from lymphadenitis may be difficult. In such cases extension to the opposite side indicates mumps, as also does the transitory character of the swelling.

In glandular fever, which is an acute infective adenitis of the cervical and other lymphatic glands, the salivary glands are not involved.

Treatment.—Mumps is infectious for 2 or 3 days before the glandular swelling appears, and isolation for not less than 2 weeks from the onset is advisable, provided that 1 clear week has elapsed since the subsidence of the glandular enlargement. Contacts should be isolated for 26 days unless they have previously had the disease. The patient should be isolated and confined to bed. The incidence and severity of orchitis are said to be less in those who are not allowed to get up until the time at which this complication usually appears is past. Foods which are easily swallowed and need no mastication are indicated during the acute stage. The mouth should be kept clean with a mild antiseptic lotion. Pain in the parotid may be relieved by smearing it with glycerine and covering with hot cotton-wool or by fomentations. Acetyl-salicylic acid in 10-grain doses is also of value. The inflamed testicle should be enveloped in cotton-wool, and suspended or supported by a small pillow. Hot applications are also serviceable. If pancreatitis be suspected, fomentations may be applied to the abdomen, small doses of opium administered, and the diet strictly restricted to fluids. In all cases the bowels should be regulated with calomel, followed by a saline or some other aperient. Delirium and pyrexia are met by sponging, wet-packs or the ice-cap; and collapse by warmth, stimulants and strychnine.

GLANDULAR FEVER

Synonym.—Infectious Mononucleosis.

Definition.—An acute infectious disease characterised by fever and rapid enlargement of the anterior cervical lymph glands, and sometimes

also those of other regions. In most cases lymphocytosis occurs. Recovery is the rule.

Ætiology.—The disease occurs in small epidemics, and is infectious, although the infecting organism is unknown. It is a disease of childhood, not often seen in infancy and rare after puberty. Most of the attacks occur in children of school age, and more males than females are affected. The duration of infectivity is probably short.

Symptoms.—The incubation period is about a week, but it may vary from 5 to 12 days. The onset is sudden, with malaise, fever, slight soreness of the throat and, perhaps, slight stiffness of the neck and pain on swallowing. Soon swelling of the lymph glands of the anterior cervical and submandibular groups becomes evident, and increases rapidly. By the second or third day the glands may attain a considerable size. They are discrete and tender, but the skin over them is not inflamed. The swelling at first is unilateral and more commonly appears on the left side, but afterwards the glands on the other side may enlarge in turn, and sometimes minor enlargements of the posterior cervical, axillary, inguinal and epitrochlear glands occur. The adenitis is accompanied by pyrexia, the fever ranging irregularly from 100° to 103° F., or even higher.

The glandular swelling need not be limited to the superficial groups, or even commence in them. Paroxysmal cough, sometimes accompanied by substernal pain and dysphagia, suggests implication of the mediastinal glands, and may precede the cervical swelling. Vomiting and abdominal pain may be accompanied by palpable swelling of the mesenteric glands. In many cases, slight enlargement of the spleen and also of the liver may be detected. Examination of the blood in the acute stage of the disease shows a characteristic increase in number of mononuclear, non-granular cells, which resemble lymphocytes, and the lymphocytes may form from 40 to 80 per cent. of the total leucocytes, instead of the normal 20 per cent. The total leucocyte count is rarely more than 12,000 to 18,000. The red cells are not diminished in number.

The febrile stage of the disease may last for 10 days or longer, and exacerbations of fever, with involvement of fresh glandular groups, may occur. The glandular swellings subside more slowly than the fever. The lymphocytosis may be very transitory, or may persist for some time. Convalescence is slow.

Complications.—These are few. The sore throat is little more than a mild catarrh; sometimes there is exudate on, or actual ulceration of, the tonsils or pharynx. There may occur a slight temporary albuminuria, with a few tube casts, but in some 6 per cent. of the cases a hæmorrhagic nephritis ensues. Suppurative otitis and retropharyngeal abscess have been recorded. Suppuration of the glands is rare.

Diagnosis.—The disease has been mistaken for mumps, scarlet fever, Vincent's angina, acute lymphatic leukæmia, Hodgkin's disease, tuberculous adenitis, and the rare form of tonsillitis known as agranulocytic angina. The clinical course is so characteristic that if this, together with the epidemic prevalence, be borne in mind, no mistake will be made. The salivary glands are not enlarged as in mumps. There is no rash. Vincent's angina may complicate glandular fever, but any leucocytosis is said to be polynuclear, with very rare exceptions. Acute lymphatic leukæmia at its onset

constitutes a very real difficulty, but the leucocytosis is usually far in excess of that of glandular fever, anæmia is progressive, and the issue fatal. Hodgkin's disease is a much more chronic and progressive affection, and lymphocytosis rarely occurs. Tuberculous adenitis also has a greater chronicity, with sooner or later a tendency to periadenitis and perhaps suppuration; and other signs of tuberculosis may be present. Agranulocytic angina, as its name denotes, is characterised by the disappearance of all granular cells from the blood. It usually occurs in middle-aged women, and the prognosis is very bad.

Treatment.—This is purely symptomatic.

CHARLES R. BOX.

RHEUMATIC[1] FEVER

Definition.—An acute, specific disease, characterised by fever, arthritis and a special tendency to endocarditis.

Ætiology.—The essential cause of the disease is unknown. That the *materies morbi* is microbic there can be very little doubt, and for these reasons: the clinical features of the disease bear a strong resemblance to those seen in diseases of undoubted microbic origin, and especially in septicæmia due to streptococci and to staphylococci; the curves of incidence of the disease rise and fall with the curves of incidence of scarlet fever and of erysipelas; and the disease runs a natural course—or it did prior to the use of salicylates. By some the disease is thought to be a mild form of (streptococcus) pyæmia. Against this view is the fact that the disease is by no means always a mild affair, even when compared with known streptococcus pyæmia; also against the view is the fact that the inflammatory lesions produced, though often very acute, never suppurate; and salicyl preparations have a marked inhibitory action upon the disease-process, whereas their effect in coccus septicæmias is almost nothing.

Others consider the disease to be an intoxication from a local (streptococcus) infection; this conception introduces scarcely fewer difficulties than the former. The bacteriological part of the problem, to which during recent years much attention has been given, remains unsolved.

Poynton and Paine, whose many contributions to this part of the subject and to the pathology of the rheumatic process in general, have been of great importance, claim to have isolated the specific cause of rheumatic fever in the shape of a paired coccus to which they give the name *Micrococcus rheumaticus*. The characters ascribed to this micro-organism have varied somewhat in different descriptions, and Andrewes and Horder pointed out that in its morphological and biochemical features it corresponds with the short streptococci of feeble virulence normally present in the intestine, to which they give the name *S. fæcalis*. Poynton and Paine consider that they are able to produce in rabbits, by intravenous injection of their coccus, lesions identical with those seen in rheumatic fever in man. But the comparison must be a very difficult, if not an impossible, one, between lesions so produced and lesions which it is quite easy to produce in this animal by the injection

[1] The word "rheumatic" is used thoughout this article to signify conditions strictly belonging, or allied, to rheumatic fever, and not to include either of the many states loosely described as "rheumatism."

of streptococci for which no causative relation to rheumatic fever is claimed. Thus, Cole was able to produce endocarditis and non-suppurative arthritis in rabbits by the injection of streptococci derived from cases of disease obviously not rheumatic fever, and Horder achieved the same result with *S. fœcalis* and *S. salivarius*, cultivated from healthy human stools and saliva.

Ainley Walker and Beattie have also isolated cocci from the blood and exudates in rheumatic fever, but the micro-organisms described by them do not appear to be identical with that described by Poynton and Paine.

The crux of the position is the failure of a large number of careful workers to isolate any micro-organism from the blood and joints during life, even in very severe cases of uncomplicated rheumatic fever. This was Cole's experience in Osler's wards; it was Horder's at St. Bartholomew's Hospital; it was Bulloch's at the London Hospital. Horder points out that the significance of this negative result is enhanced by the fact that modern methods of blood and joint culture are on the whole very successful, allowing of the isolation of such delicate micro-organisms as Pfeiffer's bacillus and the gonococcus, whereas the cocci described by Poynton and Paine and others are hardy growers and, therefore, unlikely to elude careful culture if present as a constant association of the disease.

Investigations conducted in the post-mortem room are of little use in evidence on this question, since it is admitted by all workers that in the fatal cases of rheumatic fever available for such purpose, secondary streptococcus infections are not uncommon. Horder draws attention to the necessity of excluding all cases of infective endocarditis as material for bacteriological investigation in respect of rheumatic fever, a warning that is prompted by the fact that Poynton and Paine term such cases "malignant rheumatism" when they follow immediately upon an attack of rheumatic fever.

The omission to make this distinction between infective endocarditis (most often a streptococcus infection of valve segments previously damaged by rheumatic endocarditis) and severe rheumatic fever may account in part for the discrepancy in the results of blood culture by different workers to which reference has already been made. But although evidence is against the view that rheumatic fever is the expression of a streptococcus septicæmia, it is less certain that it is not an intense intoxication from some focus of streptococcus infection, such as the tonsil or the intestine. It is possible that a sudden rise in virulence occurs in cocci lodged in one of these, or in some other situations, and that an auto-intoxication follows without actual blood infection. Acute tonsillitis is certainly common during the period of invasion of the disease, and there are reasons for regarding appendix inflammation as being associated in causative fashion with some cases.

In two or three fatal cases, examined post mortem at St. Bartholomew's Hospital, Mervyn Gordon demonstrated to the writer an enormous quantitative increase in Gram-positive cocci lying in the lymphoid tissue of the lower part of the ileum. But it is possible that such situations are but the channels of entry of a virus as yet unknown, and that the increase in the cocci habitually present in them is of the nature of an epi-phenomenon.

To sum up: The causative agent in rheumatic fever has not as yet been definitely established. Streptococci are frequently associated with the specific lesions post mortem, but have been obtained hitherto only by a few workers during life, and the types of streptococci obtained by them show certain

marked differences in character. It is possible, indeed it is probable, that the causative microbe, if bacterial, is of the nature of those micro-organisms termed ultra-microscopic. The subject requires further work before a solution is forthcoming.

The disease is more common in humid and temperate *climates* than in others; it is probably more common in Great Britain than anywhere else. The *sexes* are affected almost equally, but there is a slight preponderance in males, no doubt owing to their greater tendency to exposure. Rheumatic fever is pre-eminently a disease of pubescents and young adults, but it occurs at all *ages*, though it is uncommon in infants and in the elderly. If a person has had recurring attacks up to the age of 40, he is prone to them afterwards, but otherwise the susceptibility to the disease becomes greatly diminished after the age of 30. It is one of the striking facts of medicine that there are rheumatic families, in whom the tendency to the disease is highly marked. A certain *complexion* is common in them: a clear skin, with fair—often rufous—colouring.

Exposure, *fatigue* and *damp* are precipitating causes of the attack: a railway journey in wet clothes after muscular exercise, or sleeping in a damp bed, is a not unusual event in the patient's history of the onset. But it is equally true that many attacks come on in the absence of all these factors; indeed, attacks are not at all infrequent in hot weather. *Autumn* provides more attacks than any other season of the year.

Symptoms.—The onset is usually abrupt, with the sense of chill, accompanied almost at once by pains in the joints, the knees and ankles being the commonest. One or two joints usually precede the rest in order of invasion, to be quickly followed by others: wrists, shoulders, hips, neck, tarsus, metatarso-, and metacarpo-phalangeal joints. Some degree of sore throat is very common, and may be a marked feature; when this is so, the tonsils usually show the redness and swelling more than other parts. By the end of the second or third day it is usual to find a considerable number of joints affected, so that the patient is already in much pain and great discomfort. The affected joints are swollen and red, and synovial effusions appear, especially in the knees, wrists and ankles. There is great variation in the extent and in the degree of the joint involvement in different cases. In a few instances less common joints share the inflammation: sterno-clavicular, vertebral, interphalangeal. The *fibrous tissues* suffer as well as the joints, and it is often apparent that this accounts for some, at least, of the stiffness and grave discomfort. The joint effusions never suppurate.

The *temperature* usually rises to 102° to 103° F. with the arthritis and synovial effusions, and the fever remits, or even intermits, so that the chart shows an "irregular" curve. The pyrexia is peculiarly sensitive both to exacerbations in the disease (which are common), to relapses (which are also common) and to complications. Sweating is generally profuse, the sweat being of a peculiar "acid" smell. The *urine* is scanty and high coloured, and if the fever is marked there is usually a trace of albumin present; a deposit of urates, coloured brick-red by uro-erythrin, is a feature in most severe cases. As in most acute fevers, the *secretions* of the mouth and alimentary tract are lessened, leading to a heavily coated tongue, anorexia and constipation.

The *heart* is generally—some authorities believe always—affected, though the nature and the degree of the affection is variable. There are few, if any,

cases in which careful examination from day to day does not reveal a slight degree of "softness" of the first sound of the heart, due, no doubt, to affection of the myocardium. The *pulse* is raised moderately in frequency (90 to 120), its volume is good but its tension is reduced. In more cases than not, probably, a soft systolic apex-bruit appears, not necessarily indicating either endocarditis or dilatation. In about half of all cases there are reasons for concluding that *acute endocarditis* is present, as judged by the character of this bruit, its transmission towards the axilla, some evidence of enlargement of the heart and a rise in the temperature coincident with the appearance of the heart signs. This complication usually arises about the eighth to the tenth day.

The *blood* shows a considerable leucocytosis (15,000 to 30,000) and an acute "secondary" anæmia which is a constant feature of the disease and quickly reveals itself in the patient's facies.

ABERRANT TYPES.—*Subacute* attacks are common, especially in children (see p. 297) and in old rheumatic subjects. Their importance lies in the fact that all the time the heart may be suffering damage. Although this is less common in adults than in children, arthritic signs may be absent in cases of rheumatic endocarditis, as in rheumatic pericarditis.

Complications.—As already stated, about one-half of all cases develop some form of *heart* trouble. We have spoken of *myocarditis* and of *acute endocarditis*, and of the advent of the latter, should it arrive, about the end of the first week. The endocarditis is generally valvular; most often mitral, less often aortic, but in some cases both mitral and aortic. In a much smaller percentage of cases it is mural, the part of the endocardium then affected being, by choice, the lining of the left auricle. *Pericarditis* is less common; and pericardial effusion, especially of the massive sort, is nowadays quite uncommon. (For full accounts of these important cardiac complications, see special sections.)

Skin eruptions, though a specific feature of the infections, are not very common, except in children. The profuse sweating quite often leads to *sudamina*, and these, becoming inflamed, lead to *miliaria*. True *rheumatic erythemata* are much more common in the subacute cases than in the acute ones. *Purpuric* eruptions, again, are more often seen in aberrant types of the disease (*e.g.* Henoch's Purpura and Peliosis Rheumatica).

The only *pulmonary complication* of any consequence is pleurisy, and this is by no means common if we preserve the usual strict criteria of physical signs for its recognition, and omit "pleurodynia," in which condition the pain is more often intercostal than pleural. Indeed it may be said that, in the absence of pericarditis and of severe endocarditis, rheumatic pleurisy is quite rare. Pneumonia, properly speaking, does not occur, but there is a condition of lung in severe rheumatic fever, again when complicated by grave endocardial, pericardial and pleural affections, which simulates it somewhat. The lung tissue is in a mixed state of congestion, collapse and œdema.

Hyperpyrexia was formerly a much dreaded, and not very uncommon, complication. It is now quite rare. There is, indeed, by some modern observers, doubt thrown upon the rheumatic nature of the cases described under this term. May they, for example, have been fulminating cases of septicæmia or meningitis? It is clear that no case could nowadays be termed rheumatic hyperpyrexia unless lumbar puncture and blood culture

findings were proved to be negative. But the strongest points in favour of regarding some, at least, of the cases as having been rheumatic, and not meningitic or septicæmic, are (1) the very high degree to which the temperature rose (107° to 110° F.); and (2) the fact that in some of the cases, at least, the clinical picture was definitely that of rheumatic fever before the event, and when recovery occurred as the result of prompt treatment it was similar afterwards. The condition arises suddenly in most cases, though in a few there is a suspicious prodromal amelioration in the pain, sweating and general discomfort. The temperature rises rapidly to 106°, and unless checked by cold applications it may quickly reach 109° or 110° F. Before this stage is reached the patient has become tremulous and excited, then delirious and then semi-comatose, with a dusky lividity of the face and a failing pulse. Most of such cases are fatal. If prompt treatment succeeds in lowering the pyrexia it may need to be resorted to again in a few minutes or hours, since recurrence of the condition is to be expected.

Course.—Before the introduction of salicylates the course of rheumatic fever was, in the words of Sir Thomas Watson, "six weeks." Nowadays it is much shorter; 10 days to 3 weeks, if we include the joint swellings, though the fever is generally over in a shorter period than this when the treatment is prompt and thorough. If residual joint inflammations prolong the course of the disease it is important to look for contributory causes, and especially for septic foci. Recrudescences are very common, especially if full treatment be relaxed too early. Complications necessarily prolong the course of the disease.

Convalescence is often tedious, and the resultant anæmia and heart weakness warn the careful practitioner not to attempt to hurry it. Rheumatic fever patients are as liable to *relapses* as they are to recrudescences, and it is no uncommon thing to see a patient slip again into almost as bad a state as he originally was, including, it may be, painful swelling of the very same joints as were first affected. The great danger of these relapses lies in the risk of heart inflammations arising during the subsequent attacks, when perchance the patient escaped them at the first.

Rheumatic Fever in Children.—The disease is very common in children, in whom, however, the clinical picture as above described is apt to be departed from in several respects. (1) The arthritis is ofttimes a less marked feature; it may be absent altogether, and even when it is a troublesome element in the case, the degree of pain is prone to be disproportionate to the amount of redness and swelling of the joints. (2) Skin eruptions are relatively more common—various erythemata especially, but also purpura. (3) *Rheumatic "nodules"* are almost confined to children. These are discrete fibrous lumps, varying in size from small peas to horse-beans; they are found in the scalp, along the margins of the scapulæ and bones of the forearm, about the knuckles and elbows, and, less often, in other situations. They are sometimes tender and painful. They come and go. Occasionally they are present in large numbers: the case is then most likely to be subacute in type and very tedious in its course. (4) But the most important difference observable between the disease in children and in adults is the fact that in the former the process is not seldom subacute in its onset and course, and for this reason frequently overlooked for a time. Add to this fact that the tendency to heart involvement in these subacute attacks is no less than in

the more acute and more highly febrile bouts, and it is obvious that the recognition of this state of things is of the utmost importance. Unfortunately a large number of cases of subacute rheumatic endocarditis must needs arise without the possibility of prevention, but it is probable that a large number might also be prevented, or considerably modified, by prompt treatment of the subacute rheumatism in childhood which causes the injury. These attacks of subacute rheumatism are sometimes characterised by intercostal pain, sometimes by abdominal pain, sometimes by pain in the legs without special reference to the joints. There seems no doubt that so-called "growing pains" are often rheumatic in nature. In any child so affected the heart should be examined critically, and from time to time. The presence of sore throat, of acid sweats, of one of the erythemata, in conjunction with the above-named pains, should determine a decision to treat the child as suffering from the rheumatic process. The presence of nodules is decisive in a doubtful case.

Diagnosis.—Cases of the fully developed disease do not often lead to difficulty in diagnosis, given ordinary care on the part of the practitioner. A few diseases, however, require mention. (1) *Pyæmia* due to coccal infection may lead to some confusion, and the following differential points are worthy of notice. In septicæmia, when there is arthritis, the latter is usually constant in one or two joints, not fugitive and involving many as in rheumatic fever. Moreover, the joint changes tend to suppuration and permanent destruction of the joint structures. Blood cultures and joint-puncture fluids are not infrequently positive in pyæmia, whereas they are constantly negative in acute rheumatism. Rigors are common in pyæmia; in rheumatic fever they do not occur. If endocarditis complicates pyæmia, the heart infection is likely to lead to embolism, a condition not found in rheumatic fever.

(2) In children *acute osteomyelitis* may be mistaken for rheumatism; rarely does the converse error arise. But the disease-process is nearly always much more severe, the temperature being much higher and showing greater oscillations. The painful part is generally the lower end of the femur or tibia, and careful examination reveals it to be epiphysial rather than arthritic. As in pyæmia, to which type of infection the disease really belongs, blood cultures are usually positive (*Staphylococcus aureus*).

(3) *Gonorrhœal arthritis* is not usually so acute a disease, nor is the patient often so ill as in rheumatic fever. The joints are fewer in number, and, as in pyæmia, the course of the individual involvement is much longer. The inflammation, too, affects peri-articular as well as articular structures; not seldom it involves adjacent tendon sheaths also. Gonococci may be isolated from the joint effusions. Although the presence of a urethral or vaginal discharge makes a diagnosis of gonorrhœal arthritis likely it does not prove it; and it must be remembered that the discharge not infrequently ceases temporarily with the onset of the arthritis.

(4) *Acute osteo-arthritis* is a rare disease, but when it occurs it produces a clinical picture that is probably closer to rheumatic fever than does any other disease-process. The patient is more often a woman than a man, and is generally older (30 to 60) than is the average case of rheumatic fever. The failure of salicylates in full doses to reduce the temperature, and to affect beneficially the course of the joint condition, should always raise doubts as

to the nature of a supposed case of rheumatic fever. This differential point applies equally to diseases 1 to 3.

(5) *Gout*, when present in the acute arthritic form, may be mistaken for rheumatic fever; rarely does the converse happen. The patient is generally a man over 40 years of age; the number of joints involved is rarely more than two; the skin over these is generally dusky red in hue, and shining; there is often definite soft œdema. *The presence of severe pain when the affected joints are at rest is much in favour of gout.* The degree of fever is usually much less in proportion to the degree of joint inflammation than is the case in rheumatic fever. The presence of tophi may be taken as confirmatory of gout in a doubtful case.

(6) *Meningococcal meningitis with arthritis* rarely simulates rheumatic fever, but the writer has seen such a case, in which there were pungent acid sweats and purpura, and the resemblance to a case of severe rheumatic fever was for a time very close indeed.

Prognosis.—Recovery is the rule in this disease; *death during a first attack is very uncommon.* When death occurs there is invariably serious carditis, especially myocarditis, and acute pulmonary complications (pleurisy and "rheumatic pneumonia") are usually present also. In rare cases, death occurs in a state of hyperpyrexia. When the attack supervenes upon old rheumatic carditis, the prognosis is less good, heart failure being more easily induced. But in general it may be said that rheumatic fever is serious, not from its case mortality, but from its crippling effect upon the heart. *Residual conditions* are almost entirely cardiac injuries and chiefly scarred valves; rarely some degree of limitation of movement in joints.

Treatment.—(1) *General.*—With as much promptness as possible, the patient is put to bed, and is kept there until it is certain that the heart is unaffected, or, if affected, until it is certain that the inflammatory process has ceased to be active (see p. 823). The bed should be chosen carefully; narrow enough to admit of easy nursing, and having a soft but firm mattress. The patient lies in blankets with a long flannel garment opening down the front, and having sleeves to the wrists; this garment is changed as frequently as need be, according to the degree of sweating. The position of the patient is one of recumbency, with the affected joints supported in a position of maximum comfort. Movements of the limbs are generally best carried out by the patient's own efforts, and in all except severe cases, and where the heart is affected, movements of the body as a whole may also well be left to the patient. The basis of the *diet* should be milk diluted with water or alkaline mineral waters, and so long as the fever remains a marked feature of the case nothing should be added to this unless it be whey, peptonised milk, or barley water. Abundance of fluids should be allowed, for a great deal of fluid is lost to the body through the profuse sweats. Imperial drink is very useful. As the fever declines, there may be added to the milk, oatmeal, vegetable soups and chocolate. Meat should be reserved for convalescence, and even then should be given very sparingly. Tea and coffee are best omitted altogether. Fruit is disallowed. Aperients are given as necessary.

In the matter of *drugs* there is a consensus of opinion that salicylic preparations deserve the name of specific remedies. They control the arthritis, cause the fever to decline, and cut short the course of the disease-process. They also lessen the tendency to relapses, and often render these abortive

when they threaten. It may be quite true that they do not prevent the occurrence of endocarditis, nor affect this inflammatory process beneficially when once established, but a remedy which cuts short the course of a disease must necessarily, in an indirect measure, act as a deterrent in respect of its complications. Thus, by prompt exhibition of salicylates an attack of rheumatic fever may be almost resolved by the eighth day, at about which period in the disease acute endocarditis is specially liable to develop. Certain it is that pericarditis, and in particular pericarditis with liquid effusion, is much less common nowadays than it was in the pre-salicylic days; so also is hyperpyrexia; and it is unlikely, in view of the more general features of rheumatic fever and its incidence, that the disease-process has itself undergone any change during the past 25 years which is likely to account for these facts. The preparation of the drug which has become most popular, and deservedly so, is salicylate of soda. *It should be given in sufficient quantities, and the doses should be distributed as evenly throughout the* 24 *hours as is compatible with securing good sleep for the patient.* At the onset of treatment of an acute case in an adult, 10 grains may be given every 2 hours during the day, and every 4 hours during the night (90 grains in the 24 hours). As the fever and pain diminish, these quantities may be given somewhat less frequently, a note being kept on the temperature chart of the total amount given in the 24 hours. In a child of 12 years or so, half these quantities may be given. If no amelioration follows these doses in 48 hours they should be increased by 50 per cent. (135 grains in 24 hours). If an exacerbation occurs, or a relapse threatens, after the dosage has been reduced, it should be at once adjusted to its original level. The drug is not unpleasant to take, unless an effort be made to render it palatable by the addition of a flavouring agent. Quite apart from the inestimable value of giving adequate doses so as to gain time, there is an additional value in this procedure from the point of view of diagnosis, for a *patient suffering from acute arthritis with fever, who is not considerably better after* 48 *hours' treatment by full doses of salicylates, almost certainly is not suffering from rheumatic fever.* The diagnosis in these circumstances should be at once revised. It will be found that the great majority of patients tolerate the above specified doses of salicylates without ill-effects. In the few instances in which it produces vomiting, or intense depression, or delirium, or hæmaturia—symptoms thought from time to time to be toxic effects of the drug—either aspirin in similar doses, or salicin in somewhat larger doses, may be substituted. But care must be taken in deciding that such symptoms are really due to the salicylate and are not manifestations of the rheumatic poison. Modern synthetic preparations of salicylate of soda are fairly free from the contaminations which were formerly rather common. But as an additional safeguard, and in case of doubt, the physician may specify the natural product, which is certain to be free from carbolic derivatives, though it is much more expensive. Salicylate of soda is so efficacious that the young practitioner is warned against experimenting with the other salicyl preparations. Salicin is said to be less depressing, and is sometimes recommended as the best drug for children, but the writer's experience of this preparation is very disappointing. Of oil of wintergreen given internally he has had no experience. The "alkaline" treatment has been almost superseded by the salicylates, but to-day it survives in the form of a recommendation to "cover" the salicylates by

large doses of sodium or potassium bicarbonate. Lees, in particular, claims that by this use of alkali the depressing effects of salicylates are to a large extent avoided. In the early stage of the disease it may be necessary to adopt more rapid palliative measures for the *severe pain*, especially if this prevents sleep. Nothing is better than opium, either as pulv. ipecac. co., grs. x, or pil. saponis co., grs. x. It is better to avoid antipyrine and phenacetin. The treatment of heart complications is discussed elsewhere (Sect. XII.). Against the occurrence of these complications, apart from the value of early and liberal use of salicylates, we seem to be powerless. But some authors attach importance to small blisters applied to the præcordium early in the disease.

Hyperpyrexia is met by prompt application of the cold pack, with volatile stimulants; the pack may need frequent renewal, and in extreme cases the water used for it must be iced. The most constant vigilance is necessary in such cases, which, as already stated, are happily rare nowadays.

In the treatment of prolonged cases of the disease the writer believes iodine (preferably not in the form of the potassium salt) to be useful, and especially so in cases complicated by serous inflammations, whether cardiac or other. Such experimental treatment of these prolonged cases by sera and vaccines as the writer has observed has not led him to employ either of them in any routine fashion. "Channels of entry" should, in protracted cases, be adequately dealt with as in (4).

(2) *Local.*—The position of optimum comfort of the affected joints has been already referred to. The use of splints for fixing the joints often gives relief. In the milder cases it suffices to wrap the joints in cotton-wool and bandage them lightly. In the more severe cases a lotion of tinct. opii, 1 oz.; glycerin, 2 oz.; water, 12 oz.; sod. carb. to saturation, used hot, gives as much relief as anything. An alternative is one of the preparations of winter-green, used freely, but without rubbing. Aspiration of the effusion is scarcely ever needed; its indication, indeed, should raise doubts as to the diagnosis.

(3) *During convalescence.*—Convalescence is generally slow, and should not be hurried. If the heart has suffered by direct inflammation, the recumbent position must be prolonged until it is certain that quiescence is established in that respect; this usually means from 4 to 6 weeks after the subsidence of the fever. The disastrous effects of attempting to hasten convalescence in such cases are to be seen amongst patients who have been treated in institutions which advertise a false efficiency by reporting a "shorter average stay in hospital" than is the case in sister institutions. The transition from strict recumbency to a sitting posture should occupy a whole week, by the gradual addition of pillows, and the further return to ordinary active life should be graduated with care.

Tonic preparations, such as quinine and hypophosphites, are useful, but the tradition that iron is not well tolerated until late in convalescence—though the state of anæmia seems to indicate it—is confirmed by experience. Diet during convalescence has already been referred to. Massage and passive movements of the affected joints may be begun so soon as the inflammation has completely subsided.

(4) *Preventive treatment.*—Failing exact knowledge of the essential causative agent in rheumatic fever, no effective mode of prevention can at present

be devised. But if there be a doubtful "channel of entry" present in any case, this should be dealt with in some radical fashion, in any patient who has had an attack, or is a member of a susceptible family. "Septic" tonsils should be enucleated, and an appendix which has at any time shown signs of inflammation should be removed. The writer has on one occasion, at least, witnessed the complete subsidence of a prolonged and recrudescing attack of undoubted rheumatic fever after the removal of dead teeth, the roots of which were infected.

ERYTHEMA NODOSUM

Although this disease is a fairly definite and easily recognisable clinical entity, it is still uncertain where it should be placed, when considered in relation to nosology or to pathology. According to some authorities it is related to the purpuras, according to others it is most appropriately grouped under Erythema multiforme, whilst some still consider it, as did S. Mackenzie, whose collection of cases remains the most extensive in the literature, a manifestation of true rheumatism. Since it is less often than not associated with the more definite criteria of acute rheumatism (arthritis, endo- and pericarditis), since it rarely recurs in the same patient, and since treatment by salicylates in full doses does not cut short its course, it is very doubtful if it should be regarded as a true rheumatic affection.

Ætiology. The ætiology of the disease is obscure. It is possible that the condition is not due to one specific factor, but to one of several factors, as is purpura.

It occurs more often in females than in males (according to Mackenzie, in the proportion of five to one), and the majority of cases are found between the ages of 10 and 30 years. There is no seasonal incidence. In the experience of the writer it is, like the purpuras generally, much more common in hospital than in private practice; this and some other observations suggest that bad feeding or insanitary conditions may contribute to the incidence of the affection. Typical cases have been described in tuberculous patients, and Osler states that guinea-pigs have been successfully inoculated with tubercle bacilli from the lesions.

Symptoms. The symptoms consist of—(i.) the local lesions, and (ii.) certain constitutional changes.

(i.) The local lesions are bilateral and occur chiefly upon the lower limbs; indeed, in the great majority of the cases they are confined to these. When they appear on the arms they are most often found only in this situation, the patient is more often than not an adult, and the general symptoms are less like rheumatic manifestations than is the case in the more common variety of the disease. The lesions are round or oval swellings, usually confined to the extensor aspect of the limbs, affecting the shin regions chiefly, and varying in size from a large pea to half an orange. There may be two or three only on each leg, or, in severe cases, the greater part of the extensor surface may be covered by them. They involve the subcutaneous tissue as well as the skin. They are very tender to touch. On their first appearance they are deep red in colour, later they become purple in hue, and still later they often show a definite ecchymotic appearance—giving rise to the

name Dermatitis contusiformis. In bad cases there is a good deal of associated œdema of the surrounding tissues.

(ii.) The general symptoms include a mild grade of fever (not constantly present), joint pains, malaise and sore throat. But many cases occur in which the local skin condition, with pain and tenderness, covers the whole of the symptomatology. Constipation is common, and is sometimes severe; in a case of the writer's, in a young man, there had been no action of the bowels for 10 days, and the patient had suffered from constipation all his life.

The course of the disease is from 2 to 3 weeks, but some mild cases get well, if treated, within a week.

Diagnosis.—The diagnosis is not difficult. Radcliffe-Crocker says that the lesions may be mistaken for syphilitic nodes: the distinction is made by the presence of other signs of syphilis, and by the fact that the pains in the latter disease precede the appearance of the node through the skin.

Treatment.—Rest in bed, with the legs elevated, and general hygienic conditions, suffice to bring about spontaneous recovery in all cases. No drug has credit for cutting short the course of the disease. The writer has found progress to be quite as rapid when the patient is treated by small doses of hydrarg. c. cretâ with saline aperients, as when she is given full doses of salicylate of soda. As a local application, lead lotion is perhaps the most soothing.

THOMAS HORDER.

TRENCH FEVER

Definition.—A blood infection communicable from man to man by means of the louse (*Pediculus humanus*). Characterised by recurrent pyrexia, headache, giddiness, pain in the back, pain in the limbs, conjunctival congestion, sweating, moderate leucocytosis at the height of the fever, and slight enlargement of the spleen.

The infection is often very persistent, and acute febrile relapses may occur after months of quiescence. The disease was first recognised as a specific entity during the Great War, when it appeared on all the European fighting fronts—800,000 being the approximate number of cases occurring in France among the Allies during 4 years, and sporadic infections have been reported among those coming into contact with returned troops in England and elsewhere.

Ætiology.—Trench fever being transmitted by lice alone, its occurrence depends on the presence of these insects and of human carriers of the infection. As with other insect-borne diseases, considerable numbers of the vector are required before an epidemic is produced, and close contact between human beings is necessary to facilitate the transference of the lice. Both the body louse and the head louse are capable of conveying infection. The disease is conveyed by the excreta or crushed bodies of infected lice; the virus may enter through the broken skin or unbroken conjunctiva; rubbing and scratching promote infection, but the bites of the lice may cause a sufficient lesion to enable infective material to enter the body.

The causal organism.—No observer, as yet, has succeeded with certainty in demonstrating the organism of trench fever in stained or fresh blood

preparations, though it is known that the blood of patients is infective both during fever and in the afebrile intervals and for many months if symptoms persist. Further, the blood plasma has been shown to contain the infective agent, which in this condition is capable of passing through a Pasteur-Chamberland filter (L) with 740 mm. of mercury vacuum. Arkwright, working with excreta from lice fed on trench-fever patients, has shown that the infectivity of the excreta for man varies very closely with the presence or absence of rickettsia bodies.

Pathology.—Very little can be said under this heading. Though German writers refer to fatal cases of trench fever, no reliable accounts of post-mortem examinations are available, and we have no knowledge of any death caused by this disease.

Symptoms and Course.—The incubation period, as evidenced by experimental infections with louse excreta, is most frequently 7 to 9 days, but the period has been prolonged to 16 days when minute doses of louse excreta have been inoculated.

The onset of the disease is sudden in the majority of cases, though about 25 per cent. of all patients complain of prodromal symptoms, such as headache, generalised pains, weakness, diarrhœa, constipation, restlessness, or insomnia, for a day or two before the temperature rises. In some instances the onset is quite dramatic in its suddenness, the patient collapsing while out walking, or even falling from his horse. Early giddiness is a common complaint, and may be so marked that the sufferer has difficulty in returning to his home. Chilly sensations frequently usher in the attack, but true rigors are extremely rare. Nausea, vomiting, and diarrhœa occur in a small percentage of cases, and a gastro-intestinal type of trench fever has been recognised by Plesch and others.

Many cases are extremely mild. Slight fever may be the only symptom, and though complaining of pains, some patients may be entirely afebrile throughout their illness.

The temperature rises rapidly as a rule, and may reach 103° to 104° F. (39·4 to 40° C.) within a few hours of the onset of symptoms. A study of the chart reproduced (Fig. 6) will reveal the main features of the course of the fever; the curve may be extremely erratic. The pulse is usually accelerated, its curve corresponding to that of the temperature, its rate varying from 90 to 120 in men of military age. In old age the rate may be slow. The systolic blood pressure is slightly raised and its curve corresponds with that of the pulse. The respiration rate is normal, and pulmonary complications are extremely rare.

In the fully developed attack, the patient's three chief complaints are headache, pain in the small of the back, and pain in the limbs. The headache is most commonly felt across the forehead and behind the eyes; usually one of the earliest symptoms, it is often one of the most severe, persistent, and commonly recurrent. When occipital, it is often accompanied by stiffness in the back of the neck. The character of the pain in the limbs is twofold: (*a*) Dull aching or gnawing, more or less continuous, always worse at night; and (*b*) acute pain—shooting or stabbing—which may last many hours, especially at night. This latter pain is nearly always felt in the bone and, most frequently, in the tibia. There is no part of the body which invariably escapes from pain. After a few days, however, the "pain all over" sub-

sides and localised pain becomes prominent. The loins and lower limbs are most often affected. Pain is usually, but not invariably, symmetrical; its situation may vary from day to day. The pain complained of in the left hypochrondium points, in most instances, to involvement of the spleen. In early cases the splenic region is frequently so tender that examination by palpation is impossible, on account of stiffness of the muscles over the organ. When the spleen is felt, its edge is well defined and firm. Its actual size, however, varies from day to day in the early stages, and does not remain constant until late in the disease. It is often observed to increase suddenly with the relapses and decrease during the afebrile periods (Day). An appreci-

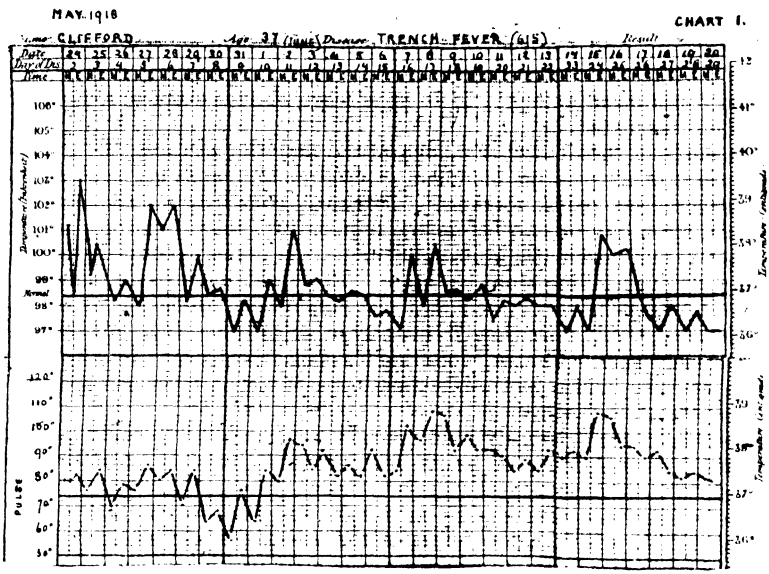

FIG. 6.—Trench fever. Typical temperature and pulse curves.

able percentage of all our cases have had palpable spleens during some period of the disease, though such enlargement has never been more than two finger-breadths below the costal margin. Definite enlargement is most often the result of a prolonged infection, and such enlargements may persist for many months after the patient has resumed his normal life. Areas of tenderness are frequently associated with the pains, and may involve the spleen, tendons, bones, or joint cartilages. The nerve trunks themselves do not appear to be involved. Such tenderness may occur independently of pain, or *vice versa*, and either or both may persist for long periods after the fever has subsided. The extent of the areas of tenderness usually increases with exacerbations of the disease, which exacerbations may be entirely afebrile. As with the pain, the areas of tenderness are usually bilaterally symmetrical, the shin from knee to ankle along the outer border of the tibia being most frequently involved.

The general appearance of the patient during the acute fever suggests a condition of extreme discomfort. He is restless, moving constantly to relieve the pain, and always failing to find comfort. A fairly constant feature of the initial attack is a mild degree of conjunctival congestion; it is usually transient, but frequently recurs with subsequent rises of temperature; this "pink-eye" is not accompanied by increase of secretion. At first the tongue is slightly coated with cream-coloured fur, though there is nothing characteristic about its appearance: it soon clears, and remains remarkably clean. A peculiar and very constant feature is the rapid alternations of shivering and sweating, such alternations occurring several times in the course of a single day or night. Profuse sweating, however, is rare. Rose spots upon the chest and abdomen are frequently seen during the first few days of fever. "They appear in crops, are fairly uniform in size (4 to 8 mm. in diameter), with fairly well-defined edges, varying in hue from bright pink at first to a dull red colour later. They disappear on pressure and are not raised, although vesiculation has been observed in a very few cases. They last from 6 to 48 hours and disappear suddenly, leaving no stain; at times they make their initial appearance during the relapses, which may be afebrile" (H. Fairley Marris).

The mental condition remains normal throughout the disease in the great majority of cases, though rarely there may be some delirium in the most acute attacks. The tendon reflexes are exaggerated, and a pseudo ankle clonus is often found. During fever, lateral nystagmus on extreme deviation of the eyes is common. Frequency of micturition is complained of by about 13 per cent. of all cases, and is not associated with pain, but results in the passage of an increased amount of urine. A trace of albumin is often present. The polyuria occurs as the temperature falls.

The blood picture indicates abnormal activity of the bone marrow, and a moderate and rapidly varying leucocytosis precedes and accompanies the fever waves. The count rarely exceeds 20,000 leucocytes per c.mm. The increase of white cells is due to outpouring of immature polymorphonuclears up to 80 per cent. or more of the total. In the afebrile intervals the mononuclear elements are relatively increased. This last is probably a condition common to many soldiers in the field. In chronic cases the total of red cells is increased, the colour index as a rule being about 0·8.

Progress of the case.—When a definite afebrile interval occurs between the initial fever and the first relapse, all symptoms usually subside as the fever abates, to return as the temperature rises. In prolonged cases, the patient's general condition obviously deteriorates and he presents an appearance of exhaustion. As relapse succeeds relapse the intervals bring less and less relief, though in some cases the later fever waves are accompanied by singularly few symptoms. The body weight steadily declines. Usually, after a period varying from a few days to about a fortnight from the onset of the disease, the acuteness of the patient's pain subsides, he sleeps well, and his appetite returns. There is even then generally some return of pain each night in some part of the limbs—most commonly the shins, calves, or ankles. If he be allowed to get up he finds walking increases the pain. During the next week or two, whether pyrexia recur or not, there are recurrences of symptoms —especially leg pain, each exacerbation being a short replica of the original attack, or of some portion of it. In some cases such recurrences are few and

slight, and the patient soon feels fit and complains of nothing but slight pain or still slighter tenderness in a limited area of the legs, from the knees downwards. In others the recurrence, even if quite late in the disease, as after months of quiescence, may be more severe than the original attack.

The chronic disease.—It has become evident, in a large proportion of the cases of trench fever invalided home, that there is a tendency to advance through a subacute towards a chronic condition, with symptoms of disordered action of the heart, and also in some of neurasthenia. Breathlessness on exertion, palpitation, præcordial pain, and giddiness are features of the subacute and chronic conditions. The temperature in these chronic cases varies considerably; definite fever waves lasting from a few hours to several days occur at irregular intervals, which frequently are to be measured in months.

Diagnosis.—The acute disease may be mistaken for the enteric fevers, malaria, cerebro-spinal fever, influenza, dengue, rheumatic fever, European relapsing fever, typhus, rat-bite fever, or mild infective jaundice with absence of jaundice and albuminuria. Trench fever in the chronic form is particularly liable to be mistaken for some form of cardiac disease, neurasthenia, myalgia or chronic rheumatism; and, in addition, must be differentiated from other chronic infections, such as malaria, dysentery, and tuberculosis.

Prognosis.—Trench fever is practically a non-fatal disease, but may result in prolonged ill-health in from 10 to 20 per cent. of all those affected. A certain degree of immunity follows an attack of trench fever, more particularly when the attack has resulted in a complete clinical recovery; and it has been shown experimentally that such immunity may persist for six months.

Treatment.—The prospects of prophylaxis against lice-borne disease are more hopeful than in the case of any other insect-borne malady. In all their stages, lice have no normal life apart from their host, and may thus be made the subject of complete control. It is a simple matter to free the individual from lice, and as regards the community this depends on successful organisation. The sick should be immediately and completely freed from vermin; but their isolation alone is not likely to control the spread of an epidemic, as mild cases are apt to escape recognition, and chronic cases remain infective for too long a period to permit of segregation till all danger is passed. The curative treatment is mainly symptomatic, the chief indication being to get the patient to bed as early as possible, and to keep him there for 8 days after the fever has subsided. In this way the incidence of chronic symptoms has been reduced. Chronic cases are best treated by healthy open air exercise, with tonics and small doses of thyroid extract. Even when complaining of shin pain it is a mistake to allow such cases to live a sedentary indoor life.

W. Byam.

HYDROPHOBIA

Synonym.—Rabies.

Definition.—Hydrophobia is an acute infective disease of dogs, wolves and some other animals, communicable to man by the bites of such infected animals.

Ætiology.—The disease can also be communicated by the licking of an

abraded surface, and is communicable from man to man by bites. In Western Europe man is almost always infected by rabid dogs, but in Eastern Europe wolves provide the commoner origin. Infections from rabid dogs were said to occur in 16 per cent. of bitten individuals, whereas 80 per cent. of cases bitten by rabid wolves are said to become infected. Inasmuch as the lesions caused by wolves are more extensive this increased infectivity may depend on the amount of virus introduced.

Pasteur demonstrated that rabies was essentially an infection of the central nervous system by injecting experimental animals subdurally with emulsions of any part of the nervous system of infected animals, and reproducing the disease. Further experiments showed that the virus, gaining admission by the infected wound, reached the central nervous system by spreading up the peripheral nerves. Thus di Vestea and Zagari showed that the lumbar cord of an animal inoculated in the sciatic nerve is infectious several days before the virus can be shown in the brain. An explanation is therefore forthcoming of the fact that in cases bitten about the head the incubation period is short.

The virus of rabies.—It was shown by Remlinger and Riffat-Bey that the virus of rabies would pass through a coarse Berkefeld or Chamberland filter. Animals killed by such filtrates provided virus that would communicate the disease to further animals. Finer filters produced a filtrate capable of killing animals, though the disease could not be again propagated. Hence symptoms and death may be caused by a toxin containing no living virus. The virus is destroyed by a temperature of 50° C. for one hour, and is attenuated by drying.

In 1903 Negri described bodies, known as Negri bodies, which are now universally considered to be specific to the disease. They are present in all portions of the brain in 98 per cent. of cases of rabies in dogs, as well as in other animals and man. Much controversy has occurred as to whether these bodies are parasites, or simply degenerated cell products caused by the ultra-microscopic parasite of the disease. The balance of opinion tends to the theory that they are parasitic. The cultivation of the parasites entirely failed till Noguchi employed similar methods to those by which he cultivated *Spirochæta pallida*. He preserved the virulence of the virus through 21 generations, covering a period of 100 days.

Symptoms.—The *incubation period* varies from 15 days to 7 or 8 months, but it is usually about 40 days. Three stages are described in the symptoms.

1. *The invasion stage* includes certain local symptoms in the region bitten, such as irritation or pain. But these local symptoms may be absent. There is very moderate pyrexia, the pulse is raised in frequency, headache is common, and some restlessness and insomnia.

2. *The stage of excitement* follows after a period of 2 or 3 days, and itself lasts about the same time. It is characterised by intense restlessness, mental excitement, and great and generalised hyperæsthesia. Any stimulus to any of the special senses, or to the mind, leads to spasm affecting the muscles of the mouth, pharynx and larynx. Laryngeal and pharyngeal spasms are immediately induced by any effort at drinking. This stage is usually marked by a higher temperature. Mania may occur.

3. *The paralytic stage* ends the scene, the patient lying exhausted and unconscious; death occurs from heart failure after 1 or 2 days in this condition.

Diagnosis.—This presents no special difficulty, but some cases of neuro-

mimesis (lyssophobia) or hysteroid counterfeiting of the disease are said to resemble it rather closely. These patients are not ill, however, and they are very emotional. Tetanus is probably the infective disease which bears the nearest resemblance to rabies.

Prognosis.—When once the disease is established no hope of recovery exists. Reported recoveries are probably cases of pseudo-hydrophobia (lyssophobia).

Treatment.—This is entirely preventive.

1. *Local measures.*—Cauterisation of a rabies wound within 5 minutes of its occurrence prevents development of the disease; within half an hour of infliction cauterisation prevents a certain proportion of cases from developing. Subsequent cauterisation tends to prolong the incubation period, and the prolongation thus obtained is of great importance when specific prophylaxis is undertaken.

2. *Specific therapy.*—Pasteur published his researches in 1885. He showed that rabies virus obtained from rabid dogs—"street virus"—had a nearly constant virulence, in that it killed rabbits in 15 to 20 days when inoculated subdurally. By passing this street virus through a series of rabbits, the virulence became gradually raised till it remained constant at a titre, when it killed rabbits in about 7 days. He called this *virus fixé*. Similar passages of street virus through monkeys attenuated the virulence. He thus had various strengths of virus at his command, and he found that, commencing with a weak, and gradually working up to a strong, virus, he could by subcutaneous injections so immunise a dog that subdural inoculation with a strong virus was not fatal.

Subsequently he devised a method for attenuating the virulence of infected rabbits' spinal cords by drying in air over caustic potash. The next step was to inoculate a man bitten by a rabid dog with emulsions of these dried cords. Commencing with a cord that had been dried for 14 days he gave doses of emulsion of cords of increasing virulence till by the ninth day he completed the series of 12 inoculations with a dose of a cord that had been dried for 1 day. No sign of hydrophobia supervened, and with only slight modifications this still constitutes the famous Pasteur prophylactic treatment.

Högyes states that 50,000 people have been treated within 10 years with an average mortality of but 1 per cent.

THOMAS HORDER.
JOHN MATTHEWS.

EPIDEMIC JAUNDICE

Jaundice may occur in the form of outbreaks which may be due to—(1) some specific disease of which jaundice is a symptom, such as influenza, yellow fever, relapsing fever, malaria, etc.; or (2) some chemical poison capable of producing toxic jaundice, which may act on a large scale on a number of persons exposed to it and an outbreak of jaundice result. Examples of this occurred during the Great War, from tetrachlorethane poisoning in connection with the manufacture of aeroplanes, and from poisoning by trinitrotoluene and other similar substances used in the manufacture of munitions (*vide* Lettsomian Lectures, 1919; Willcox).

The term "Epidemic Jaundice" is not applied to the above types, which

are named after the disease or poison causing the jaundice. The term is restricted to—(1) Epidemic catarrhal jaundice; (2) Infective hæmorrhagic jaundice occurring in—(*a*) Spirochætosis ictero-hæmorrhagica, (*b*) Weil's disease, and (*c*) Mediterranean yellow fever.

1. Epidemic Catarrhal Jaundice

This is a type of jaundice often occurring in large outbreaks where the symptoms resemble those of ordinary catarrhal jaundice, and, in addition, there are some symptoms of a mild general infection.

Ætiology.—*Occurrence.*—Serious outbreaks of this disease have occurred in recent wars. Thus, in the American War 22,509 cases occurred, with 161 deaths; in the South African War 5648 cases occurred, with a few deaths; and in the Great War the disease was of very common occurrence. In the Mesopotamian campaign during 1917, 1538 cases occurred in British troops, the mortality being 0·6 per cent.; and there were 2633 cases in Indian troops, the mortality being 0·3 per cent. Localised epidemics have occurred in civil life in this country; thus in 1918 a small outbreak in Cambridgeshire was reported by Dr. G. S. Gray, and Dr. S. Hartill investigated a similar outbreak in 1918 in Hertfordshire.

Infection.—This is probably gastro-intestinal in origin. In the Dardanelles and Mesopotamian campaigns, the incidence curve followed that of dysentery and diarrhœal diseases, the maxima for jaundice occurring about 3 weeks after those for diarrhœal diseases, thus indicating a similar channel of infection. The epidemic character of the disease is beyond doubt, since there were numerous instances of large numbers of cases occurring amongst a single unit. The epidemic character appeared to be due to a common cause, rather than to a spread from person to person, for infection from one case to another in hospital was uncommon. Defective sanitary conditions whereby food is contaminated by dust, flies, etc., and where the drinking water is polluted, strongly predispose.

Age and sex do not appear to have any influence on the occurrence. The disease occurs in all climates, but the maximum incidence is in the cold months. There is sometimes a history of diarrhœa for several days before the onset of jaundice, and the disease has often occurred during the course of an attack of dysentery.

Pathology.—No specific organism has been isolated from the blood in this disease during life, and this is not surprising, since the signs of general infection have usually disappeared by the time that jaundice has developed. Organisms of the *B. coli* group have been obtained during life, and post mortem from the liver on several occasions. Bacteriological examination of the duodenal contents after withdrawal by means of Einhorn's evacuator has failed to yield any definite results (Martin and Hurst). In two fatal cases in the Dardanelles, a marked duodenitis was present, and there was redness and swelling of the mucous membrane of the common bile-duct, the catarrhal condition spreading up the cystic and hepatic ducts. Usually, however, in cases of epidemic catarrhal jaundice, when death occurs, it is at a late period of the disease, from acute atrophy of the liver, so that the signs of the original duodenal infection have largely disappeared. Paratyphoid infections may be associated with catarrhal jaundice, but the clinical course of

these cases is that of paratyphoid and not of epidemic catarrhal jaundice. It seems probable that the disease is caused by an intestinal infection setting up a duodenitis and ascending catarrh of the bile-ducts, with resulting obstructive jaundice, and in the uncommon fatal cases the infection causes such degenerative changes in the liver cells as to lead to the symptoms of acute yellow atrophy. The organisms causing the disease may be similar in type to those found in health in the intestinal tract, such as the *B. coli communis* group.

Symptoms.—In some cases, there is a history of diarrhœa or dysentery during the previous few weeks. Usually there is a prodromal period, lasting a few days, in which anorexia, nausea and perhaps occasional vomiting occur. Diarrhœa frequently occurs during this period, but sometimes constipation is present. Pyrexia of a mild type now sets in, with some chilliness and occasionally shivering. The tongue is furred, and headache and general pains, with perhaps vomiting, may occur. Some discomfort in the hepatic and epigastric region is present. The pyrexia usually lasts from 2 to 4 days, but may be longer or shorter. About the third or fourth day of fever, jaundice occurs, at first slight, but gradually deepening, and becoming of the obstructive type, with pale stools and bile-stained urine. The jaundice attains its maximum in about 10 days and then gradually subsides. Definite uniform enlargement, with some tenderness, of the liver occurs as the jaundice develops, and in about 10 per cent. of cases enlargement of the gall-bladder can be detected. Enlargement of the spleen accompanies that of the liver, and it can usually be felt extending half an inch or more below the left subcostal border in inspiration. The enlargement of the liver and spleen diminishes as the jaundice subsides. The pulse is quickened to 80 or 90 per minute during the pyrexial period, and there is definite increase in the area of cardiac dullness to the right of the sternum. The dullness on percussion in the fourth intercostal space may extend to 1 or 2 inches to the right of the sternum, and this is a very characteristic sign. Anæmia, herpes, conjunctival congestion and hæmorrhagic symptoms do not occur in this disease. The urine shows the usual characters of obstructive jaundice, and albumin and casts are only present in those rare and fatal cases which develop icterus gravis. During the course of the attack, definite impairment of hepatic efficiency can usually be demonstrated by the lævulose tolerance test (Stokes). This proves that an actual involvement of the liver (hepatitis) occurs.

Prognosis.—Usually cases of epidemic catarrhal jaundice give rise to no anxiety and the jaundice gradually clears up in about 3 weeks, so that signs of pruritus, etc., do not occur. The convalescence is somewhat slow, especially in cases with marked hepatic and splenic enlargement, and 2 or 3 months are required before the patient is fully restored to health. In a few cases (about 0·5 per cent.) the disease runs a more severe and often fatal course. About 10 days after the onset of the jaundice in such cases, mental irritability, vomiting and stupor occur; subsultus tendinum, Cheyne-Stokes breathing, coma and a rise of temperature supervene, and death commonly occurs within about 3 days of the onset of these grave symptoms. Hæmorrhages such as hæmatemesis, epistaxis or hæmaturia may occur during this stage, and the urine contains albumin and casts, and may be suppressed. The clinical symptoms are those of icterus gravis, and the signs

found post mortem are those of acute yellow atrophy of the liver. Before death a marked diminution in the liver dullness can be made out. Fortunately, the occurrence of acute yellow atrophy of the liver is uncommon, but its possibility always renders cases of epidemic catarrhal jaundice serious.

Treatment.—Rest in bed, light diet of lacto-vegetarian type, in which proteins and fats are restricted, an alkaline mixture of citrate of potash and bicarbonate of soda, and saline aperients are all that are needed. Small repeated doses of calomel should not be given, since mercurial stomatitis may be caused. In cases where symptoms of icterus gravis threaten, bicarbonate of soda, half a drachm every 2 hours, should be given by the mouth, and injections of normal saline containing bicarbonate of soda, 2 drachms to the pint, should be administered per rectum as frequently as they can be retained. In severe cases, normal saline containing 1 drachm of bicarbonate of soda to the pint should be given intravenously. In some cases by this treatment the dangerous symptoms may be warded off.

2. Infective Hæmorrhagic Jaundice

(*a*) *Spirochætosis ictero-hæmorrhagica* (see p. 183, under Spirochætal Infections).

(*b*) *Weil's disease.*—This is a form of infective hæmorrhagic jaundice similar in many respects to the spirochætal form just mentioned. It was first described by Weil in 1886, and German physicians claim that it is not identical with spirochætal jaundice. The disease does not appear to occur in this country, and it must be classified amongst the "Hæmorrhagic Infective Jaundice group," further bacteriological investigations being necessary before a specific organism can be assigned to it.

Pathology.—The *B. proteus fluorescens* has been found in the urine and organs in fatal cases, but not during life in the blood of those affected with the disease. It has been stated that the disease is conveyed by the drinking of polluted water or the eating of contaminated cheese or meat.

Symptoms.—The disease is an acute one, with sudden febrile onset and marked gastro-intestinal symptoms. Jaundice occurs from the second to the fourth day. The liver and spleen are enlarged, and albuminuria and nephritis often occur. Hæmorrhagic symptoms, such as purpuric rashes, epistaxis, hæmoptysis and bleeding from the stomach and bowels, occur in severe cases.

(*c*) *Mediterranean yellow fever.*—This disease was described by Kartulis as occurring in Alexandria, Smyrna and Nauplia, and must be regarded as a very toxic form of hæmorrhagic jaundice of unknown causation.

Pathology.—No specific organism has been found in this disease, but it has been associated with defective drainage and inadequate sewage disposal.

Diagnosis.—The disease differs from yellow fever in the late development of jaundice.

Prognosis.—The mortality was high, being from 30 to 75 per cent., and death usually occurred from the tenth to the sixteenth day.

Symptoms.—It is an acute febrile disease, with very severe toxæmia, in which jaundice occurs about the fourth or fifth day, with marked hepatic

enlargement. Purpuric rashes, hæmorrhages from the nose, bowel and kidneys are common, and nephritis with suppression of urine frequently occurs.

W. H. WILLCOX.

YELLOW FEVER

Definition.—A specific febrile complaint associated with characteristic symptoms, endemic in parts of tropical America and also on the West Coast of Africa, the parasitic cause of which is unknown, the virus being filterable and transferred from man to man by the agency of the common domestic mosquito *Aëdes ægypti* (formerly *Stegomyia fasciata*).

Ætiology.—The endemic haunts of yellow fever have been considerably curtailed lately by the general destruction of its intermediary host the mosquito, areas where it used to exist being now completely free. A circle with its centre in the Isthmus of Panama and embracing the northern parts of South America, the West Indian Islands, and the southern parts of North America nearly includes the area of its late prevalence. In addition, however, cases of yellow fever keep cropping up in different parts of West Africa, and the disease must now be looked upon as endemic there. Recently Stokes, Noguchi, and Young, when investigating yellow fever in West Africa, acquired the disease themselves and died of it. In other parts of the world it is unknown.

People born in, and living in, endemic areas of the disease seem to acquire an immunity which is not altogether easy to explain. It has been generally supposed they have had mild infections in their youth and so have become immune, one attack generally conferring this protection. It is certainly the newcomer to an infected place who takes the disease, the so-called *non-immune*: but it is difficult to explain how in some of the West Indian islands that have been free for years, sufficient for a new young generation to grow up, when an epidemic does occur these people seem to escape the complaint. To explain this, Boyce supposed the disease was always present in slight unrecognised forms, but, if so, then certain of the constant stream of non-immunes always arriving would assuredly acquire the complaint, and in them it would be severe, with definite recognisable symptoms. This was what actually happened in the old days in Havana when that town was an endemic focus. Negroes have also been said to enjoy a special immunity, but this is doubtful, as some of the Barbadian epidemics have shown. There is something then still lacking in our epidemiological knowledge of the disease. The organism is an ultramicroscopical one, so small as to be invisible under the highest powers of the microscope, and filterable through the closest filters. It therefore comes under the filterable virus group. Noguchi found a spirochæte *Leptospira icteroides*, and believed it to be the causative agent of the disease. Recent work, however, has shown that the *Leptospira icteroides* is only one of the *Leptospira icterohæmorrhagiæ* group, and not the true cause of yellow fever.

The virus is found in the blood of a yellow fever case on the second and third days of the disease, and the *Aëdes ægypti* (*Stegomyia calopus* vel *fasciata*) which then sucks the blood takes in the germ. The insect, however, does not itself become infectious until 13 days have passed, this indicating that some

developmental changes have had to take place in the organism. (Compare the development of the malaria parasite in the mosquito, pp. 220, 221.) Once a mosquito becomes infectious it probably remains so for the rest of its life, and as this may be as long as 60 days (Guiteras) it is therefore able to do infinite harm. Some have believed the infection might even spread to the ova and so infect the next generation of mosquitoes, but fortunately this has not been confirmed. Thirty to forty per cent. of non-immunes after being bitten by an infected mosquito acquire the disease, the incubation period usually being 3 days. The ætiology of the disease, then, apart from the actual discovery of the parasite, is complete, the virus existing in the blood and having to pass through the mosquito or intermediate host before it can be transmitted to a fresh individual.

Pathology.—There is little doubt that the pathological changes produced by the causative germ are due to toxins, the changes found at autopsy all pointing in this direction. The skin after death is markedly yellow, and sometimes a post-mortem rise of temperature occurs. The liver is very characteristic, of a bright yellow ranging to a light brown colour. It is in an advanced state of fatty degeneration, with necrosis of the cells and hæmorrhages. The spleen is acutely congested, but about normal in size. The kidneys also show acute congestion and fatty degeneration of the cells of the tubules, a true parenchymatous nephritis often being present. The heart muscle is pale and fatty. The mucosa of the stomach is much swollen, and the organ is generally full of the black grumous material, which, when vomited during life, gives what is called the black vomit. In fatal cases it will be found in the stomach even though not voided during life. Hæmorrhages, chiefly of the nature of ecchymoses, may be found on the pleura, meninges and other places. The brain and lungs show congestion.

Symptoms.—Clinically, the disease may be divided into four, more or less well-defined, types, as follows: (1) Larval; (2) Mild; (3) Severe; (4) Malignant.

1. *Larval forms.*—In epidemics of yellow fever, aberrant or irregular types are often seen—some so slight as to be unrecognisable; some with slight fever, perhaps, and vomiting, and on the next day a return to health with no further trouble. Such cases are difficult if not impossible to diagnose, and it is only their frequent occurrence in epidemics that betrays their identity. They are important because mosquitoes may become infected from them, and transmit the severe types of the disease.

2. *Mild forms.*—These are slightly more marked than the former. There is a single paroxysm of fever, lasting 2 to 4 days, then a rapid fall, and restoration to health. Distinct jaundice, however, may be noticeable, and if the urine be examined carefully, albumin is generally present after the second day. Headache, eye pains and vomiting may also occur.

3. *Severe forms (the ordinary form).*—The onset is usually sudden, a rigor or feeling of chilliness down the back ushering in the disease. The temperature rises rapidly to 103° F. to 104° F., and the patient looks ill. Further, there are pains in the back and limbs, severe frontal headache, with flushing of the skin of the face, and injection of the eyes (ferrety eye) and photophobia. The tongue is sharp-pointed with bright red edges, and thickly furred dorsum, appetite is lost, and bilious vomiting may appear quite early. Epigastric pain has been said to be pathognomonic. Jaundice—which has given the

characteristic name to yellow fever—appears, according to Sternberg, on the third day of the disease; but it may sometimes be noted even earlier. Albuminuria appears after 48 hours, and continues to increase until very large degrees may be present.

After remaining high for 3 or 4 days, the temperature falls suddenly to 100° F. or lower, and this lull is known as the remission. In the mild type of case it does not rise again, but in the severe case, after remaining low for some hours to a day, there is a febrile exacerbation, and this occasions the second paroxysm or relapse. The pulse, which in the early stages of the disease was full and bounding, 120 or so per minute, gradually decreases as the time of the remission approaches, and remains low, 40 or 50 per minute, when the temperature rises the second time (Faget's sign). This when well marked is one of the surest tests of yellow fever.

During the second paroxysm most of the symptoms of the first return. Vomiting becomes marked, with much tenderness in the epigastrium; the thirst is excessive with great prostration, the tongue becomes dry and cracked, and hæmorrhages may appear on different parts of the body. The temperature may eventually fall after 2 or 3 days and the patient recover, or further symptoms of great gravity appear—black vomit, melæna, suppression of urine, delirium, coma, convulsions and death.

4. *Malignant forms.*—In this type, the symptoms proper to the remission stage make their appearance within the first 3 or 4 days. The temperature may reach 106° F. Violent vomiting followed by black vomit occurs early, and symptoms referable to the nervous system are apparent—subsultus tendinum, hiccough, tremors and delirium. Often profuse hæmorrhages, as in black smallpox, take place under the skin and the patient quickly dies, overcome by the severe toxæmia.

In yellow fever, the blood is not characteristic. The red corpuscles are not reduced; the whites vary between 7000 to 15,000 per c.mm. The polymorphonuclears are in excess, and there is no relative increase of the large mononuclears.

Complications and Sequelæ.—Boils, abscesses, dysentery and general debility may follow an attack, but, as a rule, once convalescence has set in, recovery is rapid.

Diagnosis.—The disease most readily mistaken for yellow fever is malaria—the so-called bilious remittent type. Careful blood examinations must therefore be made for malarial parasites, and quinine should not be given until this is done. The blood in malaria shows a relative increase of the large mononuclears, an important point in differentiating the two diseases. The occurrence of many cases simultaneously points to yellow fever. Dengue has also been mistaken for yellow fever. It may be recognised by the preliminary rash, leucopenia, and the absence of albuminuria.

Prognosis.—The death-rate varies in different epidemics from 30 to 80 per cent. It must always be considered a deadly disease; features such as a high degree of albuminuria, marked diminution of urine, black vomit and disturbances of the nervous system, are always of grave omen.

Treatment.—By adopting segregation of infected individuals, by preventing mosquitoes obtaining access to them, and at the same time by destroying mosquitoes (*Aëdes*) both in their adult and larval stages, the Americans cleared Havana, Panama, Colon and other infected areas completely, and

stamped out the disease in many of its old endemic haunts. There is no specific drug for the disease, the treatment of which is mainly symptomatic. Sternberg proposed the following mixture: Sodii bicarb., grs. 150; hydrarg. perchlor., gr. ½; aquam ad oz. 40—3 tablespoonful doses every hour. This is said to prevent vomiting and also suppression of urine. It often fails, however, to ward off a fatal termination.

For vomiting in addition, a mustard leaf may be applied to the epigastrium, or sips of iced champagne given; chloroform, 2 or 3 drops, a drop of creosote, tinct. iodi, 2 drops may be tried. Opium should not be given. Heart failure is an indication for stimulants—alcohol, strychnine, etc. For suppression of urine, hot fomentations over the back and injections of 15 grains of urea are valuable. Diet should be of the simplest nature; very little of anything should be given at first, then milk and lime water; toast water, raisin tea and barley water may be cautiously tried. The diet must not be increased during the remission, as this is a dangerous time. After the temperature has been normal for 4 days after the second paroxysm, a gradual increase in the food may be begun—chicken broth, custard puddings, etc.

After convalescence a change of air is advisable—a voyage home to England or to some other place, if possible. One attack confers immunity almost without exception, so there is no danger in returning to the endemic haunts of the disease.

Hindle has recently shown that a vaccine consisting of carbolised or formalinised livers of monkeys (*Macacus rhesus*) which have died of the disease will confer on these animals an immunity against very large doses of virus. The application of this vaccine towards the protection of human beings is now in progress.

PHLEBOTOMUS FEVER

Synonyms.—Pappataci Fever; Three-day Fever; Sand-fly Fever; Simple Continued Fever; Pym's Fever.

Definition.—An acute specific fever due to a filterable virus which lasts about 3 days and is spread by sand-flies, *Phlebotomus papatasii*.

Ætiology.—The disease is common in the Mediterranean basin, in India, Mesopotamia, Persia, etc. It would appear to be commonest amongst the white races, though natives are also affected. No germ is known, the disease being due to one of the filterable virus group of diseases. The virus can be filtered through an F. Pasteur-Chamberland candle, and is present in the peripheral blood on the first and second days of the disease. Sand-flies (*P. papatasii*) that suck the infected blood on those days become infected, and a development of some sort takes place in their bodies, the flies themselves becoming infective 7 days after biting. (Compare Yellow Fever and Dengue.) Once a fly is infected it probably remains so for the rest of its life. Experimentally, blood taken on the first and second days will produce the disease by inoculation, and volunteers have also been bitten by infective flies, and acquired the disease. The incubation period of the experimental cases varied from 3 to 7 days.

Pathology.—Of this little is known, as cases rarely, if ever, die.

Symptoms.—Prodromal symptoms may usher in the disease—malaise, vague pains, discomfort and weariness. The onset is sudden, with chilly feelings, frontal headache and lumbar pains. The temperature rises rapidly, reaching 104° F. or 105° F. at the end of 24 hours. The mouth and throat are congested. There is no vomiting as a rule, but there may be diarrhœa. Pains in the joints and cramps are not uncommon. The skin is usually dry, but in some cases there is sweating. The blood shows a leucopenia of 4000 or 5000 whites per cubic millimetre. In 36 to 48 hours the temperature falls slowly to normal. With the fall there may be epistaxis, more rarely sweating, vomiting and diarrhœa. After the temperature falls all the symptoms abate. Convalescence is usually prolonged.

An afebrile variety is described. Abortive forms are also seen.

Diagnosis.—This is difficult in the first instance. The disease closely resembles influenza. The blood should be examined to differentiate it from malaria.

Prognosis.—This is good. Apart from the temporary discomfort, there is nothing to fear. One attack is supposed to confer immunity. The disease, *per se*, is not fatal.

Treatment.—Destruction of sand-flies and avoidance, as far as possible, of their bites speak for themselves. There is no specific treatment. The patient should be kept in bed till the temperature falls. Aspirin and phenacetin may be given to relieve the headache and general discomfort.

DENGUE

Definition.—Dengue is an acute specific fever, due to a filterable virus, and spread from man to man by the agency of a mosquito (*Aëdes ægypti*, (formerly *Stegomyia calopus*). There are generally two febrile paroxysms, with an intermission or remission without jaundice, albuminuria and hæmorrhages, but with a marked leucopenia and with a pulse which varies directly with the temperature.

Ætiology.—The disease occurs universally throughout the tropics and subtropics, and is often epidemic. All ages and sexes are liable. No definite germ has yet been isolated. The virus is filterable, the filtrate, as, also, the unfiltered blood if taken on the third or fourth days of the illness, causing the disease when inoculated into suitable individuals. The mosquito acts as an intermediate host, the virus undergoing development in the insect before it is capable of being transmitted back to man.

Pathology.—The disease is rarely fatal. Œdema and congestion of the lungs have, however, been noted in cases that have died in Calcutta. There is nothing specially characteristic on post-mortem examination.

Symptoms.—Prodromata—feelings of general malaise, with pains in the fingers and limbs generally—may usher in the fever. More commonly, the onset is sudden with a rapidly rising temperature, headache and aching in the eyeballs. The limbs and joints then become stiff and very painful. The pains are often so severe that the name of break-bone fever has been given to the disease. The skin shows a general flushing, with congestion of the mouth and throat; this erythematous condition forms the so-called initial rash. If the case become severe, all the symptoms are intensified, the temperature reaching 105° F. or 106° F., and owing to the pains move-

ments are impossible, the patient being bedridden. Vomiting is not infrequent. After 3 or 4 days, the temperature falls by crisis, diarrhœa, sweating and epistaxis often accompanying the fall. All the symptoms then improve, and the stage of remission is reached. After feeling quite well for a day or two, so well in fact that the patient may have got up and gone out, the temperature rises again (the third stage), this time associated with a measly roseolar rash, best seen on the hands, wrists, elbows and knees. The spots disappear on pressure, and do not become petechial. The pains are severe in this stage, but after lasting a few days the temperature finally falls, the rash fades and convalescence begins. The blood shows a leucopenia.

Complications and Sequelæ.—The pains may persist with a considerable degree of crippling and lameness. General debility, often combined with sleeplessness, is common. Boils are also sometimes troublesome. One attack usually confers immunity, though second and third ones have been recorded. It is now generally considered that the seven-day fever of Calcutta described by Rogers is a variety of dengue.

Diagnosis.—Measles, German measles, scarlet fever, influenza, rheumatic fever, secondary syphilis and malaria may all quite easily be mistaken for dengue. Yellow fever is distinguished from it by the presence of jaundice and albuminuria. The rapid occurrence of other cases and the special pains greatly help the diagnosis.

Prognosis.—This is good, the death-rate being very small. Charles mentions a pernicious form in Calcutta with œdema of the lungs, and finally death with cyanosis. In old people and in children, especially if debilitated by other diseases, an attack of dengue may prove fatal. Different epidemics vary greatly in their virulence.

Treatment.—Destruction of mosquitoes will remove the disease. Rid the town of *Culex fatigans* and *Aëdes aqypti* and the disease must disappear. The abolition of mosquitoes in Port Said freed that port from dengue (E. H. Ross). Every one in the tropics should sleep in a mosquito net. This considerably diminishes the chance of infection. The patient should be put to bed and kept there for 10 days, namely, until the terminal eruption has disappeared. The diet should be light and of a fluid nature. A.B.C. liniment may be used to rub on the limbs and joints for the pains. Morphine may even be required. Purgatives must be avoided, because of the movements they entail. Ice relieves the headaches.

When convalescence is established, gentle massage and electricity will be found useful for the limbs. The food should be good; a voyage should be taken if possible for change of air. Tonics such as Easton's syrup are also indicated.

SPOTTED FEVER OF THE ROCKY MOUNTAINS

Synonyms.—Blue Disease; Black Fever; Spotted Fever.

Definition.—A fever of the typhus group, spread by a tick, *Dermacentor venustus*, and not by lice.

Ætiology.—The disease is more or less strictly limited to some of the States of America, Idaho and Montana especially. All ages and both sexes

may suffer. The germ has not yet been isolated, though rickettsia bodies have been found. It has been abundantly proved that the cause of infection is carried and spread by a tick, *D. venustus*, a common parasite in the valleys where the disease occurs.

Pathology.—The signs of a severe toxæmia, as in typhus, are present, such as fatty heart, liver and kidneys, enlarged congested spleen, hypostatic congestion of the lungs.

Symptoms.—The temperature, which rises to 104° or 105° F., or higher, comes on somewhat insidiously, after a variable incubation period of from 7 to 14 days. The usual loss of appetite, headache, malaise, as seen in other fevers, are present. On the fourth to the seventh day the characteristic eruption appears, first on the wrists and then extends to the limbs and trunk, the face remaining free. The spots are rose-coloured, pink or red, not unlike the ordinary typhus rash, some of them becoming petechial from extravasation of blood. Some remain discrete, others become confluent. The rash gradually fades as the fever subsides, at the fourteenth day or a little later. The bowels are usually constipated, vomiting is common, congestion of the lungs or pneumonia may appear and the urine generally shows albumin. The leucocytes are increased.

Complications and Sequelæ.—Gangrene of the fingers and toes, pneumonia, suppuration of the parotid gland, femoral thrombosis and otitis media may follow the disease.

Diagnosis.—This must be made from ordinary typhus. The geographical distribution gives one the clue to the diagnosis.

Prognosis.—This varies considerably, the mortality being much higher in Montana (90 per cent.) than in Idaho, where it is only 5 per cent. (Ricketts). It must always be considered a grave disease.

Treatment.—Where possible the tick should be exterminated. In the infected areas small mammals, such as ground squirrels, and woodchucks, have been destroyed, because the larval and nymphal forms of the ticks develop and live on these animals. Systematic dipping of goats and sheep should be carried out, as these animals act as hosts. The symptoms must be treated on general principles as in other fevers. Serum treatment, the serum being obtained by passing the virus through guinea-pigs and then inoculating horses, such as has been tried by Nicolle and Blaizot for typhus fever, might also prove useful.

TSUTSUGAMUSHI FEVER

Synonyms.—Japanese River Fever; Flood Fever; Kedani Disease; Akamushi Disease; Shimamushi Fever.

Definition.—An acute infectious disease, occurring in the island of Nippon, Japan, caused by the bite of a trombidium, and associated with fever, lymphangitis, and an erythematous eruption.

Ætiology.—The disease is strictly limited to one or two areas on the banks of some of the rivers on the west coast of the principal island of Japan. All ages are liable. The parasitic cause is still unknown, but the virus is spread by a trombidium, now named the *Leptotrombidium akamushi*, a mite which is common in the Yamagata district in which the disease is endemic.

The mature form or prosopon produces larvæ (mites) which feed on mammals, chiefly field mice, and thus man may become infected. (Compare the harvest bug or mite in England.)

Pathology.—Few post-mortem examinations have been recorded in English literature. Kawakami's cases showed hypostatic congestion of the lungs, bronchitis, myocardial softening, enlargement of the spleen, injection of the mucosa round the ileo-cæcal valve and general enlargement of the mesenteric lymph glands.

Symptoms.—The bite of an infected mite gives rise to a small, round, black eschar or scab, most commonly found near the genitals or the axillæ. An incubation period then supervenes of 5 to 12 days, after which there is a rise of temperature, often ushered in by severe rigors. The lymphatics, draining the area of the bite, then become inflamed, with enlargement of the proximal glands. The pyrexia continues high, and on the sixth or seventh day the exanthem appears, viz., an eruption of large, irregular, dark-red papules, or small hæmorrhages, first appearing on the face, and spreading to the forearms, legs and trunk. This lasts for a few days, 4 to 7 as a rule. After lasting on an average from 14 to 21 days, the temperature falls and convalescence begins. Conjunctivitis, with signs of bronchial irritation, profuse sweating, spongy gums and constipation have been noted. During the course of the disease the scab falls off and a small ulcer is seen in its place.

Diagnosis.—In an infected area this is easy, the scab of the bite, with the other symptoms, can hardly be mistaken for anything else.

Prognosis.—The mortality is high: 20 to 50 per cent.

Treatment.—Infection should be avoided as far as possible. Treatment is purely symptomatic, the patient's strength being conserved as far as possible.

OROYA FEVER.

Synonyms.—La Maladie de Carrion; Carrion's Disease.

Definition.—An acute infectious disease of doubtful ætiology, limited to the western slopes of the Peruvian Andes, associated with peculiar rod-shaped bodies in the red blood corpuscles, *Bartonella bacilliformis* or Barton's bodies.

Ætiology.—The members of the Harvard School of Tropical Medicine, who studied the disease in Lima in 1913 under Strong, finally came to the conclusion that the bodies mentioned above were akin to the protozoa and caused the disease. How they are transmitted from one person to another is unknown. An insect vector is suspected. Any one living in, or staying for a time in, the endemic area is liable to acquire the disease. Both sexes are liable and children may be attacked. The Commission also concluded that Verruga peruviana is a separate disease and not a stage of Oroya fever. Lately, however, Noguchi, in experimental work on these two diseases, has shown again that they are connected with each other, and, according to him, the verruga eruption is only a phase of the oroya fever.

Pathology.—The spleen is usually enlarged and large swollen endothelial cells, containing rod-shaped bodies, are seen. The lymphatic glands also show similar cells. The liver shows toxic degeneration, with areas of necrosis. Lesions of an ulcerative nature have also been described in the large intestine.

Symptoms.—The incubation period is said to be 21 days. After this the onset is fairly rapid, with malaise, headache, pains and the usual signs of fever. The pains are usually very marked and are sometimes the first symptom noted. They may affect any part of the body, the bones frequently being involved and very tender. The temperature rises and runs an irregular course somewhat similar to that of a paratyphoid infection. It gradually falls in the fourth week. Severe cases generally die; there are no skin eruptions apart from the verrugas. The superficial and lymphatic glands are enlarged and palpable. Anæmia rapidly develops, the red blood corpuscles falling to as low as 1,000,000 or even lower. The leucocytes are said to be increased 20,000 per c.mm. or upwards. Barton's bodies are very numerous in the red cells in bad cases, but are also seen in mild cases. In fatal cases the patient sinks into a comatose condition, the temperature falls to normal or sub-normal.

Diagnosis.—This has to be made specially from the paratyphoids. All fevers occurring in the endemic areas should be treated as suspect until proved to be due to some other cause. Malaria and tuberculosis have been mistaken for this disease. Rheumatic may simulate it closely as regards the pain and sweating; in Oroya fever, however, the joints are rarely involved, and anti-rheumatic treatment has no effect.

Prognosis.—This is good in mild cases, bad in the severe kind. The mortality among undoubted cases of Oroya fever has been stated by Strong to be 30 to 40 per cent. In some epidemics it has even been higher than this.

Treatment.—There is no specific treatment; the patient ought to be kept strictly in bed, and the fever dealt with on general principles. A diet similar to that employed in typhoid fever is indicated. As the temperature falls, the diet may be gradually increased. From a prophylactic point of view one should avoid the endemic areas where possible, or at any rate should not spend the night in them. Little, however, can be done as regards prophylaxis until the exact ætiology of the disease has been worked out.

Verruga Peruviana

Ætiology.—According to some, this condition is only a phase or stage of Oroya fever, while others believe it to be a separate disease. Strong and the Harvard Commission, who believe in the duality of the two conditions, have transmitted the disease to monkeys by scarifying their skin and rubbing in verruga material. The lesion remains local. Noguchi's recent work, however, does not support the dual view and tends to show that verruga peruviana, as previously believed, is only a phase of Oroya fever. Barton's bodies have been found in it also. The eruption in some ways resembles yaws, but the *Treponema pertenue* is absent, the Wassermann reaction is negative, and salvarsan and similar drugs have no effect upon it.

Pathology.—The pathological changes found are those of an infective granuloma. The endothelium of the lymphatics and blood vessels proliferates. Plasma cells, granulation-tissue cells and fibroblasts appear, these being contained in a delicate reticulum or stroma of fibrous tissue. In the early stages there are many newly-formed blood vessels which make the tumours very vascular, so that they bleed easily. In the later stages the

amount of connective tissue increases, and the appearance of a fibrosarcoma may be simulated.

Symptoms.—The incubation period varies from 14 to 21 days, then pains of a rheumatic nature develop in the limbs and joints and a moderate temperature appears. Following this period of invasion the second stage appears—this consists of the *eruption of the tubercles* or *papules* which are usually described as being of a miliary or nodular nature. At first these are slightly raised, red spots, which later become dark-red or dusky blue, and then later still, in the nodular variety, take on the form of warty excrescences. The eruption may come out over the whole body, though the face, neck and limbs are the favourite sites—their number varies, from a dozen in the nodular variety, to hundreds in the miliary type. The size also varies, many of the nodular ones reaching the size of a chestnut and often ulcerating (the mulaire lesion) while the miliary ones are about the size of a small pea—they bleed easily, their apices often being dotted with little black marks. The mucous membranes are attacked as well as the skin, and even the internal organs; if in the nose they may cause bleeding, and if in the larynx, cough and hoarseness and sometimes sudden death. Successive crops continue to come out, each preceded by a fresh rise of temperature.

The third stage consists of *desiccation of the eruption* as a result of shrinkage of the tubercles, or by ulceration. The larger ones usually ulcerate and bleed very freely, resembling malignant masses. Finally they scab, and when this drops off a cicatrix remains at the site. If no ulceration has taken place, little or no scar is left. The condition is very rarely fatal, and there is no marked anæmia.

Diagnosis.—The warty excrescences are easily recognised and should not be mistaken for other diseases.

Prognosis.—As already mentioned this is good, fatal results being rare.

Treatment.—No specific treatment is known. Salvarsan has no effect upon the lesions. When the nodules ulcerate they must be kept clean by antiseptics and excessive hæmorrhage suitably combated.

G. CARMICHAEL LOW.

SECTION III

TROPICAL DISEASES OF DOUBTFUL OR UNKNOWN NATURE

LATAH

Definition.—A form of cerebral neurosis, in which the patients make involuntary movements and incoherently utter sounds or words (Scheube).

Ætiology.—The condition has been found in Java, the Philippines, Burma and Siam. Natives are affected, principally young women. Heredity may play a part. No exciting cause is known.

Pathology.—There are no records of any post-mortem examinations.

Symptoms.—The movements and incoherent sounds are involuntary, the patient being unable to restrain them. The reflexes may be increased, and people affected take fright easily.

Diagnosis.—The disease must be distinguished from ordinary mental and nervous disorders.

Prognosis.—The disease may persist for years, and appears to be incurable.

Treatment.—None is known. Suggestion treatment might be tried.

KUBISAGARI

Definition.—A disease associated with dimness of sight, diplopia and paresis of the cervical muscles (Miura).

Ætiology.—The condition is found endemically in parts of Japan. It attacks the agricultural natives of any age or sex, and house epidemics have been recorded. The cause is unknown.

Pathology.—This has not been established.

Symptoms.—Depression is usually present, followed by dimness of vision, often accompanied by ptosis; paresis of the cervical muscles, muscles of the trunk, etc., is also common. Owing to the implication of the cervical muscles the head hangs down, whence the name of the disease. The symptoms intermit, intervals of freedom alternating with new attacks.

Diagnosis.—It must be distinguished from other forms of paralysis.

Prognosis.—The disease is said never to end fatally.

Treatment.—Miura recommends potassium iodide and arsenic.

AINHUM

Definition.—A disease of the toes, characterised by a ring-shaped constriction, which finally causes amputation of the toe affected.

Ætiology.—The disease is principally found on the West Coast of Africa, but it has also been seen in Brazil, British Guiana, the West Indies, the southern states of the U.S.A. and in India. Negroes and Hindoos are attacked. The cause is obscure. A trophic origin has been suggested; also injuries, such as cuts from grass, jiggers, etc.

Pathology.—The constricting ring is formed of fibrous tissue. An increase in the adipose tissue of the part has been noted by some, a thickening of the epidermis by others. Natives are very prone to fibrous tissue formation, *e.g.* keloid.

Symptoms.—The little toe is most usually affected. The disease commences by a groove or furrow, which first appears in the digito-plantar fold; this gradually deepens and spreads round the portion of the toe distal to the swelling. The change advances until the band is so narrow that the toe hangs by a thin pedicle. Finally the organ may drop off spontaneously, be torn off, or be purposely cut off by the patient. The course of the malady is slow—usually several years.

Prognosis.—There is no danger to life.

Treatment.—The toe should be removed by the knife, or by a silk ligature. Da Silva proposes vertical incisions through the constricting band in the early stages.

GOUNDOU

Synonyms.—Anakhre; Gros Nez; Dog Nose.

Definition.—Symmetrical bony excrescences, occurring on both sides of the nose.

Ætiology.—(*a*) The disease occurs on the West Coast of Africa—on the Gold Coast, Ivory Coast and in Sierra Leone. It is apparently confined to negroes—both children and adults. Recently the author has seen the photograph of a Dyak child from Sarawak suffering from the same or a similar condition. Chalmers thinks the condition follows yaws, others have suggested nasal myiasis.

Pathology.—The tumours consist of spongy bone covered by a thin shell of compact bone, and are oval in shape, and may eventually attain the size of a hen's egg. They are supposed to grow from the nasal process of the superior maxilla.

Symptoms.—Pain is complained of at first, often with severe headaches, and there may be a nasal discharge with pus and blood. These symptoms ultimately disappear, but the swellings continue to enlarge slowly and progressively.

Diagnosis.—The characteristic swellings can hardly be mistaken for any thing else.

Prognosis.—The condition is not dangerous to life.

Treatment.—Chiselling away the bone is the treatment usually recommended.

GANGOSA

Synonym.—Destructive Ulcerating Rhino-pharyngitis.

Definition.—A destructive ulcerative process attacking and destroying the nose, mouth and pharynx.

Ætiology.—The condition has been described in the West Indies, Fiji, Guam, etc. Natives are attacked—children and adults alike.

Tubercle, leprosy, syphilis and yaws have all been suggested as the cause. Others believe it to be a disease *sui generis*. A somewhat similar condition follows American dermal Leishmaniasis, and the possibility of some of these cases being Leishmanial should always be borne in mind, and a search made for such parasites.

Pathology.—The disease generally begins as a small ulcer of the palate, gradually spreading, until it ultimately destroys most of the nose, the pharynx, soft palate and mouth.

Symptoms.—As the ulceration spreads pain is complained of, and a constant discharge oozes out of the lesions, giving the breath a horribly foul odour. The mutilation may be extreme and destroy most of the face.

Diagnosis.—This must be made especially from Leishmaniasis, and from syphilis, leprosy and yaws.

Prognosis.—Sometimes the disease stops of its own accord, more frequently it progresses, ultimately killing the patient by general exhaustion and sepsis.

Treatment.—Salvarsan or some of its products should be tried, in case syphilis or yaws may be present. Antimony, on the assumption of a Leishmanial origin, should also be given a trial.

BIG HEEL

Synonym.—Endemic Hypertrophy of the Os Calcis.

Definition.—A peculiar hypertrophic condition of the os calcis.

Ætiology.—This has not yet been established. The condition occurs in natives of the West Coast of Africa, chiefly on the Gold Coast.

Symptoms.—The disease is ushered in with fever, followed by pain and tenderness in the heel, with swelling of the os calcis of one or both feet. Cold and damp are apt to produce an increase in the symptoms. Walking is hindered. The condition may become chronic, permanent thickening of the bone resulting.

Treatment.—If the enlargement be excessive, removal of some of the hypertrophic bone may be attempted.

MOSSY FOOT

Thomas described this condition some years ago in Manaos, Brazil. He considered it had something to do with elephantiasis. Recently Castellani saw a condition, called Central American Mossy Foot, in Costa Rica and Guatemala. His case showed the foot covered with granulomatous nodules and masses covered by dirty yellow crusts. No sinuses or sclerotia were

present, this distinguishing it from Madura foot. It was not Yaws nor Verruga. He thinks it similar to the cases described by Thomas. Treatment is very unsatisfactory. X-rays might be tried.

CHAPPA

Definition.—A peculiar affection of the joints associated with nodules in the subcutaneous tissues, which finally ulcerate.

Ætiology.—The disease was described by Read in Southern Nigeria. Natives only are attacked, as far as is known.

The causative agent has eluded detection.

Pathology.—This is not yet entirely known. Nodules, as large as a pigeon's egg, form in the subcutaneous tissues, with ultimately complete destruction of the joints—the bones are also attacked.

Symptoms.—The disease, according to Read, begins with severe pains in the limbs, muscles and joints. After a time the pains decrease, but some of the joints swell, and fluctuation occurs. At this time nodules appear in the tissues, and the skin over them breaks down with resulting ulcer formation. The ulcers have no tendency to heal, but may remain for years.

Diagnosis.—The disease may be a late stage of yaws; some of the nodules might be onchocerca tumours (see p. 337). Tropical ulcer is also possible.

Prognosis.—This is bad.

Treatment.—Read tried mercury and iodides without effect. Scraping is indicated. Salvarsan and its derivatives should be given a good trial, on the chance of the infection being spirochætal in nature.

JUXTA-ARTICULAR NODES

Definition.—A nodular condition occurring around the joints.

Ætiology.—Such tumours have been described in Africa, on the West Coast and equatorial regions, also in Java and Siam.

Pathology.—The constitution of the nodes seems to be of a fibrous nature, but more work is required to determine their exact composition.

Symptoms.—The tumours usually appear in the vicinity of one or other of the joints. At first they are small, the size of peas, but later as they grow may be as large as a pigeon's egg. They are round or oval, and very hard to the touch. There are generally four or five or more, and they may have a symmetrical distribution. Rarely they disappear spontaneously, more commonly they increase gradually in size, but very slowly; at other times they remain stationary for long periods of time.

Diagnosis.—The diagnosis lies between ordinary rheumatic nodules and onchocerca tumours. A tumour may be excised and sectioned. They may be of rheumatic origin, but are not quite like the ordinary rheumatic nodules. An onchocerca tumour when needled is found to contain fluid, and when opened is seen to be loculated, with the filariæ in situ and many embryos in the fluid.

Prognosis.—This is quite favourable as regards life, and in many instances the nodules cause little or no trouble.

Treatment.—The best way of dealing with the nodules is to excise them; this can be more easily done, of course, when they are small.

ONYALAI

Definition.—A vesicular condition of the buccal mucosa, associated with renal hæmaturia.

Ætiology.—The disease is met with in Portuguese West Africa, and on the Lualaba river. Natives are attacked. No cause is known.

Pathology.—No proper autopsies have yet been made.

Symptoms.—The disease is usually ushered in by a febrile disturbance, and after some little time an eruption of small blebs or vesicles appears on the buccal mucosa and the hard palate. Some of the blebs show umbilication —their contents consist of blood. Blood is also present in the urine.

Diagnosis.—This has to be made from purpura, pemphigus, small-pox, etc.

Prognosis.—Natives are said to dread the disease. Most cases are said, however, to recover in from a week to 10 days.

Treatment.—None is known. Calcium lactate might be tried.

EPIDEMIC GANGRENOUS RECTITIS

Definition.—A form of rapidly spreading phagedæna which starts in the neighbourhood of the anus and spreads to the rectum.

Ætiology.—The disease has been reported from Venezuela and the Guianas. Possibly the condition is only a gangrenous form of one or other of the dysenteries.

Symptoms.—The disease starts with itching at the anus, followed by the passage of blood and mucus, great tenesmus, thirst and fever. Gangrene then sets in, and the patient quickly dies.

Treatment.—Local native treatment consists of enemata of lemon juice and rum, or a decoction of the stalks and leaves of a South American plant, *Spigelia anthelmintica*.

CLIMATIC BUBO

Definition.—A febrile condition associated with glandular groin enlargements, which tend to become chronic and indolent, some ending in suppuration.

Ætiology.—The condition is specially common on the East Coast of Africa. It also occurs on the West Coast of Africa, Hong-Kong, China, Japan and in the Straits of Malacca. Males apparently are alone affected. Recent work tends to show that, though not venereal in the ordinary sense, the disease is nevertheless acquired from sexual connection with black women. A history of such connection is always obtainable. The germ is unknown. Puncture of the glands usually gives negative results; when suppuration takes place the ordinary pyogenic cocci are present.

Pathology.—Section of the affected glands only shows a chronic adenitis. Resolution takes place spontaneously, but is very slow. Suppuration is a secondary feature due to the invasion of ordinary cocci. There are no signs of any lesions on the penis.

Symptoms.—The condition occurs a variable time after connection.

The temperature, of a remittent type, remains up for a week or longer. The glands then start to enlarge and become painful, interfering with walking. One or both sides may be affected. The size of the glands varies, some attaining the size of a pigeon's egg, others that of a hen's. They are very chronic and indolent, showing little or no tendency to disappear. The temperature finally falls, and if the patient keeps quiet the adenitis gradually resolves, but some slight thickening often remains. The glands are hard to the touch and do not show signs of fluctuation unless suppuration has occurred.

Diagnosis.—Some of the glands, the hard type with no fluctuation, closely resemble those of filariasis. Other signs of filarial disease elsewhere will help in the diagnosis. As a rule also, unless a definite attack of filarial lymphangitis is present, there is no temperature with these glands. Climatic bubos have nothing to do with plague, and are not *Pestis minor*. The other ordinary venereal causes must be excluded before arriving at the diagnosis of climatic bubo, as must also scratches, abrasions or foci of infection about the legs or feet.

Treatment.—If the glands be small and resolving they are best left alone. The patient should walk as little as possible, as exercise of any sort generally aggravates them and delays their absorption. If suppurations have taken place, aspiration of the pus should first be tried, instead of laying the glands open, as then secondary infection results and healing may be long delayed. Extensive removal of the glands is dangerous, as elephantiasis of the thigh and leg may follow, if there be too much interference with the lymphatic system. After the temperature and acute signs have quietened down, the glands may be painted with linimentum iodi, and potassium iodide may be given internally to promote their absorption. If chronic and not resolving protein shock may be tried. In such a case 2 intravenous injections of ordinary T.A.B. vaccine—100 million for the first dose and 200 for the second—had a most marked effect upon the condition.

FEVERS OF DOUBTFUL OR UNKNOWN ÆTIOLOGY

As diagnostic methods improve, many of the irregular fevers which used to be variously classified as pyrexia of unknown origin (P.U.O.) have disappeared; but even so, there are still more or less definite conditions which cannot be explained satisfactorily on our present knowledge.

Simple continued fever.—Some of these cases may in reality be sand-fly fever or mild typhoids or paratyphoids. The extended use of Widal's reaction for the enterica group should certainly eliminate some of them.

Seven-day fever.—Rogers has described this fever in Calcutta, and it is found in other ports as well. It is characterised by a sudden invasion, with headache and pains in the back. The temperature chart shows a saddleback type of fever, and the pulse is slow as compared with the temperature. It lasts 6 or 7 days. Some authorities consider it a form of dengue. Quite recently Japanese observers have isolated a spirochæte from the 7-day fever in Japan. This is a *Leptospira* and has been named the *Leptospira hebdomadis*. It is quite possible all these are varieties of dengue.

Low fever.—An evening rise of temperature to 99° F. or 100° F. or a little higher is not uncommon in people who have resided abroad. None of the definite causes of slight fever, such as helminthic infections, are to be found. Possibly some are due to some hidden focus of tubercle, others to syphilis or to early malignant disease.

Double continued fever.—Manson describes cases of this fever in Amoy, China. There are waves of fever with apyrexial intervals. The charts somewhat closely resemble undulant fever. A similar type of fever has been met with in cases from the West Coast of Africa. They seem to be akin to, though perhaps not absolutely identical with, undulant fever. Some may be para-undulant fever infections.

Hyperpyrexial fever.—One or two examples of this peculiar condition have been reported from the West Coast of Africa. The fever is associated with a very high temperature—107° F. or higher, and this continues for 3 weeks or longer. If recovery take place the temperature then drops and ultimately the patient gets well. Many cases, however, die. The spleen and liver are not enlarged. Quinine is useless, and the only treatment is cold baths and cold sponging with ice water.

G. CARMICHAEL LOW.

SECTION IV

DISEASES DUE TO METAZOA

1. DISEASES DUE TO TREMATODES OR FLUKES—DISTOMIASIS

PARAMPHISTOMIASIS

Definition.—An invasion of man with trematode parasites of the family *Paramphistomidæ*. Two of these parasites are known. ***Watsonius watsoni*** (*Cladorchis watsoni*).—L. 8–10 mm. × 4–5 mm.; Ova, 120–130 μ × 75–80 μ. The parasite has a reddish-yellow colour when fresh and inhabits the duodenum and upper part of the small intestine.

Gastrodiscus hominis.—L. 5–8 mm. × 3–4 mm.; Ova, 150 μ × 72 μ. The parasite has a large posterior disc by which it attaches itself to the mucous membrane of the bowel; it occurs in the cæcum and colon.

Symptoms.—Diarrhœa, with loose bilious stools, containing many of the adult parasites, is the outstanding symptom of the former species; severe infections of the latter produce some intestinal disturbance, with diarrhœa.

Treatment.—Thymol followed by saline purgatives; or eucalyptus, castor oil, chloroform mixture. (See Treatment of Ankylostomiasis.)

FASCIOLIASIS

Definition.—An invasion of man and other animals with flukes of the family *Fasciolidæ*. Several of these are known.

Fasciola hepatica (***Distoma hepaticum***)—the common liver fluke—L. 20–30 mm. × 8–13 mm.; Ova, 130–145 μ × 70–90 μ. Oval and operculated. These parasites normally inhabit the bile-ducts of sheep and other animals. They undergo their developmental changes outside the body in snails (***Limnæa truncatula***) and finally disseminate the infection by the cercariæ which have left the snail and become encysted on grass stems.

Symptoms.—Man is not often infected. In some of the reported cases, mild infections evidently, there were no symptoms, the diagnosis being made by finding the ova in the stools. In sheep, the parasite produces a disease named liver rot or sheep rot. The infected animals become emaciated and many die.

Treatment.—Ordinary anthelminthic drugs do not reach parasites in the liver; antimonium tartaratum might be tried intravenously.

Fasciolopsis buskii (*Distoma crassum; Distoma buskii*)—L. 30–70 mm.× 12–14 mm.; Ova, 120–130 $\mu \times 77$–80 μ. This, the giant fluke, is found in China, Borneo, the Federated Malay States and other regions in the East; it inhabits the duodenum and other parts of the small intestine. Its intermediate host is supposed to be oysters or shrimps. Three other species have also been described in man.

Symptoms.—Dyspepsia, diarrhœa with pale stools, sometimes streaked with blood. Increasing anæmia, œdema, ascites, harsh, dry skin. The signs sometimes resemble those of enteric fever and the infection has been mistaken for that disease.

Diagnosis.—This is made by finding the characteristic ova in the stools.

Treatment.—Thymol, or eucalyptus mixture, etc., will get rid of the parasites.

PARAGONIMIASIS

Synonyms.—See p. 1119.

Definition.—An invasion of man with the lung fluke, a member of the *Troglotremidæ* family.

Paragonimus westermanii (*Distoma ringeri; Distoma pulmonis*, etc.)—L. 8–10 mm.×4–6 mm.; Ova, 85–100 $\mu \times 50$–70 μ. Oval and operculated. Paragonimiasis occurs endemically in the Far East, especially in Formosa, Japan, Korea, and China. Sporadic cases, originally infected elsewhere, are from time to time met with in Western countries. The parasites live for preference in burrows in the lungs, but may be found in other parts of the body; the ova are found in the sputum or fæces. They then enter water, where the miracidium emerges from the egg and enters a fresh-water snail, the *Melania libertina*. Here it forms a sporocyst, then rediæ, then cercariæ, the latter escaping and finding their way into fresh-water crabs—*Potamon obtusipes*, *Geothelphusa dehaanii* and *Eriocheir japonica*. Encystment takes place here in the gills, liver and muscles, where further developmental changes take place. Man becomes infected by eating the crabs, or possibly the cercariæ escape from the crab into the water, and so are ingested; or bore themselves indirectly through the skin.

Pathology.—The parasites in the lungs live in cysts with dense fibrous walls; the largest cysts are the size of a hazel-nut. Cysts communicate with the bronchi and contain material resembling anchovy sauce. They have also been found in the brain, liver, intestines, spleen, pancreas, etc. They may give rise to suppuration; they also cause ulceration of the intestine.

Symptoms.—These are divided into general, thoracic, abdominal and cerebral.

General.—General adenitis and skin ulcerations are present. Blame can only be laid at the door of the paragonimus when the parasite is found in the affected parts.

Thoracic.—See p. 1119.

Abdominal.—If ulceration of the intestinal mucosa have taken place, diarrhœa with blood and mucus in the fæces will be present (paragonimus dysentery).

Cerebral.—Epileptic fits, giddiness, headaches, loss of memory, insomnia and loss of vision have been described.

Diagnosis.—This is made by finding the ova in the sputum or in the fæces.

Prognosis.—This is not good, the infection remaining indefinitely; tubercle is also apt to be superadded. The brain cases are fatal.

Treatment.—None so far is known. Antimony tartrate intravenously ought certainly to be tried, in view of the success which has followed its use in schistosomiasis.

CLONORCHIASIS

Definition.—An invasion with trematode parasites of the family *Opisthorchiidæ. Clonorchis sinensis* (*Opisthorchis sinensis; Distoma sinense*). L. 10–20 mm.×2–5 mm.; Ova, 27–30 μ ×15–17 μ. Oval-shaped with a well-marked operculum. The parasites live in the bile-ducts and gall-bladder. The ova escape in the fæces, where a miracidium emerges, which finds its way into a snail, probably *Melania libertina*. The cercariæ escape in due course from the tissues of the first intermediate host and find their way into a second one, becoming encysted in the muscular tissues of some fresh-water fishes. Man or cats become infected by eating such infected fish in a raw condition.

Pathology.—Cystic dilatations and sinuses in the walls of the bile-ducts are produced by the parasites, irritative changes due to their presence causing localised fibrous changes as well (helminthic cirrhosis). The parenchymatous cells show fatty degeneration and necrotic changes. The liver becomes enlarged, with, perhaps, signs of chronic enteritis, ascites and œdema of the legs.

Symptoms.—Mild infections cause no symptoms; in more severe ones there is pain in the epigastrium and liver, with general wasting, diarrhœa and jaundice. The patient becomes feeble and cachectic and death may take place from exhaustion. Paralysis of the limbs has also been described.

Diagnosis.—The symptoms just described call for an examination of the fæces for ova; if found in large numbers, they probably are the real cause of the trouble.

Prognosis.—This is bad if the infection be severe; ascites and emaciation are serious omens.

Treatment.—None so far is known; as the parasites are lodged in the liver, ordinary anthelminthics do not reach them.

HETEROPHYIASIS

Definition.—Infection with flukes of the family *Heterophyiidæ*. Two genera occur in man:

Heterophyes heterophyes (*Cotylogonimus heterophyes*).—L. 2 mm.×1 mm.; Ova, 30 μ ×17 μ. Oval, light brown colour.

Metagonimus yokagawai.—L. 1–2 mm.×0·4–0·7 mm.; Ova, 28 μ ×16 μ. Elliptical, dark brown in colour, the shell membrane having a double contour.

The first stage is passed in a snail; the cercarial stage in fresh-water fish. This is the smallest fluke found in man.

Symptoms.—Both these species live in the small intestine and if present in large numbers produce diarrhœa with blood in the stools (heterophyes diarrhœa or dysentery).

Diagnosis.—This is reached in the ordinary stool examination, the eggs of the parasites being readily found in the fæces.

Treatment.—Eucalyptus, castor-oil and chloroform mixture is efficacious. In one of the author's cases over 250 adult worms were recovered after such treatment, and all signs of diarrhœa, etc., disappeared. The stool must be strained through fine muslin and searched carefully for the worms; otherwise, as they are so small, they are readily lost.

SCHISTOSOMIASIS

Synonym.—Bilharziasis.

Definition.—Invasion of man with members of the family *Schistosomidæ*. Three species occur in man—*Schistosoma hæmatobium*, *S. mansoni* and *S. japonicum*. The parasites live in the blood vessels—in the portal venous system—their eggs escaping by the urine or fæces; their external development takes place in different species of snails, from which the cercariæ escape into the water, passing directly into man through the skin, and finding their way to the blood vessels, where their complete development takes place.

Schistosoma hæmatobium (*Bilharzia hæmatobia*).—L. ♂ 12–14 mm. × 1 mm., 4 mm. round; ♀ 20 mm. × 0·25 mm.; Ova, 120–190 μ × 50–70 μ. Oval, no operculum, sharp terminal spine at end of egg; the intermediate host is a *Bulinus*—*B. dybowski*, *B. innesi*, *B. contortus*. The males are stout, with the sides rolled in to the ventral surface, forming the gynæcophoric canal in which the female lies. The integument is covered with fine tubercles. The females are much longer than the males and are thread-like or filariform in aspect. They can at once be distinguished from the presence of the two suckers of the trematodes.

Pathology.—When mature the adult females pass into the venous radicles of the bladder and rectum and deposit their ova, which, when deposited, cause a blockage, leading to engorgement and final rupture, with the escape of the ovum into the urine or fæces.

Two types of lesion are produced in the parts where the eggs are laid: (1) proliferative; (2) destructive, with ulceration; the irritation, plus the toxin excreted by the worms themselves, also causing considerable fibrosis—a change well seen in the liver. The bladder and rectum may show polypoidal or papillomatous growths, which bleed easily. Instead of such growths there may be smooth sandy patches, and in the rectum definite ulcers. The prostate is thickened and infiltrated with calcified eggs, the fibrous tissue being much increased. The seminal vesicles are also attacked, and the vagina and cervix in women. In bad cases the whole of the urinary tract is affected and also the rectum and considerable areas of the colon.

Symptoms.—Early general symptoms often precede the local ones: abdominal pain, enlargement and tenderness of the liver and spleen, pyrexia,

bronchitis, intense urticaria and diarrhœa, with a well-marked eosinophilia in the blood. A latent period then sets in, after which local symptoms appear. Hæmaturia with pain in the bladder, perineum and penis may be all that is noticed in mild bladder cases, but if severe there is much hæmorrhage, a heavy deposit of cells and débris, and often severe pains. A general septic cystitis may be superadded, and calculi and gravel are common. When the rectum is attacked, blood and mucus are passed in the fæces (Schistosomiasis or Bilharzial dysentery). The appendix may be specially involved, giving rise to Bilharzial appendicitis.

Diagnosis.—The ova are large objects and can be found in the urine or fæces with ease. The terminal spine indicates the presence of *S. hæmatobium*. This is the only certain method of distinguishing the condition from amœbic and other forms of dysentery. Eosinophilia in the blood is also suggestive.

Schistosoma mansoni (*Bilharzia mansoni*).—L. ♂ 12 mm. × 0·4 mm. in the middle; ♀ 14–15 mm. × 0·16 mm.; Ova, 146 μ × 62 μ. Oval, no operculum, sharp spine, placed laterally at one side of the egg. The intermediate host is a *Planorbis, Planorbis boissyi*.

Pathology.—This species is found in the rectal and mesenteric veins, and hardly ever lays its ova in the venules of the bladder. The lesions produced are similar to the rectal lesions of *S. hæmatobium*.

Symptoms.—Blood and mucus in the motions are the chief symptoms, a condition exactly resembling dysentery being again produced.

Diagnosis.—The lateral spine on the egg betrays the condition.

Schistosoma japonicum.—L. ♂ 8–12 mm. × 0·5 mm.; ♀ 12 mm. × 0·4 mm.; Ova, 70–75 μ × 45–55 μ. Oval, no sharp spine, but sometimes a little knob or nipple is seen laterally situated. The intermediate host is a snail, the *Hypsobia nosophora* (formerly *Blanfordia nosophora*). The anatomy of the worms is similar to the species just described; there are no tubercles on the male.

Pathology.—The lesions are somewhat different from those produced by the other bilharzia. The ova are deposited in the mucosa of both the small and large intestine and may be seen in very large numbers. They eventually ulcerate and escape into the fæces. The bowel wall becomes very greatly thickened by fibrotic changes. There is a peculiar form of cirrhosis in the liver, and the pancreas and mesenteric glands are also affected. The bladder escapes entirely.

Symptoms.—The entry of the cercariæ through the skin gives rise to some local irritation (Kabure disease). The symptoms produced later are known as *Katayama* disease. These depend upon the intensity of the infection. At first there is fever with an urticarial eruption, sometimes associated with pulmonary symptoms. A long interval then usually appears, after which intestinal troubles begin, with enlargement of the liver and spleen. Wasting is progressive, and anæmia and ascites develop. Finally a chronic cachexia sets in and the patient dies. The blood shows an eosinophilia. The stools are often dysenteric, with blood and mucus (*S. japonicum* dysentery).

Diagnosis.—This is made by finding the ova in the stools. Fever, with urticaria, and an eosinophilia should raise the suspicion of this condition.

Treatment of Schistosomiasis in general.—Antimony tartrate (tartar emetic) injections intravenously act in a specific manner on *S. hæmatobium* and *S. mansoni* infections. They are certain to act equally well on *S. japonicum* infection.

The injections are given in a similar manner as in kala-azar and trypanosomiasis (see treatment of these diseases, pp. 230, 235).

The first dose should be half a grain, and this should be increased by half a grain each dose on every second or third day, until 2½ grains is reached. This quantity is then continued until 20–30 grains in all have been administered. The blood, as a rule, disappears from the urine and fæces after 6 or 8 grains have been given, and subsequently the ova. The clinical signs also clear up and the infection comes to an end. The drug evidently kills the adult worms so that no more ova are produced. Ova already laid and in the tissues are probably also destroyed. Local treatment should also be adopted for cystitis and bladder troubles if these be severe.

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II. DISEASES DUE TO CESTODES—TÆNIASIS

INTESTINAL TÆNIASIS—TAPE-WORMS

Definition.—An invasion with different forms of *Tænia* (tape-worms), either occurring as adult forms in the intestine (Intestinal tæniasis), or as the cystic stage in the muscles and other tissues of the body (Somatic tæniasis).

Diphyllobothrium latum.—L. 2–9 m. and over. Head almond-shaped, no armature. 3000–4200 segments. Ova, L. 68–71 μ × 45 μ. Oval, with an operculum. The segments are broader than they are long. The plerocercoid stage occurs in fish, the first stages being passed in a mollusc.

Symptoms.—This tape-worm lives in the intestine and its presence there gives rise to anæmia (toxic in origin), often of a severe grade. The mature segments are passed in the fæces.

Treatment.—As for other tape-worms.

Tænia solium.—L. 2–3 m. Head globular, four suckers, rostellum with double row of hooks. Ova, circular to oval, 31–60 μ in diameter. Uterus, 7–10 lateral processes. The cysticercus stage is reached in the pig (*Cysticercus cellulosæ*). Man acquires the parasite by eating badly-cooked infected pork.

Tænia saginata (*Tænia mediocanellata*).—L. 4–10 m. Head cubical, four suckers, but no armature. Ova, slightly oval-shaped, 33–40 μ × 20–30 μ. Uterus, 30–40 side processes. The cysticercus stage is found in the ox (*Cysticercus bovis*). Man is infected by eating badly-cooked infected beef.

Symptoms.—Gnawing pains in the stomach, attacks of colic, diarrhœa, loss of appetite, sometimes a voracious appetite with neurasthenia and mental symptoms are the chief symptoms.

Treatment.—The patient should be starved for two days, then on the morning of the third day extractum filicis liquidum in 30-minim doses is given as follows: one dose at 7, one at 7.15, one at 7.30 (90 minims in all), either in a capsule, or as an emulsion.

If a case have been treated before, with no bad symptoms, and the tape-worm recurs, an extra 30 minims may be given, *e.g.* 4 capsules of 30 minims, in all 120 minims, or 2 drms. This is the maximum dose. A purgative is taken at 10 a.m. This must not be castor oil as this dissolves the filicic acid. Sodium

or magnesium sulphate can be employed. The motions must be carefully examined to see if the head be passed or not. If not, segments will appear again in about 3 months' time. The writer has found it useful, when the head is not passed, to wait 10 days and then to repeat the treatment. This is often effective in obstinate cases. A capsule of 30 minims of oil of turpentine may be given with the last capsule of filix-mas.

Hymenolepis nana.—The dwarf tape-worm. L. 10–45 mm. Head: Scolex subglobular, rostellum with a single row of hooks. Proglottides, 100–200. Ova, oval or globular 30–60 μ in diameter. Common in Southern Europe and in parts of the tropics.

Symptoms.—Abdominal pain, attacks of diarrhœa. Convulsions in children and headaches and strabismus.

Treatment.—Male fern is efficient and may be given as for ordinary tape-worm. *Vide* supra. Thymol and ol. chenopodii are also effective.

SOMATIC TÆNIASIS—CYSTICERCUS STAGE

Tænia solium.—The cysticercus stage of *T. solium* is sometimes met with in man. The cysts occur in the connective tissues, in the brain, eye and other organs. Osler describes a case of generalised infection where the symptoms complained of were stiffness and weakness, with numbness and tingling in the extremities—an examination revealed a number of painful subcutaneous nodules, which proved on excision to be cysticerci.

Cysts may be present in the brain, in the silent areas, without giving rise to any symptoms, whereas in other areas localising signs are met with. When in the eye the condition can be more easily recognised.

The diagnosis is not as a rule easy. If the cysts be in the connective tissues and superficial, one may be removed for examination.

HYDATID DISEASE

Echinococcus granulosus.—L. 2·5–5 mm. Head, four suckers with a rostellum with hooks. Ova, globular, 30–36 μ across. The parasites live in the intestines of dogs, jackals and wolves. Man becomes infected in the cysticercus stage (hydatid cyst), by swallowing the eggs, which may contaminate his hands or sometimes his food. Intimate contact with dogs is seen in countries where the condition is common—Australia, New Zealand, Greenland, etc. The hydatid cysts in man may occur in the liver, brain, lung, peritoneum and other organs. Two forms are usually now described: *Echinococcus granulosus*, which forms the ordinary cysts, and *E. multilocularis*, the alveolar or multilocular type of lesion.

Development.—After the egg is swallowed the six-hooked embryo escapes from its shell and is carried by the circulation to the tissues or viscera. Here it loses its hooks and forms a cyst, this consisting of two layers—a laminated outer layer and a granular inner layer—with the tissues of the organ forming a fibrous capsule around. The inner or granular layer is also known as the germinal layer, and in time protuberances are seen upon it. These grow larger, push out into the cavity of the cyst, and form what are known as brood

capsules. The base of the brood capsule may gradually narrow till a pedicle is all that attaches it to the wall of the cyst, and then, if this breaks, it becomes free in the cyst—the brood capsules consist again of two layers, and on the inner one heads or scolices with minute hooklets appear. While this is going on a vesicle may form between the two layers of the wall of the mother cyst (secondary or daughter cyst), and by pressing on the inner layer gradually protrude into the cavity (endogenous daughter cyst); on the other hand, however, growth may take an outward direction, protrusion eventually taking place outside the wall of the mother cyst (exogenous daughter cyst). Both those varieties form brood capsules, and heads with hooklets (scolices) appear on their inner layers. A third generation may even follow, thus giving rise to what are known as granddaughter cysts.

The cysts often die and become caseous with calcification, or they may suppurate and form abscesses, or they may rupture. Growth is slow, and their length of life is not accurately known. The fluid in the cysts is colourless or slightly opalescent, with a specific gravity of 1005 or slightly higher, non-albuminous, but with traces of chlorides and sugar. Hooklets are present in the clear fluid and also in the pus in suppuration, the latter process killing the embryos. Occasionally the cysts are sterile, and in such cases hooklets will be absent.

Diagnosis.—When the cysts are of large size and within reach of palpation a peculiar thrill or fremitus—the hydatid thrill—may be elicited. Aspiration of some of the fluid may demonstrate the hooklets, or if those are not present, the absence of albumin and the presence of sugar will be helpful. Sero-diagnosis has recently been used, Weinberg and others employing the Bordet-Gengou fixation of complement method. A precipitin test has also been tried, and Bettencourt, by applying a hæmolytic system of human red cells and a rabbit homo-serum, has obtained positive results (Stiles). All these may fail, however, where suppuration has occurred in the cysts.

Treatment.—No medical treatment is of avail. Short of surgical procedures, simple aspiration of the cyst may be successful. In other cases the cyst requires to be opened and drained (See treatment of Hydatids in Liver, Lungs, etc.)

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III. DISEASES DUE TO NEMATODES

STRONGYLIASIS

Strongyloides intestinalis or *stercoralis* (*Rhabdonema intestinale*) is a common parasite of the intestines. Such parasites were at one time supposed to be concerned in some way with sprue, but this has not been confirmed. They may cause some intestinal catarrh if the infection be severe.

FILARIASIS

Definition.—An invasion of man with members of the family of the *Filariidæ*. Four species are known: *Filaria bancrofti*, *Filaria loa* (*Loa loa*), *Filaria perstans* (*Acanthocheilonema perstans*) and *Filaria demarquayi*. The first two only are of importance.

Filaria bancrofti.—L. ♂ 30–40 mm.; ♀ 76–100 mm. × 0·2 mm. The adults are like fine catgut. They live in the lymphatic vessels and glands and breed there, the females giving birth to embryos, which find their way into, and live in, the blood stream. The embryos measure 0·310 mm. × 7·5 μ, the breadth of a red-blood corpuscle, and are enclosed in a loose sheath. They live in the lungs and blood vessels of the thorax by day and only come into the peripheral blood at nights. The intermediate host is a mosquito (chiefly *Culex fatigans*) which sucks the embryos out of the blood at night. A metamorphosis takes place in the thoracic muscles of this insect, and when this is accomplished, the matured embryos are inoculated into man from the proboscis of the mosquito. They pass into the lymphatics and there develop into adults.

The parent worms may cause considerable damage to the lymphatic system, and give rise to a series of lymphatic diseases, filarial lymphangitis, abscesses, dilated inguinal glands, hydrocele, lymph scrotum, chyluria and elephantiasis.

Pathology.—The changes produced are due partly to mechanical obstruction of the parts, partly to toxins excreted by the adult worms. These produce changes in the endothelium of the vessels with inflammatory exudations and finally fibrotic changes which may completely obstruct both the glands and the vessels. As far as is known the embryos are non-pathogenic.

Symptoms.—These depend upon the nature of the lesion. Filarial lymphangitis is associated with high fever, enlargement of the lymphatic glands and inflammatory swelling of the part affected. After repeated attacks permanent thickening appears, and an elephantoid condition is the result. In chyluria the patient passes milky-white urine, often mixed with blood.

Treatment.—Prevention of mosquito bites is a *sine qua non.* Every one in the tropics should use a mosquito net. Towns and municipalities should enforce regulations for the destruction of all domestic mosquitoes. No drug has yet been discovered which will kill the adult worms. Antimony injections are being tried, but so far do not appear to be efficacious.

Loa loa.—The adults of this parasite inhabit the connective tissues, the embryos, the blood stream, occurring in the peripheral blood by day and not by night. The adults in their wanderings excrete toxins and these may cause the production of what are known as Calabar swellings. These are about the size of a small hen's egg, come up suddenly, with no redness or inflammation, and after lasting a day or two disappear. The adult worm may cross the conjunctiva and produce conjunctivitis and lachrymation.

Another member of the Filariidæ, the *Onchocerca volvulus*, is found in man in some parts of the West Coast of Africa. The parasite forms small tumours, cystic swellings, with a dense fibrous wall. Inside, the cyst is loculated, and contains the adult worms and numerous embryos. The cysts are superficial, over which the skin as a rule is movable. They vary in size from a pea to a pigeon's egg and are most commonly found on the lateral aspects of the thorax; along the iliac crests is another favourite site. The embryos are found in the cysts or free in the small lymphatic channels. A sandfly *Simulium damnosum* is the intermediate host.

A similar parasite the *Onchocerca cæcutiens* is met with in Guatemala. It also gives rise to small nodes or tumours, often met with on the head, and

locally known as Guatemala nodules. A mosquito is supposed to be the intermediate host (Calderon).

Filaria medinensis (*Dracunculus medinensis*).—The guinea-worm. This worm inhabits the connective tissues, and the female, when mature, pushes her head to the surface, causing the skin to rise as a blister. This finally gives way, and out of the prolapsed uterus, the opening of which is close to the mouth of the parasite, the little embryos are ejected. These find their way into water and enter the tissues of a cyclops. Here they undergo development, and man is infected by swallowing the cyclops. The female guinea-worm is very long, 50–80 cm. × 0·5 mm.–1·7 mm. It takes 12 months for the guinea-worm to come to maturity after the infected cyclops is taken into the body.

Pathology.—The worm causes irritation, very likely from the excretion of toxins, and if injured may abort her embryos into the tissues, causing an acute cellulitis, with abscess formation.

Symptoms.—As the parasite comes to the surface it causes a pricking sensation, with some local pain at the spot where it is about to point. The blister may not at first be recognised, but after it bursts a little orifice is noticeable in the centre of the raw surface. From this opening the embryos are ejected.

Treatment.—The affected part should be kept covered. Every day water should be dropped on the foot some distance away from the blister, and by doing this a daily discharge of embryos will be produced. After the uterus is emptied the end of the worm should be attached to a match and then gradually wound round it. It must not be pulled out, as otherwise it may break and set up severe inflammation. Cellulitis and abscesses are treated by ordinary surgical methods. Injections of tartar emetic have recently been reported as efficient.

TRICHINIASIS

Definition.—A condition or disease produced by the migration of the embryos of *Trichinella spiralis* from the intestinal canal of man to the muscles.

Ætiology.—Man becomes infected by eating flesh (pork) in which the embryonic stage of the worm is being passed. The cyst wall is dissolved by the gastric juice and the embryos develop into adult forms in the intestine, where they breed, the females giving birth to numerous embryos, which migrate into the lymphatics in the intestinal wall and are carried all over the body and deposited in the voluntary muscles.

The adults are small—♂ 1·4–1·6 mm. × 0·04 mm.; ♀ 3–4 mm. × 0·06 mm.

Symptoms.—Gastro-intestinal symptoms may usher in the disease, nausea, vomiting, diarrhœa and pains in the stomach. The most striking feature of the invasion period—which occurs 7 to 10 days after infection—is the myalgia, resulting from the inflammatory changes taking place in the muscles. The latter may be exquisitely tender, with severe pains on attempting any movements. Stiffness is often complained of, and the affected muscles are hard to the touch. In addition, fever of a remittent type, varying from 102° to 104° F., is common. Œdema appears about the end of the first week, commencing on the face. Profuse sweating, urticaria and

erythematous patches have also been described. The blood shows a leucocytosis with a very marked eosinophil increase.

Diagnosis.—This may not be easy at first. The condition is often mistaken for rheumatism and typhoid. The increase of the eosinophils should put one on one's guard. A piece of muscle may be cut out and examined for the minute white specks which indicate the coiled-up embryos.

Prognosis.—This is uncertain. Convalescence is slow, and some muscular atrophy may follow.

Treatment.—Infected pork should not be eaten. Such meat should be condemned in the slaughter-house. The adults must be expelled from the intestine with all possible speed. Purgatives should be given and glycerine, santonin, turpentine and thymol are also employed.

ŒSOPHAGOSTOMIASIS

Definition.—A rare infection of man with members of the *Strongylidæ* amily.

Œsophagostomum brumpti and *O. stephanostomum.*—The worms form small cysts in the walls of the small and large intestine, oval in shape and 2–3 cm. in length. Both the inside and the outside of the bowel are implicated. When a cyst is opened, a small worm is seen occupying its interior. The mesenteric and retro-peritoneal glands are enlarged.

Symptoms.—In Thomas' case in Manaos the patient was admitted into hospital for severe dysentery, with delirium. The true nature of the infection was diagnosed after death.

Treatment.—None is known.

ANKYLOSTOMIASIS

Definition.—An invasion of the human subject with members of the family of the *Ancylostomidæ*. Three species are known to affect man: the *Ancylostoma duodenale*, the *Necator americanus* and the *A. ceylanicum* (rare).

A. duodenale.—**L.** ♂ 8–10 mm. × 0·4–0·5 mm.; ♀ 12–18 mm. × 1 mm.; Ova, elliptical, thin-shelled, vitellus generally segmented into 2 or 3 spherules, 55–65 μ × 32–45 μ.

Necator americanus.—**L.** ♂ 7–9 mm. × 0·3 mm.; ♀ 9–12 mm. × 0·4 mm.; Ova, 64–75 μ × 36–40 μ. Larger than the preceding species.

The buccal armature of the two species differs. The buccal capsule is smaller in *N. americanus* and has an irregular border instead of the 4 ventral hook-like teeth of *A. duodenale*. There is also a ventral pair of semilunar plates. The pathology, symptoms and treatment apply equally to both.

Pathology.—The life history of the worms is as follows. The ova escape in the fæces, and if passed into suitable surroundings embryos emerge. After moulting, such embryos bore their way through the skin of man, pass to the lungs, then into the trachea, and subsequently down the œsophagus into the duodenum and small intestine, where they become mature and breed. The worms attach themselves by their buccal apparatus to the mucosa and feed on it. By their constant bites they produce small hæmorrhages; they

also excrete a toxin. On autopsy extreme pallor may be noted; œdema over the legs and sacrum is common. Fluid is generally present in the serous cavities and petechial hæmorrhages on the pericardium and pleural surfaces. The heart is often hypertrophied, especially the left ventricle; the myocardium is soft, pale, friable and of a yellow colour like a thrush's breast (fatty degeneration). The liver in the early stages is the colour of a nutmeg, in the later almost completely yellow and very friable. The spleen is normal, the kidneys fatty. The duodenum and upper part of the ileum show small petechial spots where the worms have been attached, with occasionally large hæmorrhages in the submucous coat. Microscopically the tissues exhibit the usual changes of fatty degeneration.

Symptoms.—These vary considerably with the extent of the infection, which falls principally on the alimentary and circulatory systems. The patient tires easily, appetite is impaired and there may be a desire to eat abnormal substances. In addition there is pain in the epigastrium and often nausea and vomiting. There may be diarrhœa and blood in the stools (Ankylostomiasis dysentery). The usual subjective signs of a severe anæmia are present; dyspnœa on exertion, palpitation, præcordial pain, etc. On auscultation hæmic murmurs are to be heard.

The blood shows anæmia of a secondary type, which according to some may pass into pernicious anæmia. Sometimes the hæmoglobin follows the chlorotic type, though in many cases the colour index is somewhere about 1. Eosinophilia (18–20 per cent. on an average) is present. A dermatitis is seen at the site of entry of the embryos (coolie itch, Ankylostomiasis dermatitis).

Diagnosis.—Anæmia with eosinophilia in a person who has lived in the tropics is suspicious. The stools should then be examined and the presence of the characteristic eggs will settle the diagnosis.

People should not walk bare-footed on fæcally contaminated soil. Ground known to be contaminated should be dug up, if possible, and lime strewn thickly on it. Infected coolies should be treated and promiscuous defæcation forbidden, latrines being always used.

Treatment.—There are five main drug treatments in use, namely, thymol, β-naphthol, oleum chenopodii, carbon tetrachloride, and the eucalpytus castor-oil mixture. After a preliminary starvation of two days, with purgation, 30 grains of thymol or β-thymol are given in a cachet, at 6 a.m., 8 a.m. and 10 a.m., followed by a saline purge at 12 noon; or instead oleum chenopodii, ℥viii (0·5 c.c.), may be administered at 6 a.m., 8 a.m. and 10 a.m., followed by a purgative at 12 noon. This method sometimes succeeds where thymol fails. It is efficacious in ascaris and strongyloides infections also. Carbon tetrachloride is given to adults in doses of 3 c.c., 50 minims approximately, and the preliminary starvation has not to be so drastic. It sometimes causes sickness and nausea.

The eucalyptus mixture consists of ol. eucalypti, ℥xxx; chloroform, ℥xlv; ol. ricini, ʒx. This is divided into two portions, one being given, say, at 9 a.m., the other at 9.30. No purgative is required, the castor oil being sufficient.

All these methods may be followed by poisoning symptoms. No alcohol, ether, glycerine, turpentine, chloroform, fats or oils must be given with the thymol or β-naphthol, as they act as solvents of the drugs, rendering absorption possible. Carbon tetrachloride is said to have caused fatty degeneration

of the liver, similar to delayed chloroform poisoning. The aim with all anthelmintics is to pass large doses of the drug through the intestines quickly without absorption.

After the purgative, the number of worms passed is counted. The stools are then checked for a week or ten days, and if ova reappear, a complete cure has not been obtained. In that case, another course of treatment will be required. If thymol has been given the first time, it may be repeated, or one of the other methods may be employed in its place. Quassia, filix mas, oil of peppermint, kerosene, carbonate of guaiacol, and areca nut have also been used. The dosage given above is for adults, appropriate reductions being made for children.

ASCARIDIASIS

Definition.—The presence of round worms (*Ascaris lumbricoides*) in the intestine. L. ♂ 17–25 cm. × 3 mm.; ♀ 20–40 cm. × 5 mm.; Ova, 50–70 μ × 40–50 μ. Elliptical with thick outer shell. Yellow colour. The ova escape in the fæces. These are swallowed by man in due course, and if they contain mature embryos, the latter pass from the intestines, as Stewart has shown, to the lungs, where they undergo development, then into the trachea, and so back into the intestine, where they become sexually mature adults.

Symptoms.—The presence of ascarides in the intestines may give rise to many symptoms. In children convulsions are common; gnashing the teeth, abdominal pains and intestinal obstruction from a knot of coiled-up worms may occur. The worms have a tendency to wander and may pass up and obstruct the bile-duct, causing jaundice, or into the liver and produce liver abscess. They have even been known to enter the larynx and give rise to suffocation. Intestinal symptoms are also common, purging, with sometimes blood in the motions (Ascaris dysentery). Œdema of the face, hands and feet, simulating Bright's disease, has been reported, and also curious skin rashes. Appendicitis may be set up if a worm enters the appendix. Symptoms of broncho-pneumonia, due to the passage of the embryos through the lungs, are common in children.

Treatment.—Santonin is the stock remedy. It should be given, after the usual starvation, three times on alternate days, in doses of 5 grains for an adult, with smaller doses in proportion for children. For the latter it may be combined with scammony; or it may be administered as an emulsion with castor-oil. The worms may take a day or two to be ejected. The proof that all have been removed lies in the absence of ova on subsequent examinations.

TRICHURIASIS

Definition.—The presence of *Trichuris trichiura* (*Trichocephalus dispar*) in the cæcum. The trichocephalus or whip-worm chiefly inhabits the cæcum. Whether or not it produces pathological symptoms is not certain. Very severe infections might quite likely cause some intestinal disturbance. It has been known to enter the appendix and excite an appendicitis. L. ♂ 40–45 mm.; ♀ 45–50 mm.; Ova, 50–54 μ × 23 μ. Brown colour, barrel-shaped, with a little knob at each end. Posterior part of body thick, rolled up in male, anterior part drawn out into a whip-like process.

Symptoms.—The infection is a very common one in the tropics, almost all natives harbouring the parasites.

Treatment.—Thymol and chenopodium may be tried and are said sometimes to be efficient, but the worms are difficult to remove.

ENTEROBIASIS

Definition.—Infection by the thread or pin worm, *Enterobius vermicularis*.—L. ♂ 3–5 mm.; ♀ 10 mm. × 0·6 mm.; Ova, 50 μ × 20 μ. Thin-shelled, a developed embryo often being noted inside the adult.

Symptoms.—Irritability of the bladder with frequency of micturition, tenesmus, prolapsus ani and a secretion of mucus may all be observed. In girls a vaginal discharge is common. The worms live in the colon and by descending and passing out of the anus at night cause great discomfort, itching and pruritus. A strong tendency to neurasthenia develops in adults. Itching at the anus is, however, the chief complaint, often rendering sleep at night impossible.

Treatment.—Infected children should occupy separate beds; the hands should be kept clean and the nails short.

Santonin may be tried, but it is not so good as in ascaris infections. Naphthalene sometimes does good—10 grains and upwards, 3 grains for a child.

Most success is, however, obtained by local methods. The rectum is first cleaned out by a warm-water enema, and then an injection of 6 to 8 oz. of a solution of the drug to be employed is given. Salt water, inf. quassiæ, tinct. of iron 40 minims to the pint; creosote, ½ per cent. solution; sulphate of copper (1–2000) or thymol (1–2500) are all recommended.

For the local anal discomfort orthoform as an ointment, or one or other of the mercurial ointments, such as ung. hydrarg. or ung. hydrarg. nit. diluted, will be found useful.

G. Carmichael Low.

IV. DISEASES DUE TO INSECTS

MYIASIS

Definition.—An invasion of the tissues by larvæ of dipterous insects.

Ætiology.—Several flies deposit their eggs upon man, the larvæ developing in the nasal cavities, under the skin or in the intestinal canal. Two varieties are thus distinguishable, the dermal and the intestinal.

Dermal

The screw worm (*Chrysomyia macellaria*).—This fly, common in the West Indies and adjacent areas, is like an ordinary blue-bottle, from which, however, it can be distinguished by the presence of 3 linear marks on the dorsum of its thorax. It measures 9 to 10 mm. in length. It has a habit of laying its eggs upon foul wounds, and from these larvæ hatch out in a few hours. They

resemble a screw superficially, and are formed of 12 segments, each with a series of spines. Whenever hatched they burrow quickly into the tissues, upon which they feed, causing great destruction of the parts invaded. When the nose is affected, the larvæ pass up into the accessory sinuses, bore their way through the bones, and even penetrate the skull, causing death by purulent meningitis. The vagina or ear may be attacked as well as any ulcers or wounds on different parts of the body.

Treatment.—Avoid sleeping in the open. Great care must also be taken to protect all wounds, and people with nasal or aural discharges must take special precautions to protect these orifices from the attacks of such flies. They are specially attracted by foul-smelling discharges of all sorts. They can be removed from wounds by ordinary antiseptic methods. For nasal cases, injections of chloroform, carbolic acid and turpentine are used. The accessory sinuses may have to be opened.

The mosquito worm—

Synonyms.—Ver macaque. Beef Worm.

This is the larvæ of a fly, the *Dermatobia hominis* vel *cyaniventris*, common in Central America, northern parts of South America, Trinidad, etc. It measures 14 to 16 mm. in length, has a yellow head, with brown eyes, with a greyish thorax, and dark metallic blue abdomen. The eggs are deposited in damp ground, where a mosquito, the *Janthinosoma lutzi*, frequents. In some way or other the eggs get attached to the mosquito's thorax and are conveyed by it to the skin of man, where the larva comes out of the egg, drops on the skin and finds its way through the hole made by the puncture of the mosquito. Here it develops, and in doing so produces a boil or warble of a very painful nature. This enlarges as the larva grows, and if carefully observed will be seen to have a minute opening at the top, out of which a black material exudes—the fæces of the maggot. Finally the parasite escapes through the opening, falls on the ground and becomes a chrysalis. In due course the fly emerges. Cattle are often affected with multiple warbles all over their backs, whence the name beef-worm.

Treatment.—The natives kill the larva with tobacco juice and then squeeze it out. The opening should be enlarged with a bistoury, and the maggot removed with a pair of forceps. The cavity soon heals up if treated antiseptically.

Ver du Cayor—

Synonym.—Tumbu Disease.

This is the larva of an African fly known by the name of the *Cordylobia* (*Ochromyia*) *anthropophaga*. The infection is common in various parts of the West Coast, and other parts of Africa. The fly measures from 8·5 to 11·5 mm. in length, and is of a yellowish colour with black abdominal spots. The eggs are laid on clothing or on the skin, the larva on emerging boring its way into the tissues by means of its mouth hooks. The first sign of its presence is a pricking sensation, and then the boil or warble develops, often with considerable inflammation around it. A central hole allows of the ejection of the fæces, and ultimately of the larva itself when mature. The cavity may suppurate.

Treatment.—Squeeze the maggot out, enlarging the aperture if necessary, and then treat the cavity antiseptically.

The Congo floor maggot.—At one time it was supposed the larvæ of the

Auchmeromyia luteola (*Musca luteola*) occurred under the skin of natives, but these were probably the larvæ of some other fly, as more recent work has shown the maggots live in the dust of the floors of houses and outhouses, emerge at night and suck the blood of any one sleeping on the ground. They can crawl about quite actively, and consist of 11 segments, measuring when full grown 15 mm. in length. The fly is an orange-yellow colour with two longitudinal stripes on the dorsum of the thorax, and measures 10 to 12 mm. in length.

Intestinal

Larvæ of flies are common in human fæces, some of these having come from the intestinal tract. Something like 20 different species have been described, the genera *Sarcophaga*, *Fannia* and *Apiochæta* furnishing most examples. The eggs are taken in with food, dirt, vegetables, etc. There may be gastro-intestinal symptoms as a result, diarrhœa and griping; general symptoms such as headache, thirst, rigors, vertigo and convulsions have also been described.

Treatment.—Castor oil should be used to clear out the bowel thoroughly. Thymol, filix-mas and santonin have also been tried. Soltau Fenwick recommends turpentine.

TUNGIASIS

Synonyms.—Chigger Disease; Chiggers; Jiggers; Sand Flea Infestation.

Definition.—An infestation of the skin with the burrowing flea or chigger.

Ætiology.—The disease is endemic in South America, and has spread to Africa, and now even to India. All races are affected, and both sexes. Children often suffer severely. The flea, the *Tunga penetrans*, lives in the dust or mud of earth floors, and the impregnated females burrow in under the skin, where they come to rest, and gradually swell as their eggs develop. When the ova are mature they are expelled and fall on to the ground where the larva hatches out, this in turn becoming a chrysalis, from which in 14 days or so the adult flea emerges.

Pathology.—The chigger acts as an irritant as it grows, causing inflammation and often suppuration of the sac in which it lies. When mature, the swellings are the size of a fair-sized pea, and appear as little inflamed nodules; in some instances the skin is raised in the form of a blister. Finally ulceration takes place.

Symptoms.—The first thing noticed is a slight smarting or pricking sensation where the chigger is located; if on a toe it feels as if the boot were irritating the part. Later on, definite pain occurs with, as the inflammation spreads, itching and redness. As a rule the nature of the trouble is then suspected, and the parasite removed, when all the symptoms quickly clear up. Tetanus has been noted as a result of the tetanus bacillus gaining access from the ground into the sores. Sometimes the parasite is located under the nail and gives rise to a very painful onychia.

Diagnosis.—This is easy, and may often be made before the swelling has reached any size. People in chigger areas periodically inspect their toes

and if any little brown mark be seen it is picked out with a sharp-pointed needle.

Prognosis.—This is quite favourable, unless there is a very large infection. The ulceration is often extensive, and the patient lamed and rendered unable to walk for long periods of time.

Treatment.—Tobacco infusion to the floors and areas where the chiggers are, at the same time soaking one's boots and shoes in a little of the mixture, is the best preventive. Removal of the chigger as soon as possible, and cleansing the sore with a little carbolic lotion is all that is required.

BÊTE ROUGE

Synonyms.—The Red Mite, Tlalsahuate, Balata, Pou d'Agoute.

Definition.—Infections of the skin with the red mite, *Trombicula thalzahuatl.*

Ætiology.—The disease is similar to the papular eruptions produced by the ordinary harvest bug in England.

Symptoms.—After penetrating the skin the mites set up an itchy, papular eruption known by the name of Red Mite dermatitis.

Diagnosis.—This is easy, the little crimson spot in the middle of the papule supplying the clue.

Treatment.—The spots may be touched with pure carbolic or sulphur ointment, or tincture of iodine may be employed.

V. DISEASES DUE TO SNAKES

OPHIDIASIS

Synonyms.—Snake Poisoning.

Definition.—Poisoning, often of a deadly and fatal nature, produced by the bites of different snakes.

Ætiology.—The tropics are the chief home of most of the deadly snakes; in England there is only one poisonous variety, the viper. All races are liable to attack, children and adults alike, and both sexes equally.

There are many varieties of snakes, the cobra, *Naja tripudians*, the coral snakes, the vipers, the rattlesnakes, etc. The poisons of the different examples differ in their action on the human organism, some being of the nature of neurotoxins, others of the nature of agglutinins and still others of the nature of cytolysins, the latter group including the hæmolysins, the hæmorrhagins and the leucolysins. Colubrine neurotoxin is said to act upon the respiratory centre in the medulla, while viperine neurotoxin acts upon the vasomotor centre. Colubrine venom (cobra, for example) causes paralysis of movement, salivation, paralysis of respiration, lachrymation and mucous discharges from the nose, etc. Viperine venom (*Vipera russellii*) causes intravascular clotting of the blood, while that of *Echis carinatus*, a viperine snake common in dry tracts of South-west Asia and Tropical Africa, acts as a coagulant in the first instance, but when absorbed causes hæmorrhages, evidenced by hæmaturia, etc.

Symptoms.—The symptoms will depend upon what sort of poisonous snake has bitten the patient, and also as to what amount of poison has been introduced.

Diagnosis.—This depends upon whether the snake is a poisonous one or not, and also whether the patient really is bitten or not. It is important then to look for fang marks and any signs of venom on the skin.

Prognosis.—If a person receive the full dose of any of the poisonous varieties, death is certain, unless, perhaps, some of the antivenene of the species that inflicted the bite is immediately available. Many cases supposed to have been bitten by poisonous varieties have probably only been bitten by harmless ones. The prognosis also depends upon the amount of venom injected.

Treatment.—The first aim of treatment is to try to prevent the venom reaching the general circulation. A ligature must be tied round the affected finger or limb, and then the area of the bite should be freely incised and potassium permanganate crystals, dissolved to form a strong solution, rubbed freely into the wound.

If the patient recovers, the after treatment of the wound consists in keeping the parts clean, and if sloughing occur, treating the part with ordinary antiseptics. Once the poison has entered the general circulation, an attempt should be made to neutralise it, and this is done with antivenene. This must, however, have been prepared from the same species of snake that has inflicted the bite, otherwise it is useless, *e.g.*, viperine antivenene will not protect a person bitten by a cobra. The antivenene should be introduced intravenously. General symptoms must also be combated, failure of respiration by artificial respiration, heart failure by cardiac stimulants, alcohol, ammonia and strychnine. A binder should be applied to the abdomen, and bandages to the limbs.

POROCEPHALIASIS

Definition.—An invasion of the tissues by the larval forms of different species of *Porocephalus*.

Ætiology.—The adult forms of the parasite, *Porocephalus armillatus* and *P. moniliformis*, inhabit the lungs of snakes, while the larval stages are usually met with in monkeys, lions and hedgehogs. Accidentally, the eggs may be ingested by man, and then the larvæ encyst in the different viscera, such as the liver, lungs, peritoneum, etc. Zoologically, these creatures belong to the Arachnoidea, the body being annulated, and often being mistaken for a worm. The females measure 10 to 12 cm. in length by 6 to 9 mm. in breadth, and possess a mouth surrounded by a chitinous ring with two protractile hooklets on either side of it. The nymphal forms, which are found encysted in the tissues, are usually coiled up spirally, and resemble the adults in miniature. These develop from ova passed by the adults, when taken up by the intermediate host in water or food. When a snake swallows an infected monkey, for example, the cyst wall is dissolved and the young forms are liberated, finding their way to the lungs, where they develop into adults.

Pathology.—A heavy infection of cysts might give rise to various

troubles, whereas one or two are probably of little importance. Occasionally, the larval forms emerge from the cysts and wander about the peritoneum and in such a case are dangerous. Most of the reported cases in man have been met with accidentally at autopsy.

Treatment.—None is known.

Prophylaxis.—Avoidance of food likely to be contaminated, and care in drinking water that has not been boiled, is all that can be done.

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SECTION V

DISEASES DUE TO PHYSICAL AND CHEMICAL AGENTS

CAISSON DISEASE

Synonyms.—Compressed Air Illness; Diver's Paralysis.

Definition.—Caisson disease is the name given to a series of phenomena which may result in any living animal upon return to a normal atmospheric pressure after exposure to an air pressure which must exceed 18 lb. to the square inch above mean atmospheric pressure. These phenomena occur the more frequently and severely the greater the air pressure, and in direct proportion to the length of time of exposure to the high air pressure, and the more rapid the return to a normal atmospheric pressure. They are caused by the saturation of the living tissues with nitrogen at high atmospheric pressure which, on too rapid return to lower atmospheric pressures, boils within the tissues, and this liberation of bubbles of nitrogen causes tissue disruption and destruction on the one hand, and gas emboli on the other. The major capacity for fat to hold nitrogen in solution causes the liberation of nitrogen bubbles to occur most readily in the fatty tissues, and this occurs more easily in those parts of the body where the blood supply is less abundant, and therefore the rapid return of the excess of nitrogen to the atmosphere by solution in the blood stream, less easy. For these reasons the white matter of the nervous system, composed as it is of fatty substance, and particularly those parts of it which are less liberally supplied with blood, such as the white matter of the lower dorsal spinal cord, is the most common site of gas liberation. The joints and also their surrounding structures, which are lowly vascularised, are also common sites of the lesions, as are also the subcutaneous tissues of fat subjects, on account of the high solubility of nitrogen in the fat.

These phenomena occur only upon decompression, and are always preventable if adequate means be adopted (1) to limit the time of exposure to very high atmospheric pressures, so that high degrees of tissue saturation with nitrogen shall not occur, and (2) to regulate the return to normal atmospheric pressure by graduated decompression, in such a way as to prevent boiling of nitrogen in the tissues. They are curable, after they have appeared, by immediate recompression followed by very gradual decompression. Exposure of the living animal to very high atmospheric pressures may be associated with most serious and usually fatal results, which occur before decompression, and which are due to over-saturation of the tissues with oxygen, death resulting from oxygen poisoning.

Ætiology.—This disease made its appearance in the middle of the nine-

teenth century, when the invention of Siebe's diving dress and of subaqueous chambers made it possible for subaquatic engineering and marine salvage to be performed under high atmospheric pressures. The men work in a pressure of air, which just exceeds the hydrostatic pressure of that depth of water which extends from the working position to the surface, and the pressure is produced and maintained by pumps and regulating apparatus. Workmen reach the working face of the caisson by passing from the normal atmosphere through a series of chambers with airtight doors, in which the air pressure is raised by rapid stages, until the high pressure of the working face is reached. They leave through the same chambers, the air pressure being lowered for some space of time in each as they pass through. This process is termed "compression" and "decompression," or "locking in and out." The diver is compressed as he slowly descends by an increasing air pressure from his pump, and is decompressed as he ascends much more slowly, this compression being regulated by an automatic valve in his helmet which retains the air pressure until it exceeds that of the water pressure outside. Caissons are worked under a much lower pressure than that at which divers can work; but the working shifts are much longer, whereas the diver at great depths remains down only a very short time. Roughly speaking, each 33 feet of water produces a pressure of 15 lb. to the square inch (5½ fathoms). Caissons are usually worked at a pressure of below 35 lb. and in 6- to 8-hourly shifts, but they have been successfully worked at a pressure of 45 lb. with 2-hourly shifts, and at 50 lb. with 1-hourly shifts. Divers frequently work at 20 fathoms (53 lb.), and the record depth and pressure reached has been 210 feet (95 lb.).

During compression no trouble is experienced beyond discomfort in the ears and rarely perforation of the membrana tympani, from disparity of air pressure in the middle ear. This the workmen avoid by opening the Eustachian tubes with an act of swallowing or yawning; but it must be remembered that no person suffering from Eustachian catarrh should be allowed to enter the air locks. Under high atmospheric pressures combustion proceeds more readily, a candle when lighted burns away furiously, and a pipe bursts into flame with each draw. The workmen find that they can work more easily and with less fatigue.

The symptoms of the disease become manifest upon return to a lower atmospheric pressure, and directly in proportion to the suddenness of return to such pressure. If the return to a normal atmospheric pressure from a high and prolonged pressure be sudden, there may be a liberal escape of bubbles of nitrogen gas in the blood and in the tissues. The presence of the nitrogen may sometimes be felt as gas crackling underneath the skin or subcutaneous emphysema.

When the return to a normal atmospheric pressure is more gradual, the nitrogen may have time to escape from the blood and from most of the tissues by diffusion through the lungs, but in those tissues which are relatively less vascular, and from which, for that reason, interchange of gases by means of the blood stream is slow, or in those tissues in which nitrogen is especially soluble, such as the fats and myelin of the nervous system, the nitrogen is liable to escape in the form of bubbles, and to the mechanical effects upon the tissues in which the boiling of the nitrogen occurs, the symptoms of caisson disease are due.

That part of the nervous system which is least vascular, namely the four lower dorsal segments of the spinal cord, is the most common region for the lesions to occur, while the joints and peripheral nerve trunks are often affected.

Massive escape of gas may occur into the blood stream, and the heart has been found distended with gas after death in rapidly fatal cases. A similar escape of gas into the intestines may produce severe and even fatal abdominal distension. It is doubtless one of the causes of the abdominal pain, nausea and vomiting which are common symptoms of compressed air sickness.

The liberation of these gases, and therefore the occurrence of the compressed air disease, depends directly upon these factors—(1) the amount of pressure to which the living animal is exposed; (2) the length of time of exposure to the high pressure; and (3) the rapidity with which a return is made from the high pressure to normal atmospheric pressure. For example, the malady never occurs after short exposures, such as 15 minutes at a pressure of 45 lb., or 2 minutes at a pressure of 75 lb., even though decompression be as rapid as possible, for these periods are too short to allow of nitrogen saturation of the tissues. It is for this reason that compressed air sickness is so much less common in divers, who for the most part work for very short times only at high pressures, and so much more common in caisson workers, who work for many hours at a stretch at a pressure of from 30 to 40 lb.

There is one other factor which must be carefully borne in mind, and that is the amount of fat present in the body, which, from its nitrogen dissolving qualities, greatly increases the tendency to nitrogen boiling within the tissues if it be present in large amount. It has been shown experimentally that fat animals succumb to the disease while lean ones escape, and experience has shown the necessity of excluding fat workmen on account of their liability to the malady.

The disease is obviously always preventable, firstly by shortening the periods of exposure according to the height of the pressure so as to obviate nitrogen saturation; and secondly by arranging that such a graduated and prolonged return to normal pressure be made, as will prevent any possibility of nitrogen boiling, the slow return to normal pressure allowing of the nitrogen desaturation of the tissues without bubble formation.

It is quite safe, and does not produce any ill effects whatever for a man to breathe pure oxygen for as many as 6 hours at a time. This has been proved by the use of the Siebe-Gorman life-saving dress for rescue work from choke damp in mines. Beyond a certain limit of pressure, however, oxygen becomes poisonous. Highly compressed air causes rapid toxic effects in proportion to the partial pressure of the oxygen. It tends to cause direct death of the tissues. At lower partial pressures it has a convulsant effect, and at still lower pressures produces congestion of the tissues and especially of the lungs, which may present consolidation and all the signs of acute pneumonia, however slowly and carefully decompression has been accomplished. The limit of safety so far as oxygen poisoning is concerned is 10 atmospheres, or 300 feet of water. Neither divers nor caisson workers ever work at anything like so high a pressure.

The essential feature on post-mortem examination is the presence of bubbles of nitrogen in the tissues or bulky collections of nitrogen within the

organs, as in the heart or in the intestines, and the results of the associated tissue disruption and air emboli. When it is considered that the mass of blood constitutes about 5 per cent. of that of the whole body, and that the capacity of the tissues in a thin subject is thirty-five times that of the blood, the ratio being much higher in a fat subject since fat will dissolve five times as much nitrogen as will any other tissue, the presence of bubbles in the tissues, and especially in the fatty tissues, will readily be understood.

The bubbles form first in the venous blood and in the fatty tissues, where they grow by accretion and cause tearing of the tissues, while air emboli and subsequent necrosis are common. Hundreds of bubbles have been counted in the spinal cord, and these are much more numerous in the white than in the grey matter. Collections of nitrogen may be found in the subcutaneous tissues, and may cause palpable crackling. Bubbles of gas are not uncommonly found in the liver cells. Occasionally similar lesions are found in the brain or in the eye, and in fact may occur in any of the tissues. In every fatal case which has been adequately examined patches of necrosis in the dorsal region of the spinal cord, with the usual secondary degenerations, have been found.

Symptoms.—The symptoms may be first manifest during the process of decompression, when the latter is rapid, and from a high pressure. More often the signs of the malady appear soon after a normal pressure is reached, while not infrequently they do not present themselves until an hour or more has elapsed. In slight cases headache, giddiness, diplopia and faintness may occur, and these symptoms pass off soon and leave no trouble. Severe and important symptoms occur in the following order of frequency: (1) pain in the extremities or trunk, commonly called by the workmen "the bends" from the position in which the painful limbs are held; (2) pain in the epigastrium, sometimes accompanied by nausea, vomiting and abdominal distension; (3) paraplegic paralysis which usually involves motor, sensory and sphincter functions, and extends as high as the ninth dorsal segmental level; (4) headache, vertigo and coma; (5) sudden death; (6) hemiplegia or monoplegia of cerebral origin.

The pain in the limbs is of a neuralgic character and is referred to the joints, which are kept in the semiflexed position, any attempt to straighten them causing great pain. The pain may come on gradually, or suddenly, and may be slight and transient, or severe and persistent. It is often intolerable. The knees, ankles and hips are the most frequently affected; but sometimes the joints of the upper extremities, or of the back and especially of the lumbar region, may be affected. Epigastric pain is common, and unless quickly relieved by recompression is followed by nausea and vomiting.

The paraplegia usually has its upper limit in the lower dorsal, but it may reach the cervical region and involve the arms. It comes on rapidly, and involves motor, sensory and sphincter functions. It may be of any degree of severity from a slight and transient effect to a complete and permanent loss of the functions of the spinal cord. The paraplegia occurs with increasing frequency and completeness in proportion to the degree of pressure and the length of exposure to its influence. It occurred in 61 per cent. of 119 cases in the St. Louis bridge caissons, which were worked at plus 50 lb. of pressure, and among these there were 14 deaths. There is no general relation between the pain and the paralysis, as either may occur

without the other, and it seems, therefore, that the pain is due to a peripheral lesion and not to the lesions of the spinal cord. It is an interesting fact that the peripheral pains may persist in severe degree, even when there is total loss of pain sensibility from the spinal cord lesions.

Course and Prognosis.—The duration of the attack may vary within very wide limits. The severity of the initial symptoms, and the immediate application of appropriate treatment, are the all-important modifying factors in the prognosis. The attack may last for a few hours only, or it may continue for days. The paralysis may recover in a few days, or it may last for months and may never recover. Death occurs only in cases which have severe initial symptoms, and except when occasioned by complications such as cystitis and bed-sores it usually takes place shortly after the attack.

Treatment. — *Prophylactic.* — Since the malady is due entirely to nitrogen saturation of the tissues, and the subsequent escape from solution of this gas into the tissues during a too rapid return to normal pressures, it follows that the malady can always be prevented by adopting suitable period lengths for compression. In the first place, the malady never arises from compressions below plus 18 lb. to the square inch, or roughly 40 feet of water, and those who work at such a pressure may do so for long hours and return to a normal pressure rapidly, and without any risk. At higher pressures the working shifts must be shortened as the pressure gets higher. The shifts should be not longer than 6 to 8 hours at a pressure of 30 to 35 lb., or 3 atmospheres; 2 to 3 hours at a pressure of 45 lb., and 1 hour only at a pressure of 50 lb. At higher pressures than this, which are only encountered by divers, a few minutes' exposure is allowed only.

Compressed air sickness never occurs if the return to the normal atmospheric pressure be sufficiently slow. Animals can be exposed to very high pressures short of those causing oxygen poisoning, with impunity, provided they be decompressed slowly enough. This decompression is carried out in the case of the diver by raising him to various levels in stages, and letting him remain at each stage a longer and a longer period as the surface is approached. In the case of caisson workers a series of air-locked chambers is provided in which the air pressure is lowered in stages, the men remaining longer and longer at each stage as they approach the normal pressure. The important fact in connection with decompression is that the absolute pressure can always be halved forthwith without any risk. In the first air lock on leaving the working face of a caisson, for example, the pressure is at once reduced to one-half that of the working face, and in the remaining air locks the pressure is reduced by stages until zero is reached.

Leonard Hill has shown experimentally that it is always safe to lower the pressure to plus 20 lb. by gradual decompression during the space of 10 minutes, then to wait at that pressure for 2 hours, and then bring the pressure to zero by gradual reduction in 10 minutes. The Admiralty rules for divers require that a diver working, say at 140 feet shall be first raised straightaway to a depth of 50 feet where he waits 10 minutes, then to 40 feet for 10 minutes, 30 feet for 20 minutes, 20 feet for 30 minutes, 10 feet for 35 minutes, and then he leaves the water abruptly.

The difficulty and danger is the tendency on the part of the workers to curtail these weary waits, and get away from work as soon as possible. It is important that all fat subjects, and all those who have shown a

susceptibility to compressed air sickness, and all those not in absolutely sound bodily health, shall be excluded from working in highly compressed air.

Curative.—It was early discovered by the caisson workers themselves that the only remedy for the malady was to re-enter the high-air pressure. A recompressing apparatus in the form of a medical air lock is now supplied at all caisson works, and on all ships engaged in deep salvage. On the appearance of any symptoms the worker is placed in the compressing room and the pressure is run up to the full pressure at which he has been working, when it is usual for the symptoms to ameliorate rapidly or disappear. After the recompression the decompression must be carried out very slowly, for the bubbles once formed in the tissues are not easy to get rid of, though they may be kept at a small size by the pressure. Cases apparently at the point of death with cyanosis and coma have many times been completely recovered in a few hours by recompression. When symptoms have appeared, the decompression should take at least 5 hours. Caisson workers and divers should sleep and live close to the medical air lock that they may be near aid during the first hours following decompression. The paralysis when once established is to be treated upon ordinary lines.

ANOXÆMIA

Synonyms.—Altitude Sickness ; Mountain Sickness.

Definition.—A series of phenomena which occur in the human subject when breathing an atmosphere in which the partial pressure of oxygen is greatly reduced and which are entirely due to deficient oxygenation of the tissues. They are met with from the respiration of the rarefied atmosphere at high altitudes in mountain climbing and aviation, and are increasingly prone to occur with altitudes above 14,000 feet. They can be produced experimentally by breathing an atmosphere rarefied within a closed chamber and by dilution of the ordinary atmosphere with nitrogen, and can be avoided even in a highly rarefied atmosphere by continuous oxygen inhalation.

Pathology.—The condition is directly referable to lack of oxygen. There is considerable difference among individuals as regards liability to the appearance of symptoms at low atmospheric pressures, some suffering earlier and more than others. The immediate effect of exposure to such pressures is to cause rapid concentration of the blood and therefore a relative increase of the ratio of the hæmoglobin to the volume. A 10 per cent. rise in the hæmoglobin ratio may occur after 20 minutes' exposure. This serves as a compensation for the oxygen-want of the tissues, and its occurrence is associated with a disappearance or amelioration of the initial symptoms of oxygen-want. In those who remain at a bearable high altitude many weeks, some degree of acclimatisation occurs, and this is associated with hyperactivity of the blood-forming organs and a true erythræmia. The anoxæmia produces a hyperglycæmia, and there is at first an increased alkalinity of the blood from increased ventilation which subsequently lessens.

Symptoms.—*Mental effects* occur most importantly when rapid ascents to high altitudes are made in aviation, and consist of a gradually increasing dulling of perception, of which the subject is usually unaware. There is an increasing inaccuracy and lethargy of mental functions with a tendency

to torpor and loss of memory. The skilled photographic observer takes eighteen photographs upon the same plate, the observer throws his valuable notes overboard, the pilot makes for a wrong destination or goes to sleep, and the fighting scout forgets to go into action. On return to land a muddled and confused memory of what has happened during the flight is all that remains. Lesser degrees of this condition have led to great errors in judgment, foolhardiness, apparent cowardice and irresponsibility in military aviation. So insensibly does this mental paralysis come on and so deep may be its effect before its presence is realised, that in Tissandier's balloon ascent in 1875, though provided with oxygen apparatus, all three aeronauts were paralysed beyond movement before realising the necessity for using it, and two of them lost their lives. Diminution of auditory perception becomes so great at high altitudes that the aeroplane engine becomes almost inaudible.

Respiratory effects.—At an altitude of 12,000 feet, nose-breathing ceases, and above this height the breathing deepens into hyperpnœa, which may be most distressful and may be periodic. The dypsnœa is greatly increased on exertion and is accompanied by cyanosis. Even such acts as talking and using a pressure pump may greatly increase the dyspnœa.

Muscular weakness.—Accompanying the mental lethargy is an increasing condition of muscular weakness. The slightest exertion is hard work. The machine is difficult to fly at very high altitudes, and the marksman shoots badly, and the mountaineer becomes incapable of taking exercise.

Other symptoms which may occur are—(1) headache, which may be very intense and which is very usually met with in prolonged exposure to high altitudes, as in mountain climbing; (2) spasmodic gulping accompanying the hyperpnœa; (3) fainting on exertion; (4) vomiting; and (5) hæmorrhage in the form of epistaxis, both of which are rare; and (6) frequency of micturition, which is common.

The mental effects are most conspicuous in aviators who had to make prolonged flights at very high altitudes during the Great War before the regular use of the oxygen apparatus. The dyspnœa, headache, and muscular effects have been most troublesome in mountain ascents where exertion is unavoidable.

Death has occurred only in balloon ascents to gain a great altitude, and it occurs very rapidly, and is preceded by general muscular paralysis. Glaisher and Coxwell survived 29,000 feet by a lucky chance after complete paralysis of the limbs had set in. Sivel and Croce-Spinelli died at a height of 27,500 feet, while Tissandier, who was with them, survived. The after-effects of exposure to high altitudes has been well described by Birley, who, after observing many flight landings after high patrols during the Great War, writes: "The gait of the men on landing is unsteady and laboured. Reports are laboriously made out (there being a general disagreement as to what was seen and done). Tempers are short, every one looks and feels tired, and the idea uppermost in the mind is to lie down and go to sleep. Severe frontal headache is common; it may persist until the following day and at times proves incapacitating. Appetites are poor and spirits are depressed. It is easy to understand that a repetition of this kind of work over any length of time was rapidly productive of deterioration of mental and physical well-being."

Remarkable individual tolerance to anoxæmia occurs in some subjects,

but this tolerance tends to disappear with repeated long exposure. Physical fitness and training increase toleration up to a certain point, whereas unfitness and especially digestive disturbances lower tolerance, and the latter are apt to induce vomiting.

Treatment.—Since the symptoms are due solely to lack of oxygen they can be entirely avoided by the use of a portable apparatus to deliver the necessary oxygen by all those who have to encounter an altitude of over 15,000 feet. Professor Dreyer's apparatus is portable, compact and satisfactory, and its essential feature is the regulation of oxygen delivery by an aneroid controlled valve, so that the amount of oxygen delivered varies in inverse proportion to the barometric pressure of the atmosphere surrounding the instrument and consequently in direct proportion to the altitude.

When symptoms have developed, the immediate treatment requisite is the cessation of exertion, the provision of oxygen if available and a speedy return to a lower altitude.

SEA-SICKNESS AND ALLIED CONDITIONS

Definition.—A disorder of the central nervous system produced by an unaccustomed and irrelative stimulation of the afferent organs which subserve the orientation and sense of movement of the body in space, namely, the eyes, the labyrinths, the splanchnic sensorium and the common sensorium of skin and muscles. This stimulation may occur when the body as a whole is subject to continuous movement which does not allow of continuous correct ocular and vestibular correlation of self and external objects, as in train-sickness and dancing-sickness, and more especially when it is subject to alternating movements which destroy the correspondence between the afferent impressions reaching the nervous system from those organs, as in sea-sickness and swing-sickness. The symptoms of this disorder are expressed as a feeling of spatial insecurity and visual disorientation, vertigo, diplopia, headache, anorexia, nausea and vomiting, pallor, lowering of blood-pressure and prostration.

Pathology.—Animals are as liable to the disorder as is man. Early infancy is immune from the affection, since the orienting mechanism has not attained physiological activity; and old age is relatively immune, probably from lessening irritability of the nervous system. Individual hypersusceptibility and individual immunity are very common, and the readiness with which toleration is acquired by training varies greatly in different people. Personal immunity is for the most relative only, for there are few who can pass through excessive and prolonged stimulation without developing some of the characteristic symptoms. The development of tolerance by habitude varies greatly. Some develop tolerance readily, others with great difficulty. Twelve years of continuous sea-going passed before any tolerance was developed in 2 cases under my observation, and Admiral Nelson never acquired any tolerance. An attack of sea-sickness resembles closely an attack of migraine, and again it resembles acute cerebellar irritation, and again the symptoms which follow chloroform and ether anæsthesia and alcohol poisoning, for the reason that in all these conditions it is the nervous mechanism of orientation which is especially disturbed. The subjects of

migraine are almost invariably particularly bad sailors and train travellers, and the symptoms of their attacks of sea-sickness and train-sickness often take the pattern of the migrainous attack. The importance of the factor of ocular disorientation is well shown by the fact that "sea-sickness" may occur in a susceptible subject when he is stationary but when the objects around him move in undulatory fashion, as from the movements of the waves when he is upon a pier and when he witnesses sea movements as a stage effect. The vestibular irritation is shown by the vertigo and ataxy, diplopia and vomiting, and by the high potentiality of short angular movements in causing the symptoms, as from a small boat anchored in a swell, or an observation balloon anchored in a puffy wind. The importance of the splanchnic sensation when the vessel "lifts" and "scends" in producing nausea and adding to the general misery is obvious to any one who has experienced sea-sickness. It is this factor which tends to cause an attack of sea-sickness during sleep when the ocular and vestibular mechanisms are relatively at rest.

The precautions which tend to obviate sea-sickness are those which tend to eliminate or lessen the essential factors in its production. A position amidships where the angular movements are least, a supine decubitus which most protects the semicircular canals from stimulation, and which removes the muscular sense element, and in a cabin which moves more or less with the body, and therefore produces little ocular disorientation, is the one best calculated to avert or lessen the disorder. A gyroscopic cabin which removes all the factors except the "lift" and "scend" element is said to obviate the disorder even in the most susceptible subject.

There are many adjuvant factors which are important but not essential, such as apprehension from previous experience, cold, expectant attention, the smell of the ship, dyspepsia and the presence of others suffering from sea-sickness.

Symptoms.—The initial symptoms are a loss of the usual feeling of well-being, accompanied by a vague feeling of cephalic, ocular and epigastric discomfort. Salivation, gaping and yawning follow, with irregularity of respiration, flatulency, pallor of the face, and a sense of squeamishness, as though at any moment vomiting might occur.

In the fully developed attack it is convenient to divide the symptoms into two groups—cephalic and gastric; but though in different subjects one or the other group may dominate the aspect of the attack, yet few persons suffer from the one group of symptoms to the complete exclusion of the other. The cephalic group comprises ocular distress, diplopia, which may be severe though transient, giddiness, headache, depression, and mental despondency and apathy. These may persist for a very considerable time after the patient goes ashore.

The gastric symptoms consist of nausea, retching and vomiting, which are often most violent and distressing, the vomit ultimately consisting of a thin, bile-stained fluid. There is complete anorexia, and in severe cases nothing can be retained in the stomach. Constipation is often obstinate.

The general constitutional effects of prolonged sea-sickness may be very severe. There is a general condition of collapse. Alternate heats and chills, with frequent chattering of the teeth and shivering, pervade the system; the eyes are dull, and may be bloodshot from straining; the countenance

becomes shrunken, pale and perhaps greenish, inexpressive and dejected. The cardiac action is depressed, the blood concentrated, the body desiccated, and little urine is passed. The pulse and respiration are quickened, the skin is cold and either dry or clammy, the tongue is moist and coated, and both the breath and the urine are likely to contain acetone bodies. Hebetude is always marked, and in severe cases the mind may be utterly indifferent to the surroundings and no consecutive train of thought can be pursued. There is a general feeling of bodily soreness and weariness and a sense of exhaustion.

Course and Prognosis.—The symptoms usually subside rapidly when the voyage or other movement causing the condition is over, but sometimes both the cephalic and gastric symptoms persist for a time, and the patient is "good for nothing" until he has had a night's sleep. In persons taking long sea voyages, the symptoms usually lessen in a few days, reaction sets in with a return of appetite, and convalescence is complete within a week, but symptoms are liable to return with an onset of rough seas. Some persons, on the other hand, never lose the symptoms until the voyage, however long, is over, and these may be reduced to a piteous condition of bodily weakness, from which subsequent convalescence is slow. Death appears never to have occurred even in the most severe condition of bodily depression and starvation from sea-sickness. Apart from the prolonged convalescence which may be required in severe and long-lasting cases, there seem to be no harmful results from sea-sickness. It has been held to have a salutary effect upon subsequent health since ancient times. In pregnant women it does not have any tendency to cause miscarriage.

Treatment.—*Prophylaxis.*—To avoid sea-sickness a susceptible subject should, for a few days before taking to the sea, eat sparingly, avoid alcohol and over-fatigue, take regular exercise and carefully attend to any condition of dyspepsia and constipation, and partake of a good wholesome meal some two hours before going on board. He should secure a berth amidships, lie supine with the head low, and keep warm. Some persons find a closed cabin insufferable, and are better on deck in the open air. The administration of bromides some hours before sailing is often of signal service, and this will often lessen the cephalic symptoms when an attack has developed. Chloretone also is very valuable both as a prophylactic, when it should be taken just before sailing, and as a remedy during the attack. Combinations of these two remedies are very useful, and there is at least one patent remedy, of which the basis is monobrom-camphor and chloretone, which is very efficacious.

During the attack it is essential to keep warm and as quiet as is possible, and avoid any source of further irritation of the organs of orientation; to quiet the irritation of the nervous system with bromides and chloretone; to secure sleep, to which end barbitone or adalin is very useful; to prevent acidosis and to see that the patient is fed. With severe and prolonged vomiting, anorexia and prostration it may be difficult to secure these ends. Swallowing food must be insisted on, and the administration of very small perfectly dry meals, such as cold chicken and biscuit, will often break the anorexia and vomiting. A severe case should always be brought into the open air on deck after four days in the cabin. Acidosis should be combated by the alkaline carbonates. Alcohol and aromatic carminatives are sometimes valuable.

JAMES COLLIER.

HEAT-STROKE AND THE EFFECTS OF HEAT

Under this heading are included those types of illness caused by exposure to a high atmospheric temperature. They are classified as—(1) heat exhaustion; (2) heat hyperpyrexia (heat-stroke or sun-stroke); (3) the gastric type of illness; and (4) the choleraic or gastro-intestinal type.

Ætiology.—*Exposure to high temperature.*—Cases commonly occur amongst those exposed to the sun in the hot seasons of a tropical climate; but the high temperature of the air in a dwelling, or the excessive heat to which stokers are exposed on board of ships, or, indeed, any prolonged exposure to a high atmospheric temperature, whatever its nature, may cause any of the types of heat-stroke. When the shade temperature reaches 110° F., danger occurs, and with each degree rise above this limit an increasingly larger number of cases results. The effect of heat exposure is cumulative in action, and it is a succession of hot days which is followed by a large number of cases of heat-stroke. A comparison by Willcox of the case incidence curves with the temperature curves in the Mesopotamian campaign indicated a delay of a few days in the rise of the former. An individual exposed to heat for one or more days may not be taken ill until the evening or early morning, when the temperature has fallen considerably, the cumulative effect of the exposure gradually overcoming the body resistance. Since the temperature in the sun greatly exceeds that in the shade, exposure to the sun's rays is a very important exciting cause. In the hot seasons of tropical countries this danger is well known, and exposure to the sun is avoided, as far as possible. It has not been shown that any rays of the sun other than the heat rays have a special significance in the causation of heat-stroke.

Climate.—Tropical climates in seasons when the shade temperature exceeds 110° are associated with the various forms of heat-stroke, and heat waves in any climate, if the temperature is sufficiently high, act as causes of illness. The absence of shade from the sun is an important factor, and heat-stroke is specially associated with hot climates of countries where flatness and absence of trees and vegetation are marked, as, for example, in Mesopotamia and the country round the Persian Gulf, and desert regions generally, as in the Sahara Desert in Africa. In countries where, during the hot season, there is little fall of the temperature at night, the danger from heat-stroke is increased.

Humidity of the atmosphere is an important predisposing factor. If this is high, heat loss is retarded, and there is greater liability to heat-stroke.

Stagnation of air.—Free currents of air promote the evaporation from the skin and protect by increasing heat loss. The great protective value of electric fans and punkahs in dwellings is due to this cause. It is important to remember, however, that when the temperature is very high, currents of hot air may do more harm than good, and for this reason in tropical countries, houses provided with fans should be kept closed during the heat of the day, in order that the hot air may be excluded as far as possible. The "Kata" thermometer, introduced by Professor Leonard Hill, F.R.S., records the rate of heat loss from evaporation of a wet

bulb, and is a valuable guide in estimating the dangers from heat-stroke in different situations, such as the wards of hospitals.

Dwellings.—Thick walls of non-conducting material, such as stone, brick, or dried mud are protective, and it is important that the roofs of dwellings should be thick, so as to keep out the heat from the sun's rays. A tent, even of double canvas walls and roofs, affords only poor protection.

Persons of any age are subject to heat-stroke if the exposure is sufficiently great. The case mortality is higher in those over 40. Race is a very important factor. The natives of tropical countries are rarely affected by heat-stroke, unless some complicating disease, such as malaria, is present. White races unaccustomed to tropical climates are specially susceptible to the effects of heat exposure. Exertion is an important predisposing cause. Heavy physical exertion in temperatures over 110° is very dangerous.

Predisposing diseases.—Any disease causing pyrexia, such as malaria, sand-fly fever, enteric and paratyphoid fever, typhus fever and small-pox, predisposes to heat-stroke.

Intercurrent diseases.—In a high percentage of cases the heat hyperpyrexia supervenes in the course of another disease, especially malaria. Cases of febrile disease may be suddenly complicated by hyperpyrexia if exposed to great heat, and special precautions are necessary to prevent this.

Pathology.—The symptoms of heat-stroke in its various forms all point to an auto-intoxication. The effect of high temperature on the brain and central nervous system is to diminish its functional activity, and likewise the excretory organs, such as the liver and kidney, are undoubtedly impaired in their excretory power. In addition, owing to the effect of heat on the muscles and tissues of the body generally, there must be an increased production of toxic substances, due to protein katabolic changes. These factors all tend to produce a marked auto-intoxication, which explains many of the symptoms of heat-stroke. Indican is usually present in the urine in considerable excess, and is evidence of an auto-intoxication. Acetone and diacetic acid are not found in appreciable excess in the majority of cases, though in a small percentage they are present in moderate degree. The auto-intoxication cannot, therefore, be regarded as an acidosis. It has been recently shown by Dr. W. Cramer that beta-tetra-hydro-naphthylamine will cause hyperpyrexia in animals, and it is likely that substances having a similar action are produced as the result of the heat on the tissues. Suppression of sweating has been shown by Dr. K. G. Hearne to be an important factor in the hyperpyrexia cases, the paralysis of the sweat secretion by the intense heat leading to a rapid rise of body temperature. In hot climates, the administration of atropine may be followed by hyperpyrexia from a similar cause. Suppression of sweating does not explain the causation of the gastric and choleraic type of heat-stroke, nor of heat exhaustion. It has been stated that heat-stroke is due to a bacterial infection; but there is no recent evidence to support this view. In the Mesopotamian campaign a large number of blood examinations were made during life in cases of heat-stroke, but all gave a negative result.

Rigor mortis occurs early, and putrefactive changes set in within a few hours of death. Œdema and general hyperæmia of the brain and lepto-

meninges occur, and the nerve cells in the grey matter show marked degenerative changes. Petechiæ occur in the skin and mucous membranes in severe cases. The right side of the heart is dilated, and venous congestion is marked in all the organs. Signs of intercurrent diseases, such as malaria and typhoid, may be present.

Prophylactic Treatment.—Adequate protective covering for the head by thick pith topees or good cork helmets is essential. Spinal pads for protection of the spinal cord are valuable. The clothing should be light and loose and not too thin. Hand-fans and umbrellas are of value. A large amount of water should be drunk by those exposed to great heat, as so much moisture is lost by the skin in regulating the body temperature. Alcohol should be avoided during the heat of the day. Constipation should be guarded against, as it predisposes to the effects of heat.

Symptoms, Prognosis and Curative Treatment.—1. HEAT EXHAUSTION.—The onset is sudden, with weakness, giddiness, faintness and inability to walk. A mild pyrexia of 102° or 103° F. occurs, lasting 2 or 3 days. The pulse is rapid and weak, and some cardiac dilatation is usually evident. If early treatment is adopted, the symptoms quickly improve; otherwise, there is a great risk of the supervention of hyperpyrexia.

The treatment consists in removal from heat, rest in bed and the administration of aperients.

2. HEAT HYPERPYREXIA.—The onset may be sudden, with rapid rise of temperature, coma and convulsions. In other cases, the onset is preceded by malaise, headache, restlessness and sometimes nausea or vomiting. Frequency of micturition and urethral pain may occur. The temperature is somewhat raised—to 100° or 102° F. or so—and the skin hot and dry. These premonitory symptoms may last for a few hours, sometimes as long as 48, when the temperature rises to 110° F. or more, and mental excitement and delirium supervene. Coma and stertorous breathing now occur, and the face is flushed and cyanosed, the conjunctivæ being congested. The pupils are commonly dilated in the early stages and contracted in the comatose condition. Parotitis may occur, and petechiæ of the skin may be present in severe cases.

Albumin is frequently present in the urine in small amount in acute cases. An excess of indican is usual, and in some cases acetone and diacetic acid occur. Fibrillary twitchings of muscles and convulsions usually result, and the breathing is frequently Cheyne-Stokes in character. Incontinence of urine and fæces occurs with the coma, and death rapidly results, unless the temperature is reduced. Marked cardiac dilatation, often associated with a systolic murmur, is present. Bronchitis and pulmonary congestion sometimes occur, and pulmonary œdema is a terminal event. In the acute stage the knee-jerk is almost always absent, and does not return until the symptoms have cleared up.

Defective articulation (anarthria) occasionally occurs as an after symptom, and sometimes nystagmus, or squint, with diplopia has been observed. Multiple neuritis, with weakness and wasting of the extensor muscles of the legs, is a rare late complication. After the subsidence of the hyperpyrexia, a pyrexia up to 102° or 103° F. may persist for several days, and is due to the auto-intoxication present, no organism being found in the blood in the uncomplicated cases. For some weeks after the subsidence of the tempera-

ture there is great liability to a recurrence of heat hyperpyrexia, and the utmost care must be taken to avoid exposure to heat.

Sequelæ.—Cardiac dilatation may last for some days or weeks after an attack. There is a great susceptibility to heat for a long period after an attack, and headache may follow slight exposure, so that residence in a cool climate is advisable for some years afterwards. An abnormal mental condition, amounting in some cases to insanity, may result. Persistent nervous symptoms, the result of actual organic changes in the brain or cerebellum, may remain. The presence of the knee-jerks is a valuable prognostic sign; if they remain absent there is danger of a recurrence.

Treatment.—The patient should be placed in cool surroundings and hydro-therapeutic measures immediately adopted. Spraying with ice-cooled water, the patient lying on a bed with a rush mattress, so that there is free circulation of air round the body, is the most convenient method. Ice should be applied to the back of the neck and head. Rectal injections of ice-cold water are of value. Should the hyperpyrexia not quickly subside, or should it not be readily controlled, an intramuscular or intravenous injection of a solution of quinine bihydrochloride, grs. x, should be given. Blood film examinations should always be made immediately when hyperpyrexia occurs, and if these show a malarial infection the quinine treatment should be continued, daily injections being given for 3 or 4 days, and afterwards an oral course. Convulsions are best treated by a venesection of 10 to 20 ounces, and rectal injection of ice-cold water containing 2 drms. of bicarbonate of soda to the pint. In cases with convulsions it is not advisable to give intravenous saline after venesection, for the intravenous injection may cause recurrence of the convulsions. In some cases morphine hypodermically or inhalations of chloroform may be required. Cardiac failure should be treated by digitalin, strychnine, adrenalin or pituitary extract hypodermically. Failure of respiration should be treated by artificial respiration, and oxygen bubbled through alcohol may be administered.

3. The Gastric Type.—In this insidious type of illness for several days the patient will suffer from restlessness and mental irritability, nausea and occasional vomiting. The face is flushed and the mouth temperature normal; but the rectal temperature may show a rise of a degree or two. The liver shows some enlargement, and the knee-jerks are lost. In many of these cases after 4 to 10 days' illness a sudden hyperpyrexia occurs, which is often fatal.

Treatment.—This consists in keeping the patient as cool as possible, free purgation, a lacto-vegetarian diet, and rectal injections of ice-cold water containing bicarbonate of soda, 2 drms. to the pint, and the administration of 30 grains of sodium bicarbonate every 3 hours; by these means hyperpyrexia is avoided.

4. Gastro-Intestinal or Choleraic Type.—In this form of illness the onset is sudden, and marked collapse is present. The temperature is raised to 100° or 102° F., and vomiting and diarrhœa occur. The face is pale, the skin clammy and the eyes sunken. The knee-jerks are lost. The stools are watery, and free from cholera organisms. Death usually occurs after a 3 or 4 days' illness.

Prognosis.—This is very grave.

Treatment.—This consists in protection from heat, the administration

of normal saline subcutaneously or intravenously, and the administration of suitable cardiac stimulants hypodermically.

HEAT CRAMPS.—Attacks of heat cramps occasionally occur in persons who perform muscular exercises while exposed to high temperatures. The condition occurs in stokers on board ship, and in furnace workers. The muscular spasms occur in the calves, arms and sometimes the abdominal muscles, and are severe and very painful. They may last from 12 to 36 hours, and are followed by soreness and weakness.

ALCOHOLISM

The term "Alcoholism" denotes the toxic effects, whether acute or chronic, resulting from the ingestion of alcohol in some form. The subject may be conveniently divided into—(1) Acute alcoholism; (2) chronic alcoholism; and (3) delirium tremens (*see* pp. 367, 1701).

1. ACUTE ALCOHOLISM

Pathology.—The mucous membrane of the stomach may be found red and congested, the brain and viscera are usually congested and the right heart filled with dark fluid blood. Alcohol may be detected in the stomach contents, and also in the blood and cerebro-spinal fluid.

Symptoms.—When a large quantity of alcohol is taken the symptoms come on in a few minutes. The face is flushed and often slightly cyanosed. There is mental disturbance and confusion of ideas, with excitement. The speech is thick. The gait is ataxic, and muscular inco-ordination marked. After a short period, in severe cases, the patient becomes stuporose and later unconscious and comatose. In the unconscious stage of alcoholic poisoning the patient may usually be roused to some extent so as to give an incoherent reply. The comatose condition may gradually pass away and the patient recover. The pupils are generally dilated, and in severe cases may not react to light. The pulse is full, and the respirations are deep until the late stages. The breath generally has the odour of alcohol; but it should be borne in mind that frequently alcohol is administered as a restorative to patients in an unconscious state, and the smell of the breath may be due to this cause.

In some cases death occurs—(1) from shock, which may occur early when a large quantity of concentrated alcohol is taken; (2) from syncope, preceded by prolonged coma; and (3) after an apparent recovery from a comatose state, a sudden fatal syncope may occur.

Diagnosis.—This is of the greatest importance, since serious consequences may result if a diagnosis of acute alcoholism is made in conditions due to other causes. It is often impossible for an exact diagnosis to be made until the patient has been kept under observation for some little time, and this precaution should always be taken where there is any doubt as to the diagnosis.

Conditions simulating the coma of alcoholic poisoning are:

1. *Cerebral lesions.*—(*a*) Traumatic lesions, such as fracture of the skull, concussion, etc. (*b*) Vascular lesions, such as hæmorrhage, thrombosis

or embolism. (*c*) **Inflammatory conditions**, such as acute meningitis, *e.g.* epidemic cerebro-spinal meningitis, and encephalitis lethargica. (*d*) **Cerebral tumour**, with sudden coma. (*e*) **Epileptic coma**, especially that occurring in status epilepticus. (2) *Auto-intoxications*, e.g. uræmia, diabetic coma, and the coma of acid intoxications. (3) *Toxæmic conditions*, e.g. the coma occurring in typhoid fever, influenza, septicæmia of various kinds, malaria, sleeping sickness, etc. (4) *Toxic conditions*, resulting from other poisons producing a state of coma, *e.g.* opium and its alkaloids, sulphonal, veronal, chloral, chloroform and a large number of other narcotic drugs.

An exact diagnosis can only be made by carefully considering the history of the case, and by a very careful physical examination. Examination should be made for signs of injury, or evidence of a cerebral lesion, such as hemiplegia, papilloedema, cranial nerve paralysis, unequal pupils, etc. The urine should be examined for albumin, sugar, acetone, diacetic acid, casts, etc. A careful clinical examination should be made for evidence of toxæmic conditions, such as pyrexia, enlarged spleen, rashes, abnormal conditions of the blood, etc. The presence of other poisons than alcohol can in some cases be suspected by the symptoms, *e.g.* in opium poisoning the pupils are generally pin-point, the skin moist, and the breathing slow and shallow. An exact diagnosis can be made by the analysis of the gastric contents or of the urine, when alcohol or other poisons may be detected. Alcohol can be found in the blood, urine and cerebro-spinal fluid of persons suffering from acute alcoholism.

Recent toxicological research has shown that alcohol is always present in the blood and urine during the acute stage of alcoholic intoxication. The amount present is usually over 0·1 per cent. It has been suggested that these tests should be made use of for the medico-legal diagnosis of "drunkenness." In the present state of our knowledge, no exact percentage of alcohol in the blood and urine can be fixed as the precise limit between sobriety and drunkenness for medico-legal purposes, though excessive percentages of alcohol strongly indicate the diagnosis of drunkenness or acute alcoholism.

Treatment.—The stomach should be washed out by means of a soft stomach tube and funnel, and about a pint of hot strong coffee introduced. In severe cases strychnine may be given hypodermically, *e.g.* $\frac{1}{30}$ grain every 4 hours.

DIPSOMANIA is a form of acute alcoholism which manifests itself in periodic attacks of indulgence in great alcoholic excess. Between the attacks alcohol is often entirely abstained from. In dipsomania there is a paroxysmally recurring overwhelming desire for excess of alcohol, which must be regarded as an abnormal mental condition not induced by the previous taking of alcohol.

PSEUDO-DIPSOMANIA is a condition in which paroxysmal attacks of alcoholic excess occur, these attacks being induced by the ingestion of alcohol. There is no overwhelming craving for alcohol; but the accidental taking of alcohol from any cause is the starting-point of a drinking bout.

Treatment.—In *dipsomania*, if the patient is seen during an attack, rest in bed and special nursing supervision are essential. A dose of apomorphine hydrochloride hypodermically of $\frac{1}{10}$ gr. should be given, unless there is marked cardiac weakness. This will probably induce vomiting, and sleep for some hours usually follows. Afterwards the craving has usually abated, but further small doses of apomorphine hydrochloride, *e.g.* $\frac{1}{30}$ gr., may be

given for an hypnotic effect. This dose may be repeated after a few hours for three or four doses. In the premonitory stages of dipsomania, when the craving is commencing, one or two hypodermic doses of $\frac{1}{10}$ gr. of apomorphine hydrochloride will often induce slight nausea, followed by sleep, and on awakening the craving for alcohol will have disappeared.

In *pseudo-dipsomania* the treatment during an attack is similar to that of dipsomania.

Total abstinence is essential in the intervals between the attacks in both conditions. Often a complete change in the surroundings and mode of life will be effectual in preventing a recurrence of the attacks. Psycho-therapeutic treatment has been of value in some cases.

2. Chronic Alcoholism

In this condition alcohol is taken over long periods in amount to produce toxic effects without necessarily the manifestation of the symptoms of acute poisoning described above.

Ætiology.—An unstable nervous system is commonly the basis on which habitual alcoholic excess develops. Worry, over-work, grief, disappointments, etc., often lead to the resort to alcohol as a temporary relief, and so the habit of alcoholic indulgence becomes implanted. *Occupation* is an important factor. Those engaged in the sale of alcoholic drinks are frequently unable to resist the temptation of the alcoholic habit. Occupations involving great mental or bodily strain, long hours and excitement often predispose. *Heredity.*—There is commonly a family history of alcoholic excess; but it is the inherited condition of an unstable nervous system which may cause slight indulgences to lead to the formation of the alcoholic habit. *Habit.*—In predisposed persons the alcoholic habit is quickly established, and for this reason medical practitioners must use the greatest caution in prescribing alcohol for patients except in special cases.

Pathology.—The important constituent of alcoholic drinks is ethyl-alcohol. Spirits (brandy, whisky, rum, gin, liqueurs, etc.) contain from 40 to 60 per cent. of alcohol. Wines, such as port, sherry, madeira, contain from 15 to 25 per cent. Light wines, such as claret, hock, champagne, burgundy, contain from 10 to 15 per cent. Light beers contain from 2 to 5 per cent. of alcohol. In the case of spirits, higher alcohols, such as propyl-butyl, and amyl-alcohols (constituents of fusel oil), may be present in small amount. These are much more toxic than ethyl-alcohol; but researches have shown that they are not present in a sufficiently high percentage to be really important toxic factors. The presence of esters in wines and spirits adds to their flavour and bouquet without increasing their toxicity. It may be accepted that the determining factor in the toxicity of alcoholic beverages is the percentage of ethyl-alcohol present. Medicated wines often contain quite a high percentage of alcohol.

Alcohol in small quantities may have a slightly stimulating action on the gastric digestion and on the heart, and when a certain degree of tolerance is established alcohol may have a definite food value; but there is abundant evidence to show that the effect of alcohol in appreciable quantities is of a toxic nature. Thus there is a depressing action on the nervous system, and judgment and perception become quickly impaired. In large quantities

alcohol is a narcotic poison and also it is a definite tissue poison, producing degenerative changes in the liver, heart, kidneys, blood vessels and nervous tissues. There is no doubt that the toxic effects of alcohol are more marked if it is taken on an empty stomach, or with an insufficient amount of food in the dietary.

The combination of alcohol with other poisons, *e.g.* arsenic, may increase the toxic effect of the latter. This was well shown in the epidemic of beer poisoning in 1900, where the presence of relatively small quantities of arsenic in beer caused in a number of cases severe symptoms of chronic arsenical poisoning.

Circulatory system.—In the blood vessels the result of chronic alcoholism may be atheromatous change. In the heart fatty degeneration is common, and this is often associated with brown atrophy. Fibrous myocarditis may result from atheromatous changes, causing obstruction in the coronary arteries. Cardiac dilatation may occur as a consequence of the myocardial changes, or of atheromatous valvular changes. *Liver.*—Fatty degeneration of the liver cells occurs, and this is often accompanied or followed by cirrhotic changes (see pp. 383, 633). Alcohol may produce an enlarged, yellow, fatty liver, which is characteristic of excessive beer-drinking, or an atrophic cirrhosis—the so-called hob-nailed liver—such as follows excessive indulgence in spirits. *Kidneys.*—Alcohol may cause fatty degeneration and necrosis of the renal epithelium, and it is undoubtedly an important factor in the causation of chronic parenchymatous nephritis and chronic interstitial nephritis.

Nervous System.—The atheromatous changes occurring in the cerebral vessels lead to degenerative changes in the cells of the grey matter; but there is no doubt that alcohol has also a direct effect upon them, so that the nerve cells in the cerebral cortex show the usual appearances resulting from a direct tissue poison, *e.g.* swelling of the nerve cells with vacuolisation, pigmentation and chromatolysis, and also marked degeneration of the apical processes. In the nerve fibres degenerative changes are seen in the axis cylinders, and also interstitial changes are common.

Symptoms.—The tongue is usually furred, and morning retching is common. The appetite is poor, and complaint is made of abdominal discomfort and flatulence. There may be pain and discomfort in the epigastric and left hypochondriac regions, due to gastritis, or discomfort in the right hypochondrium, due to hepatic congestion and perihepatitis. There may be looseness of the bowels, and hæmorrhoids are common. The liver may be enlarged and somewhat tender, and this is sometimes accompanied by splenic enlargement. In old-standing cases symptoms of alcoholic cirrhosis, such as slight jaundice, ascites and intestinal catarrh, are likely to occur (see Cirrhosis of Liver). The venules on the face become dilated, and the patient may show the characteristic appearance of the face and nose such as occurs in acne rosacea. The eyes are prominent and may show some conjunctival injection, with slight bile staining of the sclerotics. The heart is often dilated, and as a result œdema of the legs may occur. The urine often contains albumin, with possibly some granular and hyaline casts.

In chronic alcoholics there is undoubtedly a lowered resistance to tuberculosis, and a careful look out for signs of pulmonary tuberculosis should be kept.

Nervous system.—The mind becomes affected early. The patient is

irritable, and the judgment and will are impaired. Loss of memory is a characteristic symptom. Change in the moral character is common. Tremor of the hands and tongue is frequent, and unsteadiness of the muscles in performing any action is often seen. Symptoms of peripheral neuritis are likely to occur, such as pains and numbness in the limbs, hyperalgesia, tenderness of the calves and weakness of the legs. In severe cases, foot-drop and even wrist-drop may occur, there being great muscular weakness and loss of the patellar reflex. Mental symptoms, such as hallucinations and delusions, are common, and in advanced cases a condition of dementia may result.

Korsakoff's psychosis is a term which has been applied to a combination of polyneuritis with a characteristic mental condition due to alcohol. A condition of low delirium may occur, and hallucinations and even delusions are common. There is loss of memory for recent events. Marked symptoms of polyneuritis develop, and paralysis of cranial nerves may occur.

Epilepsy sometimes occurs in cases of alcoholism. This may be due to the toxic effect of alcohol, the gradual withdrawal of which effects a cure. In some cases the sudden withdrawal of alcohol in patients accustomed to large doses over a long period may induce epileptiform attacks. Of course an epileptic patient who indulges in alcoholic excess is thereby rendered more liable to an increased frequency of recurrence of fits.

Treatment.—This depends on the form of chronic alcoholism present. It is usually advisable in this condition to place the patient in a nursing home or special institution, where there will be strict medical and nursing supervision. The patient should understand that the object of the treatment is to remove his desire for alcohol, and it should be impressed upon him that his only safeguard against relapses is continued and entire abstinence. Rest in bed for the first week or so of the treatment is advisable. Sudden withdrawal of alcohol is inadvisable in patients who have acquired a high degree of tolerance, and who have been taking large quantities over a long period. In such cases a gradual reduction of the daily dose is to be recommended, so that at the end of a week complete withdrawal has been effected. At the commencement of treatment a purgative is advisable. The diet should be light and nutritive—fruit, vegetables and milky foods being freely given. Meat and meat soup and highly flavoured cheeses are best avoided. Smoking should be given up, especially in patients in whom it induces a desire for alcohol.

A tonic mixture of cinchona and gentian containing small doses of atropine and strychnine may be given with advantage 5 times daily every 3 hours, *e.g.*

Liq. atrop. sulph., ♏ ½.
Liq. strychnin., ♏ i.
Tinct. cinchonæ co., ♏ xx.
Glycerin., ʒss.
Inf. gent. co. ad. ℥ss.

In addition a mixture of strychnine and atropine is given hypodermically three times a day after meals. The dose of liquor strychnine begins at 2 minims and the dose of atropine begins at 1 m. of a solution of atropine sulphate (1 grain to 1 ounce). The strychnine is increased in dose by 1 m. of the solution every other day until a maximum of 5 minims is reached. The

dose of the atropine solution is increased by 1 minim every other day up to a maximum of 6 minims of the weak solution (1 grain to 1 ounce). After the end of the third week the doses of strychnine and atropine hypodermically are gradually reduced, so that at the end of the sixth week the hypodermic treatment is discontinued. If patients are specially susceptible to the action of atropine it is advisable not to give this drug except in the mixture by the mouth, and only then if it is well borne.

The medicinal treatment should, after the first week, be accompanied by gentle open-air exercise, fatigue being avoided. It is important that congenial occupation should fill up the day, and country surroundings and open air are essential. It is important that insomnia should be avoided by suitable treatment. In debilitated patients general massage and rest in the open air are helpful. In the case of many patients a course of treatment of 6 weeks to 2 months is sufficient, and then the ordinary occupation may be resumed. Every case must of course, be treated according to its special requirements.

3. Delirium Tremens

This is a condition always to be borne in mind in chronic alcoholics. The sudden withdrawal of alcohol, or the occurrence of any accident or acute illness may cause symptoms of this condition to develop. For description of this complication, see p. 1701.

ARSENICAL POISONING

Arsenic is the most important of the irritant poisons, and owing to the almost tasteless property of many of its compounds and preparations it is perhaps the commonest poison used for homicidal purposes. It used to have a reputation as a cosmetic, and was added to face powders, skin lotions, etc. It is practically never used now for such purposes.

Occurrence.—White arsenic, i.e. arsenious acid, or arsenious anhydride, As_4O_6, is the most important of the compounds of arsenic. It occurs in the form of a white powder, or in lumps like glass or porcelain (vitreous arsenic). The powdered form resembles powdered sugar or flour, and when mixed with solid food is tasteless. It is slightly soluble in cold water, an ounce of cold water dissolving from a half to 1 grain. In boiling water it is twelve times more soluble, from 6 to 12 grains dissolving in an ounce. Alkaline solutions readily dissolve arsenic. If white arsenic is sold to the public the law requires that it should be mixed with soot or indigo to colour it. It is used in the composition of sheep dip, arsenical soap, rat poisons, etc.

Metallic arsenic is a black powder and is very poisonous, and is used for killing flies. *Copper arsenite* (Scheele's green) is bright green in colour, and used to be employed for colouring wall-paper, toys, floorcloth, fabrics, etc. Its use for such purposes has fortunately been abolished. *Arsenious sulphide*, or orpiment, is a yellow powder known as king's yellow. *Arsenic acid*, in the form of its potassium and sodium salts, which are white, crystalline and soluble in water, is used as a fly poison and in the manufacture of aniline dyes. Injurious effects, such as local skin eruptions, are sometimes caused by the action of the arsenical compound present in the dye of stockings, etc.

Arseniuretted hydrogen, or arsine, is a very poisonous gas. It is produced when hydrogen is generated in the presence of a compound of arsenic, for example, in the action of mineral acids on impure metals, as occurs in balloon filling, etc.

Salvarsan and the many similar derivatives of arsenobenzene, which are extensively used in the treatment of syphilis and other diseases, may give rise to fatal poisoning.

Sodium arsenite, in the form of solutions of arsenic in caustic soda, or in sodium carbonate, is commonly used for the preparation of fly-papers, weed-killer, preservative for wood, arsenical sprays for fruit trees, etc. Weed-killer and some of the so-called preservatives for wood contain as much as 20 per cent. to 40 per cent. of arsenic in solution, and are intensely poisonous. Both weed-killer and the arsenic obtained from fly-papers have been used for homicidal purposes.

Arsenic in food.—Accidental contamination of food with arsenic, or its preparations, such as weed-killer, has occurred. Arsenical pigments have been used for colouring sweets and cakes, with fatal result. A serious epidemic occurred in 1900, due to the contamination of commercial glucose by arsenic. Sulphuric acid prepared from pyrites and containing a considerable amount of arsenic had been used in the process of the conversion of starch into commercial glucose, so that the latter became impregnated with arsenic. The use of the glucose in the manufacture of beer led to the arsenical beer poisoning epidemic which occurred in Manchester and the North of England. A Royal Commission investigated the cause of this epidemic, and safeguarded the further occurrence of such poisoning. Limits of the amount of arsenic permitted in food-stuffs were fixed at $\frac{1}{100}$ gr. per gallon for liquids and per pound for solids.

The varieties of arsenical poisoning are—(1) acute, (2) chronic, (3) arseniuretted hydrogen poisoning, and (4) poisoning by salvarsan or arsenobenzol derivatives.

1. Acute Arsenical Poisoning

Pathology.—The stomach contents usually contain much mucus, which may be blood-stained. The signs of gastro-intestinal inflammation will be present. The mucous membrane is swollen, red and congested, and petechiæ are usually well marked. The redness is most marked on the summits of the rugæ. When the arsenic has been taken in solid form, white or pigmented particles may be seen on the mucous membrane of the stomach. The duodenum shows marked redness and congestion, and petechiæ may be present; there is usually marked yellow staining, due to altered bile. The small intestine may show similar signs to the duodenum, but these diminish markedly on passing downwards. The liver, kidney and other organs may show cloudy swelling. In fatal cases the arsenic absorbed into the tissues has a preservative action, and tends to delay putrefaction.

Symptoms.—When the poison is taken by the mouth, if well diluted or mixed with food, no taste or pain in the mouth or throat is experienced. The symptoms commence within an hour if the stomach is empty; but may be delayed if the stomach is full, and if the poison is in the solid state there will be further delay. A burning pain occurs in the epigastric region, and nausea

and vomiting usually follow. The vomit will contain any food present in the stomach, and there is often much mucus. Bile is usually present, and sometimes streaks of blood. As the poison is passed on to the intestine, abdominal pain, of a griping or colicky type, and usually diarrhœa occur. The stools are watery, and may contain flakes of mucus. The continued vomiting and diarrhœa cause exhaustion, faintness and collapse. Cramps in the legs may occur, but are not a constant symptom. In a severe case restlessness, stupor and coma develop, and death follows shortly. Death in an acute case may occur within 24 hours, or may be delayed for 3 days or more. When several repeated doses are taken, so that the symptoms are protracted over several days, some of the symptoms of chronic arsenical poisoning may develop.

Fatal dose.—Two grains of arsenic have caused death in a woman, and this is accepted as a possible fatal dose.

Treatment.—The stomach should be washed out, and afterwards as an antidote freshly precipitated ferric hydrate may be given. This is prepared by adding to half a tumblerful of water half an ounce of tincture of perchloride of iron and also sodium carbonate solution till the mixture is distinctly alkaline. Pain is relieved by the hypodermic injection of morphine. Demulcent drinks should be given, and the usual stimulant treatment for collapse.

2. Chronic Arsenical Poisoning

Symptoms.—The gastro-intestinal symptoms—nausea, abdominal pain, vomiting and diarrhœa—are not prominent, and even may be absent. The tongue is often covered with a silvery white fur. General malaise, anorexia and anæmia are usually present. Irritation of the throat and huskiness of the voice, due to the presence of pharyngitis and laryngitis, result. Conjunctivitis may occur, with redness and swelling of the eyelids. Skin affections, such as erythema, herpes, pigmentation, or erythromelalgia, are commonly to be noted.

If taken medicinally, or otherwise, over a long period, arsenic produces a marked general brownish pigmentation of the skin, with localised patches where the pigmentation is darker in colour. The appearance of the skin resembles that of Addison's disease, but differs from this condition in the absence of pigmentation of the mucous membrane and in the presence of the other signs of chronic arsenical poisoning and of arsenic in the urine and hair and nails. Thickening of the epidermis of the soles and palms, and irregular thickening of the nails are present in long-standing cases. In some cases salivation is a marked feature, a condition of paroxysmal attacks of excessive secretion of saliva occurring. Symptoms of multiple neuritis are likely to develop, and these affect both the upper and lower extremities.

Long-continued poisoning causes marked anæmia, peripheral neuritis, progressive wasting and heart weakness, death resulting from exhaustion and cardiac failure, ascites and general œdema occurring towards the end. The urine, fæces, the distal portions of the hair and the nails contain arsenic, its detection serving to confirm the diagnosis during life. The tests for arsenic will be found in works on toxicology. It must be remembered that in cases of suspected arsenical poisoning the diagnosis can always be made

with certainty by an analysis of the urine, vomit and fæces, and these should always be taken for examination, the tests being made by an expert toxicologist.

Treatment.—This consists in the prevention of the absorption of arsenic in any way, and eliminative and stimulant treatment.

3. Arseniuretted Hydrogen Poisoning

Arseniuretted hydrogen is a very powerful poison, and cases of poisoning result when hydrogen containing the gas is inhaled. Cases have also occurred when "ferro-silicon," a substance used for hardening steel, has come in contact with water, when a mixture of arseniuretted and phosphoretted hydrogen is evolved. Arseniuretted hydrogen has a very toxic action on the liver and kidneys, and it is also a blood poison.

Pathology.—Marked degenerative changes in the cells of the liver and kidneys, and numerous petechiæ on the mucous and serous membranes, are to be noted.

Symptoms.—Malaise, headache, dizziness and shivering occur within a few hours. Vomiting, jaundice, hæmaturia and anæmia develop. Delirium, stupor and coma precede death, the symptoms being exactly similar to those of icterus gravis.

4. Poisoning by Salvarsan and Arsenobenzene Derivatives

Salvarsan and kharsivan are usually administered intravenously. After a full dose (0·6 gramme) usually nausea, a slight rise of temperature, with perhaps vomiting and a little diarrhœa, occur in the following 24 hours, after which the patient is quite well. Occasionally severe vomiting and diarrhœa, with furred tongue, erythematous rash and acute gastro-intestinal symptoms, may follow. In such cases it is probable that there has been some decomposition in the solution administered, the symptoms resembling those of acute arsenical poisoning. This type of poisoning is rare.

When dangerous toxic symptoms occur after salvarsan they are usually of the following type: After an interval of 2 or 3 days, vomiting and restlessness, delirium, stupor, often with twitchings of muscles, convulsions and Cheyne-Stokes breathing, occur. Sometimes jaundice may be observed. Coma develops, suppression of urine, and death may occur within 48 hours of the onset of symptoms. The symptoms are those of an auto-intoxication like icterus gravis, and are the result of the action of salvarsan causing impairment of the function of the liver and kidneys. The prognosis is very grave. Treatment consists in the administration of alkalis by the mouth and bowel, and saline per rectum.

Salvarsan and allied compounds often cause, especially after the administration of successive doses, such damage to the liver that extensive necrosis occurs and toxic jaundice develops, which may be fatal (see also p. 210).

CHRONIC MERCURIAL POISONING

Ætiology.—This condition occurs chiefly amongst workers in the metal, or amongst those who are constantly brought into contact with compounds of mercury; for example, it is found amongst those engaged in mining

and separation of the metal, *e.g.* at Almaden in Spain, at Idria in Austria, and at the mines in California, China, Peru and the Ural Mountains. Mirror makers, thermometer and barometer makers, and those engaged in the manufacture of chemical and electrical apparatus in which metallic mercury is used, are exposed to risk. Those engaged in the frequent handling or grinding of mercury compounds in chemical works and businesses are sometimes attacked. It must be remembered that mercury is volatile at ordinary temperatures, and those working in ill-ventilated rooms where mercury is exposed are liable to attack. Cases have been recorded of chronic mercurial poisoning from the amalgam in tooth stoppings, and from sojourn in a respiration apparatus fitted with mercury air-valves. The nitrate of mercury is used in the preparation of some furs, and hat makers and furriers may be liable to chronic poisoning. The condition may result from the medicinal use of mercury, as for example from the continued administration of calomel or blue pill or other mercurial preparation in small doses, or from the prolonged use of mercurial vaginal douches or skin applications.

Symptoms.—Dyspepsia, anæmia, general cachexia, with loss of weight and strength, occur. Sometimes a marked blue line is seen on the gums if the teeth are neglected. Stomatitis is one of the most constant symptoms; increased salivation and marked fœtor of the breath occur, and are associated with tenderness of the gums, looseness of the teeth, and all the symptoms of severe pyorrhœa; this condition is associated with a streptococcal infection of the gums, and is progressive, so that after the patient is removed from the influence of mercury or its compounds a condition of pernicious anæmia may result. In 1920 the writer had under his care at St. Mary's Hospital a man suffering from typical pernicious anæmia. The patient had for some years been working at a chemical store where he frequently had to grind and handle vermilion (mercury sulphide). This set up a severe pyorrhœa, from which resulted the progressive pernicious anæmia, which continued long after his removal from the influence of mercury. A streptococcal infection was found in the gums, and a secondary intestinal infection resulted. Colitis, often of an ulcerative type, may result from chronic mercurial poisoning. It is a dangerous complication and difficult to treat. Skin rashes of an erythematous, eczematous or pustular type have occurred. Glycosuria has been described, but it is rare.

The most characteristic symptoms are the nervous manifestations. Tremors, affecting the muscles of the tongue and face, the arms and hands, and later the legs and trunk, occur. They are of a fine type, resembling paralysis agitans; but the rigidity of the muscles in the latter condition is absent, nor are the characteristic facial appearance and gait present. Sensory disturbances, such as anæsthesia or hyperæsthesia, may occur, and sometimes marked mental symptoms, such as hallucinations, delusions and mania result. The kidneys may be affected and a chronic nephritis develop.

Diagnosis.—This is made by the history and symptoms; but it should be confirmed by the analytical tests. Mercury is excreted in small amounts in the fæces. The greatest care should be taken that no mercurial preparation is being administered medicinally during any time when the patient is undergoing treatment. The fæces are collected, and the organic matter destroyed by treatment with hydrochloric acid and potassium chlorate. The resulting

solution is submitted to electrolysis, and the mercury present is deposited on a gold kathode, from which it may be dissolved and submitted to the usual chemical tests.

Treatment.—This consists in the removal from all influence of mercurial intoxication. Saline aperients, such as Epsom salts or sodium sulphate, should be given daily, to promote the free elimination of the poison by the bowel. The treatment is conducted on general lines to counteract the symptoms produced.

LEAD POISONING

Acute Lead Poisoning

This is rare. It usually results from swallowing a large dose of a soluble lead compound, such as acetate of lead, which is also known as sugar of lead, from its sweetish taste.

Pathology.—There are the usual signs of acute gastro-enteritis, and the stomach may be covered with a whitish grey deposit. The wall of the stomach and duodenum is sometimes thickened and softened, and erosions may occur from the local action of the lead compound.

Symptoms.—An astringent metallic taste is at once experienced, followed by a feeling of constriction in the œsophagus. A burning sensation and pain are felt in the epigastrium, and vomiting occurs. The vomit contains opaque whitish material, due to the precipitated albuminate of lead and lead chloride, formed by the action of the lead salt on the gastric contents. Blood may also be present. Severe colicky pains occur in the abdomen, with rigidity of the abdominal muscles. Pressure on the abdomen gives relief, and the patient may bend forwards for this purpose, or lie on his abdomen. The tongue is coated, and the bowels are usually constipated; but occasionally diarrhœa occurs. The stools are dark coloured, owing to the formation of black sulphide of lead. Prostration and collapse occur, if the abdominal symptoms are severe. There may be numbness or paræsthesia of the limbs and cramps in the legs. The urine may be partially suppressed. A blue line on the gums does not usually occur during the acute symptoms following a single dose of the poison.

The subacute form of poisoning follows the taking of repeated doses of a soluble lead compound. It may occur from repeated medicinal doses of lead acetate given to control diarrhœa. The symptoms of abdominal colic (lead colic) are pronounced, and the bowels are very constipated. The other symptoms of acute lead poisoning occur, but are less intense in character. A blue line usually appears round the margin of the gums, owing to the formation of lead sulphide by the action of the decomposing food material around the teeth on the albuminate of lead in the gum tissue. If the teeth are frequently cleaned a blue line on the gums is less likely to be formed. Symptoms of lead neuritis may result if the symptoms are of long duration.

Diagnosis.—The diagnosis of acute or subacute lead poisoning can be confirmed by analysis of the vomit and fæces for lead during life, and after death by finding lead in the gastro-intestinal tract, liver, spleen and kidneys.

Acute and subacute lead poisoning are rarely fatal.

Treatment.—If the case is seen within 3 hours of swallowing the poison, the stomach should be washed out with water. Sulphate of soda or sulphate of magnesia in half-ounce doses, dissolved in half a tumblerful of warm water, should be given every 4 hours, till free purgation results, and this may be assisted by soap enemata if necessary. The abdominal pain may be relieved by hot applications, or, if necessary, morphine and atropine hypodermically. Demulcent drinks, such as albumin water, barley water and milk, should be given, and saline aperients should be administered for some weeks.

Lead Tetra Ethyl Poisoning

Lead tetra ethyl is a liquid organic compound of lead, which is very poisonous. It has a selective action on the central nervous system, and produces acute mental symptoms, such as mania, and the symptoms of "lead encephalopathy." Several fatal cases have been recorded. This substance has attracted public notice recently, owing to its use as an addition to motor petrol, in amounts of about 1 in 1300. This variety of motor fuel is known as "ethyl petrol," and its use has been submitted to a Government inquiry. No cases of poisoning from the use of ethyl petrol have been recorded, but special care is required in its preparation and handling, for fear of toxic effects.

Chronic Lead Poisoning

Ætiology.—Chronic lead poisoning is common, and is caused by the continued absorption of lead into the system. In certain industrial occupations lead and its compounds are largely used, and workers are exposed to serious risks. The strict regulations of the Home Office have greatly reduced the frequency of lead poisoning in these industries; but there are numerous occupations, such as those of painters and plumbers, which cannot be efficiently controlled, and these give rise to a large number of cases of poisoning. The channel of absorption of lead appears to be the alimentary canal, and the poison is taken into the system, either in the form of small particles entering the mouth or nose, which are swallowed, or by eating of food, which becomes contaminated with lead compounds from the hands of the worker, owing to lack of cleanliness. Statistics show that women are more susceptible to lead poisoning, when exposed to the same risks as men. Idiosyncrasy is a factor in the development of lead poisoning, certain persons being more susceptible, especially those with gouty tendencies. Alcoholism also seems to be a predisposing cause.

The sources from which lead is derived in chronic poisoning are very numerous, and they may be divided into those due to occupation risks, and those due to accidental poisoning.

Occupation risks.—Workers in lead factories, especially white lead, are often attacked; but the frequency of occurrence amongst them has been much reduced by recent legislation. Painters provide the largest number of cases. Plumbers, earthenware markers who use lead glazes, file cutters, compositors who handle lead type, gasfitters who use red and white lead, and those working with electrical lead accumulators, are exposed to serious risks. The enamelling of iron plates with lead glazes and the smelting of lead ores also give rise to a certain number of cases.

Accidental causes.—Drinking water, especially if it is soft, or contains traces

of acids derived from peaty sources, may dissolve lead from lead pipes, or cisterns, and so give rise to poisoning. The cooking of food in vessels tinned with solder containing lead may give rise to lead poisoning, especially if vegetable acids are present. The lead glaze on earthenware vessels may contaminate food or drink containing organic acids, *e.g.* vinegar, lemon juice, cider and home-made wines. Tinned foods sometimes contain lead from solution of the solder used in the tinning process. The lead foil used for wrapping sweets or foods may give rise to contamination of the food. Beer or cider, drawn from casks through lead pipes for consumption, may become heavily contaminated. Hair dyes and cosmetics containing lead, and aerated waters in syphons with pewter or lead valves, and chromate of lead, which has sometimes been used to colour confectionery and for dyeing hosiery, may all give rise to lead poisoning. Accidental poisoning may occur in many other ways than those mentioned.

Abortifacient uses of lead.—It has been well known that lead compounds, if absorbed into the system, give rise to abortion in pregnant women. A like effect has been observed in animals in the proximity of lead works. Lead plaster, known as "diachylon," has been largely used in certain districts by pregnant women in order to cause miscarriage, the substance being swallowed in small portions rolled up in the form of a pill. This form of lead poisoning is very dangerous, and usually if a miscarriage occurs death occurs later from lead poisoning. In consequence of this custom, the sale of lead plaster or "diachylon" has been restricted by placing it in Part I. of the Poisons Schedule.

Pathology.—Arterial disease and chronic interstitial nephritis result from chronic lead poisoning, and are the common causes of death, so that the usual post-mortem signs of these conditions are generally found. Lead paralysis is usually regarded as peripheral; but it does not correspond with the distribution of the peripheral nerve supply. Degenerative changes have been found in the anterior cornual ganglion cells and in the peripheral nerves.

Toxicological analysis will show a wide distribution of lead in the various organs; but since death frequently occurs years after exposure to lead poisoning, the quantities found may be very small, and require special methods for their detection. Recent researches by refined methods of analysis have shown that lead is commonly present in the urine of persons in normal health. Quantitative analysis is, therefore, necessary before deciding that lead poisoning is present. The amounts found should far exceed those minute quantities that may be present normally.

Symptoms.—The most important changes caused by chronic lead poisoning are those of chronic interstitial nephritis and arterial disease, and many of the symptoms, for example, cachexia, chronic dyspepsia, anæmia, vertigo, high blood-pressure and cerebral symptoms, are really due to these secondary conditions rather than to the direct action of the lead in the system. The early symptoms are dyspeptic in type: anorexia, constipation, epigastric and abdominal pains, and discomfort bearing an indefinite relation to food. The skin is of a lemon colour. Anæmia of a secondary type occurs, and may be marked. Vertigo, headache and insomnia often occur.

Special symptoms due to lead.—The blue line on the gums has already been described. Colic usually occurs as an early symptom, but it may be absent in cases showing marked arterial disease and renal changes. Arth-

ralgic pains round various joints are common, the knees, shoulders and elbows being most frequently affected, and creaking or grating and impairment of movement may be present. Gouty changes of an advanced type are seen, especially in the fingers in chronic cases. Nervous.—Lead neuritis is the commonest manifestation. This is usually motor in type, and few, if any, sensory changes occur. The neuritis is generally bilateral, but may be limited to one side. The upper extremities are generally only involved, and the extensors of the forearms are most commonly affected. The extensors of the fingers and wrist are usually the first to suffer, the supinator longus being spared, so that marked wrist-drop occurs early. Exceptionally, an upper arm paralysis results, the deltoid, biceps, coraco-brachialis and supinator longus being attacked. Sometimes the interossei and thumb muscles are affected, and a "claw hand" results. The lower extremities may be affected, but only after marked changes in the upper extremities, and the extensor muscles of the feet are usually involved in such cases.

The cerebral symptoms have been termed "Lead encephalopathy." Headache, vertigo and insomnia are common. Amaurosis may occur, and sometimes marked mental symptoms, such as hallucinations, delusions and delirium, are present. Drowsiness and stupor may occur and develop into coma. Epileptiform convulsions are common symptoms in diachylon poisoning, and they may occur as the result of the uræmia from the nephritis caused by the poison. Papillœdema occurs in chronic lead poisoning.

Any of the symptoms of chronic interstitial nephritis or arterial disease, such as those due to uræmia or cerebral hæmorrhage, may occur as late symptoms of chronic lead poisoning.

Prognosis.—Chronic lead poisoning usually attracts attention in consequence of the symptoms due to the arterial disease and chronic renal disease caused thereby. In such cases the prognosis is grave, and is determined by the arterial and renal damage which has resulted. The occurrence of convulsions is of grave significance. Symptoms of chronic lead poisoning, such as lead colic, or neuritis, if not associated with arterial or renal changes, are not of grave significance, and will most likely clear up, though some permanent wasting may occur in cases where neuritis is present.

Treatment.—*Prophylaxis* is all-important, and should early symptoms of lead poisoning occur, permanent removal from any chances of lead absorption is imperative. Cleanliness of the hands, and prevention of access of lead, or its compounds, to the mouth, or nose, by avoidance of contaminated dust, and the use of respirators are essential. Saline aperients, such as sulphate of soda or sulphate of magnesia, should be taken daily over a long period to eliminate the lead from the system. Iodide of potassium in doses of 10 grains three times daily may be taken for a long period, if tolerated. The symptoms of secondary anæmia, arterial disease, and chronic interstitial nephritis, should they occur, require treatment on the lines indicated under these headings. Lead neuritis should be treated on the lines described under peripheral neuritis.

CARBON MONOXIDE POISONING

Carbon Monoxide, or Carbon Oxide (CO), is a very poisonous gas. If present in the air breathed in an amount equal to 0·2 per cent. it is capable

of destroying life; while an atmosphere containing 0·05 per cent. of carbon monoxide gives rise to definite symptoms of poisoning.

Ætiology and Pathology.—When carbon is burnt in a limited supply of oxygen, carbon monoxide is produced in varying amount. Thus, charcoal fires and braziers give rise to considerable amounts of CO. *Gas geysers*: Certain types of water heaters and slow combustion stoves are common sources of production of the gas, which may give rise to poisoning if the ventilating flues are inadequate. In lime kilns there is evolution of CO_2 and CO. The exhaust fumes from motor-cars and petrol-burning engines contain approximately 6 per cent. of carbon monoxide. The commonest source of carbon monoxide poisoning is from coal gas which is used for illuminating or heating purposes. Coal gas contains normally a percentage of from 4 to 10 per cent. carbon monoxide, and it often approximates to the latter figure. It, either from accidental leakage of pipes or from purposive exposure due to turned-on taps, is a common cause of death. Carbon monoxide occurs in the smoke and fumes from fires with inadequate chimney ventilation. It is important to remember that the products of combustion of gas stoves and gas fires contain an appreciable amount of carbon monoxide. The flues from these are often quite inadequate completely to carry away the products of combustion, in which case the gas stoves and gas fires, when used, give rise to the addition of carbon monoxide to the air of dwellings and so are a source of ill-health or chronic CO poisoning. *Industrial poisoning*: This occurs from the fumes from blast furnaces, in iron smelting, and in blasting operations in mines. In coal mines the explosions from coal dust, or inflammable gases, lead to the production of carbon monoxide ("after-damp"). *Water gas* is prepared by passing steam over red-hot coke, and contains upwards of 30 per cent. CO. It is used for heating purposes, and is sometimes added to coal gas before its distribution. It is very poisonous and, owing to its slight smell, is very dangerous unless mixed with odorous gases. *Producer gas* is prepared by passing a mixture of steam and air over red-hot coke in retorts. It is used for heating the coal retorts for the preparation of coal gas. Producer gas is a mixture of carbon monoxide, hydrogen and nitrogen, and is similar in composition and properties to water gas, and may contain as much as 30 per cent. of carbon monoxide. Industrial dangers also arise from leakages in the plant and from the process of charging the producer-gas retorts.

Action of carbon monoxide.—Carbon monoxide has 220 times the affinity for the blood pigment of the red blood corpuscles (hæmoglobin) that oxygen has. If respired, it will, therefore, more or less completely displace the oxygen from its combination with the hæmoglobin of the red blood corpuscles. This prevents oxygen being carried in requisite amount by the blood corpuscles to the tissues of the body, which thus become deprived of the oxygen necessary for their vital functions. The extent to which the hæmoglobin is saturated with carbon monoxide depends upon the percentage of the latter in the air breathed. When the hæmoglobin becomes one-third saturated with carbon monoxide, definite symptoms of poisoning occur, and when the saturation percentage exceeds 50 per cent. there is grave danger of a fatal issue. It is important to note that carbon monoxide is a tissue poison. It does not act simply as an oxygen depriver to the tissues, but undoubtedly has in addition a narcotic action upon them. This is best

illustrated by considering the serious symptoms of narcosis (muscular paralysis and loss of consciousness) which occur in a person in whom 50 per cent. saturation of the hæmoglobin with carbon monoxide exists. These symptoms far exceed in gravity those of a person possessing only 50 per cent. of hæmoglobin as the result of anæmia from disease or loss of blood (hæmorrhage). Carbon monoxide acts as a tissue poison especially to the nervous system, but there is evidence to show that it acts on all the tissues of the body, notably the cardiac muscle, and may cause degenerative changes in them.

Post-mortem appearances.—The external appearances are characteristic, the cheeks and lips and post-mortem stains appearing cherry-pink in colour. On opening the body, the blood, muscles and internal organs have a characteristic cherry-pink colour. The lungs may show areas of consolidation due to broncho-pneumonia. Small hæmorrhages may be visible, and œdema is common. The brain shows congestion and œdema, and small punctiform hæmorrhages may be found in the cortex and basal ganglia. The heart may show degeneration of the cardiac muscle and punctiform hæmorrhages beneath the pericardium. In some cases of carbon monoxide poisoning putrefaction is markedly delayed.

Symptoms.—The onset of carbon monoxide poisoning is usually very insidious, since the gas is odourless and any smell of an atmosphere containing it is due to the presence of other gases or vapours having a characteristic odour, and also the gas may be respired freely without any irritation to the air passages. Premonitory symptoms are giddiness, a swimming sensation, headache or a sensation of heaviness or constriction in the head, noises in the ears, and a feeling of oppression in the chest. Sometimes nausea and vomiting occur. The onset is, however, often sudden, and this is likely to be so when the percentage of carbon monoxide is relatively high. In these cases, the first symptoms may be sudden collapse, with loss of consciousness, and this is associated with complete loss of power of the muscular system.

Cardio-vascular symptoms, such as violent beating of the heart and throbbing of the blood vessels, occur. The blood-pressure rises at first, and the pulse is full and may not be increased in frequency. Muscular weakness and drowsiness quickly supervene in severe cases, and the patient falls down unconscious. In the *condition of coma* the blood-pressure falls and the pulse becomes rapid and small. The conjunctivæ become markedly hyperæmic and the eyes have a staring appearance, the pupils being partially dilated, and do not react to light. The complexion has a cherry-red appearance. Froth may be present on the lips. The breathing is stertorous. The temperature is usually lowered in the early stages of coma, but is sometimes raised above the normal in the later stages. There is relaxation of the sphincters in severe cases. Broncho-pneumonia may develop if the coma is prolonged for more than a few hours. When the state of coma lasts only for an hour or two, the recovery may be rapid. It is very important to remember that though the muscular power recovers quickly, the tissues of the body have been submitted to a serious acute toxæmia. In all cases where coma has occurred, careful after-treatment is essential, since thereby the occurrence of after-effects, such as cardiac weakness, nervous symptoms, such as weakness or paralysis, or mental disorder, may be avoided.

Diagnosis.—In all cases, at the earliest opportunity after the immediate treatment has been commenced, it is desirable that some blood be removed from a vein for analysis. About 10 c.c. should be removed from a convenient vein of the arm, and placed in a small test-tube so as almost to fill it, and a cork inserted. This can then be sent to the laboratory for analysis. It should not be shaken or exposed to the air. The carbon monoxide present in the blood is most conveniently estimated by means of Hartridge's reversion spectroscope. The percentage of carbon monoxide present is of value not only for diagnosis but for prognosis.

It may be remarked that a record of the blood analysis in cases of carbon monoxide poisoning would be of great interest and value for research purposes.

Treatment.—Elimination of the carbon monoxide from the system is best effected by the ventilation of the lungs with pure air and oxygen.

Immediate removal of the patient to a pure atmosphere is the first step. Onlookers should not be allowed near the patient. If removed to a room, the windows and doors should be widely open and a free current of air encouraged. Complete rest is absolutely necessary, and attempts to keep the patient on the move should be forbidden. The patient should be lying flat, and all constricting clothing round the neck and chest should be loosened or removed. Care should be taken that the air passages are free, and any froth or saliva wiped away from the mouth or nose. If necessary, the tongue should be pulled forwards with tongue forceps. In some cases, especially if convulsions have occurred, a gag may be required to keep the mouth open. Warmth of the body is important, and blankets and hot-water bottles should be used.

Artificial respiration is of great value, as this enables the air and oxygen to reach the alveoli of the lung. The method most suitable is Sylvester's, for this permits of free access of fresh air to the air passages and is more convenient for the administration of oxygen. The upper extremities are moved upwards to a fully extended position above the head and kept on the stretch for two seconds, they are then lowered to the sides of the chest and firmly pressed against the ribs for about two seconds, the double movements being repeated about fifteen times per minute. Oxygen should be administered without delay, and for its efficient administration an oxygen cylinder, with a suitable regulating valve tap, a rubber bag and Haldane mouthpiece are required. Recent researches have shown that the administration of oxygen mixed with about 5 per cent. of carbon dioxide acts as a powerful stimulant to the respiratory centre, and causes deep and rapid breathing. It has been calculated that this mixture increases the lung ventilation by about five times. The use of the mixture in severe cases of carbon monoxide poisoning is of great value, since it enables a much greater amount of oxygen to reach the lung alveoli. Its use, however, should be reserved for the severe cases of poisoning. The mixture of oxygen and carbon dioxide can be used in two ways: (1) By using a sparklet bulb. A special metal perforator with tube attached is available for the purpose of perforating the sparklet and admitting the carbon dioxide at a desired rate by means of a rubber tube. The rubber tube is placed under the oxygen mouthpiece, so that the mixture of oxygen and carbon dioxide can be conveniently administered. This method of administration is easily and con-

veniently effected and is entirely free from any risk. (2) Gas cylinders, which contain a mixture of oxygen with 5 per cent. carbon dioxide, are on the market. This mixture has been used as a respiratory stimulant during anæsthesia. When the respiration of the patient has become normal, pure oxygen should be administered for about 3 hours, with short intervals for feeding. This will be of value in getting rid of the carbon monoxide from the blood of the patient.

For cardiac stimulation.—Strychnine, gr. $\frac{1}{30}$. Camphor, grs. 3, in oil and ether. Pituitary extract, 1 c.c., may be given hypodermically. Adrenalin hydrochloride solution, 1 : 1000, 5 to 10 mins. *For respiratory stimulation.*—Atropine sulphate, gr. $\frac{1}{100}$, may be given hypodermically, and repeated, if required. Lobeline, gr. $\frac{3}{20}$, hypodermically, has recently been used with benefit, and may be tried with advantage. It is supplied in solution in ampoules. The dose may be repeated at intervals until the respiration becomes normal. *Collapse* in severe cases may be treated by means of subcutaneous normal saline (1 pint), or possibly blood transfusion (1 pint).

After-Treatment.—In mild cases, where coma only lasts a very short time, it is important that the patient should be kept completely at rest in bed and under medical supervision for a few days. In severe cases, where coma has been prolonged for several hours, complete rest in bed under medical supervision for 2 or 3 weeks or more will be required, since otherwise there is a danger of after-complications.

W. H. Willcox.

LACQUER POISONING

Definition.—A form of poisoning met with amongst people who handle lacquer (*Rhus vernicifera*).

Ætiology.—It is met with in China and Japan, the home of the lacquer industry. Raw lacquer and its derivatives are the most dangerous.

Symptoms.—Fever, itching and a feeling of tension of the skin of the head, face and limbs, with, later, œdema of the affected parts, are the initial symptoms. Catarrh of the nose may occur. Red papules finally appear on the œdematous areas, and form blebs full of serum and pus. These eruptions are found on the arms up to the elbows, and on the legs as far as the knees. The pustules may become confluent, and on bursting form large ulcers.

Diagnosis.—The occupation of the patient gives the clue.

Prognosis.—This is favourable; death is said not to occur.

Treatment.—Care should be taken in handling the lacquer; some people are much more susceptible than others. Washing with soap and brisk scrubbing should be adopted to get rid of as much of the poison as possible. Antiseptics to the eruption, lead lotion and astringents such as tannin are all recommended. The juice of the garlic, applied externally, is said by the Japanese to be an antidote.

G. Carmichael Low.

POISONS ACTING ON THE LIVER

The liver plays a most important part in the body metabolism, and impairment of its metabolic functions quickly leads to toxic symptoms.

Thus, *protein metabolism* is mainly carried out in the liver, and if this function is impaired by the action of toxic substances on the liver cell, nitrogenous compounds intermediate between protein and urea are formed, which have a profound toxic action on the body. Thus, many poisons by their direct action on the liver cell cause such impairment of the controlling influence of the liver on protein metabolism that symptoms of auto-intoxication result. These symptoms may be of the gravest kind and constitute the condition known as *icterus gravis*, which is the clinical manifestation of an extensive pathological damage to the cells of the liver.

If the process is rapid the morbid anatomical condition found post mortem will be a large yellowish liver of fatty appearance, and on microscopical examination the liver cells will be found to show extreme degeneration and to be often distended with fat. The swelling of the liver cells may lead to obstruction in the passage of bile through the small intrahepatic bile vessels, so that the liver becomes stained with bile and a general jaundice of the body may result. This condition is seen in cases of acute liver poisoning, such as that resulting from phosphorus, arsenobenzene compounds and chloroform after an anæsthetic, and it is sometimes seen in cases of alcoholic poisoning.

Where the process is less rapid, the liver cells after undergoing degeneration, shrink up and disappear, so that a condition of acute yellow atrophy results. The morbid appearances of the liver in this condition are described later (see pp. 626–7). The morbid anatomical condition of acute yellow atrophy of the liver may result from many liver poisons, for example: tetrachloride of ethane, trinitrotoluene; and—where the patient survives for several days—it is found in poisoning by phosphorus, arsenobenzene compounds, chloroform, etc. The condition of acute yellow atrophy of the liver usually causes obstruction of the intrahepatic bile vessels, and is thus associated with general jaundice. Acute yellow atrophy of the liver causes complete impairment of the protein metabolic function of the liver, so that the clinical symptoms of auto-intoxication, namely, icterus gravis, result.

In some cases of liver poisoning where a portion only of the hepatic cells are destroyed by the degenerative processes, the affected cells shrink up and disappear, their place being taken by connective tissue, so that a condition of "replacement fibrosis" of the liver results. This has been observed in tetrachlorethane poisoning, and may occur after trinitrotoluene, arsenobenzene, and any of the liver poisons where the process is not acute. The occurrence of "replacement fibrosis" in cases of acute liver poisoning has an important bearing on the pathology of cirrhosis of the liver. There appears to be little doubt that the production of various forms of cirrhosis of the liver is due to the action of poisons of different kinds on the hepatic cells, leading to their degeneration and disappearance, their place being taken by fibrous tissue.

The fat metabolism function of the liver.—Normally fat is stored up in the liver, being converted into salts of unsaturated fatty acids, and it is disposed of as required. Where the function of the hepatic cells is impaired, as occurs from the action of many of the liver poisons, such as phosphorus, arsenobenzene, and chloroform, the hepatic cells become engorged with fats of the saturated fatty acids, and the disposal of this stored fat cannot be effected, so that post mortem in acute cases a large canary-yellow fatty liver is found, the cells being distended with fat of a low iodine value.

The bile-producing function of the liver.—The action of poisons on the liver has a very important relation to the production of jaundice. Many liver poisons have a direct action on the intrahepatic bile vessels, causing an inflammatory catarrh, and an altered condition of the bile, which becomes viscid and irritant in its action. The classical example of this is toluylenediamine, which was shown by William Hunter to cause a catarrhal inflammation of the intrahepatic bile-ducts in dogs, and this led to the rapid development of jaundice. The jaundice caused by many liver poisons, *e.g.* tetrachlorethane, trinitrotoluene, phosphorus, and arseniuretted hydrogen, is partly due to this cause, and the type of jaundice is known as *hæmo-hepatogenous jaundice.*

Many of the liver poisons causing hæmo-hepatogenous jaundice are also hæmolytic poisons, causing increased destruction of the red blood corpuscles; this is the case with toluylene-diamine, phosphorus and arseniuretted hydrogen, and many other poisons, so that an additional factor in the causation of hæmo-hepatogenous jaundice is an increased production of bile, consequent on the hæmolytic action of the poison. It is now held that "catarrhal jaundice," which has been thought to be due to an obstruction of the common bile duct from catarrh, is almost always intrahepatic in origin, the obstruction occurring in the small intrahepatic bile ducts from a catarrhal inflammation set up by some poison.

The function of the liver in protection of the body from poison.—In the case of poisons absorbed by the alimentary tract, the liver is the first line of defence, and much of the poison is taken up by it. In the case of poisons in the general circulation, as, for example, after the intravenous administration of arsenobenzene derivatives, the liver absorbs much of the poison from the blood stream. In its attempt to protect the body from the action of poisons, the liver is often severely damaged, many of its cells undergoing degeneration and necrosis. In consequence of the function of the liver in absorbing poisons from the portal or systemic circulation in cases of death from poisoning, the liver is the most important organ to be reserved for toxicological analysis. This function of the liver is the "toxiphylactic function."

Liver poisons may be classified into—(1) Chemical poisons; (2) bacterial poisons, resulting from bacterial infections, such as typhoid and paratyphoid fevers, streptococcal infections, influenza, and pneumococcal infections; (3) protozoal poisons, *e.g.* those of malaria, amœbic dysentery, relapsing fever, spirochætal jaundice, kala-azar, and yellow fever, all of which may be associated with degenerative changes in the liver, hepatitis and jaundice; (4) auto-intoxications, such as those occurring in the recurrent vomiting of children, and in the pernicious vomiting of pregnancy; (5) the poisons associated with blood diseases, such as pernicious anæmia, splenic anæmia, and acholuric jaundice.

It is only the chemical poisons with which we are here concerned. A great increase of our knowledge of these resulted from the use of poisons either industrially for war purposes or for the preparation of explosive munitions. The action of chemical liver poisons is usually twofold:—(1) The poison may have a poisonous action on the body apart from its effect on the liver, so that gastro-intestinal symptoms, skin rashes, etc., may occur. (2) The poison has a toxic action on the liver, and, if this is sufficiently severe, symptoms of auto-intoxication (icterus gravis), due to suppression of liver function, result

which are usually fatal. The symptoms of icterus gravis are mental irritability, vomiting, twitchings of muscles and stupor, developing into coma, and often associated with Cheyne-Stokes breathing and convulsions. Death usually occurs within three days. Jaundice, which may be only slight or deep, usually occurs; it may be present before the onset of the symptoms, or it may develop during their course, or in rare cases may be absent. Hæmorrhages, *e.g.* hæmatemesis, melæna, hæmaturia or purpura, may occur during the course of icterus gravis. Not uncommonly the temperature rises to 102° F. or more shortly before death, and a temperature of 106° F. may occur.

Phosphorus is a classical example of a liver poison. If swallowed it acts as a gastro-intestinal irritant, and after 2 or 3 days, when the irritant symptoms may have subsided, the signs of the poison on the liver become manifest by hepatic enlargement, jaundice and fatal symptoms of auto-intoxication (icterus gravis).

Tetrachlorethane was used largely in the manufacture of aeroplanes as a constituent of the varnish applied to the canvas wings. The vapour of this liquid acted as a liver poison, causing toxic jaundice in the severe cases, and the terminal symptoms were those of "icterus gravis."

Trinitrotoluene, a yellow solid substance, used for its explosive properties in the manufacture of munitions. It caused skin eruptions, symptoms of gastritis and sometimes severe anæmia. Its effect on the liver was the production of toxic jaundice, and in the severe cases symptoms of icterus gravis were the terminal event.

Dinitrobenzene, *dinitrophenol* and *picric acid* are yellow powders used for explosive purposes, and they may cause anæmia, from blood destruction, and sometimes dermatitis. They are liver poisons, and have caused toxic jaundice, followed by fatal symptoms of icterus gravis.

Arsenobenzene derivatives.—These are usually given intravenously, and slight symptoms of gastro-intestinal irritation, etc., frequently follow their administration. A toxic action on the liver occurs occasionally in some cases, and after 3 or 4 days symptoms of profound toxæmia, icterus gravis, may result, and death may occur within 3 days of their onset. In some cases where the toxic action is less intense symptoms of toxic jaundice result. These may occur weeks or months after a course of salvarsan or its substitutes, and are associated with enlargement and tenderness of the liver and marked jaundice. The patient may recover, the liver shrinking and a condition of replacement fibrosis occurs. Where there is extensive liver degeneration, fatal symptoms of icterus gravis may develop. Cases of toxic jaundice from arsenobenzene derivatives are of common occurrence at the present time, and in all cases of jaundice inquiry should be made as to the previous administration of arsenobenzene derivatives.

Chloroform.—"Delayed chloroform poisoning" sometimes occurs 2 or 3 days after the administration of chloroform as an anæsthetic. The symptoms are those of icterus gravis, and may be fatal within 3 days of their onset. These cases usually occur in children, and are often associated with acidosis. As a prophylactic measure, plenty of sugar and carbohydrate food should be given to children up to the time that food has to be withheld, and if acetone or diacetic acid is present in the urine the administration of the anæsthetic should be delayed, if possible, until these substances disappear. If this is not possible, chloroform should not be given.

Arseniuretted hydrogen and phosphoretted hydrogen are both powerful gaseous liver poisons, and they also cause great blood destruction. They may cause death by the development of symptoms of icterus gravis.

Alcohol.—In certain cases of alcoholic poisoning great fatty enlargement of the liver occurs, and death results from symptoms of icterus gravis. In such cases the liver is canary-yellow in colour, fatty and much enlarged. The cirrhosis of the liver resulting from alcohol is probably a replacement fibrosis, following on the degenerative effect of the poison on the liver cells.

Mushroom poisoning.—Poisonous fungi eaten in mistake for edible mushrooms are powerful liver poisons. They usually cause acute gastro-intestinal symptoms, and in severe cases these may be followed by symptoms of acute auto-intoxication due to suppression of liver function, consequent on the intense degeneration of the hepatic cells.

W. H. WILLCOX.

FOOD POISONING

Food poisoning occurs when, in mistake for a wholesome food, some article is eaten which is of itself normally poisonous, or, owing to the food being rendered poisonous, by contamination from outside sources. The former is called Endogenous Food Poisoning, while the latter, which is the ordinary form of food poisoning, is spoken of as Exogenous.

ENDOGENOUS FOOD POISONING.—The following are examples:

(1) *Poisonous fungi* are sometimes eaten in mistake for edible mushrooms, and dangerous or even fatal results may follow, owing to the presence in them of poisonous substances. Thus, the fly fungus, *Amanita muscaria*, contains the highly poisonous alkaloid muscarine; another poisonous fungus, *Amanita phalloides*, contains a powerful toxic substance, phallin or amanita toxin, as its active principle; while *Helvella esculenta* is a fungus which owes its toxic properties to helvellic acid.

The immediate symptoms caused by poisonous fungi are those of acute gastro-enteritis, together with collapse from the effect of the poison on the nerve centres. Usually the liver suffers severely (see above). Death from auto-intoxication may occur after a few days, owing to cessation of function of the liver, and possibly also of the kidneys.

(2) *Poisonous fish.*—Certain fish, such as those of the species tetrodon, found in Japanese waters, are normally poisonous, and the same applies to mussels when grown under unhealthy conditions. The symptoms caused by these poisonous foods are those of acute gastro-enteritis, with marked nervous disturbance and collapse.

(3) *Poisonous parts of plants* may be eaten in mistake for foods; for example, aconite root for horse radish, or deadly nightshade berries for edible fruit.

POTATO POISONING.—Under certain conditions potatoes may contain a dangerous amount of the poisonous alkaloid solanine. This is produced by the growth of certain forms of bacteria in the tubers, which is likely to occur if, owing to improper storage, sprouting of the potatoes has taken place. The symptoms of solanine poisoning are those of acute gastro-enteritis, associated with nervous prostration and collapse, resembling those caused by poisonous fungi.

The above types of poisoning do not, strictly speaking, come under the term "Food Poisoning," because the offending articles are unwholesome or poisonous substances taken in mistake for wholesome foods; but in some countries certain harmful vegetables are more or less habitually used as foods. [See (4) and (5).]

W. H. Willcox.

(4) Lathyrism—

Definition.—A disease of certain countries, characterised by spastic spinal paralysis, and caused by poisoning with various kinds of chick pea or common pulse, *Lathyrus sativus*.

Ætiology.—The disease has been reported from India, Algiers, France and Persia. It used also to be met with in Italy. It is solely confined to countries where the pulse is used for food. Young people are specially liable to the complaint, and men much more so than women, probably because they are more exposed to the weather. Lathyrism is an intoxication produced by eating different kinds of chick pea, the disease occurring in epidemics amongst the poorest classes, who have fed for months on bread made from a mixture of pea and wheat flour. It is also eaten as porridge, or the peas are boiled with oil and then consumed.

Pathology.—Changes are found in the spinal cord, and consist of a slow sclerosis apparently of the lateral columns. If the lumbar enlargement is involved, incontinence of urine and fæces may be met with.

Symptoms.—The onset is often sudden, without premonitory signs. After a hard day's work in the rain a patient may wake next morning with stiff, weak and trembling legs, and very heavy to lift. These symptoms increase rapidly, and, in 10 days or so, walking, without the aid of a stick, is impossible. Both legs are usually affected simultaneously, first the calves, then the thighs. After having lasted for some time, a peculiar gait appears, and walking is only carried out by the aid of a two-handed staff. "The leg bearing the weight of the body is bent at the knee and trembles, while the advancing leg, dragged wearily forward, strongly adducted, is planted unsteadily directly in front of its fellow, the toes reaching the ground first." If the patient lies on his back, the spasm of the adductors ceases, and the thighs can be separated; there is no atrophy or loss of tone of the muscles, and no reaction of degeneration. The knee-jerks are increased, and ankle clonus is marked. Sensation is normal.

Diagnosis.—The occurrence of many cases at one time, and the history of chick peas being used as food, are sufficient to draw one's attention to the real nature of the cases.

Prognosis.—The patient does not die of the disease, but on the other hand rarely completely recovers, a certain degree of spasticity remaining.

Treatment.—Lathyrus must not be allowed to be used as a human food. Its abolition at once stamps out the disease. Avoidance of damp and wet ameliorates the symptoms. Massage and electricity are indicated.

(5) Atriplicism—

Definition.—A disease associated with local œdemas, disturbances of sensibility, and vaso-motor and trophic disorders.

Ætiology.—It occurs in North China. Females are oftener attacked than males; no age is exempt. The condition is due to poisoning with *Atriplex*

littoralis (Chenopodiaceæ). Poor people and beggars eat the young shoots, either raw in salads, or in bread.

Pathology.—There are no records of post-mortem examinations with proper histological examinations.

Symptoms.—The onset is sudden, occurring quickly after the ingestion of the plant. First, there is tingling of the fingers, then the backs of the fingers and hands begin to swell, then the forearms to the elbows, and finally the face with violent itching. There may be anæsthesia of the forefingers and thumbs. Heat sensation is increased. Scratching may cause an ecchymotic condition of some of the areas, from which eventually the skin is shed in patches, and ulcers may follow.

Diagnosis.—It may be mistaken for Raynaud's disease or erythromelalgia.

Prognosis.—The swellings last for a week or so and the general health is not affected. The ulcers often become chronic.

Treatment.—All that is required is to avoid eating the plant. Salines, gastro-intestinal disinfectants and, later, tonics may be employed.

G. CARMICHAEL LOW.

EXOGENOUS FOOD POISONING.—The contamination may be due to bacteria, or to fungi, or to chemical substances.

A. *Contamination by Bacteria.*

(1) The commonest type of "food poisoning" is that frequently known as "ptomaine poisoning," and is caused by contamination with the special bacteria associated with the condition; for convenience it is called "Bacterial food poisoning" (see p. 386).

(2) Specific diseases may be caused by the accidental contamination of food with the specific pathogenic organisms. Thus typhoid or paratyphoid fevers may be caused by milk or oysters containing the specific bacilli; scarlet fever or diphtheria by infection of milk with the specific virus; cholera by the contamination of foods or water with cholera germs, amœbic dysentery by contamination with the specific amœbæ or their cysts, and bacillary dysentery by infection of food with its specific bacilli.

A very common cause of these forms of food poisoning is the handling of food by persons known as "carriers," who are apparently healthy but harbour in their bodies the specific germs of a particular disease, their excreta containing large numbers of the pathogenic organism, so that it is an easy matter for the infection of a food-borne disease to be conveyed by the hands of a "carrier" who is engaged in any way in the handling of food; cooks or milkmen frequently spread infection in this manner. The course of the disease is exactly similar to that described under the diseases in question.

(3) Diseases in animals communicable to man may arise from the consumption of food derived from a diseased animal. Thus the flesh of an animal which has died from anthrax may give rise to this disease in man. Tuberculosis of the mammary glands in the cow will cause the presence of tubercle bacilli in milk, the consumption of which may give rise to human tuberculosis. The flesh of animals suffering from actinomycosis may cause this disease in man. Parasitic diseases, such as trichinosis and tapeworm infections, arise from the consumption of the flesh of animals suffering from

these infections. These types of food poisoning are fully described under the diseases in question.

(4) Specific organisms may produce in food highly poisonous toxins, the ingestion of which causes acute and perhaps fatal illness. An instance of this is Botulism (see p. 395).

B. *Contamination by Fungi.*

(1) Ergotism.—The grains of cereals attacked by the ergot fungus (*Claviceps purpurea*) are poisonous, and if consumed give rise to a series of symptoms known as ergotism. Two types of this condition are known—(*a*) The gangrenous type, where gangrene of the toes or fingers, and occasionally of the ears or end of the nose, occurs. (*b*) The nervous type, where sclerosis of the posterior columns of the spinal cord, or degenerative changes in the nerve cells of the brain result, causing characteristic nervous symptoms.

C. *Contamination by Chemical Substances.*

Chemical poisons may accidentally contaminate foods and give rise to the special symptoms of that kind of poisoning. Examples of this are:

Metallic poisoning resulting from contamination of tinned foods by poisonous metals derived from the container. This is a rare form of poisoning, and is only likely to occur when the contents of the tin are liquid, such as fruit juice, liquefied jelly or soups. If the tin is sound, and composed of pure tin, care being taken in the canning and in the soldering process, so that the solder does not come in contact with the contents of the tin, the risk of poisoning is negligible. Cases of poisoning have occasionally occurred from the solution of tin by the acid juice of tinned fruits, or by the solution of lead, derived from the solder, coming in contact with the tin contents. The symptoms of metallic poisoning are described elsewhere.

Arsenical poisoning from the contamination of commercial glucose during its manufacture is described under arsenical poisoning.

Drinking water may be contaminated by lead or copper, and give rise to chronic poisoning.

Food preservatives, such as boracic acid, formalin, and salicylic acid, if added to foods, may give rise to illness from their toxic effects. The addition of food preservatives to milk is for this reason prohibited by law in this country.

BACTERIAL FOOD POISONING

Synonym.—Ptomaine Poisoning.

This is the form of poisoning caused by the contamination of food with certain forms of bacteria, and the resulting symptoms are caused by the toxic substances produced in the food by its bacterial contamination, and there may also be an actual bacterial infection, should the organisms not be killed in the process of cooking. Since bacterial contamination finds a most suitable culture medium in foods rich in protein, this type of food poisoning usually follows the consumption of meat, fish or milk—especially meat.

It was formerly thought that food poisoning was caused by the presence in food of poisonous alkaloidal substances called ptomaines, produced by putrefactive changes. Neurine and mydaleine are examples of such. It is now known that ptomaines are very rarely, if ever, the cause of food

poisoning, but that the usual cause is bacterial contamination of food. It is possible that in the consumption of food highly advanced in putrefaction, such as high game, ptomaines may play a part in the causation of toxic symptoms, but cases of this kind are uncommon.

Ætiology.—*Predisposing causes.*—Contaminated food has a much more serious effect on persons suffering from pre-existing gastro-intestinal disease. Thus the presence of colitis or enteritis greatly increases the susceptibility of the patient to bacterial food poisoning, and the resulting symptoms are likely to be more severe than in a person previously healthy. Dysentery or post-dysenteric colitis has a like effect. Starvation or malnutrition increases the susceptibility to bacterial food poisoning, and emptiness of the stomach at the time of taking of contaminated food is likely to lead to the earlier onset and greater severity of the symptoms produced. The above considerations help to explain the remarkable fact that sometimes when several persons partake of the same unwholesome food some may suffer from serious symptoms of food poisoning, while others may only have very slight symptoms, or even be unaffected. Young children are much more susceptible. In hot climates bacterial food contamination is likely to be followed by a very rapid development of bacterial poisons. Dust, flies, dirt and insanitary conditions generally are likely to favour the contamination of food with the bacteria of food poisoning. Careful storage of food in proper safes, where it can be kept cool and free from contamination, is most important.

Meat poisoning may be due to contamination of the flesh during the cutting-up process by the butcher, or the meat may be contaminated either in the process of cooking or afterwards, owing to lack of care in storage.

Sausages.—Many epidemics of poisoning have occurred from infected sausages. This can be readily understood, since the process of mincing, which the meat undergoes, renders it liable to contamination. Moreover, in sausages it is easy for unwholesome meat to be used, with little possibility of detection. The fact that sausages are made with raw or only partly cooked meat, and that they are frequently eaten merely smoked, with little or no cooking, still further adds to the risk. One special organism, the *Bacillus botulinus*, has frequently been found associated with sausage-poisoning.

Tinned meat.—This has been frequently the cause of food poisoning. The meat may be contaminated by poisonous bacteria before tinning, and though the process of canning, by the heat applied, may kill the microbes, yet the toxins may not be destroyed, and these will give rise to symptoms of poisoning when the food is eaten. During the war tinned meat was consumed in enormous quantities by our troops. Very few cases of food poisoning from tinned meats were recorded, and in those cases where investigations were made the cause of the poisoning was traced to infection of the food after the tins had been opened.

Fish.—Numerous epidemics of food poisoning have been due to eating fish. Those have been due to the contamination of the fish with bacteria of the type already described, and the resulting symptoms have been similar in character. Cooking the fish—boiling or frying—may not entirely destroy the toxins present.

Shellfish.—These are frequently grown in waters contaminated by sewage, and microbes of disease get ready access to them. Mussels, oysters, lobsters, crabs, etc., have frequently caused severe attacks of food poisoning, and

commonly the shellfish appeared perfectly fresh, with no objectionable taste or smell.

Tinned fish.—This, like tinned meat, may give rise to poisoning from the contamination of the food by bacteria before canning. It is important to remember that tinned fish, even if wholesome at the time the tins are opened, is very liable to bacterial contamination. It should never be kept, but should be eaten on the day of opening.

Vegetables and fruit.—These may, if contaminated by bacteria of the type described, give rise to the disease. Since, however, the bacteria find vegetables an unsuitable medium for growth, outbreaks of food poisoning from vegetables are uncommon.

Milk.—Milk has on several occasions been the cause of outbreaks of food poisoning, and the organisms above quoted have been found present in the affected milk. If milk is infected with the microbes, all that is necessary is a suitable temperature for their growth, and it speedily becomes a dangerous article of food. It is readily understood, therefore, that these cases are of much commoner occurrence in the warm weather of summer.

W. H. WILLCOX.

BACTERIOLOGY.—Hitherto the term food poisoning has been limited to a clinical entity, characterised by an epidemic outbreak of acute gastro-enteritis among a group of individuals who have partaken of some common article of food. The bacteriological details have been subsequently worked out in the laboratory.

With the increase of routine bacteriological examinations of the intestinal contents in cases of chronic illness or recurrent gastro-intestinal disturbances, coupled with the enormously increased exactitude made possible by the introduction by Browning of enrichment methods, it is becoming increasingly apparent that a large number of infections exist which can only be generically described under the term Chronic Food Poisoning. This latter class of case is quite distinct from that described as acute epidemic food poisoning, and formerly described as ptomaine poisoning, under the mistaken idea that the symptoms were due to an alkaloidal-like group of substances produced in food commencing to putrefy by bacteriological action, which substances were not destroyed by heat.

It has long been recognised, however, that acute epidemic food poisoning is caused by bacterial contamination of imperfectly cooked food, and that the consequent infection in the human consumer has a definite incubation period, though such period may vary in length according to the concentration of bacterial poisons present in the contaminated food. There is considerable evidence, moreover, that the special bacilli concerned in acute food poisoning epidemics, are bacilli that tend to inhabit or infect the intestines of animals whose flesh is used for human consumption.

Both forms of food poisoning are caused by infections with one or other members of a large group of bacilli that have the common characteristic of not being capable of fermenting lactose, in which respect the group is allied to the bacilli of typhoid fever and the dysenteries. This group of bacilli has had various names suggested; for instance, Durham proposed the term "intermediate group," Trautman, "paratyphoid group," while Lignières

suggested the "Salmonella group," after Salmon who discovered the bacillus of hog cholera, restricting the term, however, to that group of bacilli which has the cultural and morphological attributes of the bacillus of hog cholera. It will be seen that the terms paratyphoid and Salmonella have meanings which are hardly comprehensive enough, and the term "intermediate group" does not seem to have any advantage over the term "bacilli of the food poisoning group."

ACUTE EPIDEMIC FOOD POISONING.—Till recently, it was held that this disease was caused by food infected with *B. paratyphosus* B, or *B. enteritidis gaertner*. The question was, however, settled by Bainbridge, who published his results in the Milroy Lectures of the Royal College of Physicians in 1912. He differentiated the *B. enteritidis aertrycke* from paratyphoid B, and showed conclusively that as a cause of epidemic food poisoning paratyphoid B was not to be considered. On the continent of Europe this differentiation has not been recognised, the terms paratyphoid B and *B. aertrycke* being merely used as labels to indicate the source of two strains of the same species. Yet Bainbridge finds that all bacilli causing outbreaks of food poisoning in Germany that had come under observation by him are strains of *B. aertrycke*. The result of Bainbridge's work was to establish the fact that, with very few exceptions indeed, epidemic food poisoning is caused by *B. aertrycke* or *B. gaertner*.

Chronic food poisoning differs from the epidemic type in that it is met with in individuals with no relationship, or no recent relationship, to epidemics of food poisoning. It is usually diagnosed in the laboratory, though a history of recurrent attacks of gastro-enteritis lasting perhaps over a number of years, and possibly dating from a typhoid-like illness, may suggest the presence of a member of the food poisoning group of bacilli. Such infections are not infrequently met with in cases of colitis, or "intestinal toxæmia," and again may be disclosed when intestinal examinations with reference to a possible overgrowth of streptococci, in connection with rheumatoid conditions, are being made. These infections do not throw any light, perhaps, on the rheumatic state, but not infrequently account for associated conditions.

The varieties of bacilli involved in chronic food poisoning are possibly numerous, but reference can only be made to some seven or eight which have been to some extent worked out.

The main characteristics of the better known members of the food poisoning group will be considered under their individual names, while their sugar reactions will be tabulated in an abridged and comparative form subsequently.

B. paratyphosus A.—This bacillus has never been identified with an epidemic of food poisoning, but being a member of the paratyphoid group, it has close relationship with the food poisoning group generally. Originally described by Schottmüller, it is only found in England in individuals returned from India and the East. In India, however, it is so common that it has been stated that paratyphoid fever connotes an infection with this bacillus. Morphologically, it resembles typhoid bacilli more than the other members of the group, and though it has the same sugar reactions, it forms less gas, in glucose, mannite and dulcite, than they do. It is definitely differentiated from the other members of the group, however, by specific serum reactions.

B. paratyphosus B.—Also first isolated by Schottmüller. It is in England the common cause of paratyphoid fever, and formerly it was thought to be

a common cause of epidemic food poisoning. Bainbridge, however, by means of absorption tests showed that it was a distinct organism from *B. enteritidis aertrycke*, with which, owing to identical agglutination reactions, it had been hitherto confounded. This differentiation was confirmed by Dean by means of complement deviation tests. Bainbridge further identified the bacillus with infections clinically resembling mild typhoid fever, while in only one case did he, in association with Dudfield, find paratyphoid B causing an outbreak of acute gastro-enteritis. The bacillus morphologically resembles the coliform group of bacilli rather than typhoid.

B. enteritidis aertrycke.—This bacillus takes its name from the village of Aertrycke in Belgium, where De Nobele isolated it from cases of an epidemic of food poisoning. It was, as pointed out above, regarded as paratyphoid B till differentiated therefrom by Bainbridge, and is still so regarded on the Continent, whence arise the German statements that paratyphoid B is concerned in epidemic food poisoning. The bacillus is identical with the bacillus of hog cholera, *B. suipestifer* and *B. choleræ suis*. It is said to be a normal inhabitant of the intestine of swine on the Continent. This fact may account for the observation that epidemics of food poisoning on the Continent are more frequently associated with the consumption of imperfectly cooked pork than with other flesh foods. The bacillus resembles paratyphoid B in all respects, with the exception of the absorption and complement fixation reactions.

Since *B. aertrycke* was recognised as a distinct variety many epidemics have been traced to it, and different strains of the organism have been recognised. Thus the Newport strain, recovered by Schutze in 1915 and the Mutton strain isolated at Newcastle by Hutchens are well known. A severe epidemic of food poisoning occurred in a depot in France in April 1918, and was carefully investigated by Marrian Perry and Tidy. The outbreak was shown to be due to the Newport strain of Aertrycke, and the conclusion arrived at was that it was caused by bacterial contamination of food by a "chronic carrier," and subsequent cases were caused by contact with "acute carriers."

It is probable that nearly all recorded epidemics of food poisoning said to be due to paratyphoid B were in reality due to *B. aertrycke*.

B. enteritidis gaertner.—Isolated by Gaertner at Frankenhausen in 1888 from the spleen of a patient who died as a result of partaking of a meal in which the bacillus was found.

Morphologically and culturally it resembles paratyphoid B and *B. aertrycke*, but is sharply differentiated therefrom by specific agglutination tests. It seems to be a less common cause of epidemics of food poisoning than *B. aertrycke*, but such epidemics have been recorded by van Ermengem at Moorsele, Brussels and Gand, and by McWeeney at Limerick. Bainbridge mentions eleven epidemics. It has been identified with epizoötic disease in rats and rabbits by various observers.

B. typhi murium, Danysz's virus, and the bacillus of psittacosis, have now been identified with the paratyphoid B, *B. aertrycke* and *B. gaertner* group, or Salmonella group.

B. asiaticus (Castellani).—This bacillus was found but rarely prior to the war except in cases who had resided in India. Indeed, prior to that date the writer had only observed it once apart from residents in India and the

East, the case being that of a man who had apparently had an attack of food poisoning acquired from oysters eaten in Havana, and was at the date in question the subject of recurrent attacks of gastro-enteritis. During and since the war, however, *B. asiaticus* has become increasingly frequent in patients who have not left England, but who may have had more or less direct contact with soldiers from the East. The first such case the writer saw was that of a woman whose husband was invalided with "dysentery" from Gallipoli. In the writer's experience it is at this date decidedly more frequently met with than paratyphosus B.

The bacillus of epidemic jaundice.—This is a common organism, infections with which are, as a rule, much less severe than are those of the paratyphoid group, though a case of septicæmia has been observed in a colleague of the writer's, who had an illness at first suggesting enteric. On the other hand, the organism may swarm in the intestine of an individual who shows no symptoms of food poisoning. In one case observed by the writer it was found in not far from pure condition in the stool of an individual who had recently had a surfeit of Strasbourg pie, but exhibited no intestinal symptoms. A companion *pâté* was found to be heavily infected with the same bacillus.

It is possible that the difference in virulence just alluded to may mean that more than one variety of bacillus gives the sugar reactions characteristic of the bacillus of epidemic jaundice. Douglas has, in fact, shown that there are differences in agglutinating power. On the other hand, it may be that a bacillus which gives one individual a septicæmia is only able to effect a lodgment in another individual, without producing any immediate obvious symptoms of infection.

B. dysenteriæ morgan. –This bacillus has cultural affinities to the food-poisoning group. It was found by Morgan in 63 per cent. of a series of cases of summer diarrhœa investigated by him. It occurs in a small proportion of cases of chronic food poisoning, and there is some evidence to suggest that a certain proportion of intractable skin affections are associated with the presence of this bacillus in the intestine.

B. fœcalis alkaligenes.—This bacillus resembles in several respects the typhoid bacillus, but can be differentiated therefrom by the sugar reactions and by agglutination. Its presence in the intestine is associated with much fœtor. It is sometimes, at least, pathogenic in that it may be the cause of ulceration of the intestine, and stricture following cicatrisation of such ulcers has been noted.

B. pyocyaneus, the organism associated with blue pus, must be mentioned, though there is perhaps little evidence to connect it with food poisoning. It may be the cause of acute ulcerative colitis, but usually its presence is associated with intestinal toxæmia without acute symptoms. In culture, its property of forming the characteristic green, blue or even black pigment, suffices to differentiate it, while its sugar reactions separate it from the rest of the group, with the exception of *B. alkaligenes*. It, however, grows with much more luxuriance on ordinary medium than does this latter bacillus.

As has been indicated above, the ultimate classification of any member of this group must rest upon specific serum agglutinations, and in the case of *B. paratyphosus* B and *B. aertrycke*, absorption tests are necessary. But a provisional and useful classification is possible by means of sugar reactions.

Monosaccharides, disaccharides and polysaccharides, and some of the allied alcohols have been used. Whatever the substance employed it must be pure, and the basis of the medium containing it must be glucose-free. The list of such substances available is a long one, but for practical purposes may be usefully abridged to five, namely, lactose, glucose, mannite, dulcite and saccharose. This group of five sugars was chosen for routine work by Cap-

	Lactose.	Glucose.	Mannite.	Dulcite.	Saccharose.	Indole.	Motility.	
B. paratyphosus A	−	+	+	+	−	−	+	Definitely classified by agglutination.
B. paratyphosus B	−	+	+	+		−	+	Can only be differentiated one from the other by absorption or complement deviation tests. The common agglutination reaction differentiates them from the other members of the group.
B. aertrycke	−	+	+	+	−	−	+	
B. guertner	−	+	+	+	−	−	+	Definitely classified by agglutination.
B. asiaticus	−	+	+	−	+	+	−	The only non-motile member of the group.
B. of epidemic jaundice	−	+	+	−	−	+	+	
B. morgan	−	+	−	−	−	+	+	
B. pyocyaneus	−	−	−	−	−	−	+	Usually shows characteristic pigment formation.
B. fæcalis alkaligenes	−	−	−	−	−	−	+	Fine growth resembling that of typhoid.

(+) indicates formation of acid and gas in sugar tubes, or formation of indole, or active motility, respectively.
(−) indicates the converse, respectively.

tain S. R. Douglas, and the experience of over 10 years confirms the wisdom of his choice.

The specimens to be examined should invariably be passed through dilutions of brilliant green in peptone water. The writer uses two strengths of this stain of about 1 in 300,000 and 1 in 1,000,000 respectively. The investigation becomes infinitely more delicate in consequence, and constant object lessons occur of the extreme value of the method introduced by Browning.

The foregoing bacilli are the common abnormal bacilli found in acute and chronic food poisoning. The list is not to be taken as in any way exhaustive. There are, for instance, bacilli giving the sugar reactions of the paratyphoids,

which do not agglutinate with the specific sera of the members noted above. The term paratyphoid C has been used to denote some at least of these atypical strains.

There is more than one variety of Morgan's bacillus, and Castellani has described a *B. pseudo-asiaticus* which ferments dulcite, specimens of which are occasionally found in the human stool in this country.

Again there appears to be an indefinite group of bacilli which have been termed the late lactose fermenters. These tend to show the sugar reactions of the paratyphoid group for 48 hours, and then lactose tends to become fermented. This group appears to be abnormal as an inhabitant of the human intestine, but the pathogenicity thereof has not been worked out.

Finally, there is a group of bacilli which give the paratyphoid sugar reactions as far as acidification of the medium is concerned, but no gas formation occurs. This group, apparently abnormal to the human intestine, has not been classified.

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Pathology.—The *post-mortem signs* are those of an acute gastro-enteritis, with evidence of a general bacterial infection or toxæmia. When diarrhœa has been very severe, the tissues of the body may be shrunken from drainage of fluid. Rigor mortis sets in early. The stomach may show some redness from congestion, and, especially where vomiting has been severe, there may be small submucous hæmorrhages. Much mucus is generally present, but the stomach contents are free from blood. The inflammatory signs in the small intestines are usually more marked than in the stomach, which is an important distinction from chemical irritant poisoning, such as that caused by arsenic. The mucous membrane is swollen and congested, and the lymphoid follicles and Peyer's patches often show marked swelling and congestion. The signs are often more marked in the ileum than in the upper part of the small intestine. The mucous membrane of the large intestine may be swollen and congested, and the lymphoid follicles much enlarged. The contents are liquid and may contain much mucus. Small submucous hæmorrhages may occur in any part of the intestinal tract. The spleen is congested and soft, and in cases where infection with living bacteria has occurred, it may be enlarged. The liver and kidneys may show cloudy swelling or fatty degenerative changes. It is important to remember that in fatal cases of food poisoning the macroscopic morbid changes found post-mortem may be very slight.

Symptoms.—*Latent period.*—The period which elapses between partaking of the contaminated food and the onset of symptoms may vary from a few hours to 3 or 4 days. Usually, however, the latent period is short, from 2 to 6 hours being common. The greater the amount of preformed bacterial toxins in the food, the earlier will be the appearance of symptoms. The latent period is influenced by other conditions. Thus, if the poisonous food is taken on an empty stomach, the symptoms will come earlier. Again, if the infected food is taken alone, the symptoms will occur earlier than if it is taken with a considerable amount of other wholesome food. In the Welbeck epidemic, investigated by Dr. Ballard, the latent period was accurately determined in 51 cases. In 5 it was 12 hours or less; in 34 it was 12 to 36 hours; in 8 cases it was 36 to 48 hours.

The symptoms are of sudden onset, and in some cases a rigor may usher in the attack. The symptoms are usually those of gastro-enteritis, namely, furred tongue, severe abdominal pain and a rise of temperature, and often vomiting and purging. The stools are liquid and very offensive, and sometimes contain mucus and blood. In severe cases there may be cramps in the calves of the legs, and collapse with heart weakness, and the patient may become cold and blue owing to the feeble circulation consequent on a state of extreme collapse. In some cases rashes appear of the type of "erythema," or "urticaria," and in severe cases "purpura." Often the severe cases present the symptoms of bacterial infection of the blood (septicæmia) and such complications as pneumonia are then likely to occur. In some attacks of food-poisoning, especially those due to contaminated fish, the toxins appear to act especially on the blood vessels, producing rashes with considerable swelling of the skin (erythema and urticaria), which are associated with fever and a furred tongue, though there may be but little or no diarrhœa and vomiting.

Diagnosis.—The diagnosis is usually clear, from the sudden onset of typical symptoms a short period after taking contaminated food. It cannot be too strongly emphasised that the symptoms of bacterial food poisoning are almost identical with those of poisoning by arsenic or antimony or other chemical irritant poison. An analysis of the vomit, fæces and urine for arsenic and irritant chemical poisons at once renders the diagnosis clear.

Course and Prognosis.—In mild cases, the symptoms clear up in a few days and the patient is completely restored to health. Where there is an actual infection with living pathogenic organisms the illness may run a course similar to that of typhoid fever. Severe cases may present symptoms so acute as to resemble true cholera, and in these the prognosis is grave.

Complications and Sequelæ.—An attack of bacterial food poisoning may be complicated by the development of a specific disease, such as enteric or paratyphoid fever, owing to the living organisms of this disease being also present in the contaminated food. After an attack of bacterial food poisoning there is sometimes left a latent bacterial intestinal infection so that the patient, in addition to being a "carrier" of disease, is liable to recurring attacks of enteritis from slight causes.

Treatment.—*Prophylaxis.*—The importance of this has been already indicated above. The greatest care should be taken in the avoidance of articles of food likely to be contaminated, and the efficient cooking of food whereby any living bacteria present are destroyed is a great safeguard. After cooking, rigid care should be taken in the storage of food to prevent contamination.

General treatment.—Rest in bed is essential. The diet should consist of liquids, such as water, albumin water, chicken broth or whey. *Milk* is often best avoided; peptonised milk or citrated milk (2 grains of citrate of soda to the ounce of milk) diluted with an equal quantity of water may be given. The feeds should consist of 3 or 4 ounces of liquid every 2 hours, and to these 1 or 2 teaspoonfuls of brandy may be added with advantage. As the symptoms improve, the dietary is gradually increased. Hot applications to the abdomen are advisable. Where there is much pain and diarrhœa without collapse, the hypodermic injection of morphine is advisable. Colon irrigations with 2 pints of normal saline are of value in cases with diarrhœa and slight collapse. In cases with choleraic symptoms and marked collapse, sub-

cutaneous or intravenous injection of normal or hypertonic saline should be given. A mixture of bismuth and soda with hydrocyanic acid is of value in relieving the gastric irritation, and to control the diarrhœa bismuth salicylate in 10 or 15 grain doses is useful.

The treatment of a case of food poisoning should be accompanied by periodical bacteriological investigations of the stools, and a case cannot be regarded as cured until three successive bacteriological examinations made at intervals of 2 or 3 days have shown freedom from infection with the pathogenic organisms of the disease.

W. H. WILLCOX.

BOTULISM

Synonyms.—Sausage poisoning, Allantiasis.

Definition.—A rare, but very fatal form of poisoning due to the effect on the nervous system of the toxins of the *Bacillus botulinus*. Botulism belongs to the food-poisoning class of disease, but differs from the old conception of ptomaine poisoning, in which the actual poison was supposed to be altered food product, on the one hand, and from the bacterial food poisonings, in which an actual infection is transmitted, on the other hand. Ptomaine poisoning has now only historic interest, and the bacterial food poisonings fall into the group of infections known as enterica, in which a period of incubation is involved, and more or less symptoms of gastro-enteritis occur. Botulism depends upon the ingestion of a certain minute quantity of preformed toxin, and in no way upon the introduction of the bacillus or spores thereof.

Ætiology.—Sausage poisoning was known in Wurtemburg as long ago as 1820, and it gradually came to be associated with the eating of smoked sausages that were not consumed in the fresh condition. In 1895 an outbreak occurred in Elezelles, a village in Belgium, which was very thoroughly investigated by Van Ermengem. He recovered a bacillus, to which he gave the name *B. botulinus*, from the ham partaken of by all the patients, and from the spleen of one of the fatalities. The ham itself, which was in no wise decomposed, caused typical symptoms of the disease, when inoculated into animals, as did also the recovered bacillus. Other outbreaks occurred in Europe, mostly associated with the eating of partially cooked flesh, in which storing constituted a definite part of the ripening process, no cooking being employed at the period of consumption. During the last fifteen years botulism has excited considerable anxiety in America, chiefly in California, and is there associated with the eating of home-canned vegetables. Contrary to the generally accepted views, it was found by Meyer that the bacillus was a natural inhabitant of soil, in its virgin state. It was found more abundantly in soil from high mountains and virgin forests than in soil from crowded stockyards and highly cultivated gardens.

Bacteriology.—*B. botulinus* is a large gram-positive bacillus, 4–9 μ long by 0·9–1·2 μ broad. It stains well with ordinary dyes, but tends to lose Gram's stain if care be not taken. It possesses flagella, and is slightly motile. It forms terminal or sub-terminal spores, especially, in the case of most strains, at a temperature between 20° and 25° C. Likewise the optimum temperature of growth for most strains is between 20° and 30°. The bacillus is a strict anaerobe, and will only grow in slightly alkaline or neutral media,

though in this connection may be mentioned an outbreak that followed the eating of some tomato-onion-chilli sauce found to be heavily infected, and of an acid reaction. In deep stab, culture growth occurs as a thin whitish streak, not reaching to the surface; later the medium is cracked by the abundant formation of gas. With strict anaerobiosis the organism grows well on the ordinary media. Gelatine is liquefied. There are two types, A and B. They are readily separated by the fact that chickens are susceptible to type A only. Three different strains are named. They are the Boise (type A), the Nevin (type B), and the Memphis (Type A). Type A is more common on the Pacific Coast of America, while type B is more common in the Eastern States, and in Europe. The strains differ in their behaviour to heat. Most strains are killed by boiling, but the Boise strain can survive boiling for an hour, and consequently steam pressures are necessary to sterilise adequately food products contaminated therewith. Dr. Meyer mentions that of 17 strains isolated from different food products the spores varied in their resistance to a temperature of 100° C. from 10 to 230 minutes. The toxins of the various strains all seem to be destroyed by temperatures slightly less than 80° C., the Boise strain toxin being destroyed by 10 minutes at 73° C. The toxicity of the toxin can be so high that 0·0001 c.c. of the filtrate of a culture grown at 35° C. proved lethal to a guinea-pig of 350 grammes. The Boise strain also differs from the others in that it grows best at or about body temperature, and has a characteristic odour.

Symptoms.—There being no incubation period, there are no symptoms prior to the onset of the dizziness and diplopia that constitute the first signs of the involvement of the cranial nerves. Occasionally there are some abdominal pains, accompanied by vomiting, and there is some weight in the suggestion that the vomiting denotes an unusually heavy dose of toxin, for vomiting usually presages a fatal termination. Other cranial nerves are gradually affected, the larynx becomes involved and speech may be lost, and later respiration and the heart's action become affected, by reason of the involvement of the spinal accessory and vagus. Consciousness is not lost. Obstinate constipation is the rule, in sharp contrast to the diarrhœa usually associated with enterica. Botulism differs from encephalitis lethargica in that there is an entire absence of the somnolent state characteristic of the latter condition, while the absence of fever differentiates it from anterior poliomyelitis.

Prognosis.—This is very grave, the mortality being more than 50 per cent. In some outbreaks, for instance that of Loch Maree, every case proved fatal. Death may take place in 36 hours, or may be delayed for a week.

Treatment.—Antitoxin given experimentally with toxin prevents the fatal issue of the latter. In practice antitoxin treatment will only be available for use in the later or less severe cases of an outbreak. Measures to promote elimination of toxin are called for, but are handicapped by the obstinate constipation. Alcohol appears to have a distinct effect in "denaturing" the toxin, and may, therefore, be given freely, partly for this effect and partly for stimulation. Strychnine should also be given. Ether anæsthesia is said to delay fixation of toxin by the tissues, and if so it might be usefully employed while antitoxin was being procured. Some relief from the mental distress due to the absence of unconsciousness would also accrue.

It is to be noted that the Loch Maree attack of botulism, the first recorded in Great Britain, occurred after the first edition of this book was written. In

consequence of this outbreak a very elaborate investigation was initiated, in the course of which much new light on botulism emerged. This was detailed in a book published by Dr. Gerald L. Leighton, together with a mass of entirely new work recorded in America, chiefly by Professors Meyer and Dickson.

JOHN MATTHEWS.

SECTION VI

DISEASES OF METABOLISM

BASAL METABOLISM

By basal metabolism is meant the metabolism of an individual when he is lying down in as complete a condition of rest as possible, and has taken no food for 14 hours—the post-absorptive state.

Basal metabolism is increased by the intake of food, and the amount and nature of the food determines the amount of its increase. Exercise also increases metabolism, and considerably so. In order to obtain an accurate estimate, certain precautions are therefore necessary. It is customary to prescribe a light evening meal some 14 hours before the test, and to make the subject lie down, with the muscles in complete relaxation, for half an hour. The actual estimation may be performed in two ways, namely, by the direct method and by the indirect method, the latter being easier but not so accurate. In the direct method, the air which is breathed out under the standard conditions is collected for 10 minutes and the total volume measured. The amounts of carbon dioxide and oxygen present are estimated by means of a Haldane gas analysis apparatus. By this means the Respiratory Quotient (R.Q.), *i.e.* the ratio of the volume of carbon dioxide given out to the volume of oxygen taken in, and the amount of oxygen used may be determined with great accuracy. In the indirect method, the subject breathes oxygen which is in a closed system for 10 minutes. The carbon dioxide formed is absorbed with soda lime, and the oxygen which has been used is calculated from the amount of gas which has disappeared from the system. The surface area of the body in square metres is then estimated from the weight and height of the patient by means of the nomograph (Fig. 7). The amount of oxygen which has been used by the patient is then expressed in terms of one square metre of body surface per minute. The next step may be done in one of two ways. (1) The amount of oxygen per square metre of body surface is compared with the amount of oxygen which an average subject of the same age and sex consumes (see Table I.). (2) The number of heat calories which the oxygen would give when burnt under standard conditions is ascertained from the tables of oxygen values, and this result is compared with the calories per square metre of body surface which an average subject of the same age and sex would consume (see Table II.). The final result in either method is expressed as plus or minus x per cent. as compared with the average values in the case of normal people.

It is accepted that the subject is normal if the figure lies within the limits of plus or minus 10 per cent. Important variations occur when the thyroid is affected. If the gland is atrophied or absent (myxœdema), the basal rate may be as low as minus 40 per cent.; while if it is overactive

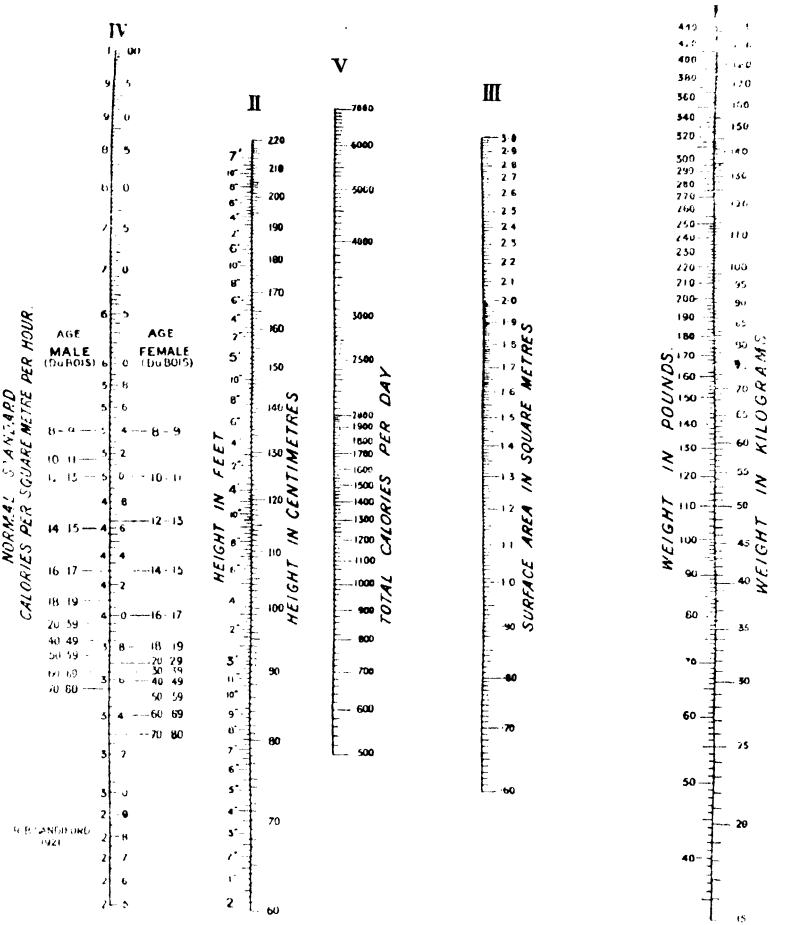


FIG. 7. – BOOTHBY AND SANDIFORD'S NOMOGRAPH.

The weight in pounds or kilogrammes is shown on Scale I. The height in inches and centimetres is shown on Scale II. The surface area in square metres is shown on Scale III. The normal standard calories per square metre of body surface per hour is shown on Scale IV. The total calories per diem is shown on Scale V.

Directions.—Keep the chart flat. Use a flexible ruler with a straight edge, or a strip of stiff paper, such as a postcard. (A) Locate the position of the weight and height on Scales I. and II. respectively. Apply the straight edge of the ruler, and note where it cuts Scale III. Read the figure on Scale III., which will give the surface area of the body in square metres. (B) Locate the surface area on Scale III., and the normal standard calories per square metre per hour for the age and sex of the subject on Scale IV. Apply the straight edge of the ruler, and see where it cuts Scale V. Read this figure, which gives the total basal calories per 24 hours.

Large scale nomographs may be obtained from W. B. Saunders Co., West Washington Square, Philadelphia, U.S.A., or from H. N. Elmer, 1641 Monadnock Buildings, Chicago, U.S.A.

(exophthalmic goitre), the basal rate may be very high, varying from plus 15 to 20 per cent. to 100 per cent. or even more. In starvation and severe undernutrition, the basal rate may be below minus 10 per cent.

STANDARDS

TABLE I.—Average Amounts of Oxygen per min. per square metre of body surface (Du Bois).

Age.	Males.	Females.
	Cubic Centimetres of Oxygen.	
12–13	172	—
14–16	159	148
16–18	148	138
18–20	142	131
20–30	136	128
30–40	136	126
40–50	133	124
50–60	129	121
60–70	126	117
70–80	122	114

TABLE II.—Average Calories per hour per square metre of body surface (Du Bois).

Age.	Males.	Females.
14–16	46·0	43·0
16–18	43·0	40·0
18–20	41·0	38·0
20–30	39·7	37·0
30–40	39·7	36·6
40–50	38·7	36·0
50–60	37·7	35·0
60–70	36·7	34·0
70–80	35·7	33·0

ACIDÆMIA, ALKALÆMIA, AND ALLIED CONDITIONS

Definitions.—*Acidœmia* signifies that there is an increase in the H ion concentration of the blood. This may be due to an increase in the amount of CO_2 in the blood, or to an increase in the fixed acids of the blood. In the latter case, the acid unites with the bases and lowers the amount of CO_2 which can be carried in the blood. The name *acidosis* has been applied to this latter condition, but it has given rise to so much confusion that it is better to abandon the name altogether, and to speak of a decrease in the alkali reserve of the blood. *Alkalœmia* signifies that there is a decrease in the H ion concentration of the blood. The name *alkalosis* has been used to describe the conditions in which there is an increase in the alkali reserve of the blood, but, for the same reason as for acidosis, it would be better to drop the name altogether, and to speak of an increase in the alkali reserve.

Physiology.—The reaction of a fluid is best expressed in terms of the concentration of the H ions. It is known that the H and OH ions react in accordance with the equation $(H)\times(OH)=(H_2O)$, and that the equilibrium reached obeys the law of mass action. This is expressed as follows: $\frac{(H)\times(OH)}{(H_2O)}=K$. The brackets signify concentrations and K is a constant, which is dependent on the temperature. Since the mass of the water is enormously greater than the mass of (H) and (OH) ions, (H_2O) may be regarded as a constant, and the equation may be written in a simpler form $(H)\times(OH)=K$. The constant K is called the dissociation constant of water, and at 15° C. has the value of $10^{-14\cdot14}$. If a solution is neutral, the concentration of H and OH ions will be equal, *i.e.* $(H)=(OH)=10^{-7\cdot07}$, since $(H)\times(OH)=10^{-14\cdot14}$. An acid solution has a greater concentration of H ions than OH ions, and it follows from the equation that an increase in the concentration of the H ions results in a decrease in OH ions, since K is a constant.

It is inconvenient to express (H) as a negative and fractional power of 10, and Sörensen has introduced a notation which avoids this difficulty. Since $(H)=10^{-7\cdot07}$, $-7\cdot07$ is, by the definition of the term logarithm, the log. of the H ion concentration of water. Sörensen disregarded the negative sign and called the numeral 7·07 the PH value of water. It follows from this that as the PH value of a fluid increases, the H ion concentration and, therefore, the acidity diminishes, because a large negative number is actually smaller than a small negative number. If a fluid has PH=7·07 it is neutral, like water; if it has PH=1 it has the acidity of decinormal hydrochloric acid; while if PH=13·2 it has the alkalinity of decinormal caustic soda. Normal blood has a PH which is slightly alkaline, and lies between 7·30 and 7·50.

It is very easy to change the reaction of a fluid like water, which only contains H and OH ions. Blood, however, is a very complex fluid, since it contains salts of weak acids, such as the acid and alkaline phosphates, and sodium bicarbonate, which, together with the hæmoglobin and proteins, act as "buffers" and prevent the reaction of the blood being easily changed. Further, other regulating mechanisms are at work, since urea can be split up into carbon dioxide and ammonia; the former can be excreted by the lungs, while the latter can be used to neutralise an acid. The kidney can excrete acid or alkaline salts which may be in excess, and thus help to keep the reaction of the blood constant. Much attention has been paid to the regulation of the blood by means of the sodium bicarbonate and carbon dioxide. In this process, the respiratory centre plays a very important rôle, since, if it is damaged in disease or by drugs, such as morphine, the regulating mechanism is upset. The H ion concentration of a fluid which contains only weak acids and their salts has been shown to be equal to $\frac{(H_2CO_3)}{(NaHCO_3)} \times K$, where K is a constant, and the brackets signify concentrations. The significance of this equation is more easily appreciated if it is written as follows: $K=(H) \times \frac{(NaHCO_3)}{(H_2CO_3)}$. If there is an increase in the H ions of the blood, there must be a decrease in the size of the fraction $\frac{(NaHCO_3)}{(H_2CO_3)}$, since the value of K does not alter. This can be done in two ways, either by decreasing the amount of $NaHCO_3$ or by increasing the amount of H_2CO_3. If, on the other hand, the H ion concentration is decreased, K can be kept constant, by increasing the amount of $NaHCO_3$ or by decreasing the amount of H_2CO_3. The amount of $NaHCO_3$ which is carried in the blood is termed the alkali reserve of the blood (van Slyke). It is calculated as the amount of CO_2 which can be taken up by blood at a pressure of 40 mm. of CO_2. The figure for normal blood lies between 40 and 55 vols. per 100 vols. of blood, while the figure for plasma is 53–58 vols. per 100 vols. of blood. The changes in the alkali reserve can be estimated directly by van Slyke's method. The estimation of the amount of CO_2 in the alveolar air is of assistance in this connection, since in health the CO_2 is present at the same tension in the blood and alveolar air. When the alkali reserve is reduced, there will also be a decrease in the percentage amount of CO_2 in the alveolar air, which may keep the fraction $\frac{(NaHCO_3)}{(H_2CO_3)}$ constant, and thus prevent any change

in the PH. This will necessitate an increase in the volume of the respiration, since the same amount of CO_2 will be excreted under similar conditions of exercise and food. The increased depth of respiration is seen in the "air hunger" of diabetic coma.

A simple example of the change in the alkali reserve is seen when a meal is eaten (Dodds). The excretion of hydrochloric acid into the stomach is followed by an increase in the percentage amount of CO_2 in the alveolar air. After a length of time which varies with the individual but is usually about one hour, the percentage amount of CO_2 decreases and falls below the original value. It returns to the original value in about 2 hours. If no food be eaten there is no change in the alveolar CO_2.

A diminution in the alkali reserve also occurs when the acetone bodies aceto-acetic acid and β-oxybutyric acid are present in the blood and urine. This condition is usually termed *ketosis*, on account of the acetone bodies. It is a useful term, since it serves to distinguish the condition from the diminution of the alkali reserve due to other causes. The changes which occur in ketosis are believed to be due to the enolic group of the aceto-acetic acid, which stimulates the respiratory centre. In severe cases of diabetes, there is often a great decrease in the alkali reserve and alveolar CO_2, and there may be an actual increase in the H ion concentration, *i.e.* an acidæmia. A mild degree of ketosis occurs in absolute starvation, carbohydrate starvation and after vomiting. In children a ketosis occurs much more frequently than in adults. It may be very severe in cyclic vomiting, pernicious vomiting of pregnancy, and after chloroform and ether anæsthesia; but it also occurs to a lesser degree after vomiting due to other causes, and in the course of any infectious disease, and also occasionally after large doses of sodium salicylate. When the ketosis is well marked there is always great hyperpnœa, *e.g.*, the "air hunger" of diabetic coma.

Acidæmia is present in patients who suffer from dyspnœa which is due to emphysema and bronchitis. In this case there is an increase in the amount of CO_2 which is carried in the blood. Acidæmia may be present in severe cases of nephritis, especially when the patient suffers from uræmia. The PH of the blood may be as low as 7·12 in uræmic coma. In these cases there is always a decrease in the alkali reserve, but the CO_2 is not decreased in proportion, so that there is an increase in the H ion concentration. Sometimes the hyperpnœa is almost as well marked as in diabetic coma.

The existence of *alkalæmia* is only a recent discovery. It was thought that the blood of individuals who had recently ascended to high altitudes was acidæmic, but it has recently been shown that the symptoms are really due to an alkalæmia. The urine becomes alkaline, owing to the increased excretion of alkalis. The use of alkalis in large doses in the treatment of gastric ulcer may cause loss of appetite, vomiting; and if the alkali is continued the signs of uræmia may develop. Some of the patients who suffer from dyspnœa, due to cardiac failure, have an alkalæmia. The PH of the blood may be as high as 7·90 or higher. The subject is a difficult one, since some

of the patients with cardiac failure have an acidæmia, or the reaction may lie somewhere between an alkalæmia and an acidæmia. These differences may be due to the fact that in many cases of cardiac failure there may be a co-existent renal disease. It has been pointed out that acidæmia occurs in uræmic patients, and, therefore, if the dyspnœa is partly due to the cardiac or pulmonary failure and partly to the renal disease, it will be impossible to foretell whether the blood will be acidæmic or alkalæmic.

Diagnosis.—This can only be made with certainty by employing the more accurate methods for determining (1) the H ion concentration of the blood (Hastings and Sendroy), (2) the alkali reserve of the blood (van Slyke), (3) the alveolar CO_2 (Haldane and Priestley, Hasselbach, Fridericia), (4) the reaction of the freshly passed urine, (5) the amount of aceto-acetic acid and ammonia in the urine, and (6) the amount of sodium bicarbonate which is necessary to make the urine alkaline. (In health a dose of 5 grammes is sufficient to make the urine alkaline for a short while.)

Prognosis.—This depends almost entirely on the nature of the disease causing the condition.

Treatment.—This should be directed to removing the cause of the condition. The treatment of the ketosis which occurs in diabetes is described on p. 419. In acidæmia, sodium bicarbonate, ʒi (4 g.) 4-hourly, should be given together with dextrose ʒi (25 g.) 4-hourly, with an abundance of water. The amount of alkali should be reduced as soon as the hyperpnœa becomes less. Small doses of insulin, 10 to 20 units, may be of assistance. The bowels should be kept well open.

In alkalæmia, all alkalis should be stopped and acid sodium phosphate, gr. xxx (2 g.) 4-hourly, should be given, besides sugar and water as in acidæmia. The reaction of the blood should be estimated if possible, and the reaction of each specimen of urine should be tested.

DIABETES MELLITUS

Diabetes mellitus is a disease in which the metabolism of carbohydrates, together with that of proteins and fats, is disturbed. The obvious signs of this are the presence of sugar and acetone bodies in the urine.

Ætiology.—(*a*) *Predisposing causes.*—Diabetes is more common among Jews than Gentiles, and in Frankfurt 31·5 per cent. of the cases were of Jewish descent. It is also very common in a mild form among the natives of India and Ceylon. Heredity undoubtedly plays some part, as many members of a family may be affected. This can partly be explained as being due to the same excesses of diet, especially when the disease develops late in life. But this cannot explain all the cases, especially those which occur among the younger members of the family. The familial form is sometimes very mild, but may be very severe. Joslin obtained a history of heredity in 13 per cent. of his cases. Cases of diabetes in husband and wife occur occasionally, but this is probably due to similarity of living and not to contagion. The disease is more common among males than females. It is commoner between the ages of 40 and 60; these two decades contained 48 per cent. of Joslin's cases, while only 7 per cent. of the cases occurred between the ages of 20 and 40, and 4 per cent. were under 20.

(*b*) *Exciting causes.*—The disease is often present among elderly people

who (1) take an excess of carbohydrate foods and sugar, (2) are considerably over weight, (3) have a blood-pressure which is considerably raised, and (4) are subject to great anxieties. But the exciting cause of the acute disease which is seen in young people is quite unknown.

Pathology.—The blood normally contains sugar, and the amount varies in health between 80 and 120 mgm. per cent. The total amount of sugar in the blood of a man weighing 65 kilos, or 10 st. 3 lb., would be 4 to 6 grammes, assuming that the total volume of the blood is $\frac{1}{13}$th of the body-weight, *i.e.* 5000 c.c. The percentage amount of sugar in the blood remains fairly constant, so long as no food is eaten. A dose of 100 grammes of dextrose will cause a rise in the blood sugar from 100 to 150 to 180 mgm. per cent. The change may be evident in 10 minutes, and usually reaches its maximum in 30 minutes. The sugar returns to its original level in a variable time — 60, 90, 120 minutes, depending on the individual (Fig. 8). Provided that the blood sugar does not exceed 180 to 200 mgm. per cent. no sugar is excreted in the urine; but this again is a variable factor, as some people pass sugar at a considerably lower level than 180 mgm. per cent., whereas others do not although the blood sugar rises to 250 to 270 mgm. per cent. A carbohydrate meal produces a similar effect, but the rise is usually slower and more sustained. Protein does not cause any rise in the blood sugar of healthy people, but it does so in diabetic patients.

Some of the sugar which is eaten is burnt at once as the respiratory quotient approaches 1 after the dose of sugar, but the greater part of it must be stored, either in the liver or muscles. A healthy adult can usually eat 100 to 200 grammes of pure dextrose without causing any glycosuria, but the individual variations are great.

In mild cases of diabetes the blood sugar when fasting may be within normal limits, but a dose of 50 grammes of dextrose will raise the blood sugar from 120 mgm. per cent. to above 200 mgm. per cent. The maximum height may be reached in 1, 2 or 3 hours, and then the blood sugar returns slowly to its original level (Fig. 9). Sugar is excreted in the urine all the time the blood sugar is above the threshold of the kidney for the individual, which may be 180 mgm. or 200 mgm. per cent. In the more severe cases the blood sugar is always above the threshold, and sugar is excreted throughout the day. In these cases there is a decrease in the power of burning sugar, and the respiratory quotient does not approach 1 after a meal, and may be below 0·8. When the carbohydrate metabolism is seriously upset, proteins also cause a rise in the blood sugar, as 58 per cent. of the protein molecule is burnt as sugar. The thirst of which the patient complains is due to the excretion of the sugar, as apparently this cannot be excreted without a good deal of water.

When the sugar cannot be burnt properly, the metabolism of fat is also upset, and the fatty acids, aceto-acetic acid, β-oxybutyric acid, and acetone, are excreted in the urine. These are incomplete products of fat metabolism, and cannot be burnt completely in the absence of a certain amount of sugar metabolism. The amount of acetone excreted in the urine is very small; the aceto-acetic acid forms about 30 per cent. and β-oxybutyric acid 70 per cent. of the total acetone bodies if these are present in large amounts. This condition is now called ketosis, instead of acidosis, as usually there is no change in the H ion concentration of the blood.

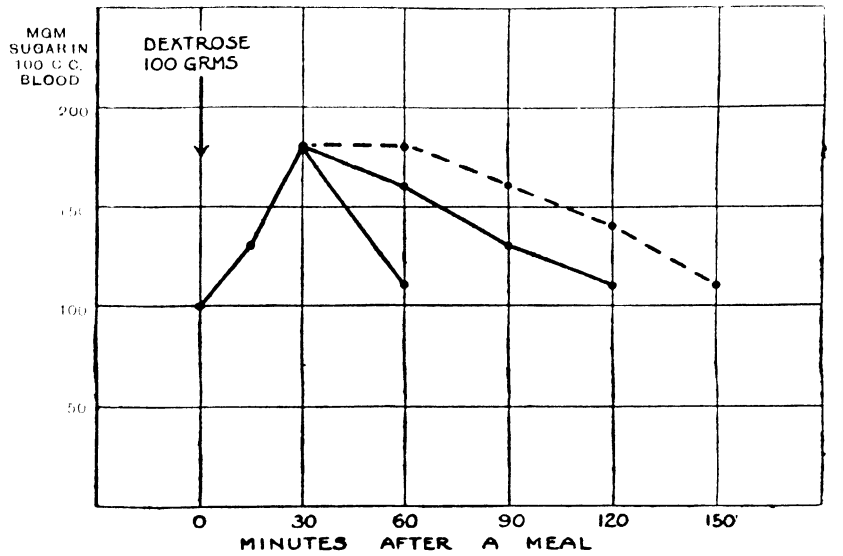

MGM
SUGAR IN
100 C.C.
BLOOD
DEXTROSE
100 GRMS
200
150
100
50
0
30
60
90
120
150
MINUTES AFTER A MEAL

FIG. 8.

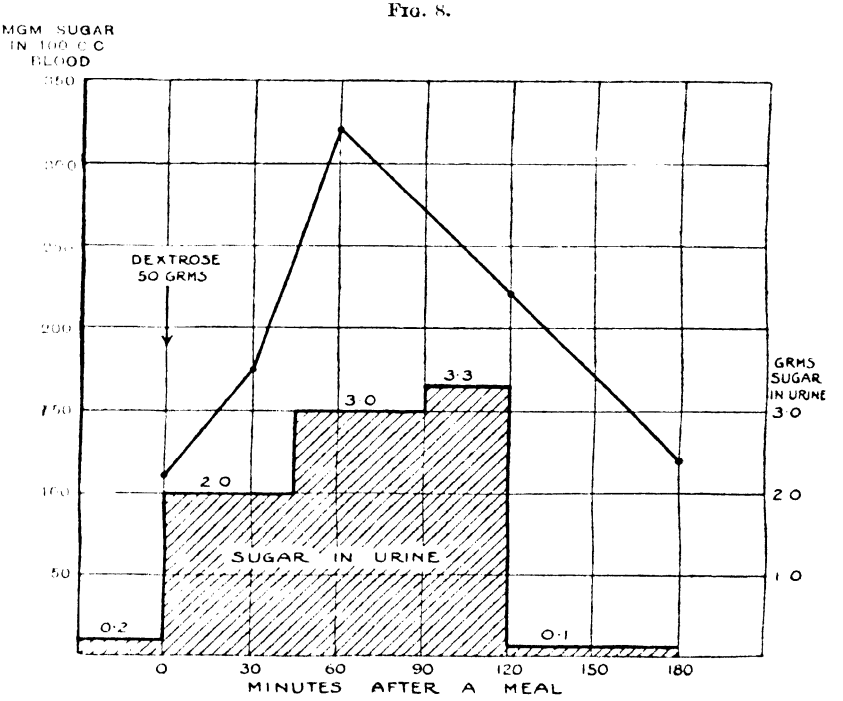

MGM SUGAR
IN 100 C C
BLOOD
DEXTROSE
50 GRMS
200
150
100
50
2·0
3·0
3·3
SUGAR IN URINE
0·2
0·1
GRMS
SUGAR
IN URINE
3·0
2·0
1·0
0
30
60
90
120
150
180
MINUTES AFTER A MEAL

FIG. 9.

The amount of carbon dioxide in the alveolar air is usually over 5 per cent. in healthy persons, but it is reduced when ketosis is present (Beddard, Pembrey & Spriggs, Poulton). It may fall below 3 per cent., but this does not mean that the patient will pass into coma at once, but only that the condition is serious. If it falls below 2 per cent., the patient is usually comatose and is unlikely to recover unless insulin is injected in adequate amounts. The poisonous substance is probably aceto-acetic acid, acting not as an acid, but through the enolic group $\begin{matrix}|\\COH\\\|\\CH\\|\end{matrix}$. This acts on the respiratory centre (Hurtley and Trevan). The alkali reserve of the blood is much reduced in severe cases and may fall from the normal 44 to 60 vols. per cent. to below 20 vols. per cent.

The sugar metabolism is controlled by the internal secretion of four glands, namely, that of the islands of Langerhans, this being opposed by the suprarenal gland, the thyroid gland, and the posterior lobe of the pituitary gland.

The islands of Langerhans.—The relation of the pancreas to the metabolism of sugar has been recognised ever since von Mering and Minkowski, in 1889, showed that complete removal of the gland caused glycosuria and death of the animal. If, in a dog, the remnant be $\frac{1}{8}$th to $\frac{1}{5}$th of the whole gland, mild diabetes occurs; if less than $\frac{1}{5}$th, severe diabetes results (Allen). The pancreas is made up of two glands:—(1) the acinous portion, which secretes the pancreatic juice through the pancreatic duct. It has no action on the sugar metabolism, since if it is entirely destroyed as a result of ligaturing the duct and replaced by fibrous tissue the sugar metabolism is quite unaffected so long as the islands of Langerhans are intact. (2) The islands, first described by Langerhans in 1869, are now recognised as definite entities, forming about $\frac{1}{100}$ part of the whole pancreas, and having an abundant blood supply. They contain three kinds of cells, called alpha, beta and gamma cells, which contain granules in their protoplasm as in the case of the gland cells of other organs. The alpha cells form about $\frac{1}{3}$rd, and the beta about $\frac{2}{3}$rds of the islands, while the gamma cells are few in number. The granules in the alpha cells stain differently from those in the beta and gamma cells, and these again stain differently from those in the acinous portion. Hence, if the tissues are fresh, the three kinds of cells in the islands can easily be distinguished from each other. When the surviving islands of a partially depancreatised dog are overworked by excessive sugar or carbohydrate feeding, only the beta cells are affected. The granules gradually disappear and a vacuole appears (hydrops of the cell). This process may continue until the cell finally consists of a large vacuole, with the nucleus flattened against one side, whilst all the granules have disappeared. Finally the cell breaks up and disappears. If the process is continued long enough the island will consist of alpha and gamma cells alone, and will be much smaller than usual. These experiments prove that it is the beta cells which control the sugar metabolism. The action of the alpha and gamma cells is unknown. The internal secretion of the beta cells had never been isolated until 1922.

Banting, working with Best, succeeded in preparing an extract which had the power of lowering the blood sugar of a depancreatised dog, and of prolonging its life considerably. At first it was necessary to destroy the acinous portion of the pancreas by ligaturing the duct thirteen weeks before the extract was made, but now the extract is made from the fresh gland, and the toxic action of the trypsin is prevented.

Properties of Insulin.—The extract of the islands of Langerhans is called insulin. Its exact constitution is not yet known. It almost certainly contains a protein nucleus, since the purest preparations always give some of the tests for proteins. It forms salts with acids, such as hydrochloric acid.

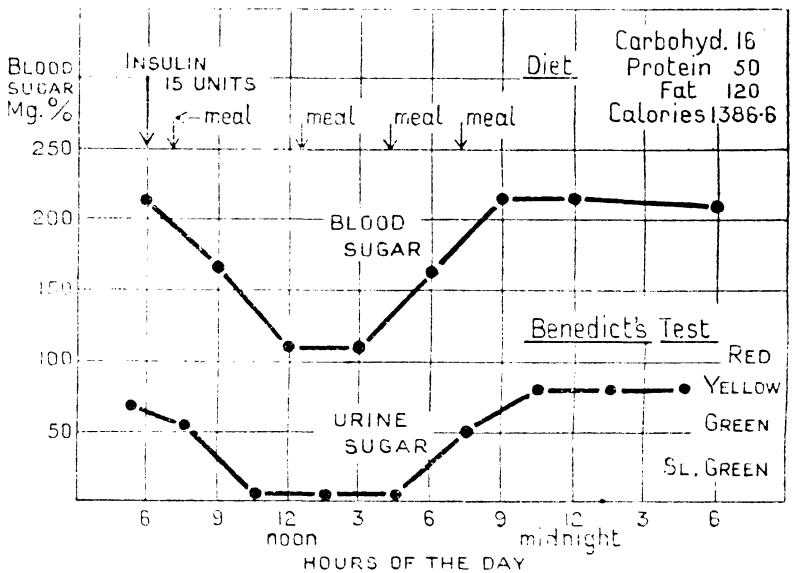


FIG. 10.—Figure showing the effect of a dose of insulin on the blood sugar and urine sugar of a diabetic patient.

The hydrochloride is a white powder, which is slightly deliquescent, and dissolves in acid and alkali, but is destroyed by the latter. It is also destroyed by pepsin and trypsin, and, therefore, cannot be absorbed from alimentary canal.

The presence of sufficient insulin in the body is necessary for the correct usage of dextrose. Without it the dextrose cannot be stored in the body, but appears in excess in the blood and urine. When insulin is present in sufficient amount, the blood sugar is normal; if too much insulin is present, the blood sugar is reduced in amount and there is no glycogen in the liver; if insufficient insulin is present, the blood sugar is increased in amount, so that sugar cannot be burnt, and the respiratory quotient falls to about 0·7. If enough insulin and dextrose are present, the respiratory quotient will be about 1·0, and the fat in the diet will be burnt correctly, so that no acetone

bodies appear in the urine. The precise way in which insulin acts is not yet understood, as it has no action on dextrose outside the body.

The potency of insulin is estimated by its power to lower the blood sugar of a healthy fasting rabbit or mouse to a certain level. The amount of insulin which lowers the blood sugar of a healthy fasting rabbit weighing about 2 kilograms to 45 mgm. per cent. in 2 hours is termed 2 units, and this represents about 0·2 mgm. of the pure product. All the insulin prepared in this country has been carefully tested under the supervision of the Medical Research Council. It is dissolved in acid solution, and is of such a strength that 1 c.c. contains 20 units (U. 20), or 40 units (U. 40, double strength). It is put up in rubber-capped bottles, and does not deteriorate even in hot climates.

If too big a dose of insulin is given to a rabbit, the blood sugar will fall below 45 mgm. per cent. and the animal may have convulsions and die. These symptoms can be relieved at once by the subcutaneous injection of 2 or 3 grammes of sugar, unless the dose of insulin has been very large. Adrenalin, 1 in 1000, 1 c.c. (m xv), or pituitrin, 10 units (1 c.c.), will also relieve the symptoms at once, but it is advisable to give sugar afterwards. In human beings insulin acts in a similar manner, and if sufficient insulin is given the blood sugar is always lowered. A dose of 5 to 10 units will lower the blood sugar of a healthy fasting adult of about 65 kilos to about 50 mgm. per cent., but usually does not cause any symptoms of hypoglycæmia. Human beings, considering their much greater weight, are, therefore, much more sensitive to insulin than a rabbit.

When the blood sugar is raised, as in diabetes, the insulin causes a similar decrease in the blood sugar provided that a sufficient amount has been given. The extent to which the blood sugar is lowered varies in every patient and no definite law can be stated. The maximal decrease (Fig. 10) occurs about 3 to 6 hours after the dose, depending on the size of the dose of insulin, and may persist for about 10 hours, and after that the blood sugar begins to rise again. If the level of the blood sugar was above the threshold of the kidney for sugar the urine will contain sugar, but as soon as the blood sugar falls below the threshold the urine will not contain any sugar. If the urine is collected every 2 or 3 hours and tested for sugar, it is possible to determine whether the blood sugar has fallen below the threshold or not. If the blood sugar is lowered to about 50 mgm. per cent., there may be symptoms due to the hypoglycæmia; but there is no definite level at which all patients develop symptoms, since some patients may feel quite well at this level whereas others, especially those who have had a high blood sugar for a long time, may experience severe symptoms although the blood sugar is 90 mgm. per cent. or even 140 mgm. per cent. The mild symptoms due to hypoglycæmia are a feeling of inertia, profuse sweating, tremor of the hands, and abdominal pain resembling hunger pains; and sometimes mild delirium and tachycardia may be observed. Rather more severe symptoms are numbness of the hands, face and tongue, diplopia and difficulty in articulation. Severe symptoms are:—(1) A state of unconsciousness resembling a deep slumber from which the patient cannot be roused. (2) Fits which may resemble epileptic fits; these occur chiefly in young children and only rarely in adults. (3) A state of inco-ordination of the muscles resembling locomotor ataxia.

The mild symptoms are easily relieved by a little orange juice, tomato juice, or some of the ordinary food of the diabetic patient, provided that it is given as soon as the symptoms appear. The more severe symptoms are relieved at once if a sugar solution is drunk. If the patient is unable to swallow, adrenalin, 1 in 1000, 1 c.c. (m xv), or pituitrin, 10 units (1 c.c.) will usually relieve the symptoms at once, but some sugar, about half an ounce (25 g.) should be given as soon as the patient is able to swallow. If the patient does not respond to treatment, dextrose 5 per cent. in saline should be given intravenously or per rectum.

The suprarenal gland.—The internal secretion of the medulla of this gland, called adrenalin, has a definite action on the sugar metabolism. If it is injected subcutaneously an increase in the blood sugar occurs, and glycosuria may occur if the level of the blood sugar is above the threshold of the kidney. An increase in the blood sugar also occurs when the splanchnic nerves are stimulated, and if the floor of the fourth ventricle is punctured, provided that the suprarenal glands are intact. Fear and excitement may also cause hyperglycæmia and glycosuria, *e.g.*, Macleod's football players. It acts as an antidote to the excessive action of insulin. The gradual destruction of the suprarenal in Addison's disease does not affect the level of the blood sugar, although an injection of adrenalin still increases the blood sugar in the usual manner.

The thyroid gland.—This has some influence on the sugar metabolism, since the sugar tolerance is lowered when the gland is active, as in exophthalmic goitre, or if too much thyroid extract is administered. When there is atrophy of the gland, as in myxœdema, the sugar tolerance is increased.

The posterior lobe of the pituitary gland.—The internal secretion of the gland has some influence on the sugar metabolism, since in Fröhlich's syndrome the sugar tolerance is much increased. Feeding with extract of the posterior lobe causes a decrease in the sugar tolerance. Although pituitrin has no direct action in raising the blood sugar, it acts as an antidote to the excessive action of insulin.

Morbid Anatomy.—The pancreas does not show any macroscopic changes. Microscopically it may show fibrosis around the islands of Langerhans (Opie). If the pancreas is fairly fresh, the finer changes, hydrops of the cells and absence of Bensley's specific granules, are present in nearly 100 per cent. of cases (Allen). Well-marked fibrosis and deposition of iron are seen in cases of bronzed diabetes, both in the liver and pancreas. Evidence of syphilis may be present; Warthin found it at autopsy in 13 out of 14 cases, but in my experience it is rarely seen during life, only 3 out of 60 exhibiting the Wassermann reaction. The heart is usually small, and occasionally shows the vegetations of infective endocarditis. The lungs may show the changes of broncho-pneumonia, lobar pneumonia or tuberculosis. If there have been nervous symptoms during life, there may be definite changes in the spinal cord, such as sclerosis of the posterior columns. There is no change in the sympathetic ganglia.

LIPÆMIA.—In severe and advanced cases of diabetes the blood contains an excess of fat, either fatty acids or cholesterol. On separation of the corpuscles the plasma or serum has a pearly white appearance; this is always a sign of the severity of the disease, but patients have occasionally made fair recoveries of sugar tolerance. The retinal vessels in lipæmia are

very striking objects. In the less severe cases, the arteries and veins have a salmon pink appearance throughout their course. In the more severe cases, the vessels at the periphery become creamy white in colour, although near the disk, they are still salmon pink. In the severe cases, the distinction between the arteries and veins is completely lost and the vessels resemble flat ribbons. The vision remains unaffected.

Symptoms.—The onset of the disease may be very acute and great thirst is complained of; the very day of onset of the thirst can often be discovered. Some of these cases die undiagnosed. Usually the onset of symptoms is insidious, with lassitude, loss of energy, or pruritus, thirst not being a prominent symptom. In the mild cases, especially among elderly people, the diagnosis is usually made either by accident or in the course of a routine examination. In severe cases, thirst is the most troublesome complaint, and this necessitates drinking a great deal of fluid and passing a great deal of urine. The pruritus also troubles the patient, especially as the usual situation for it is the penis in males and the vulva in females. Weakness is usually complained of, and sometimes a large appetite is a troublesome symptom. Constipation is usually present, and it dates from the onset of the thirst in the acute cases. The tongue does not present any changes in mild or treated cases, but in severe and untreated cases it is dry and red—the so-called "raw beef" tongue; this is only present when the patient is "desiccated," as a result of great polyuria. There is always great loss of weight. In the severe cases, the volume of the urine may be 4, 6, 8 or even 10,000 c.c. per diem, but in the treated case it is usually less than 2000–3000 c.c. The specific gravity of the urine in the untreated case may be 1040 or 1050, depending on the amount of sugar in the urine.

Complications.—(*a*) *Coma.*—Formerly this was a frequent termination of the disease, but now it should only be seen in—1. The very acute and the undiagnosed cases. 2. The severe and untreated cases. 3. As a terminal event as a result of any acute infection. Out of 9 cases of coma, 7 showed definite signs of a severe disease, 1 became comatose 7 days after the onset of the thirst, and in 1 no cause for the coma was discovered (Graham). There are two main types, namely—(1) the hyperpnœa is well marked (air hunger), but the patient remains conscious until just before death; and (2) the hyperpnœa is not very obvious, but the patient becomes deeply unconscious a long time before death. More usually the patient shows a mixture of these two types. The blood pressure is low in both types, and the tension of the eyeball is very low. Constipation is always marked, and the contents of the intestines after death may be enormous.

(*b*) *Local infections*, such as boils and carbuncles, often occur, and the latter is often a fatal complication. Perforating ulcers of the feet occur in long-standing cases with signs of peripheral neuritis. Pigmentation of the skin, especially on the back of the hands, occurs in bronzed diabetes.

(*c*) *Gangrene* of a limb, usually a leg, often occurs in elderly people. It is due to the associated arterial condition, and not to the diabetic condition.

(*d*) *Pulmonary.*—Tuberculosis of the lungs is a common termination of the disease, and lobar and broncho-pneumonia are serious complications, as the patients pass rapidly into coma.

(*e*) *Renal.*—A trace of albumin is often present. Œdema may occur after

two days of starvation, or after the administration of much sodium bicarbonate. Casts may be present in very large numbers in coma.

(*f*) *Nervous system.*—The knee-jerks may be lost early, but they may return if treatment is successful. Numbness and paræsthesia may be present. Symptoms resembling those of tabes dorsalis and due to degeneration of the posterior columns may be present. The vibration sense is often diminished or even absent in the legs. The temperament of the patient often changes, partly as the result of dietetic deprivations.

(*g*) *Eyes.*—Cataract is an occasional complication, and retro-bulbar neuritis may occur. Diabetic retinitis closely resembles albuminuric retinitis and is very difficult to distinguish with the ophthalmoscope. Lipæmia retinalis has been already described (p. 409).

(*h*) *Sexual functions.*—These may be undisturbed in the early stages of the disease, but in the late stages the male is impotent. The female may become pregnant, in which case the disease usually becomes worse. The child is never a diabetic at birth.

Diagnosis.—If the urine is tested the presence of a reducing substance is readily detected, but the nature of the reducing substance is less easily determined.

Fehling's solution is still commonly used, but the limitations of the test should be recognised. Solutions A and B should be freshly mixed, and equal quantities of urine and reagent boiled separately, mixed and not reboiled. If sugar is present in more than 0·5 per cent., the red precipitate comes at once, if in less than 0·5 per cent., it may not appear for one or more minutes. Fehling's solution is also reduced by glycuronic acid, uric acid, and creatinine. These substances are rarely present in sufficient amounts to reduce the copper solution, but when the urine is very concentrated they may cause a slight reduction.

Benedict's qualitative solution (copper sulphate, 17·3 grammes; sodium citrate, 173 grammes; anhydrous sodium carbonate, 100 grammes; water to 1000 c.c.) is not reduced by these substances. It is much more reliable than Fehling's solution and should replace it. Five or three c.c. of Benedict's solution and 10 or 6 drops of urine are boiled together for 2 minutes, or put in a boiling water bath for 5 minutes. If much sugar is present the precipitate develops on boiling, but small amounts may not cause a reduction before 2 minutes. The test will show the presence of sugar in a concentration of 0·08 per cent.

Benedict's solution is reduced by dextrose, lævulose, lactose, pentose and homogentisic acid (alkaptonuria), and special tests are necessary to distinguish these. Dextrose is dextro-rotatory, ferments with yeast, and yields crystals of glucosazone. Lævulose is lævo-rotatory, ferments with yeast, yields crystals of glucosazone, and gives Seliwanow's test. Lactose is dextro-rotatory, does not ferment with yeast, and yields a lactosazone with difficulty. Pentose is dextro-rotatory or optically inactive, is not fermented by yeast, and gives Bial's test. Homogentisic acid (alkaptonuria) reduces Fehling's and Benedict's solution to a deep brown colour; the urine blackens on standing, reduces an ammoniacal solution of silver nitrate to a black precipitate, and gives a momentary deep blue colour with the addition of a drop of very dilute ferric chloride. It does not ferment with yeast and is optically inactive.

If dextrose is present, disease of the other ductless glands and cerebral

tumours should be excluded. The pigmentation of the skin of the body and of the backs of the hands, together with an enlarged liver (bronzed diabetes), should be looked for. Acute and chronic pancreatitis should be thought of before the diagnosis of a primary lesion of the islands of Langerhans is accepted. If small amounts of dextrose are present it is necessary to make a complete test of the sugar tolerance, with estimation of the blood sugar every quarter- or half-hour for 2 hours after a dose of sugar, in order to exclude the possibility of renal glycosuria (see p. 421).

TESTS FOR ACETONE BODIES.—*The ferric chloride test.*—Add the solution drop by drop until all the phosphates are precipitated. As soon as this occurs, a violet colour appears if aceto-acetic acid is present in the urine in any quantity. This is a test for aceto-acetic acid, which can be detected in watery solutions in a dilution of 1 in 100,000. In urine, however, the test is much less delicate, owing to the interference of the pigments in the urine. The presence of sodium salicylate in the urine may cause confusion, but the colour produced in this case is purple. The distinction can be made by boiling the urine with a little weak acetic acid, and repeating the test when the urine is cold. The aceto-acetic acid distils away, whereas the sodium salicylate is unaffected by the boiling. This possibility of confusion is avoided by always using Rothera's test.

Rothera's nitroprusside test.—Saturate the urine with ammonium sulphate crystals, add 2 c.c. of liquor ammoniæ fort., and then a few drops of a fresh solution of sodium nitroprusside. If a little aceto-acetic acid is present, the permanganate colour develops slowly; if a great deal, the colour develops instantaneously, and it is impossible to see through the mixture after 20 to 30 seconds. When the nitroprusside reaction is strongly positive, the urine should be diluted 1 in 5. If the colour still appears instantaneously and deepens rapidly there is a large amount of aceto-acetic acid present. Aceto-acetic acid can be detected in a dilution of 1 in 400,000, and acetone in a dilution of 1 in 10,000.

There is no colour test for β-oxybutyric acid, but it is always present when more than 2 grammes of aceto-acetic acid are present.

Prognosis.—This depends, as in the case of other diseases, on the severity of the attack, the time which has elapsed between the onset of the disease and the commencement of treatment, the skill of the medical adviser, the care with which the patient follows the directions given, and the complications which occur. The attack is more likely to be severe and rapidly fatal in young people, but quite mild cases are often seen. In elderly people mild attacks are the rule, but severe attacks also occur. The prognosis had been much improved by the new dietetic treatment introduced in 1915. But although the prospects of life for several years were much better than they had been, the outlook remained a gloomy one for the patient with a severe form of the disease. The introduction of insulin has greatly improved the chances of life of all patients with any form of diabetes, but especially in the case of those with the severe forms. How much longer these patients will live it is impossible at present to say, but probably for many years, provided no complications occur. Insulin has completely altered the prognosis in the case of pregnancy. The risks usually attendant on the pregnancy and puerperium constitute the chief danger.

Treatment.—Although the introduction of insulin has altered the

prognosis, it has not altered the principles of treatment which have been in use for the last ten years. Great attention has always been paid to diet, but under the stimulus of insulin much more attention is being devoted to it. The principles which govern treatment are :—(1) the blood sugar of the patient when fasting should be within the normal limits of 0·08 per cent. and 0·12 per cent., and should not rise above 0·19 per cent. at any time of the day. It follows from this that the urine should never contain any sugar. (2) The urine should contain either no aceto-acetic acid or a mere trace. (3) The patient should understand that a large portion of the reserve power of the islands of Langerhans has been lost, and that he must arrange his life so that the surviving islands of Langerhans are never overworked, *i.e.*, the insulin requirements should be as small as possible. Moderate restrictions of the carbohydrate may be sufficient to prevent glycosuria in the mild type of case which occurs among elderly people, but in the great majority of cases this is quite inadequate. Removal of carbohydrates from the diet without reduction of the fat and protein of the diet is a dangerous practice and has in the past precipitated the onset of coma. Treatment should be begun as soon as the diagnosis has been made. It is convenient to watch the output of sugar and acetone bodies for one day on an ordinary diet, but if the patient is seriously ill this should be omitted. The patient should be in bed.

In Allen's original plan the patient was starved until no sugar was excreted in the urine. Prolonged periods of starvation are no longer necessary, but a short one of one or two days is very useful, as it is often sufficient to lower the blood sugar to normal and it makes the patient much more amenable to the drastic reductions in the total amount of food allowed. If it is desired to avoid a period of fasting, the patient may be given at once a diet which is just sufficient to satisfy the basal needs of the body. The following calculations are necessary in order to do this accurately. The patient's weight and height are marked on the Boothby and Sandiford Nomograph (p. 399). The figure for the surface area of the body is noted. Example : Height, 63 inches ; weight, 132 lb. ; surface area, 1·62 square metres. The calories required for each square metre of body surface are found in the Aub-Du Bois table below, which in the case of a man aged 40 are found to be 1497.

Aub-Du Bois Table. Calorie Requirement per Square Metre of Body Surface.

Age (years).	Calories per day.		Age (years).	Calories per day.	
	M.	F.		M.	F.
10–12	1236	1200	20–30	948	888
12–14	1200	1116	30–40	948	876
14–16	1104	1032	40–50	924	864
16–18	1032	960	50–60	900	840
18–20	984	912	60–70	876	816

M. = males. F. = females.

Calculate requirement in children according to weight. Up to –

22 lb.	27·5 cals. per lb.
22–33 lb.	25·0 ,,
33–44 lb.	25·0 ,,

An approximate result may be obtained by multiplying the patient's weight by 11·3, the error never being large. The diet must be correctly balanced, and the number of grammes of fat should equal the sum of twice the number of grammes of carbohydrates plus half the number of grammes of protein. This is best expressed by an equation $F=2C+\frac{1}{2}P$. The caloric value to be given—in this case, 1490—is then divided between the carbohydrate, protein and fat in the following way. For an adult, ½ g. of protein per 1 lb. of body weight is allowed. In the sample case the allowance is 66 g. This figure multiplied by 4·1 (the caloric value of protein) gives 270 calories and leaves 1220 for division between the carbohydrate and fat. In order to prevent any ketosis, the balance between these two must be carefully struck. If the caloric value—1220—is divided by the arbitrary figure 30, the quotient is the amount of carbohydrate to be consumed per diem—in the sample 41. This figure multiplied by 4·1 (the caloric value of carbohydrate) gives 168 calories; 1220 minus 168 leaves 1052 calories for the fat, and this figure divided by 9·3 (the caloric value of fat) gives 114 for the grammes of fat. The diet is then prescribed as: carbohydrates (C), 41 g.; protein (P), 66 g.; fat (F), 114 g.; calories (Cals.), 1490. The total amount of calories is divided into four meals, of approximately the following amounts:—Breakfast: C, 13·5; P, 22; F, 38; Cals., 499. Midday: C, 9; P, 15; F, 25; Cals., 330. Tea: C, 5; P, 7·5; F, 12; Cals., 163. Evening: C, 13·5; P, 22; F, 38; Cals., 499. This is called the "Maintenance Diet." The behaviour of the blood and urine sugar is watched, and insulin is administered according to the principles discussed later (p. 416). If a fast has been given, it may be broken in many different ways, but the following plan, known as the ladder diet at St. Bartholomew's Hospital, is simple to carry out, and can be varied very easily (see p. 415).

If the blood sugar is normal when Diet 5 is reached the question of insulin should be considered. It is possible that insulin is not actually required, but a small dose, such as 5 units of insulin, will often greatly improve the clinical condition. After a few weeks or months the insulin can be discontinued and the progress watched. In the mild cases the diet can be increased by the addition of 1 or 2 ounces of bread and 4 ounces of milk. Extra protein and fat may also be given if necessary, in order to keep the body weight constant. The diet may then be set out as follows:—Carbohydrate 53 grammes, Protein 65, Fat 130 and Calories 1688. This amount of food may be sufficient to make thin and wasted patients gain weight, but if not extra protein and fat should be added in the proportion of 12 g. protein to 6 g. fat every 2 weeks until the weight does begin to increase. Very fat patients should continue to lose weight until a reasonable weight is attained. If the patient is intelligent enough he can be given a set of diet tables and allowed to choose his own diet. The tables of Harrison and Lawrence are very convenient, as the amount of carbohydrate, protein and fat in the various foods is set out in a convenient form.

If the patient is unintelligent, the diet should be carefully set out with a list of alternatives. A hospital patient is usually content with much less variety than in the case of the well-to-do.

It is important to arrange the diet so that there is a proper balance between the substances which cause a ketosis and those which prevent it.

Diet.		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
	Tea,	coff	ee,	le	mon	ade,	mea	t extr	act, a	s much	as desi	red.
Eggs . .		0	1	2	2	3	3	3	3	3	3	3
Butter . .	ozs.	0	1¼	1¼	1¼	1¼	1¼	1¼	1¼	1¼	1¼	1¼
Cream . .	,,	0	2	2	2	2	2	2	2	2	2	2
Vegetables Cooked	,,	0	12	12	12	12	12	12	12	12	12	12
Vegetables Uncooked	,,	0	4	4	4	4	4	4	4	4	4	4
Meat . . or Fish . .	,,	0	2	2	2	2	2	2	2	2	2	2
	,,	0	2	3	3	0	0	0	0	0	0	0
Bacon . .	,,	0	0	0	2	2	2	2	2	2	2	2
Ham . .	,,	0	0	0	0	2	2	2	2	2	2	2
Milk . .	,,	0	0	0	0	0	4	4	4	4	4	4
Apple . .	,,	0	0	0	0	0	0	2	2	2	2	2
Orange . .	,,	0	0	0	0	0	0	0	2	2	2	2
Bread . .	,,	0	0	0	0	0	0	0	0	½	1	1½
Carbohydrate	grms.	0	8·5	8·5	8·5	8·5	15	20	25	32	39	46
Protein . .	,,	0	35	47	57	55	60	60	60	61	62	64
Fat . .	,,	0	45	65	95	122	128	128	128	128	128	128
Calories .		0	765	951	1190	1425	1517	1527	1557	1570	1607	1642

The Ladder Diet of St. Bartholomew's Hospital.

The sum of the ketogenic substances / The sum of the anti-ketogenic substances is called the aketogenic ratio, or the A.K. ratio. This ratio should be between 1·6 and 1·7. Pure carbohydrate is 100 per cent. antiketogenic ; pure protein is 58 per cent. antiketogenic and 46 per cent. ketogenic ; pure fat is 10 per cent. antiketogenic and 90 per cent. ketogenic. The A.K. ratio will be 1·6 when the fat is equal to the sugar of the diet multiplied by 2·16 + the protein of the diet multiplied by 0·635. This is written $F = 2{\cdot}16\ C + 0{\cdot}635\ P$, or more simply $F = 2\ C + \frac{1}{2}\ P$. When the diet is correctly balanced, there should be no trace of aceto-acetic acid, as shown by the nitroprusside test. If, however, the reaction only develops slowly, the amount of aceto-acetic acid is insignificant and the diet may be considered as correctly balanced. The use of insulin has enabled the amount

of carbohydrate to be much less than the hypothetical values demanded by the above equation, and the A.K. ratio is important in children and when no insulin is being injected.

If the urine still contains sugar or if the fasting value of the blood sugar is above 200 mgm. per cent. when Diet 5 is reached, or the patient is on the maintenance diet, he requires insulin in order to allow him to rest the islands of Langerhans properly. The initial dose should be 5 or 10 units, and if after 3 days no change has taken place in the blood sugar the dose should be increased by 5 units at a time every third day until the dose is 20 units. The patient should be in bed and under proper supervision of trained nurses, and it is an advantage to have facilities for estimating the blood sugar. If this amount is not sufficient to lower the fasting value of the blood sugar to normal, 5 units of insulin should be given about 6 p.m. The evening dose should then be increased every third day by 4 units until it reaches 20 units. This amount of insulin is sufficient to lower the blood sugar to normal in the great majority of cases. In a few cases the insulin must be still further increased, but it should only be done if the patient is under very careful supervision. It is sufficient to estimate the blood sugar once or twice a week, provided that the patient is responding well. After the fasting value of the blood sugar has been reduced to normal it may be necessary to decrease the dose of insulin, and a careful watch should be kept for any symptoms of overdosage. The patient should be told to report any symptoms, and the nurses must know how to treat them, either with orange juice, or sugar, or adrenalin (see p. 409).

If it is not possible to estimate the blood sugar, treatment with insulin may be carried out provided that the urine is collected in 3-hourly periods and tested for sugar. So long as the blood sugar is above the threshold, *i.e.* above 180 mgm. per cent., the urine will contain sugar, but if the dose of insulin is adequate to lower the blood sugar below 180 mgm. per cent. the urine will not contain any sugar. It is then important to test each succeeding specimen, so as to be able to say when the blood sugar rises above 180 mgm. per cent. again. By testing the urine in this way the fasting value of the blood sugar may be lowered to below 180 mgm. per cent., but after that it is very difficult to say whether the fasting value of the blood sugar is normal or not, and it is essential that the blood sugar should be estimated.

When the blood sugar is normal the question of the increase in the diet must be considered. If the patient's weight is decreasing, he is not having enough food, and the protein and fat should be increased by about 100 calories at a time every week until the weight begins to increase slowly. If the weight is constant and the patient is not more than 10 per cent. underweight, the caloric value of the food is adequate. If the patient is gaining weight rapidly, the food is too much and should be decreased, but exercise may also cause a reduction in weight. If the patient insists on having more carbohydrate, it should be given, with the addition of 1 unit of insulin for each 2 grammes of sugar. In this case the insulin should be given about 30 minutes before the carbohydrate is taken, in order to prevent the blood sugar rising either too high or falling too low. It is not good practice to give 30 units of insulin with a large amount of carbohydrate, say 2 ounces of bread, because there is always the risk that the carbohydrate may not be absorbed and the patient may then suffer severely from hypoglycæmia. Active exercise may

cause hypoglycæmia, in which event extra carbohydrate should always be available.

The patient should understand the composition of his diet, and how to vary it.

Food Values

Table I. contains some of the carbohydrate-containing foods, and 5 grms. carbohydrate are contained in the following weights of the edible parts of vegetables, fruits and nuts. The vegetables are cooked, unless otherwise stated. Any one item, therefore, may be substituted for any other without risk of serious error.

TABLE I

A. VEGETABLES

Group I —

Asparagus	11 oz.
Cabbage	13 ,,
Cauliflower	12 ,,
Celery (raw)	17 ,,
Cucumber (raw)	9⅜ ,,
French Beans	13 ,,
Lettuce	25 ,,
Mustard and Cress	35 ,,
Rhubarb	30 ,,
Radishes (raw)	11½ ,,
Sea kale	13½ ,,
Spinach	13 ,,

Group 2—

Brussels Sprouts	6 oz.
Jerusalem Artichokes	5 ,,
Leeks	4¾ ,,
Marrow	8 ,,
Tomatoes	7½ ,,
Turnips	5 ,,

Group 3 —

Beetroot	2½ oz.
Carrots	3¼ ,,
Onions	3 ,,
Parsnips	1⅞ ,,
Peas, Green	1¼ ,,
Potatoes	1 ,,

FRUITS

Apple	2 oz.
Apricot (fresh, with stone)	4 ,,
Banana	1 ,,
Blackberries	3⅝ ,,
Cherries (with stone)	3 ,,
Damsons (with stone)	4 ,,
Gooseberries (raw ripe)	3 ,,
,, (unripe, stewed)	11 ,,
Greengage (with stone)	2¾ ,,
Grape Fruit	3 ,,
Grapes	1⅜ ,,
Melon	6½ ,,
Oranges	2¾ ,,
Peaches (with stone)	3 ,,
Pears	2½ ,,
Plums (with stone)	2 ,,
Raspberries	6½ ,,
Red or Black Currants	4¾ ,,
Strawberries	4 ,,

C. NUTS

Almonds	1 oz.
Brazil Nuts	2¾ ,,
Chestnuts	⅜ ,,
Hazel Nuts	1⅛ ,,
Walnuts	1½ ,,

D. STARCHY FOODS

Milk	3½ oz.
Bread	⅝ ,,
Dry Oatmeal	¼ ,,
Rice	⅓ ,,

After R. D. Lawrence, *The Diabetic Life* (J. and A. Churchill).

TABLE II.—PROTEIN AND FAT

The following articles of food contain approximately 6·5 to 7·0 grms. protein, and 6·5 to 7·0 grms. fat, and may be substituted for each other without causing serious error.

1 oz. Beef.
,, Mutton.
,, Lamb.
,, Veal.
Egg.
1 oz. Sardines.
,, Salt Herring
,, Salmon.
,, Chicken with the addition of ¼ oz. Butter.
1 oz. Rabbit, with the addition of ¼ oz. Butter.
1 ,, White Fish, with the addition of ¼ oz. Butter.
¾ ,, Ham.
¾ ,, Cheese.
1½ ,, Bacon, but ¾ oz. Butter should be deducted from the Butter ration.
5 ,, Cream = 1 oz. Butter.

1 grm. Protein	= 4·1 Calories.	6·25 grms. Protein	= 1 grm. Nitrogen.
1 ,, Carbohydrate	= 4·1 ,,	1 kilogram	= 2·2 lb.
1 ,, Fat	= 9·3 ,,	30 grms. or cubic centimetres (c.c.)	= 1 oz.
1 ,, Alcohol	= 7 ,,		

A patient at rest requires 25 calories per kilo body-weight per 24 hours, approximately 1 calorie per kilo per hour.

Diabetic foods should only be eaten when their exact composition is stated. Some of the so-called diabetic foods contain over 40 per cent. of starch, so that only a small portion of the starch of the bread has been removed. The diabetic bread should be eaten as a part of the protein and fat ration, and never as an addition. Diabetic jellies and jams all contain about 20 per cent. of glycerine, which is burnt as sugar and must, therefore, be included under the carbohydrate ration.

The general health of the patient should be treated. Any sources of infection, such as pyorrhœa, cholecystitis, boils, etc., reduce the sugar tolerance considerably. The possibility of syphilis should also be inquired into, and, if necessary, treated.

The after-treatment is very important. The patient should be taught as much as is possible about the disease and diet, for if he understands the principles concerned, he is much more likely to carry out the treatment correctly. He should also be taught to test the urine with Benedict's solution. If no insulin is taken the urine passed after the evening meal should be tested, but if insulin is used the urine immediately before the injection in the morning or evening should be tested.

Medicinal treatment.—Many preparations of the pancreas or of herbs which can be taken by mouth are extensively advertised. With one exception they are all valueless as well as being expensive. Synthalin, 10 mgms., with decholin, 25 mgms., given for 3 days at a time with one day's rest, has a definite though slight action on the glycosuria and glycæmia in many cases. It has the great disadvantage that it often causes toxic effects, such as dyspepsia, vomiting and jaundice. It should not be recommended unless the patient refuses insulin. Purgatives are of great importance, and the necessity of an efficient daily evacuation should be insisted on. Ext. aloes, gr. iv, ext. nuc. vom., gr. ¼, in pill form, one to two at night; inf. of senna pods, ten to thirty; phenolphthalein gr. ii iv or more in liquid paraffin ℥i b.d.s., are the most efficacious; salines, together with tinct. jalapæ co. ℥ss,

should only be used in emergencies. General tonics which improve the health may be used. Opium used to be of assistance in the late stages of the disease, but should not be required nowadays.

Coma.—This requires prompt and energetic treatment with large doses of insulin. The patient is sometimes very cold and collapsed, and he should be made warm as soon as possible, by means of a hot air bath, or, if this is not available, by hot water bottles, as in the treatment of surgical shock. The blood sugar is usually high, over 300 mg. per cent., and it is safe to give 30 to 50 units of insulin as soon as the diagnosis is made without waiting for a blood-sugar determination. If it is not possible to estimate the blood sugar, a dose of 50 grammes (2 ounces) of dextrose should be given by mouth or by an œsophageal tube, and 50 to 75 units of insulin. If there are no signs of returning consciousness in 3 hours, another 25 units of insulin, together with 25 grammes (1 ounce) of dextrose in solution, should be given. The urine should be collected every 3 hours, by catheter if necessary, and tested for sugar. The urine for the first 3 hours after insulin is certain to contain sugar, and if the urine for the 4th to 6th hours contains sugar, it is safe to give 30 to 50 units of insulin. If, however, the urine for the 4th to 6th hours does not contain sugar, it is dangerous to give any more insulin, unless sugar, in the proportion of 2 grammes to 1 unit of insulin is given by the mouth or intravenously at the same time. If there is any doubt as to whether the patient is recovering, this latter procedure should always be followed. If the condition, however, is improving no insulin should be given until sugar reappears in the urine. Water in as large amounts as is possible, either by mouth or by nasal catheter, should be given; at least 10 ounces each hour for some 6 hours. If the patient is vomiting and cannot retain fluid, it is necessary to give saline intravenously, which may have to be repeated every 4 hours. An estimation of the haemoglobin should be made at intervals, in order to determine whether sufficient fluid is being given or not. Two ounces of castor oil should be given with the first drink, as these patients are nearly always very constipated. In coma the alkali reserve is always much reduced, and sodium bicarbonate is of assistance, although the enormous doses which were administered before the discovery of insulin should not be given. A dose of 12 grammes (3 drms.) is sufficient, and no advantage is to be gained by giving a bigger dose. After the patient has been conscious for about 2 days, a diabetic diet should be given.

Every patient in coma should be examined most carefully each day, in order to determine whether any other disease is present. In 7 out of 9 cases admitted to St. Bartholomew's Hospital in the first year of insulin treatment, an acute infection, *e.g.*, acute otitis media, parotitis, or gangrene of the lung, was present. The appropriate treatment should be instituted as soon as possible.

Acute infections, such as influenza, usually cause a considerable diminution of the sugar tolerance. If the infection is of mild degree, it may be sufficient to increase the dosage of insulin by 2 or 4 units for some days. If, however, the infection is of severe degree, it is important that the condition should be adequately treated, so as to prevent (1) any danger to life, and (2) any permanent diminution of the sugar tolerance. The same procedure should be adopted as in the treatment of coma (Fig. 11), but the dose of insulin should be much smaller, unless the patient is very ill. Provided the urine is collected

in 3 hourly periods and tested for sugar, a sufficient dose of insulin may be given with safety, and thus reduce the ill-effects of the infection as much as possible.

Surgical operations were always contra-indicated before insulin was known, but they may now be carried out, provided certain precautions are observed. The patient's blood sugar should be reduced to normal, provided that there is time to achieve this. Gas and oxygen, local or spinal anæsthetics cause no ill-effects. Neither ether nor chloroform should ever be given alone, but the former may be given with gas and oxygen if deep anæsthesia is required, but as little as possible should be used. Fifty grammes (2 oz.) of sugar, together with 25 units of insulin, should be given about 2 hours before the operation, in order to have plenty of sugar and insulin in the body at the time of operation. After the operation the appropriate diet for the surgical disease, together with adequate amounts of insulin, should be given for the first few days, but as soon as possible the usual diabetic diet should be given and the blood sugar controlled again. If pregnancy occurs it should not be terminated unless there are other complications.

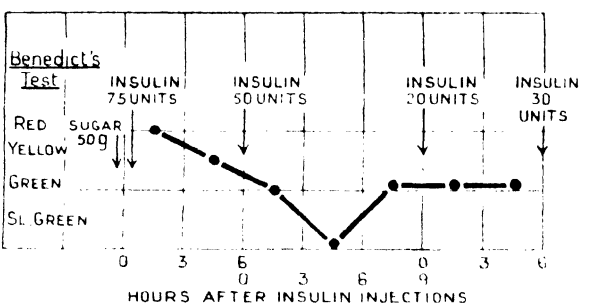


FIG. 11.—Figure showing how an adequate dose of insulin can be arrived at by testing the urine in a patient in diabetic coma.

LÆVULOSURIA is a sign of some incompetence of the liver and should direct attention to that organ. Slight reduction of carbohydrates and of fruits is usually sufficient to check it.

LACTOSURIA occurs (1) during lactation, (2) when suckling suddenly ceases, and (3) in breast-fed infants with enteritis.

PENTOSURIA is a rare occurrence. The majority of the patients are Jews. Of 7 cases, 3 were Jews, 2 Greeks, and 2 English (Cammidge).

RENAL GLYCOSURIA

This is an uncommon condition which is apt to occur in several members of a family. Although the blood sugar lies within normal limits, dextrose may be present in the urine either throughout the day or only after a carbohydrate meal. The sugar is usually small in amount, *i.e.*, less than 10 grammes per diem, but several cases are reported in which 20 to 30 grammes were excreted in the day. The amount of sugar in the diet has little

influence on the total sugar excretion. The diagnosis should only be made after a series of observations. A complete test of the sugar tolerance with doses of 25 to 50 grammes of sugar should be made. Estimations of the blood sugar should be made at intervals of half an hour for 2 to 3 hours after the dose of sugar, and the amount of sugar excreted in the urine should be estimated. If sugar is present in the urine, although the blood sugar does not rise above 180 mgm. per cent. at the end of 30 minutes and has returned to the normal level after 2 hours, the patient probably belongs to the renal glycosuria class

The prognosis is good, and no treatment is required once a differential diagnosis is made. It is wiser to treat all doubtful cases with moderate restriction of the carbohydrate ration (100 grms.), and to repeat the sugar tolerance test in 1 to 3 months' time. Very little harm can be done by this procedure, while much damage can be done if a case of true diabetes is treated with no dietetic restrictions (Salomon, Graham).

GOUT

A disease in which there is a disturbance of the purin metabolism and an increase of uric acid in the blood. The clinical sign is an attack of acute arthritis with a deposition of sodium biurate in and about the joints.

Ætiology.—*Predisposing causes.*—Gout is much commoner among certain races, *e.g.* the English and German. It is practically unknown among native races It does not follow, however, that this is a racial peculiarity. It is much commoner in temperate than in tropical climates, but it is unlikely that the climate plays any part in the causation of the disease. The evidence in favour of gout being an hereditary disease is very strong, as a history of a gouty ancestry can be obtained in 50 to 80 per cent. of the cases. A history of gout in the family was obtained in 75 per cent. of well-to-do patients and in 50 per cent. of hospital patients (A. B. Garrod). This evidence suggests that the disease is chiefly hereditary but may be acquired. It is not the disease which is inherited, but only the predisposition to it, and the disease may lie latent until it is evoked by other causes (Llewellyn). It is a disease of middle life—between the ages of 35 and 50—but it may occur much younger, even in schoolboys who have a strong hereditary taint. The malady is very much more common in men than in women. Women form only 5 to 20 per cent. of the patients in most statistical tables.

Exciting causes.—Food plays a part in the causation of the disease, but it is rather the quantity than the quality which matters. Meat and the purin bodies in tea, etc., probably have little effect, but sweetbreads may be actively harmful. Spirits have little effect, and gout is almost unknown in Scotland. Beer is much more potent and is probably partly responsible for the prevalence of gout in England and Germany. The strong wines like port and sherry, and the red wines such as Burgundy and claret, are also probably responsible for much gout among the well-to-do classes, and champagne has a bad reputation. The light white wines like Graves and hock are less evil. Gout was formerly very common among lead workers in England, and it seems to be a concomitant cause. Trauma

plays a great part in the causation of the acute attack. The big toe may be affected so frequently because of the pressure of the boot. An injured joint may be the seat of the first attack of gout. Syringing the ear of a gouty patient for cerumen was followed by an acute attack in the external auditory meatus (A. E. Garrod). Local sources of infection are very common among gouty patients, *e.g.* septic gums and tonsils. These used to be called gouty manifestations, but Llewellyn thinks that they may be responsible for causing the attack of gout.

Physiology and Pathology.—The fact that sodium biurate was deposited in and around the joints suggested that uric acid played an essential part in the causation of gout. After A. B. Garrod had demonstrated by means of his thread test that the blood of gouty patients contained uric acid in abnormal quantities the hypothesis seemed to be proved. The problem is, however, not so simple as was thought at first.

The uric acid which is excreted in the urine of healthy people on an ordinary mixed diet comes from two sources, exogenous and endogenous. When all the exogenous sources of uric acid, *e.g.* meat, fish, sweetbread, tea and coffee, etc., are removed from the diet the output sinks to a level of 0·5 to 0·7 gramme per day. This amount is fairly constant for each individual. If all proteins are removed from the diet, the endogenous uric acid output falls to a lower level than before (Folin). The removal of carbohydrates and a reduction of the caloric value of the diet also cause a decrease in the endogenous uric acid output to the lower level (Graham and Poulton). The endogenous uric acid output is believed to come from the breakdown of the cell nuclei of the body, *i.e.* wear-and-tear, but it can also be synthesised from histidin and arginin (Hopkins and Ackroyd). When the exogenous purins are eaten, or when uric acid is injected, there is an increase in the uric acid output, but the whole of the uric acid is not excreted in one day. If cincophen is given at the same time, the excretion-rate of the uric acid is increased.

The blood always contains uric acid, and the limits of normal variation in health are 1 to 3 mgms. per cent. The total uric acid in the blood of a man weighing 10 st. 3 lb. or 65 kilos would be 0·05 to 0·15 gramme, assuming that the blood constitutes $\frac{1}{13}$th of the body-weight, *i.e.* 5000 c.c.

In cases of gout there is usually a considerable increase in the amount of uric acid in the blood. Before an attack the blood may contain 4 to 6 mgms. of uric acid per cent., though occasionally between the attacks there may be only a slight increase. The uric acid may also be increased in some people who have never had gout; thus, in leukæmia, where there is a great destruction of leucocytes, and in severe cases of nephritis. The increase in the uric acid in the blood is, therefore, not pathognomonic of gout, although it is extremely suggestive of it.

In gout the output of uric acid varies widely. It may be quite small in amount, less than 0·20 gramme per day, or it may be equal to that excreted by healthy people. Before the attack of gout it is usually very small in amount, but the paroxysm always causes a great increase in the output for a few days only. When purin bodies are eaten by a gouty patient, or if uric acid is injected, there is great delay in the excretion of uric acid. If cincophen is given at the same time, the uric acid is excreted much more quickly.

The diminution in the uric acid output may be due to an increased destruction in the body or to its retention by the kidneys. There is no evidence of increased destruction in the body, as the blood of a patient before an attack may contain 4 to 6 mgms. of uric acid per cent. This suggests that the uric acid is retained by the kidneys. When cincophen is given to a patient whose blood contains 4 to 5 mgms. per cent. uric acid there is a great increase in the uric acid output and a decrease in the uric acid in the blood (Folin and Lyman). The "extra" uric acid excreted in 6 days (Fig. 12) was 1·9 gramme, while the blood uric acid decreased from 4·5 mgms. to 2·9 mgms. per cent. The "extra" uric acid must come from

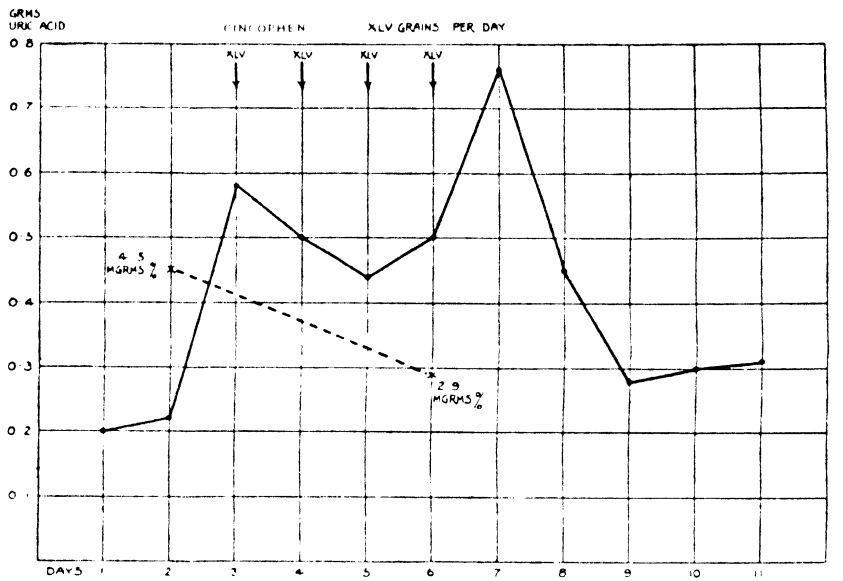


FIG. 12.—Figure showing the increase in the output of uric acid in the urine and the decrease in the uric acid in the blood after cincophen.

the uric acid in the body fluids, as the blood does not contain enough uric acid (Graham) (Fig. 12).

The evidence points to the view that although gout cannot exist in the absence of excess of uric acid in the blood yet uric acid is not the cause of gout.

The essential change is the deposition of uric acid as sodium biurate in the joints. The sodium biurate appears to be plastered over the surface of the cartilage, but on microscopical examination it is seen that there is a layer of cartilage over the deposit, which is always interstitial. The deposits may be quite small or enormous. In many cases the structure of the bones is destroyed and replaced by sodium biurate. The ligaments, tendon sheaths and bursæ are also infiltrated. The big toe joints may contain sodium biurate, although the patient has never had an acute attack

of gout. The skin covering a tophaceous deposit may ulcerate and break down, and small masses of sodium biurate may be discharged (chalky gout).

Tophi.—Sodium biurate is also deposited in the cartilage of the ear, especially in the outer margin of the pinna. The tophi appear as white nodules, and uric acid crystals can be recovered from them, which also give the murexide test and a blue colour with Folin's phospho-tungstic reagent.

The kidneys.—An uratic deposit may occur in the pyramids. Norman Moore found it in 12 out of 80 cases. Well-marked changes of chronic interstitial nephritis are often found.

Symptoms.—The earliest sign of gout is often the deposition of sodium biurate in the cartilage of the ear (tophus). This stage usually passes unnoticed, but is sometimes accompanied by an intolerable itching or tenderness.

Acute gout.—The first attack of "classical" gout usually occurs at night. There may have been a few preliminary symptoms, such as dyspepsia, slight pain in the hands, and irritability of temper, but the patient goes to bed feeling well. "The patient suddenly wakes with pain, more or less intense, in the ball of one great toe, frequently accompanied with a slight shivering; the pain in the toe gradually increases and is attended with a sensation of burning, throbbing, together with great tension and stiffness; heat of skin and other symptoms of febrile disturbance usually follow the shivering, accompanied with a considerable degree of restlessness" (A. B. Garrod). The temperature is raised to 101° or 102° F., but after a few hours the patient begins to sweat and finally falls asleep. "In the morning the toe is swollen, the skin shiny, tense and dark red, and the whole joint is extremely painful" (A. B. Garrod). Usually the acute pain lessens in the daytime, but returns with great violence in the night hours. The temperature remains high and the temper of the patient is irascible in the extreme. The attack may last many days or pass away in two days. When the attack is ceasing "the inflamed joint becomes less tense and swollen, and pitting is readily produced on pressure" (A. B. Garrod). The attack may spread from the great toe to the other joints of the tarsus or to other joints of the body. The first joint of the big toe is most commonly affected. The ankles, knees and small joints of the hand and wrists are next in the order of frequency.

During the attack there may be a considerable degree of leucocytosis, 20,000 to 25,000, and all but 2000 to 3000 are polymorpho-nuclear cells, as the lymphocytes and other cells are unaltered by gout. The uric acid output, which was low before, is greatly increased for a few days. Sodium biurate is deposited in the cartilage of the joint and head of the bone, but the swelling and stiffness may eventually disappear completely. The acute attack may be complicated by a severe gastro-intestinal disturbance which may be fatal. There may be other symptoms, such as dyspnœa, delirium and coma, but these are probably due to a coincident uræmia. Phlebitis of the veins of the limb may be a complication of an acute attack.

After the attack, whether as the result of illness or as a consequence of the simple living which the patient has endured, the general health of the patient is much improved. The attack usually follows in the spring and autumn. The second attack may follow at once, or may be delayed for many years.

Chronic gout.—After several attacks the joint does not recover completely.

The deposits of urates occur in the ligament and capsule, as well as in the articular cartilages and bones. The joint, therefore, becomes swollen and irregular in its shape. The urate is especially deposited in the bursæ about the joints. In the advanced stages the skin over the uratic deposits breaks down and masses of chalky material are extruded, and the wounds heal with difficulty. The general health of the patient suffers after several attacks and does not recover completely. Dyspepsia is complained of, and the patient may show signs of high blood-pressure and arterial disease. The urine is increased in amount, and may contain albumin and casts.

Irregular gout.—Almost any symptom or physical sign which occurred in a person who was of a gouty disposition was formerly ascribed to gout. Cutaneous eruptions, such as eczema, gastro-intestinal disorders, cardio-vascular symptoms and pericarditis, headache, migraine and neuralgia, were all thought to be gouty. A gouty patient may develop any of these diseases, but the belief that there is a general type due to gout is now regarded as unfounded. The urine is usually acid, and on cooling often deposits uric acid crystals. This does not mean that there is an excess of uric acid in the urine, but that the urine is too acid to keep the uric acid in solution. On heating the urine the urates are re-dissolved. Gouty persons may suffer from calculi. Glycosuria occurs in some cases, but usually responds readily to treatment. Albuminuria and casts are present when the kidneys are also affected. Elderly persons often suffer from chronic bronchitis. Gout has been accused of rendering patients more disposed to iritis, retinitis and glaucoma, but there is no evidence that the disease of the eye is in any way connected with gout.

Diagnosis.—The diagnosis in a case of classical gout, with recurring attacks of arthritis in the toe or tarsus, is easy, especially if the patient comes of a gouty stock or indulges in good food and drink. The presence of tophi is proof positive that the patient is a subject of gout. Tophi must be distinguished from Woolner's tip, fibroid nodules and sebaceous cysts, and in cases of doubt an examination should be made for the crystals of sodium biurate with the microscope, and for uric acid with the murexide test or Folin's phospho-tungstic reagent. The blood should be examined for uric acid in all cases of doubt, and if more than 3 mgms. per cent. are found the case is probably one of gout. It must be remembered, however, that the uric acid in the blood is increased in cases of chronic interstitial nephritis. While it is certain that gout does not occur in the absence of an increase of uric acid in the blood, the presence of excess of uric acid in the blood does not exclude the presence of other diseases.

Classical gout is much less common than it was, and the modern tendency is to overlook the disease. In the severe cases of gout in which the joints are severely damaged, the X-ray appearances are very striking (Fig. 13). The negative shows dark areas where the sodium biurate is deposited in large amounts and replaces bone or cartilage, since sodium biurate is not opaque, like the calcium ion. In the less severe cases there may be—(1) lipping at the articular margins; (2) a localised atrophy of the bone; (3) a narrowing of the joint space. These changes occur in other kinds of arthritis and are in no way characteristic of gouty arthritis (Llewellyn).

Prognosis.—If a patient has once had an attack of gout he will always be liable to another attack, unless he alters his way of living. The frequency

FIG. 13.—Line drawing from a radiogram showing the changes which take place in the bones due to the deposition of sodium biurate.

and severity of the attacks can be modified by treatment. The prospects of long life depend upon the state of the heart, arteries and kidneys.

Treatment.—*Dietetic.*—In perhaps no other disease have a greater number of dietetic fads been recommended. The total quantity of the food should be kept within reasonable limits, and civic dinners should be avoided. The meals should be simple but attractive. There is no difference between the different kinds of meat, except that for those who have dyspepsia chicken is more easily tolerated than beef and mutton. There is no need to deprive the patient of sugar, which is a common fad, or of starchy food, but they should be eaten in moderation. The same is true of fat. Some gouty persons are much too stout, and a reduction of weight is beneficial. The actively harmful foods are those which contain purins, such as sweetbreads, liver, kidney and brain. They should never be eaten, as the uric acid which they contain is much more slowly excreted than by a healthy patient. Attacks of gout have followed very quickly after eating sweetbreads and after the administration of purins for experimental purposes. The fruits and vegetables which contain an excess of oxalates, *i.e.* strawberries, rhubarb, spinach and asparagus, should be forbidden if oxaluria is present.

Heavy beers, strong wines like port and sherry, and also champagne, should be forbidden for gouty patients. The white wines, like Graves and hock, may be allowed in moderation if especially desired. If drunk in moderate amount whisky is probably the least harmful beverage. Mineral waters may be of considerable benefit to gouty persons. Their mode of action is uncertain, but is probably due not so much to the ingredients of the waters as to the amount of water drunk, the simple and restricted diet, and the regular and supervised life which the patient leads at a spa. Hot baths and douches are of assistance in aiding the recovery of stiff joints. The waters of Buxton and Bath in England, Vichy, Aix-les-Bains and Contrexeville in France, Wildbad and Homburg in Germany, Carlsbad and Marienbad in Czecho-Slovakia, and Saratoga, Bedford and White Sulphur in America, are the best known.

Local.—During the acute attack the joint should be covered with cotton-wool, placed on a pillow, and the bedclothes raised by means of a cradle. Hot fomentations or lotio plumbi c. opio may be applied.

Internal.—The treatment should be started with a purgative, and calomel is recommended. Colchicum is specific for the acute attacks. The pain is usually relieved quite quickly, and the redness of the skin and swelling of the joint subside. Fifteen to 30 minims of the tincture in an alkaline mixture should be given every 4 hours. The drug may cause vomiting or purgation, and its action must be carefully watched. Its mode of action is quite unknown, and it is of no value in averting an attack. Cinchophen (Trade names: atophan, agotan, phenoquin, quinophan) is useless in relieving the pain of an acute attack, but it is most useful in averting attacks. It is given in tablet form, gr. xv three times a day for 1, 2 or 3 days consecutively in each week and should never be given continuously. It increases the output of uric acid in the urine and decreases the amount of uric acid in the blood, and thus prevents the continuous accumulation of uric acid in the body. The drug may, however, produce unpleasant symptoms, such as urticaria, dyspepsia and jaundice. The complication of jaundice may be a very serious matter, for acute yellow atrophy of the liver may develop and death

ensue. These toxic effects have usually, but not always, occurred: (1) when the drug has been given continuously, *i.e.*, without an intermission of 4 to 5 days between the courses; and (2) when its administration has been continued after minor symptoms of toxic action have appeared. The results of the treatment of undoubted cases of gout with cincophen are so good that its toxic action is most unfortunate. It would seem that its use should be restricted to the treatment of gout, and only given in short courses each week and discontinued at the first indication of intolerance. Further, as soon as the acute joint condition has passed, the dosage should be reduced to 10 grs. twice a day, one day each week for an indefinite time. Aspirin and sodium salicylate have a similar action to cincophen, but in order to obtain a good excretion of uric acid in the urine 100 to 150 grs. per diem of both is necessary. This dosage is large enough to cause minor effects of salicylism, whereas if cincophen is tolerated, it causes no ill-effects at all.

The general health of the patient must be attended to and all causes of sepsis should be removed. Radiant heat and massage are very useful for restoring the movements of a crippled joint.

OBESITY

Obesity is a condition in which there is an excessive amount of body fat.

Ætiology.—Certain races are more prone to become fat than others, *e.g.* the Dutch, South Germans, South Italians, Maltese, Hebrews, the natives of India and Ceylon, and some African races. A clear history of heredity was obtained by Futcher in 60 per cent. of his cases. Obesity may develop at almost any age, but it is more likely to occur at certain ages: in babies, in children at puberty, in men after the age of 40, and in women during pregnancy or after the menopause. It is commoner among females than males.

Pathology.—The deposit of fat indicates that the caloric value of the diet is in excess of the individual's needs. This may be due to the large amount of food which is eaten, or to a small energy consumption in the body. Some fat people have a very large appetite and eat much more than is necessary to satisfy their energy requirements. The amount of exercise which is taken has a great influence on the amount of fat which is deposited. Thus, a patient who is lying in bed will gain in weight on a diet which contains much less caloric value than that which he eats when he is up and about. Although many cases of obesity are easily explained on the above grounds, there are many instances which cannot be explained so simply.

The investigations of the basal metabolism help us to understand many of these cases. The amount of oxygen which is burnt depends on the state of the patient. More combustion of oxygen takes place when the patient is taking exercise than when he is at rest, and when he has a meal than after a short fast. The metabolism of the resting, fasting individual is termed the basal metabolism. This is expressed in cubic centimetres of oxygen per minute per square metre of body surface. The basal metabolism is lower for adults than for children, and gradually decreases with each decade. It is lower for females than males. The basal metabolism can be altered by pro-

longed undernutrition and by the influence of the ductless glands. One of the results of underfeeding is a lowering of the basal metabolism, but the oxygen consumption of such a patient during exercise is unaltered. The action of the thyroid gland on the basal metabolism has been carefully studied, as there are two clinical conditions in which the thyroid plays an important part, namely, (1) in hypothyroidism, and (2) hyperthyroidism. In the first, the patients, among other symptoms, tend to increase in weight, and the basal metabolism in these cases is much lower than usual. In the second, one of the prominent complications is the rapid loss of weight which occurs, and the basal metabolism is much increased in these cases, and can be increased by giving thyroid extract and decreased by removal of large portions of the gland. When the basal metabolism is low, it is clear that the patient will tend to get fat, although he is eating less food than a patient whose basal metabolism is high. These experiments help us to understand many cases of obesity.

The action of the other ductless glands is not so well understood. When the posterior lobe of the pituitary gland is damaged by a tumour, considerable changes take place in the metabolism. The patients grow fat, and the fat is deposited in the characteristic feminine situations, *i.e.* the breasts and hips in male and female patients (Fröhlich's syndrome). When the posterior lobe is removed in dogs there is an increase in the weight of the animal (Cushing).

The sex glands have a considerable influence on the metabolism. When the glands develop at puberty there may be an increase or decrease in the fatty deposits. The female lays down fat around the breasts and hips, and assumes the characteristic feminine form. Removal of the testicles, as in eunuchs, usually causes an increase in the body-weight. During a pregnancy women often grow stout long before they have to restrict their normal activities, while after the pregnancy is terminated, the patient loses weight and recovers her figure. At the menopause many women tend to become stout.

In obesity the fat is deposited in the subcutaneous tissues, the great omentum, mesentery, and around all the organs, such as the heart and kidneys.

Symptoms.—The presence of large deposits of fat limits the activities of the patients and destroys their good looks. Many of the patients feel well, but some complain of difficulty in moving about, because of their great bulk. Others complain of shortness of breath on the least exertion. Some of the patients are anæmic. Eczema may occur on those parts of the skin which touch each other.

Treatment. *Dietetic.*—If the patient has only gained a little weight, moderate restriction of the carbohydrate and fat of the diet, together with an increase of exercise, may be sufficient. This is the basis of the well-known Banting cure. When the obesity is considerable, more drastic treatment is necessary if the patient really wishes to lose weight. It is a good plan to start the treatment with a fast day, when the patient should stay in bed. Tea and coffee, with milk and sugar, and gravy soups may be taken in any quantity. The fast day will often cause an initial drop of 1 or 2 lb. in weight and also a reduction in the size of the patient's appetite. The fast day should be repeated once a week, and after a few times the patient need not stay in bed.

The three components of the diet, *i.e.* fat, carbohydrate, and protein,

should be reduced in different proportions. The fat should be reduced as much as possible, because it has a very high caloric value and the patient has already an excess of fat in his body. Butter, cream, the fat of meat, and especially that of ham and bacon, should be avoided. Chicken is better than mutton or beef, as it contains less fat, while white fish contains no fat. The carbohydrates should be considerably reduced, but this must be done cautiously; for many patients are made miserable, complaining of lassitude and extreme hunger. This is probably due to the blood sugar being too low, since these symptoms occur as a result of an overdose of insulin (pp. 408, 409). The protein should be reduced least of all, for its combustion causes an increase in the metabolism of the body—the specific dynamic action of proteins. The total caloric value of the diet may have to be reduced to 1500, 1000 or even 500 calories before the patient begins to lose weight. The weight should not be decreased too rapidly. A decrease of 1 to 2 lb. a week and 7 to 8 lb. a month is sufficient. The treatment should be persevered with until the patient's weight is about the average for the height and age. The patient should be encouraged to take more exercise, but this should stop short of inducing undue shortness of breath. Physical drill and massage are of considerable assistance in increasing the energy needs of the body. Care should be taken not to eat more than usual after exercise, for this will neutralise any good effects of the exercise.

Thyroid extract has been used in the past rather indiscriminately, as it increases the basal metabolism. If the patient has a low metabolic rate (B.M.R.), it should be given; but if the B.M.R. is already normal, it may cause harm. The usual dose is 1 to 2 gr. twice daily. A careful watch should be kept for the onset of tachycardia, tremor, sweating, and glycosuria. When the B.M.R. is raised, more insulin has to be provided, and an elderly patient with a low sugar tolerance may develop glycosuria and have the symptoms of diabetes mellitus as the result of the administration of thyroid.

LIPODYSTROPHIA PROGRESSIVA

This is a rare condition, in which the subcutaneous tissues of the upper part of the body lose their fat, while those of the lower half remain unchanged.

Æetiology.—Females are affected more often than males. The cause of the condition is quite unknown.

Symptoms.—The patient feels perfectly well, but complains that the appearance of the face has altered, having become much thinner. The arms and trunk may also be similarly affected. The condition starts in the face and gradually descends to the arms and trunk. The legs are usually unaffected. On examination, the skin can be picked up easily and it is obvious that there is no fat in the subcutaneous tissues. The malar bones are very prominent. The whole appearance of the patient suggests a severe wasting disease. The breast and mons veneris in females are usually unaffected.

Course.—The condition progresses slowly.

Diagnosis.—This is made by comparing the subcutaneous tissues of the

upper half of the body with those of the lower. The presence of a severe wasting disease must of course be carefully excluded.

Treatment.—Nothing is known which has any effect on the condition. The patient should be assured that no serious disease is present.

THE LIPOMATOSES

Localised deposits of fat may occur in many situations. Various types with special symptoms have been described, but it is probable that they are only variations of a common morbid process.[1] The main types of the disease are:

1. *Adiposis dolorosa* (*Dercum's disease*).—See p. 477.

2. *Nodular circumscribed lipomatosis.*—The lipomata may be few in number or very numerous, symmetrical or asymmetrical, large or small. Most of them are painless, but some are very tender and painful. Asthenia and mental changes, such as occur in adiposis dolorosa, may be present.

3. *Diffuse symmetrical lipomatosis of the neck.*—This condition occurs chiefly in males, and the tumour usually appears after the age of 20. The thyroid and pituitary glands showed pathological changes in two cases. The fatty tumour is diffuse and symmetrical. The common sites are beneath the chin, at the nape and base of the neck, and the pre- or post-auricular region, and occasionally on the trunk. The tumour bears no relation to the general obesity of the patient. It is usually complained of because of the disfigurement which is caused. Pain, asthenia and mental disturbances may be present.

4. *Neuropathic œdema, pseudo-œdema, pseudo-lipoma.*—Swelling of the limbs may occur in patients with hysterical affections. This resembles at first sight an œdematous swelling, but it does not pit on pressure. It is due to a deposition of fat in the subcutaneous tissues.

Treatment.—This is very unsatisfactory. Thyroid extract gr. i t.d.s., has given the best results, but pituitary extract should also be given a trial. Aspirin may relieve the pain.

GEORGE GRAHAM.

DEFICIENCY DISEASES

VITAMINS

The normal dietary of man and animals, consisting in its bulk of carbohydrate, fat, protein, mineral salts, and water, is not complete without containing certain substances called vitamins. The existence of vitamins as essential to a healthy dietary was first demonstrated by Sir F. G. Hopkins in 1912 under the term of *accessory food factors*. Osborne and Mendel, and McCollum and Davis, subdivided these unknown substances into two groups, called by McCollum *fat-soluble A* and *water-soluble B*, both groups together being necessary for life and growth.

[1] Lyon, *Arch. Int. Med.*, vi., 1910, p. 28

For a long time it had been known that certain diseases were connected with errors in diet. Thus, scurvy had been proved to be due to the absence of fresh fruits and vegetables. Rickets could be prevented and cured by the intake of fats, especially of cod liver oil. Beri-beri arose from the consumption of white rice, and was curable and preventible by the consumption of whole rice or the peelings of rice. Pellagra, which arose from a diet consisting mainly of maize, was curable by a change to food containing animal protein. Chemical investigations regarding the substance in rice polishings and other foods by Funk led to his isolation of an impure substance which was curative of beri-beri in pigeons, and which he called *vitamin*. This substance was very similar in its distribution in foods and in chemical properties to water-soluble B, and it appeared that the two substances were identical. The term vitamin became applied to water-soluble B; fat-soluble A became fat-soluble vitamin A: and, to bring the unknown substance in fruits and vegetables into line, this was called water-soluble vitamin C. Later, for the purpose of simplicity, these three vitamins were termed vitamin A, vitamin B, and vitamin C. The preventive substance of pellagra was considered to be an amino-acid, present in animal proteins, but absent from the proteins of maize and other cereals.

Each of the groups of vitamins has been found to be more complex. Three fat-soluble vitamins have been distinguished, and are known as A, D, E; whilst the water-soluble group comprises B or B_1, B_2 or PP (pellagra-preventing), and C. Rickets has been closely connected with vitamin D. Xerophthalmia and lowered resistance to infections follow from absence of vitamin A. Sterility of animals on purified diets follows if vitamin E is absent. Vitamin B or B_1 is associated with the prevention of beri-beri, and B_2 or PP with pellagra. Scurvy is connected with the absence of vitamin C.

The discovery of the existence of vitamins in different foods has resulted from feeding experiments on animals. They are present in the foods only in minute amounts, and on this account their isolation and characterisation is most difficult. In all cases very concentrated extracts can be made, and vitamin D has been identified as a substance produced from ergosterol by the action of ultra-violet light. A substance of the formula $C_6H_{10}ON_2$ has been isolated from rice polishings by Donath and Jansen, which substance is curative of beri-beri in pigeons and other birds. Vitamins are thus definite chemical substances with definite function in nutrition. A balanced diet consists not only in having the correct amount and proportion of carbohydrate, fat, protein, and mineral salts to give the necessary calories, but also it must contain a sufficient amount of each of the vitamins.

The Fat-Soluble Vitamins

Vitamin A.—The presence of an unknown substance in fats became obvious from the fact that animals would grow on some fats, but not on others. The fats which made growth possible were mostly animal fats, with the exception of lard; the fat in green leaves was good, whilst vegetable fats extracted from seeds were not growth-promoting. The early work of Mellanby on experimental rickets showed a similar division of the fats into two groups. A comparison of the growth-promoting value of different fats

was made, and their values were found to be very different, as shown in the following table :

	Quantity per day for rats.
Cod-liver oil	0·02 to 0·002 gram.
Butter	0·2 to 0·4 gram.
Whole milk	2 c.c.
Cabbage	1·5 gram.

The high value of cod-liver oil in comparison with other fats was most striking. Other fish-liver oils have as high or even higher values. Some green leaves contain about three times as much vitamin A as butter does. Vitamin A is produced in the plant in the presence of chlorophyll, and it has been shown that butter contains more vitamin A in the summer than in the winter. The presence of vitamin A in milk and other animal fats has been demonstrated to come from the green foods which the animal consumes. Other investigations upon the stability of the vitamin showed that it was destroyed by heat in the presence of air. Heating in closed vessels, however, was not destructive. Chemical examination of fats has located vitamin A in that portion of the fat which is not converted into soap by means of soda, *i.e.* in the unsaponifiable matter. It has also been possible to detect vitamin A in fats by means of a colour reaction with arsenic or antimony chloride in chloroform. Fats containing vitamin A give a purple colour, which gradually fades (Rosenheim and Drummond).

Vitamin D.—Though the early work suggested that the fat-soluble vitamin promoting growth and preventing xerophthalmia in animals was the same as the antirachitic substance, there were several differences in the behaviour of the fats. McCollum found that cod-liver oil, after aeration at a high temperature, was still antirachitic, but did not prevent xerophthalmia. The antirachitic substance was thus stable to heat, and different from the growth-promoting vitamin A. The existence of two vitamins in fats was also shown from experiments with spinach. Spinach was strongly growth-promoting and anti-xerophthalmic, but it failed to prevent rickets. McCollum called the antirachitic substance vitamin D. A special rickets-producing diet had been evolved for the purpose of these experiments. It had a ratio of calcium to phosphorus of 5 to 1 ; which is much higher than the ratio of 2 to 1, that of calcium phosphate. The demonstration of rickets was carried out either by analysis of the bones, or by X-ray tests, or by a "line" test of the growing bone. Calcification in this test is shown by a reaction of freshly deposited calcium phosphate in the bone with silver nitrate at the epiphyses. A negative or faint line test indicates lack of, or poor, calcification. The differentiation of two vitamins from these experiments gave the explanation of the irregular antirachitic action of fats. Some contained both vitamins in large amounts, *e.g.* cod-liver oil ; others, like butter, much vitamin A and little vitamin D ; and others, like spinach, had much vitamin A and no vitamin D.

The curative action of sunlight upon rickets was well known, and could not be explained by the existence of vitamins. Huldschinsky, in 1920, demonstrated the curative action of ultra-violet rays from a mercury vapour lamp, and it then became possible to study the action of light experimentally. It was observed by Hume and Smith, at the Lister Institute, that rats kept

in cages exposed to ultra-violet light did not get rickets, and that these rats owed their health to the fact that they ate the sawdust which had been used as bedding of the cage. Rats in control cages, with sawdust not exposed to ultra-violet light, suffered from rickets. The light had thus produced something in the sawdust which gave the effect of vitamin D in preventing rickets. Foods of various kinds which usually led to rickets were next exposed to ultra-violet light and made antirachitic, and the substance which became activated was located in the fat. The constituents of fats were separated, and the constituent was found to be present in the unsaponifiable matter. Cholesterol isolated from fats was found to be capable of activation by ultra-violet light, and other specimens of this compound were also found to be rickets-preventing if exposed to ultra-violet light. Further examination of cholesterol led to the discovery of an impurity in the cholesterol, which was the substance capable of activation. The impurity was shown by Rosenheim, Heilbron, and others to be the closely allied ergosterol. Rosenheim has examined other members of this group of compounds, and has proved that only ergosterol can be activated and become vitamin D. Sunlight, owing to its ultra-violet rays, prevents rickets by converting ergosterol in the fat under the skin into vitamin D. Two factors are thus needed in the prevention of rickets. The one is ergosterol, the other ultra-violet light. Foods may contain ergosterol or activated ergosterol. The latter will prevent rickets; and the former will prevent rickets after exposure to ultra-violet light, either directly or after consumption by an animal through its skin. The direct irradiation of foods is not altogether practicable. The food may become unpalatable, and over-irradiation may destroy the vitamin D which is formed, and at the same time any vitamin A present in the food is destroyed by ultra-violet light. Though ergosterol is a rare substance, it can be isolated from ergot and from yeast, and subsequently irradiated. It is possible to obtain such preparations, and certain ill-effects have been described from overdosage of vitamin D. These ill-effects may be due to the formation of other substances by the action of the light rather than to the action of excess of vitamin D. The correct and natural method of securing vitamin D by taking ergosterol in the food and causing its activation by sunlight is in most cases preferable to the use of vitamin D preparations. There is at present no information of the amounts of vitamin D in the foods. Minute quantities are needed. In the case of baby rats 1/10,000 milligram a day will prevent rickets. This quantity corresponds to an amount of about 2 milligrams per diem for a child. Besides being antirachitic, vitamin D appears to be the fat-soluble vitamin the absence of which from the diet leads to phosphatic calculi in the kidney (Van Leersum).

Vitamin E.—It has been repeatedly shown that rats could be reared on a diet of pure protein, fat, carbohydrates, and mineral salts, together with cod-liver oil to supply vitamins A and D, and yeast to supply vitamin B. Vitamin C is not needed by the rat. On such diets, however, the animals failed to reproduce. The presence of another essential substance to enable the rats to reproduce was announced by Evans and Bishop in 1922, and the work has been corroborated many times. The addition of lettuce or other green leaves, of whole cereals, especially of the germ of cereals, to the food, resulted in normal reproduction. The substance is another vitamin,

and is termed vitamin E. Like the other fat-soluble vitamins, vitamin E is present in the unsaponifiable portion of the oil of wheat germ, and is a comparatively stable substance. It is present in many foods, and consequently on an ordinary mixed diet there does not appear to be any likelihood of its absence from the food.

The Water-Soluble Vitamins

Vitamin B or B_1.—The work of Eijkmann, who observed that fowls suffered from a peculiar form of paralysis called polyneuritis gallinarum on being given a diet of white rice, and its cure with whole rice or the peelings of rice, led to the testing of other foods for the presence of the anti-beri-beri substance. Subsequent work on the values of different foods as a preventive of beri-beri was carried out by Cooper, and by Chick and Hume at the Lister Institute, using the pigeon as test animal. Their data were very similar to those resulting from the examination of different foods for water-soluble B, as tested by the growth of rats. The identity of these two seemed certain. There were, however, some differences, and it appears that the unknown in these foods is two unknowns. They have been provisionally termed B_1 and B_2 by the Vitamin Committee of the Medical Research Council: B_1 the vitamin preventing beri-beri, and B_2 the vitamin promoting growth and concerned in the prevention of pellagra. The differentiation of the two vitamins is also proved by the difference in their stability to heat. B_1 is destroyed by high temperatures, especially in presence of alkali; B_2 is stable to these conditions. Vitamin B_1 and vitamin B_2 are present in different amounts in a few foods, though in most foods the amount is nearly equal. Yeast contains both; wheat germ has more B_1 than B_2; and egg white has B_2, but not B_1.

For purposes of nutrition it is important to know the comparative values of the different foods in respect to vitamins. A long series of experiments on the vitamin B or B_1 values has been made by Plimmer, Rosedale, Raymond, and Lowndes, using the pigeon as test animal. Their values are given in the following table:

	Percentage amount required in a Diet of White Flour.
Dried yeast	4
Wheat germ (Bemax)	6
Yeast extract (Marmite)	10
Peanuts, hazel nuts	20
Dried peas, lentils, etc.	30
Whole wheat, rye, barley, etc.	40
Egg yolk	50
Potatoes, artichokes	80
Oranges, parsnips, kale	70

These figures are the minimum amounts needed to prevent polyneuritis. The tests with other fruits and vegetables have not shown the presence of any appreciable amount of vitamin B. Vitamin B is most abundant in the germ of seeds, and is not usually found in other parts of plants. Egg yolk,

liver, and other internal organs of animals contain vitamin B. Experiments with rats have shown that this animal requires only about half the amount of vitamin B as the pigeon. Man's requirements are usually regarded as similar to those of the rat. The figures show that, in order to supply enough vitamin B for health, a normal diet should contain a very large proportion of whole cereals. As an alternative, in the case of a common diet of white flour and sugar, the addition of yeast extract or wheat germ is necessary, in order to introduce vitamin B, the quantity being about $\frac{1}{10}$th of the total dry weight of the food, *i.e.* from $\frac{1}{2}$ to 1 oz. per diem. Experiments on birds regarding vitamin B values of foods have shown that the food should be balanced by vitamin B, and that if this is not so the animals live for shorter or longer periods, depending on the quantity of vitamin B, and then die without showing the typical symptoms of paralysis, but with enlargement of the heart and various other internal morbid affections. These morbid affections have been described by McCarrison as the preliminary stages of beri-beri, caused by an absence of vitamin B. In the case of too small amounts, *i.e.* a shortage, of vitamin B, the internal morbid affections noted become chronic. Further investigations by M. J. Rowlands on rats on too small amounts of vitamin B have shown distension of the stomach, loss of mucosa and muscular coat of the intestinal wall, and delayed excretion, signifying indigestion and constipation. The loss of mucosa and muscular coat further allowed bacteria to penetrate through the lymph channels into the general system. The importance of sufficient vitamin B in the diet is thus clearly established. A scrutiny of an ordinary diet for its amount of vitamin B will usually show a deficiency of this vitamin, which deficiency is a probable cause of many cardiac and digestive symptoms.

Vitamin B_2 or PP.—Pellagra was originally thought to be due to the absence of animal proteins from the food. The chemistry of proteins has shown that animal proteins contain a greater variety of amino-acids than vegetable proteins, and hence the unknown substance preventing pellagra was considered to be some amino-acid. Experiments did not, however, specify any particular amino-acid. The more recent work of Goldberger has indicated that pellagra is not caused by a lack of animal protein, but rather by the absence of some definite vitamin. This vitamin is most abundant in yeast, and is present in lesser amounts in wheat germ, meat, fish, eggs, and internal organs of animals. Its distribution is thus very similar to that of vitamin B_1. The water-soluble vitamin is thus often a complex, and, as mentioned previously, the part concerned in the prevention of pellagra is heat-stable, and is termed vitamin B_2. As vitamin B_2 is present in meat, eggs, fish, and other articles of food, the appearance of pellagra in countries using these foods is rare, and can then generally be traced to peculiarities in the diet. A study of the pellagra producing diets by Wilson showed that they contained too little animal protein, and that 40 grams of animal protein per diem prevented the disease.

Vitamin C.—In the Middle Ages it was recognised that fresh fruits and vegetables cured and prevented scurvy, that dried fruits and vegetables had no effect, and that among fruits the orange and lemon were the best antiscorbutics. A ration of 1 oz. of lemon juice per diem was served out in the navy, and was found to prevent scurvy. A smaller ration of $\frac{3}{4}$ oz. was found to be insufficient. The modern experimental work of Holst and

Frölich, who discovered that the guinea-pig on a diet without fresh fruits and vegetables suffered from scurvy, led to an examination of the comparative vitamin C values of this class of foods by Chick and Hume, whose experiments were carried out during the Great War, largely to ascertain the best antiscorbutics for army use. These investigations were extended in other directions, such as the effect of cooking, and the addition of soda and citrate to milk. The following table shows the chief results:

	Minimum Daily Quantity to Protect from Scurvy.	
	Guinea-pig	Man.
Orange or lemon juice	1·5 grams	1 oz.
Tomato juice	2·0 ,,	1·5 ,,
Lime juice, *fresh*	5·0 ,,	3·5 ,,
Apple	10·0 ,,	6·6 ,,
Banana	10·0 ,,	6·6 ,,
Grapes	20·0 ,,	13·3 ,,
Cabbage	1·5 ,,	1·0 ,,
Green peas	2·0 ,,	1·3 ,,
Potato	10·0 ,,	6·6 ,,
Carrot	10·0 ,,	6·6 ,,
Swede turnip	2·5 ,,	1·6 ,,
White turnip	50·0 ,,	33·3 ,,
Beetroot	20·0 ,,	13·3 ,,
Cabbage, cooked 1 hour	15·0 ,,	10·0 ,,
Potato, cooked 15 minutes	10·0 ,,	6·6 ,,
Potato, cooked 1 hour	15·0 ,,	10·0 ,,
Milk, fresh	100·0 ,,	70·0 ,,

The figures for man in this table are calculated from those found for the guinea-pig, taking 1 oz. of lemon juice as the basis. Fruits and vegetables vary very much in their antiscorbutic value: some have a high value; whilst others, like grapes, beetroot, and turnip, have a low value. Milk also has a low antiscorbutic value. These values are now being made use of in practice. Orange juice, instead of grape juice, is commonly given to infants to avoid infantile scurvy.

The effect of cooking fruits and vegetables is destructive of vitamin C. Rapid cooking is less harmful than long slow cooking. The heating of vegetables a second time destroys vitamin C, so that reheating of cooked cold vegetables is inadvisable. The practice of cooking with soda has been found to be destructive, and similarly with bicarbonate, or the use of citrate with milk. Vitamin C is very sensitive to heat in the presence of air. On account of the easy destruction by heat, the tinning of fruits was considered fatal to vitamin C, but direct experiments with tinned fruits has shown that the vitamin C is not destroyed. In the modern process of canning, air is removed from the fruit before heating, and there is little or no destruction. Jams and marmalade are produced by long boiling, and therefore do not contain vitamin C. The preparation of condensed and dried milk by processes in which air is excluded gives a material containing vitamin C. Orange juice has also been concentrated, and contains the original vitamin C value. It is of importance to notice that dried peas and beans develop vitamin C on

being sprouted. They can thus be used as a source of vitamin C on long expeditions far from a base, and if fresh vegetables are scarce.

R. H. A. PLIMMER.

SCURVY (SCORBUTUS)

Scurvy belongs to the group of "deficiency" diseases, being due to the absence from the diet of a sufficiency of a specific "accessory food factor" or "vitamin." It consists in a general disorder of nutrition, characterised by debility, mental apathy, anæmia, sponginess of the gums, ulceration of the mouth, and a tendency to hæmorrhage.

Ætiology.—The theories, long entertained, that scurvy is the result of poisoning by a ptomaine or of a deficiency of potassium salts or alkaline compounds in the blood, have now been abandoned, and it has been abundantly proved by the experimental work of Axel Holst and his successors that the disease results from a deficient intake of an anti-scorbutic vitamin. The chemical nature of this vitamin is unknown, nor do we understand how its absence produces the change in nutrition which results in scurvy; but it is known to be present abundantly in green vegetables and the juice of fresh fruits, especially of oranges and lemons; in considerable amount in roots and tubers, and in small quantities in raw meat juice and milk. It is absent from dried vegetables and seeds, though it appears in the latter as the result of germination. It is very sensitive to heat and to drying, and is destroyed by alkalis, but protected by acids. Bad hygienic conditions appear to favour a development of the disease; but as a rule it seems to require an exposure of from 4 to 8 months to scorbutic conditions before it appears.

Pathology.—The only constant change found after death is effusion of blood into the skin and subcutaneous tissues and under the periosteum, and sometimes also in the pleura and pericardium. The effusions are diffuse or circumscribed, and may show partial clotting or even organisation. There may also be hæmorrhagic effusion into joints. The organs show no constant change, but the heart muscle may be soft and degenerated, the lungs œdematous, and the spleen congested and infarcted.

Symptoms.—Scurvy is a disease of insidious onset. The earliest symptoms are weakness and lassitude, dizziness on standing up, and bruising or bleeding from the gums on slight provocation. Pains in the lower limbs are often complained of, and there may be a characteristic hardness of the calf muscles. Follicular keratosis is an early sign (Wiltshire), and in appearance is similar to the hyperkeratosis of follicles met with in other malnutritional states. Meanwhile the patient looks ill. The face becomes sallow and drawn, and the eyes lustreless and encircled by dark rings.

Such symptoms may precede by a few days, or even weeks, the more characteristic signs. Among these the most striking, though not necessarily always present, are the changes in the mouth. The gums begin to swell, especially around stumps or carious teeth, and as the process goes on the swelling may become so great as to amount to a veritable hypertrophy, so that the teeth become buried in a mass of soft fungous tissue of a bluish or purplish tint. Ulceration quickly follows along the margins, the process

being accompanied by the discharge of a sanious fluid which imparts an odour of great fœtor to the breath. Finally, the teeth become loosened in their sockets and may fall out, while necrosis of the alveolar edges ensues.

Equally characteristic and constant are hæmorrhages into the skin and subcutaneous tissue, which assume the form either of petechiæ or of ecchymoses. The former occur as small red or purple spots resembling flea bites, which appear first around the hair follicles of the lower extremities, and impart, by the elevations which they produce, a slight feeling of roughness to the skin. They remain for about a week, and then gradually fade into greenish spots, which soon disappear; their disappearance being followed by a slight degree of desquamation. The production of the petechiæ is determined by the slight irritation caused by the friction of the clothes, and hence they are always to be found first on the outer surface of the leg, and the outer and anterior aspects of the thigh. Here and there the petechiæ may coalesce into larger areas or maculæ. In severe cases the slightest pressure on the skin is sufficient to cause ulceration, the ulcers having thick edges and bleeding surfaces with offensive discharge. Such ulcers may spread rapidly and invade surrounding tissues, giving rise in some cases to dangerous, and even fatal hæmorrhage. Ecchymoses, the other characteristic surface lesion of scurvy, are produced by hæmorrhage into the subcutaneous or intermuscular tissue. They may occur spontaneously or as the result of injury, and vary greatly both in size and extent, being commonest in the lower extremities, where they may form quite large swellings. The part affected by them is brawny, tender, and pits on pressure, the indentation persisting longer than it does in ordinary œdema. The skin over them is red, shiny and hot. Such effusions are common, also, in the popliteal space and in the bend of the elbow, as well as in the loose tissue around the malleoli, and beneath the muscles of the jaw. In these situations they form indurated swellings which fill up the natural hollows of the part, and greatly interfere with the movements of the adjacent joint. Where such effusions occur over the shins they are apt to be mistaken for syphilitic nodes. There is no marked tendency to bleeding from the internal organs; but hæmorrhages may take place from the mucous surfaces. Of such hæmorrhages, epistaxis and bleeding from the mucous membrane of the mouth are commonest. Bleeding may also occur from the mucous membrane of the intestine when there is a coexisting diarrhœa. Hæmoptysis, hæmatemesis and hæmaturia are rare. Hæmorrhagic effusion into the pleura and pericardium has also been described. Not uncommonly hæmorrhage occurs under the conjunctiva, and may be so extensive as appreciably to raise the ocular layer, leaving the cornea at the bottom of a pit surrounded by swollen and red conjunctival membrane.

As the disease progresses anæmia becomes a marked feature, though its degree has no constant relation to the extent of the ecchymoses. The blood picture is that of a secondary anæmia, the red cells being sometimes reduced to 2 millions per c.mm., or less. Poikilocytosis and anisocytosis are common, nucleated forms rare. The hæmoglobin is reduced roughly in proportion to the red cells. Observers differ as to the white cell count. Some have described a leucopenia; others a moderate lymphocytosis. All are agreed that polynuclear leucocytosis is not present unless inflammatory complications coexist. Apparently the coagulability of the blood is not diminished,

and the serum is not hæmolytic; but although the presence of a diminished alkalinity has been alleged our knowledge of the chemical changes in the blood is still limited.

Alimentary symptoms may be absent. Appetite is not necessarily impaired; but dyspepsia may be present, as the result of the dietetic conditions which produce the disease. Constipation is the rule; but the conditions in which scurvy develops often favour the production of a dyspeptic type of diarrhœa with sanguineous discharge. The urine may be albuminous.

Complications.—Gangrene of the lung is one of the most frequent and dangerous of the complications. Bronchitis and bronchiolitis also occur. Night blindness is met with not unfrequently, and is specially prone to occur in patients who have been exposed to bright light, and may be an early symptom. It is associated with anæmia of the retina.

Diagnosis.—If all the characteristic symptoms are present, and if the disease arises simultaneously in a number of subjects in circumstances known to favour its development, the diagnosis is easy. Difficulty only occurs when one has to deal with sporadic cases, such as those of land-scurvy, met with in ill-fed individuals.

The disease which perhaps most closely resembles it is purpura hæmorrhagica (morbus maculosus of Werlhof): but in this the affection of the gums is absent, and the hæmorrhages have not, as they have in scurvy, an inflammatory character. Mercurial cachexia, which in many points closely simulates scurvy, is now but rarely seen, and an inquiry into the history will usually lead to a correct conclusion. Acute lymphatic leukæmia, which is so often marked by ulceration in the mouth, can be distinguished by an examination of the blood.

Prognosis.—This, except in the severest cases, is favourable, provided that proper treatment is adopted. The outlook depends less upon the severity of the local lesions than upon the condition of the internal organs, and the presence or absence of complications. Extensive bronchitis or severe diarrhœa is of grave omen, and gangrene of the lung nearly always proves fatal. Even in uncomplicated cases, sudden death may be brought about by severe hæmorrhage or heart failure. In the most favourable circumstances convalescence is apt to be protracted, and when recovery is otherwise complete there may still be results left behind in the shape of cicatrices in the skin or partly anchylosed joints.

Treatment.—The essence both of the prophylaxis and of the active treatment of scurvy is to supply a sufficiency of the anti-scorbutic vitamin in the diet. With this object, salads of fresh uncooked vegetables, if obtainable, should be partaken of freely, and other vegetables should be cooked for as short a time as possible—no soda being added in the process. The juice of fresh lemons or oranges may be taken to the amount of an ounce daily. Ordinary bottled lime juice is useless. Fresh meat and milk, fresh or soured, are also helpful. If none of the above can be had use may be made of germinated peas, beans, or lentils—especially in prevention. Tinned fruits and tomatoes have also some anti-scorbutic power.

In addition to the dietetic measures, if the disease has actually developed, the patient should be removed as soon as possible to more hygienic surroundings. Cold and damp should specially be avoided. Drugs are of

little help, but iron may be given during convalescence. Cod-liver oil has been recommended for the night blindness. Other complications must be treated according to their nature. Locally the condition of the mouth will demand most attention. A peroxide wash will help to remove the fœtor, whilst nitrate of silver solution (2 to 3 per cent.) may be painted on the affected gums.

INFANTILE SCURVY

Infantile scurvy—known on the Continent as Barlow's disease—is identical in its pathology with the adult form of the disease, its special clinical features being due to the anatomical and physiological peculiarities of early life.

Ætiology.—The disease usually appears between the eighth and twelfth months—both sexes being equally affected. As in adult scurvy, the essential cause is the absence from the dietary of a sufficiency of anti-scorbutic vitamin. A diet of condensed milk, with the addition of a tinned food, is that which most commonly results in scurvy; but sterilised milk alone may give rise to it, and so even may milk which has only been boiled. Desiccated or pasteurised milk does not appear harmful. A few cases have been recorded in which the child had been fed on the breast only; it is probable that in these the mother's diet had been deficient in fresh constituents.

Pathology.—The chief changes are in the neighbourhood of the bones. A section made across a limb at the site of a swelling shows that the periosteum is hyper-vascular, thickened and separated from the subjacent bone by a layer of partially organised blood clot. There is no sign of inflammation, and no hard bone is formed in the periosteum, except in very long-standing cases; in which circumstances the muscles surrounding the bone may be infiltrated with blood or serum, and look sodden. The bone exhibits rarefaction, and may be fractured. There may be hæmorrhagic effusions into the joints or serous cavities. The organs exhibit no characteristic change.

Symptoms.—The onset is gradual, the first symptoms noticed being often a refusal of food, along with fretfulness and restlessness. There is a tendency for the child to resent being handled. Meanwhile the general nutrition is usually unimpaired, and the child's colour is often fresh and healthy looking. After a variable period the more prominent symptoms appear. The most striking of these is extreme tenderness of the legs, which causes the child to scream loudly when touched or even when approached. In a well-marked case some swelling will be found, usually of the lower end of the femur or upper end of the tibia. Involvement of the arm bones is much rarer. The skin over the swelling is often tense and glossy, and may be slightly œdematous; but there is no local heat. Soft crepitus may be elicited on handling the limb, indicating a fracture or a separation of the epiphysis. In some cases hæmorrhage takes place into the orbit, giving rise to proptosis and ecchymosis of the eyelid. Rarer sites of hæmorrhage are around the ribs, clavicles or bones of the skull.

Changes in the gums are not nearly so pronounced as in adult scurvy, and are not usually present, unless some teeth have been cut; in that case the gum around them is usually swollen and of a purplish colour. Petechiæ

and subcutaneous ecchymoses are very rare in infantile scurvy, and hæmorrhage from mucous membranes is not common. Hæmaturia, however, is not infrequent, and may be an early and the only symptom; it is probably often overlooked. Fever is not a conspicuous feature, but may be present if extensive hæmorrhages have taken place; it rarely exceeds 102° F. The blood changes are the same as have been described in the adult form of the disease.

Diagnosis.—This is easy in a well-marked case, provided the leading features of the disease are known to the observer. The screaming of the child on examination, the swelling and tenderness of the legs, and the condition of the gums leave no doubt as to the nature of the affection with which one has to deal. All cases, however, are not so pronounced in type. Not infrequently one encounters mild or incipient forms which it is easy to overlook. In these, tenderness when the child is handled, or when it is put in the bath, may be the only symptom. In other cases again, slight sponginess around the incisor teeth may alone be present, or one may have to deal with an apparently causeless hæmaturia. In any case in which there is doubt two points will help. One is the nature of the feeding. If this has been of such a kind as is known to favour the development of the disease the diagnosis will be greatly strengthened. The other point is the application of the therapeutic test. If the symptoms present are really due to incipient scurvy then they will certainly disappear rapidly so soon as appropriate treatment is begun; if they fail to do this, then some other condition must be thought of.

Infantile scurvy may be mistaken for rheumatism, although the mistake should not occur if it be remembered that acute rheumatism is hardly ever seen below the age of 2. The distinction between scurvy and suppurative periostitis or epiphysitis is much more difficult, especially if the gum changes are absent. A very high temperature and much constitutional disturbance are against scurvy. The nature of the diet will also be of weight in the diagnosis. A skiagram will be of great assistance in coming to a conclusion.

The absence of swelling in the affected limb and of the other symptoms of scurvy should distinguish those cases of infantile paralysis in which there is much tenderness of the paralysed leg, and the blood examination should enable one to differentiate a case of acute leukæmia or chloroma.

Prognosis.—This is quite favourable, provided the disease is recognised in time and proper treatment adopted. Nothing in therapeutics is more striking than the rapidity with which such patients improve on a change of diet, although some degree of thickening of the bones may persist for a long time. Death, when it occurs in the more severe cases, is usually the result of intercurrent disease, such as broncho-pneumonia and chronic diarrhœa, although sudden hæmorrhage, cardiac failure or exhaustion may occasionally lead to a fatal issue.

Treatment.—This consists mainly in altering the diet. Tinned foods and sterilised milk must be stopped at once, and the child put upon a due allowance of unboiled milk. Four teaspoonfuls of orange or grape juice, sweetened with a little sugar, should be given daily. Baked potato is also useful, a little of the part under the skin being rubbed up with the milk into a thin cream, which is either added to the bottle or given separately (2 teaspoonfuls three or four times a day). Raw meat juice is of some value,

especially if anæmia is present, and may be given in quantities of half an ounce daily. Drugs are of little service; but cod-liver oil and iron aid convalescence.

Scorbutic infants should be handled carefully, and the clothing so made that it can be easily taken off and on. If it is necessary to move the child about it should be carried on a pillow. The affected limb should be steadied by light splints or wrapped in wet towels, which, if allowed to dry in position, afford considerable support. In mild cases a covering of cotton-wool secured by a light bandage is sufficient protection.

RICKETS

Definition.— Rickets is a disease of nutrition occurring in early childhood. It mainly affects the growth of the bones, but is characterised also by a tendency to catarrhs of mucous membranes, and to functional disorders of the nervous system.

Ætiology.—Various theories have been held in the past as to the cause of rickets. It has at different times been attributed to inherited syphilis (Parrot), to microbic infection, to dyspepsia the result of dilatation of the stomach, and to obscure nervous influences. More plausible was the belief that it resulted from a deficient intake of lime. All these views, however, are now discredited, and it is generally agreed that the disease results from some error in feeding. Clinical observation has long pointed to a deficiency of fat as being the essential fault in the diet: but recent experimental work favours the view that it is not a deficiency of fat as such that is responsible, but of a fat-soluble vitamin (vitamin *D*). This vitamin is present in milk fat, but is particularly abundant in cod-liver oil. It can be produced artificially by the irradiation of ergosterol.

In addition to the food factor there is no doubt that defective hygiene—including in that term overcrowding, insufficient air, exercise, and light, and, in fact, the conditions of life of the poorer class in large towns generally—plays a very large part in predisposing to the disease. Noel Paton and the Glasgow School even consider that the domestic factor alone is sufficient to cause the disease, apart from errors of diet. All are agreed that the disease is mainly one of temperate climates, that it is more apt to develop in the winter and affects both sexes equally, and that heredity plays no part in its production.

Pathology.—The chief changes are in the bones. Section through the end of a long bone shows that ossification, instead of proceeding in an orderly way, is greatly disorganised. In the zone of proliferation of the cartilage the cells show excessive multiplication, and are arranged irregularly, instead of in columns. A broad bluish area results, which is the cause of the thickening of the epiphysis. In addition to this, calcification between the cells is defective, the affected area shows excessive vascularity, and the new bone formed is soft and deficient in lime. The whole process has been summed up in the statement that "there is an excessive preparation for ossification and a defective accomplishment of it." In addition, the vascular layer of the periosteum is thickened and the marrow congested.

Chemical analysis shows that the bones contain only from 30 per cent. to

50 per cent. of calcium, instead of the normal 60 per cent. or more. They may show signs of old or recent fracture. The poverty of the bones in mineral matter appears to be due to defective absorption and utilisation of calcium and phosphorus, which is the chief feature of the morbid chemistry of the disease. The internal organs show much less change; but the spleen may be rather large and firm, from an increase of its fibrous tissue, and the liver is often somewhat fatty. The mucous membranes of the respiratory and alimentary tracts frequently exhibit evidences of catarrh.

Symptoms.—The disease can rarely be recognised before the sixth month. Amongst the earliest indications to attract attention are restlessness and irritability, sweating about the head, especially when asleep, and a tendency on the part of the child to kick off the bedclothes at night. There is no wasting, indeed the infant may be abnormally fat, though usually flabby and pale. The appetite is capricious.

As the disease progresses, it will be found that dentition is delayed, and that changes in the bones become manifest. They first show themselves in the epiphyses of the ribs, which enlarge and form a row of knobs down the sides of the chest (the rickety rosary). Enlargement of the epiphyses of the bones of the limbs then takes place, being most conspicuous at the lower end of the radius.

The softening of the bones leads to various deformities. The chest sinks in at the line of junction of the ribs and cartilages, so that a broad groove forms, running downwards and outwards towards the axilla (Harrison's sulcus). The bones of the limbs bend, the femur curving forwards and outwards, and the tibia bending sharply forwards and often also outwards at its lower third; there may also be a curving of the upper part, leading to "bow-leg." The humerus and bones of the forearm may become bent in an outward direction, as the child sits supporting itself on the hands, and the clavicle may show a sharp kink at the junction of the inner and middle third. The pelvis becomes flattened. Greenstick fractures of the limb bones are not uncommon.

The skull shows striking changes. It is usually somewhat enlarged, elongated and flattened on the vertex (box head), the anterior fontanelle remaining widely open long after the normal period of closure at the eighteenth month. There may be pronounced thickening of the frontal and parietal eminences, leading to the so-called "hot cross bun" or bossed head, especially in cases complicated by anæmia with enlarged spleen. Areas of defective ossification in the parietal and occipital bones in the neighbourhood of the occipital suture (cranio-tabes), which yield on pressure a characteristic parchment-like sensation, are not uncommon.

The muscles are often so weak and flabby that paralysis is simulated, and the ligaments may be so lax that the limbs can be bent into almost any position ("acrobatic rickets"). In consequence also of the laxity of ligaments, kyphosis often develops in the lower lumbar region (rickety spine).

The blood usually shows a varying degree of anæmia of the secondary type, and in a few cases the changes are so profound as to resemble those met with in chlorosis.

The digestive system is usually deranged. Chronic diarrhœa with pale, offensive stools is not uncommon. The abdomen is distended so that the child has a pot-bellied appearance. In the production of the distension,

muscular weakness, intestinal fermentation, and the pushing down of the diaphragm by the sinking in of the chest all play a part. The edge of the liver can often be felt at a lower level than normal, partly from displacement and in part from enlargement through fatty change. The spleen is also palpable in a considerable number of cases, although this is due more to its being pushed down than to actual enlargement.

In the respiratory system bronchial catarrh is very often present, and not uncommonly results in broncho-pneumonia. In the nervous system the disease shows itself by general nervousness and irritability, and in some cases by the development of laryngismus stridulus, tetany, or even convulsions, of all of which rickets is a strong predisposing cause.

Diagnosis.—In a fully developed case the diagnosis is easy. Early cases, and those in which the rickety element is overshadowed by some complication, such as broncho-pneumonia or diarrhœa, are more apt to be overlooked. The suggestive points will be delayed dentition, an open fontanelle, and the presence of the rickety rosary. A skiagram will show a tendency to cupping of the diaphysis; the epiphyseal line will be irregular and ill-defined, and the epiphysis itself poorly ossified. There will also be a tendency to osteoporosis throughout the whole bone. The appearance of the epiphyses of the carpus and tarsus may be retarded.

The rickety head is apt to simulate hydrocephalus, but in the latter condition the skull is more globular, and bulges above the ears, the fontanelle is tense, and the eyeballs, in marked cases at least, pushed downwards. The kyphosis of rickets may be mistaken for spinal caries; but in the former the bend straightens out as a rule when the child is held up by the armpits. In severe cases this may not happen, and a radiograph may be required to settle the diagnosis. If the muscular weakness is pronounced infantile paralysis may be imitated; but the history, the retention of the reflexes, and the presence of other signs of rickets should prevent mistakes.

Prognosis.—Rickets is not fatal *per se*, and usually passes off spontaneously after the third year, although the deformities of the bone may persist for a long time. Even these, however, have a wonderful way of righting themselves without any special treatment. On the other hand, rickets is a very serious complication of other diseases, especially of broncho-pneumonia and diarrhœa, and adds greatly to their fatality if present, so that the dictum of Sir William Jenner that "in its indirect results rickets is one of the most fatal diseases that peculiarly affect childhood" is perhaps true.

Treatment.—Rickets can be prevented if the child is properly fed and cared for. Breast feeding for the first 9 months is the best safeguard; but it must always be remembered that the disease is apt to develop in children who are kept *too long* on the breast. After weaning, pure cow's milk should be given in sufficient quantity, and the premature or excessive use of starchy foods avoided. Care should be taken that the diet contains an adequate amount of animal fat. Plenty of fresh air, sunlight and exercise are also important factors in prophylaxis.

If the disease has already developed, the diet should be altered in accordance with the requirements indicated above, the most important point usually being to increase the allowance of cow's milk, which should not fall below 1½ pints per diem during the second year of life. Yolk of egg is also a valuable food. Cod-liver oil (or one of the artificial substitutes containing vitamin D)

is the most useful drug, having almost a specific influence on the disease; but iron may also be given with advantage if there is anæmia. Sun-baths or exposure to the rays of the mercury-vapour lamp have a definitely curative effect.

To prevent bending of the legs, long splints may be applied, projecting beyond the feet, so as to make standing impossible. Orthopædic treatment may be required for the more permanent deformities. Alimentary and respiratory complications should be treated by the measures appropriate to them.

Late or Adolescent Rickets

This term is applied to a disease apparently identical with ordinary rickets in its bony changes, but which sets in much later, usually between the ninth and fourteenth years. The patient may have been the subject of ordinary rickets in earlier childhood—hence the use of the term "recrudescent rickets"—or the disease may have appeared at the later age for the first time. Nothing is known of its causation.

The manifestations of the disease are practically confined to the skeleton, the long bones being particularly affected. The epiphyses become much enlarged, and pronounced deformities ensue as the result of bending. The skull escapes almost entirely, and there is no tendency to any disease of the internal organs, or to complications.

The disease is not dangerous to life; but the deformities may be lasting. The general treatment is the same as that of ordinary rickets: but most cases will require the help of the orthopædic surgeon.

"Fœtal" and "congenital" rickets are ambiguous terms which have been loosely used to cover several distinct pathological conditions, amongst which are achondroplasia, mollities ossium, and osteogenesis imperfecta. They are best avoided. So-called "scurvy-rickets" and "acute rickets" aer identical with infantile scurvy, although rickets often coexists with the latter, seeing that both are due to faulty feeding.

Robert Hutchison.

BERIBERI

Synonyms.—Polyneuritis Endemica; Kakké; Barbiers, etc.

Definition.—A vitamin-deficiency disease, occurring frequently in tropical regions, especially where rice is used as the sole article of food, characterised by peripheral neuritis, the nerves of the legs and heart being specially prone to attack.

Ætiology.—The disease is very frequent in the Federated Malay States, Sumatra, Japan, in parts of Brazil and in other parts of the world. Many cases reach London, cases from the Chinese, Japanese and Indian crews of steamers trading with India and the East. A well-marked form is found in sailing ships in the Atlantic (Ship Beriberi). Adults are most affected, but children also may suffer. Males and females appear to be equally susceptible.

It has now been abundantly proved that the cause of the disease is a vitamin deficiency. Though the disease is specially rife in rice-feeding races, rice *per se* is not essential, any food if deficient in the anti-neuritic

principle, the water-soluble B, being sufficient. This explains the attacks in Brazil, where rice is not used, and in the sailing ships, where stale and tinned foods are principally eaten—the high sterilisation required in tinning food destroying the vitamin. As regards rice, the vitamin is found in the pericarpal layer of the grain, and its removal by polishing renders it dangerous as food.

Pathology.—It is not yet clear how the absence of the vitamin or anti-neuritic principle acts; the changes found in the nerves being very similar to those found in alcoholic and other poisons.

A diet consisting of polished rice alone is completely deficient in vitamin, and this accounts for natives who use such a diet being specially liable to be attacked by beriberi. (Compare the experimental work on avian beriberi in pigeons.) A mixed diet, on the other hand, though deficient in part in the anti-neuritic principle or water-soluble B, may have in the other part quite enough to prevent the occurrence of any metabolic disturbance of the nerves.

Characteristic changes are found in people who have died of beriberi. The veins of the neck are engorged, the right heart is much dilated and distended with blood, and serous effusions are seen in the pleural cavities, pericardium and the cellular tissues. The lungs are congested and œdematous, the liver and spleen show chronic venous congestion. The duodenum is congested and reddened (the duodenitis of Hamilton Wright). The kidneys do not show nephritis. The nerves microscopically are much degenerated, the changes being similar to those seen in multiple peripheral neuritis due to other causes, namely, fatty degeneration of the myelin sheath, with gradual absorption, and finally disappearance of the axis cylinder and collapse of the sheath of Schwann, the nerve disappearing in the fibrous connective tissue of the endoneurium.

Symptoms.—The disease is variously divided up clinically, such as wet, dry and mixed forms. Hamilton Wright described rudimentary cases, ordinary typical cases and acute pernicious forms, and such a division is better than the former, the conditions really being similar in all, though of varying grades of severity. A wet beriberi simply means a case with œdema, a dry beriberi a case with none, or where the œdema has gone, the resultant paralysis and wasting of the limbs being then well seen.

Rudimentary cases (Larval or ambulatory cases).—Such are due to a limited failure of vitamin. There may be some numbness in the legs, with some patchy anæsthesia and diminution of knee-jerks, all of which symptoms quickly disappear if a more varied diet be given. Such cases, however, give the warning, that if the vitamin deficiency is kept up, more serious phenomena will follow.

Ordinary beriberi.—Prodromata such as pins and needles in the limbs, tired feelings in the muscles and heaviness in the limbs generally usher in the disease. These gradually increase, until the limbs become completely paralysed and further movements become impossible. The knee-jerks, first exaggerated, are then lost, and varying grades of œdema, from a little on the tibiæ, to extreme grades where the patient is waterlogged and bloated with fluid, are seen. The sensory nerves are also affected, hyperæsthetic and anæsthetic patches being found at different parts of the limbs and trunk. Shortness of breath and marked dyspnœa generally now appear, indicating

an involvement of the cardiac nerves. The patient is very liable to die suddenly of heart failure at this stage, largely depending on what sort of attention he receives. There is no fever throughout the disease. Finally, if recovery take place, the fluid gradually becomes absorbed, and then the atrophy of the muscles becomes very evident (dry beriberi). The degree of recovery will be in inverse proportion to the amount of nerve destruction. The nerves very slowly regenerate, and as a result the muscles improve in tone until finally complete recovery takes place—this, however, often taking 3, 4, or 6 months for completion.

The heart is dilated to the right, with engorgement of the veins in the neck; the long and short pauses are more or less equalised (equal spacing of the sounds); systolic murmurs are present, and the second sound is generally reduplicated. The pulse is rapid and of low tension. The urine is free from albumin, and there is nothing characteristic in the blood.

Acute pernicious forms.—The patient is seized suddenly, with few or no premonitory warnings, there is great cardiac distress with cyanosis, gasping for breath, coldness of the extremities, and death takes place with great rapidity.

Diagnosis.—This has to be made from all the other forms of multiple peripheral neuritis and in white people is by no means easy. When many cases are occurring amongst natives, whose food is known to be deficient, and if no arsenical or other poison can be incriminated, the diagnosis of beriberi may be made with safety.

Prognosis.—This depends almost entirely on whether the patient can be treated properly or not. If taken quickly into hospital, and surviving the first few days, the chances of recovery are quite good. On the other hand, with no attention and continuing to take the improper diet, the patient will certainly die. The acute pernicious cases all die. Vomiting is always a symptom of very grave significance, and, if severe, indicates a fatal termination.

Treatment.—Since the discovery was made that the disease is purely a deficiency one, great progress has been made in prophylactic measures to control it. The complaint has been stamped out of the jails, asylums and other government institutions in the Federated Malay States simply by changing the diet and giving a parboiled or cured rice, *i.e.* a rice that has been boiled and dried before husking, instead of a highly polished one.

A patient suffering from beriberi must be placed in bed and not allowed to sit up suddenly. If the condition be serious, amyl nitrite may first be given and small doses of digitalis; venesection may be performed if the right heart be greatly engorged. After the first few days, a dry diet rich in vitamins (eggs, yeast, milk, heart muscle, etc.) should be given. The symptoms will then gradually but slowly improve. Finally, when all acute signs have disappeared, massage and electricity to the limbs will help to restore the muscles to their former tone.

Infantile form.—Recently a form of beriberi occurring in infants has been described. It is common in some of the Pacific Islands. It usually attacks infants fed by the breast by mothers who are poorly nourished. Cessation of breast-feeding and the intake of rice bran on the part of the infant are recommended.

EPIDEMIC DROPSY

Definition.—A peculiar febrile condition, associated with dropsy, vomiting, diarrhœa, skin rashes and anæmia.

Ætiology.—The disease has been described from Calcutta during the cold weather and in Mauritius. Apparently similar conditions have also been met with in other parts of India. Cases have been seen in London by the writer amongst the native crews of steamers coming from India. Both sexes are liable to the disease, children less than adults. The exact cause is unknown, but it is believed to be a disease *sui generis*. It is probably a deficiency disease, or belongs to that group of maladies (Greig).

Pathology.—Effusions into the serous cavities have been observed at autopsy. Otherwise there is nothing special to note.

Symptoms.—The fever is of a remittent type and may precede or be present with the second symptom, namely, dropsy. This begins on the legs, and may spread all over the body. Diarrhœa and vomiting may also occur and pain and aching in the muscles and joints. The exanthem is of an erythematous nature, appearing as a rule after the œdema, and lasting 12 days. The heart shows disturbance of its rhythm with murmurs, and dyspnœa; and finally anæmia results. Scorbutic symptoms sometimes are superadded. The knee-jerks may be present.

Diagnosis.—This has to be made from beriberi, which it resembles in some ways.

Prognosis.—This varies; the death-rate may be as high as 20 to 40 per cent.

Treatment.—A more generous diet should at once be instituted, *e.g* more rich in vitamins. Cardiac tonics may be required if the heart show signs of involvement.

PELLAGRA

Synonyms.—Mal de la Rosa; Mal del Sole; Maidismus; Malattia della Miseria, etc.

Definition.—Pellagra (pelle, the skin; agra, rough) is a chronic, non-contagious disease of the poor, associated in some way with maize, and running its course with gastric and intestinal symptoms, nervous and psychical disturbances, together with an exanthem of an erythematous nature.

Ætiology.—The disease prevails endemically in Europe, Africa and America. It is very common in Italy, Roumania, Spain, Egypt and in the Southern States of the U.S.A. It also occurs in the West India Islands. Any race is subject to the disease if the conditions be suitable for its production. Children suffer as well as adults; males and females are equally liable. The disease occurs amongst the poor, and at one time was thought to be due to eating diseased maize. The most recent view as to its causation is that it is a deficiency disease—a protein deficiency; races who subsist on maize alone as their standard food receiving a deficient supply of some protein, and so becoming prone to acquire the disease. Goldberger and Wheeler's experimental work in America strongly supports this view. Sambon proposed a hypothetical germ, with the sandfly as an intermediate

host, but there is little or no proof of this, and the theory has recently fallen into disfavour.

Pathology.—The absence of some essential in the food would seem to explain the pathology of the disease. (Compare beriberi, scurvy, rickets, etc.) One of the most important things to be noticed on autopsy is the emaciation and cachexia, the internal organs showing changes associated with such a condition. The heart is small and atrophied. The walls of the stomach and intestines are greatly atrophied and thinned, the mucous membrane showing, in addition, signs of a subacute inflammation. Ulcers are also not uncommon in the colon and rectum. The liver is either of normal size, or may be slightly enlarged and fatty; the spleen and kidneys are small, the parenchyma showing fatty and often also interstitial changes eventuating in a cirrhotic condition. The most important pathological changes are found in the nervous system. According to Scheube, hyperæmia, anæmia and œdema are the conditions most frequently met with in the brain, spinal cord and meninges. Chronic inflammation of the latter also is present. The cord shows sclerosis of the posterior columns, and sometimes of the postero-lateral columns as well. Batten, in material sent by Sandwith from Egypt, found a sclerosis of the posterior columns, and came to the conclusion this was of root origin, the cord changes being secondary. These changes indicate a widespread disease of the spinal cord, being in many ways similar to those found in ergotism and lathyrism. The peripheral nerves do not suffer.

Symptoms.—The incubation period is unknown. The duration of the disease is from 5 to 15 years or more. The course of the malady is distinguished by definite attacks alternating with periods of amelioration, the exacerbations occurring in the spring of the year. Premonitory symptoms, such as giddiness, loss of appetite, and general debility, may usher in the disease. The fully developed condition may be dealt with under three headings. (1) The first attack, consisting of stomachic and intestinal symptoms, accompanied mostly with an exanthem. (2) Subsequent attacks in which the nervous disorders become more prominent, with serious cerebro-spinal symptoms. (3) The stage of cachexia and marasmus. The three chief systems affected, therefore, are the alimentary, integumentary and nervous. In the first, the appetite is lost, thirst is present, with pain and a feeling of discomfort in the epigastrium, and with eructations and flatulence. Constipation or diarrhœa may occur early; the latter is an invariable accompaniment in the later stages, and with ulceration the stools may contain blood and mucus. The tongue becomes bare, its epithelium being partly or entirely lost (compare Sprue). In the advanced cases it is raw-looking, a similar change often involving the pharynx. The gums may resemble scurvy and the teeth may be decayed.

The changes in the skin have given the name to the disease; they are of less importance than the alimentary and nervous. They usually appear simultaneously with the gastro-intestinal ones, and first appear during the spring months, when the sun is gaining power; they fade away in summer, only, however, to appear again with increased intensity next spring. The distribution is on the back of the hands and forearms, dorsum of the feet, face, neck and upper part of chest, the parts, in short, uncovered by clothing and therefore directly exposed to the sun's rays. The nature of the lesion

is an erythema, first resembling a severe sunburn, with redness, swelling and tension of the skin; sometimes itching and burning and small blebs also occur. Later a deeper dermatitis appears, and in the next year desquamation and exfoliation. As years go on, some pigment and thickening are left, until, finally, a chronic atrophy appears over the affected areas, which become wrinkled, thin, and no longer elastic.

Headaches, pains in the back, neuralgias and vague sensations of weight, pressure or fullness about the head have been observed. The intellectual functions soon become affected, the patient becoming sad, stupid, depressed and sleepless. Paralyses of various sorts are seen, tremors of the arms and tongue, cramps and wasting of the muscles in the paralysed areas with spasticity and ataxy. The electrical reactions of the muscles are usually preserved. Abnormal sensations and vasomotor and trophic changes are usually present. The knee-jerks are at first exaggerated, and later disappear. Hearing and smell do not suffer, but weakness of vision, hemianopia, diplopia, photophobia are encountered. Mental disorders generally end the picture, melancholia or mania requiring detention in an asylum. Institutions of that nature in countries where pellagra is rife are full of such sufferers.

The other systems may or may not show symptoms. There may be fever during the course of the disease, there is retardation of growth in children, emaciation in adults, and sexual desire is lost.

Diagnosis.—The characteristic distribution of the skin lesions betrays the disease. In some rare cases the cutaneous lesions are absent—pellagra sine pellagra.

Prognosis.—This is not good; large numbers of pellagrins eventually die in the lunatic asylums. The disease is very chronic, lasting even up to 20 years.

Treatment.—Attention should be given to the diet amongst the poor; maize should not form the sole component of the diet; other articles must be added. A generous and varied diet rich in protein must be given—plenty of meat, milk and eggs. Goldberger recommends dried yeast, in doses of 15 to 30 grm. daily, in syrup, and this may be added to the diet. Arsenic may be given, and is of value. The rest of the treatment is symptomatic.

G. Carmichael Low.

SECTION VII

DISEASES OF THE ENDOCRINE GLANDS

DISEASES OF THE SUPRARENAL GLANDS

The suprarenal glands consist of two parts, cortex and medulla. The cortex arises from the same type of cell as the kidney and testis, whilst the medulla is of sympathetic origin. The cortex is composed of a fine connective tissue network, surrounding polyhedral epithelial cells, which are arranged in radial rows for the greater part. Towards the surface the arrangement of the cells suggests an alveolar structure, whilst near the medulla the cells form irregular cylindrical columns. All the cells of the cortex contain coarse granules and lipoid globules. The medulla is composed of chromaffin cells. Scattered throughout the medulla between these cells are many non-medullated nerves and a few ganglion cells. Cells similar to the chromaffin cells occur close to the sympathetic ganglia in various parts, and when arranged in masses are termed paraganglia.

The physiological function of the cortex has not been determined, and has been deduced only from the changes associated with pathological conditions. The cortex is essential to life, for removal inevitably kills the animal: whilst removal of the medulla, provided the cortex is left intact, does not lead to death, but merely to fatigue and muscular weakness. The medulla normally elaborates an active substance, termed epinephrin (the proprietary article is called adrenalin), which is an ortho-dioxyphenyl ethanolmethylamine. This substance is made not only by the medulla of the suprarenal glands, but also by the chromaffin cells scattered along the sympathetic system (paraganglia). The secretion of the chromaffin cells is probably an absolute necessity to life, but sufficient is made by those forming the paraganglia, and therefore removal of the medullæ of the suprarenals does not prove fatal.

There is still very much to be elucidated about the action of all the internal secreting glands, and the tabulation of the conditions associated with morbid changes will probably need modification in the near future.

Cortex	Overactivity	Children:	Precocity.
		Adults:	Hypertrichosis.
	Underactivity	Children:	Progeria.
		Adults:	Addison's disease.
Medulla	Overactivity	(?)	Hyperpiesis.
		(?)	Hyperglycæmia.
	Underactivity		Addison's disease.

SUPRARENAL CORTEX

Hypertrophy or Tumour.—Hypertrophy or tumour of the cortices occurring in children has often been associated with precocity of growth and sexual development, along with obesity and anomalous distribution of hair. Thus, a boy of 10 may simulate one of 18, not only in his height, weight, and muscular development, but also because his voice has become deep, hair has grown on the upper lip, axillæ, and pubis, his genitalia have developed, and he has become sexually mature, whilst his interests too are those of a youth of 18 rather than those of a boy of 10. Removal of cortical tumours may lead to the abnormal hair falling and the genitalia regaining normal appearance.

Atrophy.—Atrophy of the cortices is believed to produce a condition of premature senility, impotence, or Addison's disease. This is perhaps dependent upon the degree in which the internal secreting glands are affected when the hormone made by the suprarenal cortex fails to reach them. A boy of 14 may simulate an old man of nearly 70. The subcutaneous fat is absorbed, the skin becomes thin, wrinkled, and loses its elasticity, the body becomes bowed, and the features sharp and aged.

SUPRARENAL MEDULLA

Hypertrophy.—No undoubted cases have been recorded.
Atrophy.—Addison's disease.

ADDISON'S DISEASE

Addison's disease is characterised by pigmentation of the skin and mucous membrane, myasthenia, low blood-pressure, and disturbances of the nervous system and alimentary tract, associated with a lesion of the suprarenal glands.

Ætiology.—Addison's disease is found amongst all races and in all climates. It affects men rather more than women; perhaps syphilis being one of the specific causes may account for this. The disease may occur at any age, but is commonest between 15 and 60.

Pathology.—Histological changes in the suprarenal glands have been observed in about 90 per cent. of cases; and in the remaining 10 per cent. it is within the limits of possibility that chemical methods would have demonstrated lack of efficiency, or perhaps there were pathological changes in the solar plexus which escaped detection. Tuberculosis of the suprarenal glands is the most frequent lesion, the tissue often being found to be caseating. Other changes, all of which are rare, placed in order of frequency, are: (1) A chronic interstitial inflammation, leading to fibrosis, and in the latter the glands may be reduced even to the thickness of paper. (2) Malignant disease rarely leads to Addison's disease, because death occurs before symptoms of the latter develop. (3) Extravasation of blood into the suprarenal glands has been recorded as a cause of Addison's disease.

The heart muscle occasionally degenerates. The skin is pigmented, the pigment being found in the rete Malpighii; patches of pigment also occur in the mucous membrane. The medulla of the suprarenal glands normally elaborates an active substance, termed epinephrin, which is an ortho-dioxyphenylethanolmethylamine. The manufacture of this substance is not confined to the medulla of the adrenals, but is shared by all the chromaffin tissue which is scattered throughout the body. The action of epinephrin is that of a stimulant to the sympathetic system, leading to constriction of blood vessels, rise of blood-pressure, dilatation of coronary arteries, dilatation of bronchial tubes, and to an increase in the quantity of sugar in the blood, occasionally giving rise to glycosuria. The secretion of the suprarenal also has a controlling effect over bone, which is demonstrated by its effect in osteitis deformans and certain forms of osseous new growth. The absence of epinephrin in the circulation may lead to profound changes, not only through disturbance of metabolism, but also by means of modification in the distribution of the blood supply to the different organs. Although the medullary portion of the suprarenal glands elaborates epinephrin, nevertheless it does not seem to be essential to life; perhaps the chromaffin cells in other parts manufacture sufficient to maintain life.

At present the dogmatic statement that Addison's disease is due to disease of the medulla of the suprarenal glands should not be made, for the following reasons: A few cases of what appeared to be typical Addison's disease have been examined by competent pathologists who have found that the histological appearance of the suprarenal glands has been normal. Occasionally the morbid condition has been limited to the cortices, the medullæ having been normal. It is alleged too that removal of a diseased suprarenal gland has led to recovery from Addison's disease.

Symptoms.[1]—The patient gradually falls off in general health. He becomes languid and weak, indisposed to either bodily or mental exertion, and the appetite is impaired or completely lost. The whites of the eyes become pearly, and the pulse either small and feeble, or of considerable volume, soft and compressible. The body wastes, without, however, presenting the dry and shrivelled skin and extreme emaciation usually attendant on protracted malignant disease. Slight pain or uneasiness is from time to time referred to the region of the stomach: occasionally there is actual vomiting, which in some cases is urgent and distressing. It is by no means uncommon for the patient to manifest indications of disturbed cerebral circulation. "There is characteristic discoloration of the skin, sufficiently marked, indeed, as generally to have attracted the attention of the patient himself or of the patient's friends. This discoloration pervades the whole surface of the body, but is commonly most manifested on the face, neck, superior extremities, penis and scrotum, and in the flexures of the axillæ and around the navel." The tint is distinctly brownish, similar to that produced by the prolonged administration of arsenic, and easily distinguished from the grey of argyria and hæmochromatosis. "This singular discoloration increases with the advance of the disease; the anæmia, languor, failure of appetite, and feebleness of the heart become aggravated; a dark streak usually appears on the commissure of

[1] Much of the description of the symptoms is taken verbatim from Addison's original description of the disease.

the lips; the body wastes, the pulse becomes smaller and weaker, and without any special complaint of pain or uneasiness the patient at length gradually sinks and expires." The muscles become rapidly fatigued in the majority of cases, and the hand-grip is found to wane in strength after a few contractions at intervals of 2 seconds. The pigmentation is not limited to the skin, but is found also on the mucous membrane of the mouth and vagina. Pigmentation of these areas is rare in any condition other than suprarenal inadequacy. Sometimes small dark spots are observable on the skin; but these by themselves are of little diagnostic value, although they may be confirmatory evidence.

Diagnosis.—The symptoms which suggest suprarenal disease are pigmentation of the skin, myasthenia and low blood-pressure. When all three are present, the diagnosis is simple. Pigmentation may be due to other causes. Perhaps that due to chronic poisoning with arsenic simulates most closely the pigmentation of Addison's disease. When the patient has not received arsenic as a drug, but nevertheless it is thought that the colour of the skin may be due to that metal, chemical examination of the hair will decide whether arsenic has been absorbed, but, of course, a positive result does not permit the assumption that the suprarenal glands are healthy. Pigmentation of the skin may be associated with many tumours and also abnormal conditions of the thyroid, liver and blood. The areas of pigmentation occurring in leucoderma should not lead to any error in diagnosis, provided a complete examination is made. The colour of the skin in bronzed diabetes resembles that of argyria and is of a grey rather than brown colour.

The estimation of the sugar in the blood whilst the patient is taking and retaining an ordinary diet may assist the diagnosis in doubtful cases if it proves to be abnormally low. Hypoglycæmia is far from a constant feature, and even a high sugar content of the blood does not rule out the possibility of suprarenal inadequacy.

Low blood-pressure is one of the causes of myasthenia: perhaps the lowest pressures recorded are due to some temporary change in the activity of the suprarenal and are termed functional; these are not accompanied by any pigmentation. When there is a doubt as to the cause of the low blood-pressure, big doses of dried suprarenal gland should be administered; if these lead to a definite rise of blood-pressure, the probability of suprarenal inadequacy approaches a certainty. Suprarenal inadequacy need not necessarily be due to destruction or atrophy of the suprarenal glands; a transient condition, due perhaps to some toxin elaborated by a pathogenic microbe, such as diphtheria, has been observed. The ergograph records myasthenia and may assist in the diagnosis. A positive result, *i.e.* a rapid diminution in the height of the contractions, is of considerable value, but the absence of the myasthenic reaction does not permit the exclusion of the disease; the writer has had his hand squeezed a dozen times in succession, each time with sufficient strength to cause pain, by a man who died 3 days later from suprarenal tuberculosis. Nausea and vomiting without any reference to food assist in diagnosis, but frequently these are postponed until towards the end.

Prognosis.—The disease proves fatal in the majority of cases within 5 years. Some few cases become chronic, and a still smaller number recover.

We have seen that tuberculosis of the suprarenals is the commonest lesion, and we know that localised tuberculosis may become quiescent. When recovery occurs, the diagnosis is always questioned; but the writer has seen several cases in which the blood-pressure was distinctly raised by the administration of suprarenal extract, and in which repeated cessation of suprarenal medication has led to the recurrence of symptoms and necessitated a return to the drug for a period of many years.

Treatment.—Having arrived at the diagnosis of suprarenal inadequacy, an attempt must be made to determine the cause. Syphilis will be recognised by the Wassermann test; if positive, arsenobenzene preparations may be injected intravenously, provided adrenalin in small doses be injected at the same time. Caution should be used in the selection of the dose.

Tuberculosis should be tested for by the many methods at our disposal, and the original test suggested by Koch should be used as a last resort when all other tests have proved negative. If the degeneration of the suprarenal glands be thought to be due to an invasion of the tubercle bacillus, treatment should be on the same lines as that of any other case of localised tuberculosis. Injections of minute doses of tuberculin should be given, starting with a dose of $\frac{1}{50,000}$ mgrm. T.R., and gradually increasing to $\frac{1}{10,000}$ mgrm. if no untoward symptoms arise. No increase above that amount should be attempted. The theory underlying the treatment is not an induction of immunity, but a temporary hyperæmia of the lesion, acting in the same way as a poultice does when applied to a superficial infection. There seems to be little doubt that suprarenal extract by the mouth is beneficial to the patient, provided it be given in sufficient dosage; 5 grains 3 times a day is almost useless; at least 90 grains should be the daily dose, and even this will not maintain the life of a patient in whom there is progressive disease of the suprarenal. Some advise subsidising this with intramuscular injections of adrenalin. As far as we know, it is only the secretion of the thyroid gland which can be replaced indefinitely by oral administration of the dried tissue.

Operation should be considered whenever any tumour can be felt in the region of the suprarenals; and even when there is no reason to believe that the disease is due to new growth, operation should not be dismissed lightly. Cases have been recorded in which the removal of a diseased suprarenal has been followed by complete recovery.

TUMOURS

Adenomata of the medulla and of the cortex are found frequently at autopsies and have not given rise to any symptoms. Rarely do they grow and invade surrounding tissues.

Malignant tumours of the suprarenal medulla possess the peculiarity of secondary deposits, having the predilection for growing in the bone—often the skull, sternum and vertebræ.

When the growth is in the skull, the appearance of the patient may simulate that of chloroma. The differential diagnosis is easy, because the blood changes characteristic of chloroma are not found.

The diagnosis of suprarenal tumour is difficult, because when the tumour

itself attains a fair size it simulates in many ways malignant disease of the kidney. Examination with X-rays may indicate that the kidney has been displaced downwards, which displacement furnishes evidence of suprarenal neoplasm. Often, as stated above, metastases are recognised before the primary growth produces any local signs. The course of the disease is rapid.

INFECTIONS

The suprarenal glands may be affected by many toxins. Experimentally, congestion, hæmorrhage and infiltration have been produced in animals with toxins of diphtheria, pneumonia, etc. Some observers believe that the fall in blood-pressure in various infections associated with pyrexia is in part due to affection of the chromaffin cells. This infection may be temporary or permanent; when the latter, it leads to a permanent low blood-pressure, and some of the symptoms of Addison's disease, without any pigmentation of the skin.

O. LEYTON.

DISEASES OF THE THYMUS GLAND

The thymus gland is of epithelial origin, arising from two diverticula of the pharynx at the level of the third visceral clefts. A subepithelial lymphoid formation gradually invades and ousts the epithelium, so that finally the gland appears to be a lymphatic gland, with concentric corpuscles (of Hassall), which are all that remain of the epithelium. The relative size of the gland alters greatly; at birth it is about 10 grammes, and may increase up to the age of 2, when it is slowly replaced by fat, surrounding small islands of lymphoid tissue in which the corpuscles of Hassall persist.

The thymus may hypertrophy or atrophy. The conditions arising from these pathological changes have not been studied exhaustively, perhaps because in the past evidence of the changes was usually sought after life was extinct.

HYPERTROPHY OF THE THYMUS

Hypertrophy or enlargement of the thymus is associated with a characteristic stridor and asthma, occasionally leading to sudden death, which has been termed thymic death.

Pathology.—Some have accounted for the symptoms by the mechanical pressure of the thymus upon the trachea and large blood vessels. The tracheoscope has demonstrated flattening of the windpipe, and in addition to this the relief arising from intubation with a long tube confirms the view. Whether death results from compression of the trachea, blood vessels or nerves, or is due to laryngeal spasm or myocardial degeneration is of great academic interest; but since the disease is rare, and the arguments lengthy, they must be omitted here.

Symptoms.—Difficulty in breathing is the most obvious symptom, and it may vary from a slight stridor to severe dyspnœa. For convenience of

description, the three grades of severity have been called stridor, asthma, and thymic death; the condition depending upon the extent to which the enlarged thymus impedes the passage of air through the trachea.

Stridor due to slight narrowing of the trachea, produced by excessive size of the thymus, is either congenital or develops during the first few days of life. The stridor is unlike that due to paralysis of the vocal cords in so far as it is expiratory as well as inspiratory. If the stenosis of the trachea be considerable, there will be retraction of the chest-wall with inspiration. Crying and excitement increase the stridor, by increasing the congestion of the thymus. Retraction of the head, too, will aggravate the symptoms, by drawing up the pyramid-shaped thymus into the superior aperture of the thorax, and thus increasing the pressure upon the trachea. The stridor diminishes slightly during sleep.

If repeated temporary congestion of an enlarged thymus occur, then attacks of dyspnœa simulating asthma are produced. These attacks may or may not be preceded by stridor. Asphyxia may result during the first or any subsequent seizure; rarely has complete recovery been recorded. Sudden death, occurring in a young child without any history of respiratory difficulty, is termed thymic death when the post-mortem examination reveals a thymus of more than double the average size. Often thymic death occurs during the early stages of the administration of an anæsthetic for some trivial operation. This view recently has been opposed by Dercum and others, who believe that thymic death is really due to toxins secreted by the thymic gland overwhelmingly vagotonic in action, leading to cardiac arrest.

Diagnosis.—Now that operative procedure is becoming more frequent in the alleviation of thymic dyspnœa, the accuracy of diagnosis is increasing in importance. Intubation with short and long tubes offers the most rapid and most accurate method of arriving at a differential diagnosis. Malformation of the larynx, giving rise to dyspnœa, will be relieved by intubation with a short tube; long tube intubation will remove the stridor due to pressure of the thymus upon the trachea, but will not alter that due to obstruction of the bronchi or lower end of the trachea. Since the size of the thymus gland can be determined with ease by radiography, perhaps it would be wise to replace the ritual of cardiac auscultation by an X-ray examination of the thymus before the administration of an anæsthetic to a young child.

Prognosis.—We are not in the possession of data upon which we can base prognosis. Intercurrent disease often proves fatal. Probably some number of cases are not recognised, and recover without treatment.

Treatment.—When the thymus is enlarged to an extent that makes asphyxia probable, the advisability of operation and removal of the thymus must be considered without delay. Previous to operation, intubation with a long tube should be performed, as otherwise the operation may end instead of save life.

If an operation is considered unnecessary, treatment with X-rays may lead to atrophy of the thymus. All precautions should be taken to prevent burning and too rapid disintegration of tissue. During the period of treatment the child must be guarded from everything which may lead to congestion of the thymus or compression of the trachea. In order to prevent excitement and incidental infection, the patient should be kept in bed and all visitors excluded. Baths should be avoided. In no circumstances should

the child be allowed to lie on the knees of the nurse with the head hanging back; retraction of the head must be avoided, if necessary by means of an instrument. As soon as evidence has shown that the thymus has shrunk, a quiet outdoor life is indicated, and no exertion should be permitted.

In cases in which there is a history of syphilis, it is advisable to submit the blood to a Wassermann test, and, if positive, treatment by inunctions of mercury should be adopted. The danger of intravenous injection of arsenobenzene in status lymphaticus is far from negligible.

TUMOURS OF THE THYMUS

Benign and malignant tumours have been described, but both are rare, the former being the less frequent. The benign are lipomata, fibromata, and dermoid cysts; the malignant are carcinoma, sarcoma, and lymphosarcoma. All give rise to similar symptoms, due to pressure in the upper mediastinum. This pressure causes stridulous breathing, difficulty in swallowing, and sometimes affects the cardiac rhythm. Diagnosis is assisted by a radiograph. Treatment consists in exposure to X-rays, or to the action of radium or radon.

THYMITIS

Acute inflammation of the thymus may occur, associated with infection of the surrounding tissues. It is doubtful whether there are any cases recorded in which the condition was of primary origin.

O. LEYTON.

DISEASES OF THE THYROID GLAND

It is to be observed that the thyroid gland is not symmetrically applied to the larynx and trachea: the right lobe is nearer the surface, whilst the left lobe is bounded by the larynx and trachea on the one side and the œsophagus on the other.

The gland consists of a number of vesicles, lined by cubical cells. The vesicles contain colloid substance, presumably secreted by the lining cells. In the resting gland the vesicles are full of colloid. In the active gland the vesicles are irregular, and only a small amount of colloid is present, whilst the cells tend to become columnar in shape. The function of the gland is to prepare thyroxin. It is alleged that the daily consumption of this substance is between $\frac{1}{2}$ and 1 milligramme. Thyroxin contains 67 per cent. iodine, and a shortage of that element diminishes its production. The functional activity of the normal gland differs at different times of the year, the iodine content rising and falling coincidentally.

In hyperthyroidism not only does the gland become enlarged, but microscopically the appearance of the gland suggests activity. The cells lining the irregular vesicles are larger and more columnar in shape, and

may occur in layers two or three deep. Amongst these cells mitotic figures may be seen, showing that there is an abnormal rate of multiplication of the cells. The amount of colloid varies. Usually it is diminished, but that is not characteristic, since the normal thyroid passes through phases of secretion, storing, and absorption of colloid.

HYPERTHYROIDISM

Synonyms.—Exophthalmic Goitre; Parry's Disease; Graves' Disease; Basedow's Disease.

Definition.—A condition due to abnormal secretion of the thyroid gland, usually associated with an increase in the size of the gland, protuberance of the eyes, loss of weight, fine tremor of the hands, palpitation and rapid action of the heart, and general nervous irritability.

Ætiology.—The condition occurs amongst civilised races, but is commoner in warm climates than in cold. There seems to be a family predisposition to disease of the thyroid gland, but no definite evidence that hyperthyroidism is inherited. Different observers record different proportions amongst males and females; apparently 6 females to 1 male are affected by the disease. The onset is most commonly between the ages of 15 and 30.

Pathology.—The pathology of the thyroid gland is perhaps one of the most thorny subjects in medicine. The following will probably have to be modified as further observations are recorded. There is good reason to believe that the most active principle elaborated by the thyroid gland is a derivative of a comparatively simple body, trihydro-triiodo-oxybetaindolproprionic acid, named thyroxin by its isolator, but in all probability this is not the only important substance. Since the injection of thyroxin into the blood stream does not cause tachycardia unless amino-acids are in the blood, it is within the limits of possibility that thyroxin is a derivative of a rather more complex body which is less stable. Assuming for the sake of argument that thyroxin is the immediate cause of the symptoms of the disease, we must consider what leads to its production in excess. It has been shown that repeated stimulation of the sympathetic nerves to the thyroid (such as may be arranged by suturing the central end of the phrenic nerve to the peripheral end of the cervical sympathetic) in the cat leads to all the symptoms of thyroid hypersecretion. This shifts the possible cause to that which stimulates the cervical sympathetic. The sympathetic may be stimulated in many ways, amongst others by substances elaborated by the suprarenal glands and by toxins formed in the alimentary tract. If the former be the true cause, then the disease would be of emotional origin (since the suprarenals are stimulated by emotion), whilst if the latter be the explanation the malady should be included amongst diseases due to infection. At the moment, evidence is inconclusive. It has been suggested that exophthalmic goitre should not be termed hyperthyroidism, because the disease is due to qualitative, and not quantitative, change in the secretion; and in support of this view cases have been quoted in which improvement has occurred whilst thyroid has been administered by the mouth. Two explanations of this may be offered—In (1) some cases, through an error of the butcher, thymus was given instead

of thyroid; and (2) when thyroid has been given it may be that some cases of exophthalmic goitre recover in spite of treatment.

Symptoms.—The onset of the malady may be sudden or insidious. Frequently the first symptoms the patient complains of are lassitude and nervous irritability; but since the symptoms may develop in so many directions, it will be wise to consider them under the headings of the different symptoms.

Thyroid gland.—The thyroid gland is usually—but not invariably—enlarged in cases of hyperthyroidism. The right lobe is normally somewhat larger and nearer the skin than the left, and therefore when the enlargement of the two sides is equal, usually the patient first notices that the right side is enlarged. The most rapid way of determining whether the increase in size is accompanied by an increase in activity is by auscultating the gland. On listening to a normal thyroid, or one enlarged by an increase of fibrous tissue, or through the development of cysts, either no sound is heard, or perhaps the heart sounds may be conducted and are heard faintly. In hyperthyroidism, on the other hand, a systolic murmur or a continuous murmur with systolic accentuation, is audible; this varies greatly in character. A diastolic murmur in addition to a systolic has been described, but is very rare. The extent of the increase in size bears no relation to the severity of the condition, occasionally a very large thyroid producing only slightly more than the normal amount of secretion. Huge thyroid glands occur in simple goitre rather than in hyperthyroidism. The gland itself is of normal consistency—soft when compared with a simple goitre.

Heart and circulation.—The condition of the heart and circulation alters during the progress of the disease. Palpitation and rapid action of the heart are often the first symptoms, and the onset of these may be gradual or sudden. The writer has seen the pulse rise to 150 per minute when 30 grains of dried thyroid were administered daily to a patient for a week, due to an error on the part of the dispenser. Tachycardia is due to an increase in the secretion of the thyroid gland. It is true that an injection of thyroxin into an animal does not cause a rapid heart-beat unless amino-acids be present in the blood; but this is no proof that tachycardia in hyperthyroidism is not a direct action of the excess of secretion. The heart-beat may be so forcible as to shake the clothes of the patient and even the head, whilst in cases of even moderate severity the arteries in the neck exhibit pulsation similar to that associated with aortic incompetence. Yet another sign of sudden action of the heart may be noted, namely, capillary pulsation. When the heart has continued to beat between 100 and 200 times per minute for many weeks, cardiac dilatation—perhaps due to fatigue, perhaps to degeneration—occurs, leading to the apex-beat passing outside the mid-clavicular line. When the dilatation is very considerable, relative mitral regurgitation develops and gives rise to the characteristic murmur. This murmur disappears when the heart returns to its normal size. After many months of over-action of the heart, especially when the valves are incompetent, the conductivity of the auriculo-ventricular bundle may become impaired. Changes in the auricular wall are comparatively rare, and auricular fibrillation occurs only in cases of great severity.

Nervous system.—The alteration in the mental condition varies through a wide range, some patients with advanced disease retaining perfect control

over their emotions, whilst others with only slight symptoms need restraint, owing to suicidal and homicidal tendencies. Unrest and excitement are the characteristic changes. The fine tremor of the fingers is similar to that exhibited by the normal individual when intensely excited; along with this, irritability develops and the patient becomes difficult and bad-tempered. Exhilaration and depression may alternate, but the latter is much the commoner.

Eyes.—Exophthalmos—protrusion of the eyes—develops in about 70 per cent. of cases. Usually it is not an early sign. In the majority it is bilateral, but sometimes one side is affected weeks or even months before the other. An excess of fat in the orbit has been recorded at the post-mortems, but the onset may be too rapid to make this a probable explanation. Various symptoms have been associated with exophthalmos, and although they do not add materially to the ease or certainty of diagnosis they are a tradition of medicine. Stellwag's sign—infrequent and incomplete winking; V. Graefe's sign—lids lag behind movement of eyes; Joffroy's sign—on looking towards the ceiling with face inclined downwards, forehead is not wrinkled; Moebius' sign—on making an attempt to focus the eyes upon a very close object in the sagittal plane, one eye turns outwards. Ulceration of the cornea and various infections of the conjunctiva may occur, due to the eyelids supplying insufficient protection.

Metabolism.—One of the most important changes in the body due to hyperthyroidism is the great increase in the rate of combustion of food and tissue, and this may rise to double the normal. If the appetite and absorption be not good, this excessive metabolism will lead to a rapid loss of weight. It seems unlikely that the increase of metabolism is due solely to the general restlessness, rapid heart-beat and activity of glands, because in some cases emaciation is the most striking sign, whilst in others it is very slight. Not only is the metabolism altered in quantity but also in quality; protein is broken up especially quickly, whilst the oxidation of carbohydrates may be modified to so great an extent as to lead to glycosuria.

The blood.—The blood does not present any change characteristic of hyperthyroidism. Occasionally there is an associated chlorosis, and rarely an increase in the percentage of lymphocytes. A relative lymphocytosis is common in disease in which nutrition is impaired, and need not necessarily indicate lymphoid hyperplasia.

Reproductive system.—Loss of sexual power may occur in males; but this is not frequent, and it is associated with many diseases which cause a general loss of strength. In women, menorrhagia is the commonest change in the menstrual function; but in extremely severe cases amenorrhœa occurs, as in other diseases entailing emaciation and anæmia. The mammary glands may persist in size and shape, even when the general loss of fat has been considerable. The effect of pregnancy on the patient suffering from hyperthyroidism seems to be variable; in very severe cases the danger is considerable, whilst sometimes the lesser cases improve during the period of gestation. Since the children of women suffering from this condition are rarely normal, the patient should be advised of the danger run, and act accordingly.

The cutaneous system.—The skin is usually warm and moist. Pigment is increased, especially on the face, in the axillæ, and in the groins. hair turns grey at an early age, and occasionally falls out.

Alimentary tract.—The appetite is good or may be excessive, and it is only in exceptional cases that the stomach ceases to secrete and contract normally. Paroxysmal diarrhœa, without any apparent cause, occurs in about 30 per cent.; its onset is sudden, and recovery occurs without treatment.

Diagnosis.—The difficulty in the diagnosis of hyperthyroidism varies inversely with the severity of the condition. The activity of the thyroid in an emotional individual who lives every moment of the day is greater than in a human mollusc; the argument which made the horse's tail bare may be applied to a discussion on the normal activity of the thyroid.

When the cardinal signs of the disease are present, such as exophthalmos, enlarged thyroid and fine tremor of the hands, the veriest tyro may make the diagnosis—although it must be remembered that some families have exophthalmos without hyperthyroidism, whilst an enlarged thyroid does not necessarily mean an over-active thyroid; again, there are many causes of fine tremor of the hands in addition to hyperthyroidism. The probability of these three signs appearing in the same individual without hyperthyroidism is very small, and if palpitation of the heart be present in addition the diagnosis becomes still more certain.

The cases which are difficult to diagnose are those in which only two signs appear, such as palpitation and emotional disturbance, or emaciation with sleeplessness and mental unrest, or palpitation of the heart with loss of weight. Emaciation for which no adequate cause can be found should always suggest hyperthyroidism. It is absolutely necessary to ascertain whether absorption is normal, because a patient may have a good appetite and eat much nourishing food and yet starve, because the absorption of fat is defective. The estimation of the basal metabolism may supply confirmatory evidence if it be found to be considerably above the average.

Prognosis.—The course of the disease is extremely variable. Slight increase in the activity of the thyroid is extremely common, causing palpitation of the heart, and a condition in which the patient dislikes meeting new people or going to any social function, and is accused of being irritable. When the hands are extended a fine tremor may be noted. When these symptoms are not associated with any definite enlargement of the thyroid gland nor loss in weight, recovery usually occurs within 12 months. If the exophthalmos and increase of the thyroid, along with loss of weight, become definite signs, the disease may take years to run its course. Over 50 per cent. make sufficient recovery to return to work, whilst less than 12 per cent. die from the disease; in the rest, the condition becomes chronic. Relapse is common.

The severity of the disease may be measured by the increased activity of the thyroid rather than by its size, and since the activity of the thyroid modifies the metabolism of the patient the severity may be determined by estimating the basal metabolism. In rare cases this may be found to be more than 80 per cent. above the average.

Treatment.—The treatment of hyperthyroidism may be divided into palliative and curative.

Palliative Treatment.—When possible, the patient should live in a cool, bracing climate, where the excessive metabolism will not lead to the same sense of oppression and discomfort. Apparent alleviation has sometimes followed the administration of substances which are believed to be able to

combine with and neutralise the excessive secretion of the gland, amongst which are the serum of thyroidectomised sheep and the milk of thyroidectomised goats. Quinine hydrobromide in large doses, *i.e.* 10 grains three times a day, may also lead to astonishing improvement. It is unfortunate that not very many individuals can tolerate so large a dosage, and smaller doses are uncertain in their action. The mental irritability of the patient may be treated with bromides, and the excessive perspiration by atropine. Digitalis has been given with the object of controlling palpitation of the heart, but many careful observers have come to the conclusion that it does more harm than good except when auricular fibrillation is present. The patient should be shielded from all annoyance and excitement, and if the condition be severe he should be kept in bed. Application of cold to the skin over the thyroid gland, with the intention of diminishing its activity, may be carried out with Leiter's tubes. Insulin may be given hypodermically in severe cases. As a rule, a slight hyperglycæmia is present in hyperthyroidism, which diminishes the risk of the development of hypoglycæmia; but nevertheless, if the maximum benefit is to be derived from insulin, the sugar in the blood should be determined frequently and the dose of insulin regulated accordingly, because hypoglycæmic symptoms are not easily recognised in hyperthyroidism, since excessive sweating, tremor, and muscular weakness are symptoms characteristic of the disease. Recently the treatment of hyperthyroidism with iodine has been revived. Before adopting this form of treatment, certain ascertained facts should be considered very carefully. In the first place, whilst in a large percentage of cases improvement is to be observed shortly after the commencement of this form of treatment, it is not maintained for any length of time—indeed, after a brief period, the condition of the patient becomes actually worse than before the drug was administered. Secondly, if iodine is employed and after a time stopped, the probability of again obtaining temporary benefit by means of this drug, even if tried after a very considerable interval, is very remote. This peculiarity of the action of iodine is of extreme importance, because when partial thyroidectomy has been decided upon a temporary improvement by means of this drug is of great value in reducing mortality. The dosage varies from 2 to 20 minims in a 5 per cent. solution a day. With regard to diet in hyperthyroidism, the physician finds himself in a somewhat unusual quandary. Based on the fact that thyroxin is a tryptophane iodine compound, some advise restriction of tryptophane intake, and therefore the restriction of protein. Cases have been recorded in which this treatment has been alleged to have done much good. Others have found that a generous allowance of fat in the diet leads to an increased activity of the thyroid, and they therefore suggest the advisability of restricting the fat in the diet and have found that their patients have benefited by this method of treatment. All are agreed that when the thyroid gland is over-active, hyperglycæmia and occasionally glycosuria occur, and therefore at first sight unlimited carbohydrate might seem unwise; but it has been found that the metabolism is unlike that of diabetes mellitus, for in this disease the more carbohydrate given the less is used, while in hyperthyroidism an increase in carbohydrate in the diet is not accompanied by an increase in the excretion of dextrose. One thing is quite certain, namely, that in the case of patients with a high basal metabolism a diet of high energy value is

imperative; and it may further be remarked that when a patient suffering from hyperthyroidism is made fat he usually becomes well.

Curative Treatment.—The form will depend upon the view taken as to the origin of the disease. If it be assumed that hyperthyroidism is the result of stimulation of the thyroid by substances formed in the intestines by a pathogenic microbe, the administration of antiseptics, such as thymol carbonate and salol, is indicated, and on this assumption the alleged beneficial effect of quinine compounds may be explained, since they possess bactericidal properties. The evidence of the disease being of definite microbic origin is not sufficiently convincing to justify the recommendation of vaccine therapy, unless it be explained to the patient, or his relatives, that the treatment is still in its experimental stage. At the present time no specific treatment is known which will invariably reduce the activity of the gland to normal. On theoretical grounds it would be expected that a diet containing only a minute trace of iodine would have the desired effect, but in practice this is not found to be the case with any great regularity.

We are not acquainted with any methods of controlling the activity of the thyroid except those just mentioned tentatively, and by section of the sympathetic nerve. This operation, *i.e.* sympathectomy, is followed by results so variable as to have led to its having been discarded. If the activity of the gland cannot be diminished, the amount of tissue in the over-active gland must be decreased, either by destruction of part of the gland or removal of part of the gland. Before deciding to do either, it must be clearly understood that the activity of the remaining part of the gland may at some future date fall to normal, or even to below normal, and in either case myxœdema will necessarily occur—indeed, this condition, *i.e.* myxœdema, may ultimately supervene even if none of the gland is destroyed or removed intentionally. Part of the thyroid gland may be destroyed by: (1) The application of X-rays; (2) the application of radium; (3) the insertion of radon; (4) ligature of blood vessels; (5) removal of part of the gland (done by means of surgical operation). The choice of which of these five methods should be adopted must depend upon the consideration of a number of data. (1) X-rays should be administered with very great care, in order to avoid destroying too much of the gland, which would lead to the early development of hypothyroidism, and also to avoid damaging the skin over the gland. This latter circumstance is especially important in young women, because an X-ray burn causes permanent disfigurement. The effect of X-rays upon the gland tissue is not immediate, nor is the latent period constant, and therefore considerable judgment and experience are essential for the successful application of this method of treatment. (2) Radium. The effect of radium is more constant than that of X-rays. About 1000 mg. hours may be given as the first dose, and this repeated after two months if necessary. Tubes of radium may be placed in the gland itself, and left for sufficient time to lead to the destruction of patches of gland. (3) Radon may be used instead of radium. The quantity of emanation can be estimated accurately, and since it exhausts itself in a comparatively small time it may be left in the thyroid gland. The radon seeds can be introduced through a rather stout exploring needle, and therefore cause only the most minute scars. Further quantities of radon may be inserted at intervals of about 2 months, until sufficient of the gland has been destroyed. (4) Ligature of

the blood vessels does not give sufficiently constant results, and at the present time few surgeons perform this operation. (5) Removal of part of the gland by means of surgical operation. A certain distinguished surgeon who never refuses to operate upon cases of hyperthyroidism, however severe, and in whose hands the mortality from the operation is under 1·5 per cent., states that the indication for operation is the diagnosis of hyperthyroidism. His argument is that immediate operation is almost free from risk, that medical treatment is uncertain, and if unsuccessful permanent damage of the liver and of the heart may supervene. It is difficult to find fault with this statement, but there are few surgeons and nursing homes or hospitals available in which such excellent results are obtainable. The skill and experience of the surgeon and the type of nursing home or hospital are amongst the data to be considered. The economic position of the patient is also of considerable importance. If he must earn his living and support others, it may be advisable for him to submit to operation quite early, because although it is true that nearly 90 per cent. recover without operation, recovery may not take place for several years. With the iodine treatment already referred to under "palliative treatment," only a very small percentage of cases are really unsuitable for operation. In considering whether an operation is indicated or not, it must be remembered that auricular fibrillation which has not responded to digitalis and quinidine therapy may cease after partial thyroidectomy.

HYPOTHYROIDISM

MYXŒDEMA

Definition.—A chronic disease due to insufficiency of the thyroid gland, manifesting itself by changes in the skin and subcutaneous tissues, along with loss of hair, slow metabolism and mental disturbance.

Ætiology.—Complete removal of the thyroid leads to the condition; partial removal sometimes produces a similar result, and always when the remainder of the gland atrophies. The causes of atrophy of the thyroid gland are unknown, and, therefore, all debilitating influences have been held responsible.

Hypothyroidism is often found in several members of one family. It is said to be commoner in cool and temperate zones than in the tropics; but since hypothyroidism is associated with a slow metabolism it would make itself more obvious in a cold climate, and its apparent absence in warm countries may be due to diagnosis being more difficult. Females are affected much more frequently than males, the ratio being 7 : 1. The onset in women is commonly between 40 and 45, *i.e.* shortly before the menopause. In men the range of years is greater—35 to 50. The thyroid may atrophy in young children and simulate cretinism.

Pathology.—In the majority of cases of hypothyroidism the thyroid is found to be atrophied, and to weigh less than half the average. When it is not smaller in size, histological examination demonstrates that the gland is composed to a great extent of fibrous tissue, and the secreting epithelium is much diminished—in other words, a physiological atrophy has occurred. The increased thickness of the skin is due to an infiltration with

an amorphous substance resembling mucus, but not giving the chemical tests characteristic of mucin. Metabolism is diminished, and qualitative changes may also be noted, including a considerable increase in the tolerance for dextrose.

Symptoms.—The onset of the disease is insidious. Loss of memory and mental hebetude are frequently the first symptoms of which the patient complains. Sometimes pain in the limbs near, but not in, the joints is the symptom causing most trouble, and since the pain has not the characteristic features of rheumatism or neuritis it should suggest to the physician the possibility of hypothyroidism. The skin is dry and thickened, but does not pit on pressure. It is harsh to the touch—not unlike the skin on the forearms of the normal washerwoman, the eyelids are baggy, simulating in appearance a want of tone of the orbicularis muscle such as occurs in insomnia or the œdema of nephritis. The malar flush along with the œdematous face and loss of hair makes a striking picture, which allows immediate diagnosis; but it should be remembered that the diagnosis can be completed and treatment begun long before the typical aspect has developed. The sebaceous glands of the skin become inactive, and the hair dry and brittle and often is shed, not only from the head, but also from the eyebrows. Thickening of the skin results in an alteration in the shape of the limbs, the legs appearing to be œdematous but not pitting on pressure. The hands become clumsy and spade-like.

All symptoms become aggravated in cold weather; this the patient notices, and upon being interrogated will state that the warm weather is preferred. Mental symptoms are very pronounced; in addition to loss of memory, all the mental processes become slow, and it may become impossible for the patient to arrive at any decision.

Speech is slow and rather indistinct; but occasionally when started the patient cannot decide to stop. All the special senses may be affected, partly through thickening of the subcutaneous tissue; this may cause deafness, lack of taste and a blunted sense of smell.

Although the action of the heart seems to be feeble, the blood-pressure is raised and atheroma is common.

Changes in the blood are not characteristic; a mild secondary anæmia may be observed in nearly half the patients; but the anæmia does not approach that which might be expected from the pallor of the skin. Metabolism is slow, and the temperature lower than normal. The appetite is poor, and constipation is frequent. Menstruation is irregular, and menorrhagia far from uncommon; sterility is the rule, but is not invariable.

Diagnosis.—The gradual diminution in the activity of the thyroid as age advances makes it impossible to determine accurately the onset of a condition which starts insidiously. Impairment of energy, of memory and of hair, accompanied by a gain in weight—provided the gain in weight is not due to an accumulation of fluid—suggests hypothyroidism. Occasionally pain near, but not in, the joints is an early sign. The limbs become ungainly, due to thickening of the subcutaneous tissue, but the skin does not pit on pressure. The absence of pitting on pressure assists in the differential diagnosis between myxœdema and renal œdema. The dry skin, the dry hair, the malar flush, surrounded by pale, badly nourished, rather loose skin, make the advanced case recognisable at sight. When doubt exists, the

basal metabolism may be estimated, and if found to be below the normal should be taken as additional evidence of hypothyroidism. Finally, small doses of thyroid gland may be administered tentatively; improvement suggests, but does not prove, hypothyroidism.

Prognosis.—Since the introduction of treatment by the administration of thyroid gland the course of the disease is a rapid return to health; but prior to this the condition became worse, until some intercurrent infection led to death.

Treatment.—Treatment consists in the administration by the mouth of a reliable preparation of dried thyroid gland. Perhaps in the near future thyroxin will be available at a reasonable cost, and then the chief difficulty —namely, the variability of the proportion of active substance in the medicament—will be overcome. The initial dose should be 1½ grains of dried thyroid three times a day, and if this does not lead to any untoward symptoms it should be gradually increased, until palpitation of the heart, tremor, restlessness or sleeplessness ensues. The dose should then be diminished, until these symptoms disappear. The tolerance for dextrose may be used to decide whether the correct dose has been found. If the patient is unable to take 100 grammes of dextrose as a single dose without glycosuria following, the dose of thyroid should be cut down still further. If care be taken to increase the dose slowly, and the patient be warned to lead the life of an invalid until the optimum dose has been established, the risk of any untoward event is almost negligible. The improvement is rapid and complete.

When thyroid extract is badly borne, or there is some other adequate reason for another method of treatment, an operation for thyroid grafts should be considered. If an operation be decided upon, it should be remembered that the grafts must consist of human thyroid which is secreting actively; that the tissue must be absolutely fresh and undamaged; and that it must be introduced into some part of the patient in which it is certain it will not be surrounded by a blood clot. Multiple subcutaneous implantations have given the best results; small but numerous pieces up to 40. The operation will succeed only if the utmost care be taken by the surgeon. When the grafts take they grow, and quite frequently the dose of thyroid by the mouth may be gradually diminished and finally stopped.

CRETINISM

Definition.—Cretin originally meant a small dwarf; but the term cretinism is now reserved for cases of congenital endemic and congenital sporadic thyroid insufficiency.

Ætiology.—Cretinism is endemic in most of the areas in which endemic goitre is found, and as a rule one or both of the parents of a cretin suffer from disease of the thyroid gland, and are either mild cretins or have goitres. The incidence of the disease in different districts must vary greatly, since one authority states females are affected more frequently than males in the proportion of 2 : 1, while another asserts that the proportion is quite the reverse, namely, 2 : 5.

Pathology.—The thyroid gland at birth is either absent or atrophied.

When the diminution in its size is not very striking, microscopic examination shows almost complete atrophy of the epithelium. The absence of the thyroid gland causes a general disturbance in nutrition, demonstrating itself in retarded development of bone and delayed ossification. The bones of the limbs are short, thick and often deformed. The skull is prognathic, but variable in size. As age advances the cretin often develops a goitre, which is found to be fibrous or cystic. The pathology of cretinism is debatable. Since the removal of a goitre from a cretin leads to the development of further signs, it seems probable that cretinism is due to insufficiency of the thyroid rather than complete inactivity.

Symptoms.—Cretins rarely grow to 5 feet in height. The body is relatively broad, the legs short and often crooked, the abdomen large and pendulous, the skin hangs loosely, and is thick, harsh and inelastic.

The face of the cretin is prognathic, with a flat nose and large nostrils, and a broad and low forehead, surrounded by thin, dry hair. The tongue is large and the lips thick. The genitals do not develop until after the thirtieth year. The supra-clavicular fossæ appear to be cushioned, due to thickening of the subcutaneous tissue. The mental condition in cretinism is characteristic of want of development. Cretins are apathetic, and possess little or no memory; the more severe cases are unable to talk; and many are deaf, perhaps due to obstruction of the Eustachian tubes.

Diagnosis.—When a child fails to develop either physically or mentally, inefficiency of the thyroid gland should be considered. In order to prevent error in diagnosis, we should remember that there are a number of conditions other than cretinism in which physical development is abnormal; amongst these are rickets, achondroplasia, dwarfism, congenital adiposity and hydrocephalus. The positive signs in cretinism are slow metabolism, as shown by slow pulse, low temperature and cold skin, along with the deposition of fat.

The differential diagnosis between rickets and cretinism should not be difficult, because in the former there is enlargement of the epiphyses, accompanied by profuse sweating, especially at night, and the mental condition, although placid, is not far removed from the normal; in cretinism the bones may be deformed, but the epiphyses are not big, the skin is dry and the mental condition approaches imbecility. The hands, too, are dissimilar; in rickets the hand is beaded, in cretinism spade-like. The shortening of the limbs in achondroplasia is a symptom so definite that there should be little difficulty in distinguishing it from cretinism. Examination of the thyroid may assist; often it cannot be felt, but when distinctly goitrous it clinches the diagnosis. The basal metabolism of cretins is low, but more elaborate apparatus is required than that used for patients of average intelligence. If the signs do not justify a definite diagnosis, recourse may be had to small doses of thyroid gland; a distinct improvement following its use is very suggestive of cretinism.

Prognosis.—Untreated cases remain *in statu quo*; but the immature mind and deformed body become more obvious as age advances. Usually cretins die young, from some intercurrent disease, but occasionally reach the age of 50. If the patient be quite young when the administration of thyroid is begun, all signs may disappear, and a complete cure be effected. The earlier the treatment is commenced, the more satisfactory the result.

Treatment.—Since cretins are usually the offspring of goitrous parents,

the prevention of goitre will prevent cretinism. Goitre seems to depend upon an infected water supply, so indirectly the abolition of cretinism should occur through improving the water supply in the districts in which the disease is endemic.

The administration of dried thyroid gland and the removal of the patient from goitrigenous influence will lead to immense benefit, provided the diagnosis has been made fairly early, and treatment adopted promptly. The size of the dose depends upon the extent of atrophy of the thyroid, and can only be determined by trial. Perhaps the best method of deciding the dose is to increase it until some untoward symptom appears, and then to estimate the basal metabolism of the child; if this latter be far above that of the normal child of the same weight, the amount of thyroid given by the mouth should be diminished until the metabolism falls to normal.

SPORADIC CRETINISM.—This is in every way similar to endemic cretinism.

GOITRE

Definition.—Enlargement of the thyroid gland of a chronic character, not due to new-growth nor associated with symptoms of hyperthyroidism.

Ætiology.—Sporadic cases occur, but the majority are confined to certain districts, in which the condition is found amongst animals as well as man. Most of the places in which goitre is endemic possess one thing in common, namely, a water supply which is not well protected from contamination by human excrement, and also is usually completely devoid of any salts of iodine. It is true that exceptions to this have been recorded, but they are rare. The disease is endemic in many valleys in the mountainous parts of Switzerland, France, Germany and Austria, whilst there are very few foci in Sweden, Norway and Finland. Goitre is commoner amongst women than men, except in endemic areas, where the incidence is equal. Congenital goitre is rare in non-goitrous districts. When it occurs in a locality in which the disease is not endemic, as a rule one of the parents is found to be suffering from the complaint. Goitre usually occurs in childhood and gradually diminishes in frequency after puberty. The actual cause of goitre is not certain, but evidence is accumulating that it occurs in human beings who drink water contaminated by something which does not pass through a porcelain filter. Boiling the water renders it innocuous. These observations suggest, but do not prove, that one of the exciting causes is microbic. Experiments have proved that not only in animals but also in man, an enlargement of the thyroid gland follows the ingestion of the residue on a filter through which goitrigenous water has passed. It has been suggested that goitre belongs to the group of diseases that go by the name of deficiency diseases such as rickets, which can be produced either by depriving an animal of fat-soluble vitamin or sunshine. The similarity between goitre and rickets is considerable, because apparently goitre can be produced either by the contamination of the water or by depriving the individual of a sufficiency of iodine or salts of iodine. Just as the more sunshine an animal is exposed to, the less fat-soluble vitamin is necessary, so too, apparently the greater the contamination of the water with goitrigenous substances the greater the amount of iodine necessary to prevent the disease. This theory explains

why either the filtering or boiling goitrigenous water is necessary, since these two processes modify the toxins, or the administration of iodine or salts of iodine lead to cure. In some, but not all, districts where goitre is endemic, its incidence has been reduced considerably by iodine being added to cooking salt to the extent of 2 to 5 mg. per kilo.

Pathology.—Several types must be described, although it is rare to find an enlarged thyroid quite characteristic of any one.

1. Simple hypertrophy, or so-called parenchymatous goitre, in which there is a general increase in normal thyroid tissue. A section of any part presents the appearance of a normal gland.

2. Colloid goitre, in which (in addition to an increase in the number of follicles) the quantity of colloid is excessive. In this condition the gland may be large, because not only are the follicles increased in number, but also in size.

3. Cystic goitre, due to degeneration of the walls in colloid goitre. The cysts contain colloid.

4. Hæmorrhagic-cystic goitre; as the name implies, hæmorrhages have taken place into the cysts.

5. Fibrous goitre, resulting from inflammatory changes. Calcification is not uncommon.

Temporary enlargement of the thyroid may be produced in a variety of ways, perhaps due to stimulation of the cervical sympathetic and increased activity of the gland. If simple hypertrophy were the only type of goitre, it might be explained on the lines that the organism required the gland to elaborate more of its active principle, perhaps to neutralise some toxin or to modify metabolism. This does not hold, because the simple hypertrophy usually passes on to degeneration.

Symptoms.—The onset may be sudden, but is usually insidious, a very rapid increase in the size of the thyroid suggesting a malignant growth rather than simple goitre. The symptoms are due to the mechanical effect of the gland pressing upon adjacent tissue—the trachea, various nerves (vagus, sympathetic, spinal accessory and recurrent laryngeal), the œsophagus, and perhaps indirectly upon the heart. Dyspnœa is caused by compression of the trachea, the breathing being often worse at night, probably because the recumbent position leads to an increase in the size of the goitrous—in the same way as in the normal—thyroid. Difficulty in swallowing may result from the pressure of a goitre; complete obstruction has been recorded, but this is much more common in malignant disease of the thyroid. Pressure on the veins sufficient to produce cyanosis of the face is noted only when the goitre is very large. It is true, as stated above, that various nerves may be pressed upon and cause symptoms, but this is extremely rare. Pressure upon the vagus may cause an alteration in the frequency of the heart-beat, and interference with the sympathetic will lead to dilatation of the pupil and irregular sweating in the affected side. Irritation of the spinal accessory nerve gives rise to spasm of the trapezius, whilst paralysis of the recurrent laryngeal is a cause of hoarseness. The direct effect of goitre upon the heart is debatable. Much is to be said in favour of the view that when the thyroid is enlarged and the heart's action becomes pathological, this is due to hyperthyroidism, and that the condition should be considered as such and not as simple goitre.

Prognosis.—Goitre is a chronic disease and—since its effects are purely mechanical—is not necessarily progressive, for the size of the goitre often remains stationary. Whatever the cause, we cannot expect goitres of long standing in which there are fibrous or cystic changes to diminish in size rapidly; only recent cases can be cured quickly, and occasionally the "cure" occurs without treatment. Sudden death resulting from hæmorrhage into the thyroid (causing obstruction of the trachea) fortunately is a rare dramatic end.

Treatment.—*Prophylaxis.*—It is not easy to understand how sporadic cases of goitre can be due to the same cause as endemic cases. Experience and experiments have shown that the water from streams and wells which are responsible for the development of goitre is rendered innocuous by boiling. Perhaps a perfect filter will act in the same way as boiling, but no known filter remains perfect for more than a week or two. The essence of prophylaxis, therefore, is the avoidance of water from sources known to possess the toxin, or boiling the water.

The line of treatment adopted will depend upon the view held as to the cause of the disease. If the disease is due to an infection of the alimentary tract, the administration of intestinal antiseptics, such as thymol, may be expected to benefit the patient, especially if combined with inoculations of a vaccine prepared from the organism which is considered to be the cause. Some observers have recorded rapid cures in cases treated in this way, but we must remember that the thyroid often returns to its normal size upon removing the patient from the goitrous district. Iodine has a direct action upon the thyroid, and, as has already been stated, it is necessary to avoid its administration in any form in thyroiditis, because it stimulates the gland's activity. Small doses of iodine lead to shrinking of the goitre, if it be purely hyperplastic. An excess of iodine must be avoided, lest the symptoms of hyperthyroidism be produced. Perhaps the application of potassium iodide ointment, or even painting an area of the skin with tincture of iodine, will lead to a sufficient amount being absorbed. It is not essential to apply the ointment or tincture to the skin over the thyroid. If iodine be given by the mouth, 6 grains of sodium iodide per diem should be the maximum.

When the size of the goitre is so great as to give rise to dyspnœa or difficulty in swallowing, surgical assistance should be sought. The knife of the skilled surgeon leaves a scar which only a keen eye can detect.

TUMOURS OF THE THYROID

Various forms of new-growth of the thyroid have been observed: carcinoma, adeno-carcinoma, scirrhus and sarcoma.

All these growths may remain within the capsule of the thyroid and may give rise to the same symptoms as goitre for months or even years; ultimately either the growth passes beyond the capsule and may cause erosion of the œsophagus or larynx, or metastases develop, not infrequently in bone, and most commonly in the parietal, lower jaw, sternum, pelvis and humerus.

Sometimes the growth in the bone is the first sign noted, and the primary growth may not be found until the autopsy.

The symptoms arising in new-growth are to a large extent mechanical, and are identical with those of a large goitre.

THYROIDITIS

Ætiology.—Exposure to cold or local damage to tissues may predispose to thyroiditis, through diminishing the local resistance to micro-organisms and perhaps to toxins. Thyroiditis may occur in any infection, not only of bacterial origin, such as influenza, cholera, diphtheria, puerperal fever, erysipelas and typhoid, but also of protozoal, such as malaria and syphilis. It may arise, too, during infections of unknown cause, such as rheumatic fever, scarlet fever, measles and small-pox. The condition is commoner during the third and fourth decades than in early or late life. A slightly greater proportion of females than males are affected.

Pathology.—The earliest changes are in the epithelial cells, which may be shed and fill the lumen of the vesicle, the shed cells being rapidly replaced by an increased growth. The colloid may disappear or alter in consistency. Small abscesses may form, either single or multiple.

Symptoms.—The onset of the disease is sudden, like most infections, and is accompanied by chilliness. When the glands swell—which usually takes place on the second day—a sensation of fullness, difficulty in swallowing, and pain passing backwards to the ears and occiput, develop. The thyroid becomes tender. If the gland becomes very swollen, the mechanical effect of pressure may lead to difficulty in deglutition and to partial obstruction in the veins, resulting in congestion of the face.

Prognosis.—Simple thyroiditis lasts but a few days. Suppurative thyroiditis varies in its course, death occasionally resulting from asphyxia.

Treatment.—Iodine in every form should be avoided. Sedatives and hypnotics may be given with advantage. The formation of abscesses must be borne in mind, and surgical treatment adopted if evidence can be found by the exploring needle.

INFECTIONS OF THE THYROID GLAND

Tuberculosis of the thyroid gland is far from common. Tubercles may be found in the majority of cases of miliary tuberculosis, but they are present in only 5 per cent. of those dying from chronic tuberculosis.

Tuberculous granuloma in the thyroid is rare, and indistinguishable from new growth, until it breaks down and forms a cold abscess.

During the secondary stage of syphilis the thyroid is enlarged in about 50 per cent.: the enlargement is painless, and, therefore, attention is not drawn to it. When gummata form in the thyroid the symptoms simulate those of new growth, and, therefore, in all cases of rapid enlargement the patient's blood should be submitted to the Wassermann test.

Actinomycosis, echinococcus and *Schizotrypanum cruzi* may invade the thyroid, but the first two are rare, while the last is confined to South America.

O. Leyton.

DISEASES OF THE PARATHYROID GLANDS

Removal of the parathyroid glands from certain animals leads to a definite series of symptoms, the most striking of which are tremors, rigidity of the

hind limbs, an uncertain spastic gait, muscular weakness, paresis of muscles of mastication, along with convulsions. There is often loss of appetite and vomiting, and rapid and violent beating of the heart. The urine becomes scanty. These symptoms have been attributed to the formation of an excess of guanidine and methyl guanidine, for two reasons. These substances are found in the urine of animals from which the parathyroid glands have been removed; and also because the injection of these substances may produce tetany, or aggravate tetany when it has already occurred. The fact that after ablation of the parathyroid glands in dogs the concentrations of urea and non-protein nitrogen in the blood run parallel, whilst after the injection of guanidine into normal dogs in sufficient quantity to produce symptoms the non-protein nitrogen increases to a greater extent than the urea concentration, is considered by some to be conclusive proof that guanidine and methyl guanidine do not explain completely the symptoms following parathyroidectomy.

HYPERTROPHY	Osteitis fibrosa, and probably other diseases of the bones.
REMOVAL, DESTRUCTION, OR ATROPHY	Tetany, and a syndrome associated with changes in the calcium content of the blood.

PARATHYROID INSUFFICIENCY

Symptoms.—The patient suffers from uncontrollable restlessness, inability to relax muscles and to sleep quietly. Spasms of almost any muscles may occur, sometimes accompanied by pain so severe as to call for the injection of morphine if active parathyroid extract be not available. This increased irritability of the nervous system, associated with spontaneous attacks of spasms, has been termed tetany. In tetany there is an increased response to excitation of the motor nerves with the constant current, whilst pressure on certain nerves leads to unusual results. Pressure on the nerves in the bicipital sulcus makes the hand and forearm adopt a peculiar attitude: the fingers and thumb appear to be arranged for the hand to pass through the smallest possible aperture. Tapping the facial nerve causes contraction of the muscles on the same side of the face. Carpo-pedal spasm is usually present in well developed tetany.

Tetany may arise from a series of causes, but it is usually associated with a too low calcium content of the blood.

Treatment.—Tetany is improved by increasing the calcium in the blood. This can be brought about within an hour by the subcutaneous injection of the active principle of the parathyroid glands, or more slowly by the administration of soluble calcium salts. When the calcium content of the blood rises to normal, symptoms subside and the patient returns to health. In those cases in which the parathyroid glands have been removed by the surgeon, or destruction has occurred by hæmorrhage into them or in any other way, repeated injections of parathyroid hormone must be given indefinitely. There seems to be some doubt as to whether the present day active extract contains all the essentials, since it has been stated that even if the injections be given in increasing quantities, it is not possible to prolong

for more than a few years the life of the patient who has been deprived of all his parathyroids.

O. LEYTON.

DISEASES OF THE PINEAL GLAND

The function of the pineal gland, which normally atrophies at puberty, is not known. According to some observers, experimental removal of the gland from young animals leads to hypertrophy of the testes, whilst others assert that "no sexual precocity or indolence, no adiposity or emaciation, no somatic or mental precocity or retardation follows." *Hypoplasia* of the gland has been recorded in two cases. In one there was precocious development of the mammary glands, and in the other sexual infantilism. *Hypertrophy* of the gland is not known, but tumours of the gland occur occasionally, and in 14 per cent. there is associated precocious sexual development, along with overgrowth or adiposity. The symptoms of pineal *tumour* are those of intracranial pressure, viz. headache, nausea, choked disc, drowsiness, and mental changes. The signs which occur most frequently are paralysis for upward movement of the eyes, diplopia, abducens paralysis, ptosis, nystagmus, and the absence of pupillary reaction to light. The only hope of benefiting a patient with a pineal tumour is by operation; but even in the most skilled hands the mortality has been very high. *Atrophy:* pineal gland has been given to children who are defective in mind and in muscle, but the evidence of benefit arising therefrom is inconclusive, though perhaps sufficiently encouraging for further investigation.

O. LEYTON.

DISEASES OF THE PITUITARY GLAND

The pituitary gland consists of two main parts—the anterior lobe and the posterior lobe. The anterior lobe possesses the characteristic appearance of a gland with an internal secretion, the acini containing a colloid material; this part of the gland secretes into the blood stream. The posterior lobe (pars nervosa), with its epithelial investment (pars intermedia), is of nervous origin, and secretes into the cerebro-spinal fluid.

The two parts of the gland are of different origin and possess completely different functions, and therefore morbid conditions of the two parts give rise to different symptoms.

ANTERIOR LOBE	Hypertrophy :	Acromegaly.
	Atrophy :	(?) Dwarfism.
POSTERIOR LOBE	Hypertrophy	Hyperglycæmia.
		(?) Hyperpiesis.
	Atrophy	Obesity.
		Dercum's disease.
		Fröhlich's syndrome.
		Diabetes insipidus.

1. ACROMEGALY

Definition.—As the name implies, acromegaly is a condition in which the hands and feet grow abnormally; the whole of the bony frame also increases in size—but the size of the extremities is the most obvious.

Ætiology.—The disease has been reported amongst many races in various parts of the globe. The type of acromegaly which is to be considered as a disease is not hereditary, although a slightly over-active pituitary may be a peculiarity of some families in whom height and heavy jawbone are distinguishing features. The onset may be at any age, but in males is most common between the ages of 20 and 30, while females are often older. Males and females are affected in equal numbers.

Pathology.—Acromegaly is due to hypersecretion of the anterior lobe of the pituitary gland, sometimes due to overgrowth—which may be demonstrated with the X-rays by the increase in the size of the sella turcica. The overgrowth is usually adenomatous; when malignant the growth may be too rapid to permit life to be prolonged sufficiently for the symptoms of the disease to develop. Occasionally there is no demonstrable increase in the size of the pituitary gland; but this is not proof of the gland secreting only a normal quantity. A similar condition exists in distinct hyperthyroidism without any enlargement of the thyroid gland.

Symptoms.—The onset is usually gradual. The first symptom may be bitemporal headache, with the sensation that the head will burst. Lassitude may make it impossible for the patient to carry out his usual work. The sexual functions cease early in the disease. The hands and feet grow unduly, necessitating larger sizes of gloves and boots, the height increases, and the general aspect of the patient so alters that he becomes quite unrecognisable by those friends who have not seen him for a long time. The lower jaw becomes enlarged in nearly all cases, whilst the vertebral column shows changes in 86 per cent. of cases, most commonly cervico-dorsal kyphosis. The bones of the face grow more rapidly than those of the head, so that the hypertrophied ears appear to be placed too far back. The supra-orbital ridges become prominent, leading to a profile characteristic of acromegaly. The nose broadens and becomes coarse, the lips become thick, and the lower lip often everts, and the tongue is too large for the mouth. The skin becomes thick and warty, and the hair coarse and profuse.

Diminution in the fields of vision is very common, and occasionally there is photophobia. Hemianopia may result from partial destruction of the optic nerves, due to pressure of the tumour, and if the growth be considerable the olfactory lobe may be interfered with and the sense of smell impaired; but this is comparatively rare. Transient glycosuria may be present. The sugar appears in the urine only whilst the disease is developing; when the gland has reached a stationary condition the sugar tolerance is above the normal—in some cases 400 grammes of dextrose may be administered as a single dose without sugar appearing in the urine. The blood sugar is rarely above normal (0·12 per cent.). The blood-pressure is abnormally low—systolic pressure with the Riva Rocci apparatus 90 to 100 mm. Hg. The temperature is often about 1° F. below the average.

Diagnosis.—The conditions which may be mistaken for acromegaly are osteitis deformans and pulmonary osteo-arthropathy. As a rule, in

osteitis deformans the shafts of the long bones are affected and there is no increase in stature. When difficulty arises, two observations quite unconnected with growth or appearance may prove of value: (1) As stated above, the tolerance for dextrose is often increased. If 100 grammes of dextrose be taken at a single dose by a normal individual, sugar is not excreted in the urine, but 100 grammes is near the limit; and if this be increased to 150 grammes glycosuria results in a large percentage of individuals, whilst in many acromegalics the tolerance is above 200 grammes. (2) The temperature of acromegalics is 97° F., and the injection of extract of anterior lobe leads to a thermic reaction, 0·4 grain causing a rise of temperature to 100° F.

Prognosis.—The course of the disease is extremely variable. Often the pituitary, after more than doubling its size, ceases to grow, and then the patient may live 20 years or more. A fatal termination results from the pituitary enlargement involving other tissues in the skull.

Treatment.—If acromegaly be due to increased secretion of the anterior lobe of the pituitary gland, it is difficult to understand how administration of pituitary gland in any form can lead to benefit; but, nevertheless, some number of cases are recorded in which the patient has been satisfied that the dried gland taken by the mouth has led to improvement. When the headache is intense, and makes life not worth living, or the vision is becoming more and more impaired, operative procedure should be considered. The operation is not without risk, and also it should not be forgotten that in many cases the arrest of the disease is spontaneous.

2. ADIPOSIS DOLOROSA

Synonym.—Dercum's Disease.

Definition.—A disease characterised by the development of masses of fat, which are painful and tender, accompanied by asthenia and psychic disturbance.

Ætiology.—The affection may occur at any age, but most commonly between the ages of 20 and 40 years. Females suffer from this disease much more frequently than males.

Pathology.—Dercum at one time was under the impression that the condition was due solely to an altered activity of the thyroid gland; but in several recent autopsies of patients suffering from this disease morbid conditions of the pituitary gland have been found, making it probable that the primary lesion is in the pituitary gland.

Symptoms.—The patient complains of being very depressed and having little control over the emotions. She will weep without any provocation, and on being asked why she is weeping will reply that she does not know, but cannot help it. The pain in the fatty lumps may be severe; but usually it is not sufficient to account for the mental alteration. Lumps of fat develop in the skin. The distribution varies, but usually they may be found on the posterior aspect of the upper part of the upper arm, and on the flexor surface of the lower part of the thighs. Sometimes the fat is more evenly distributed, and occasionally the lower limbs escape altogether.

Prognosis.—The disease need not shorten life, but the excess of fat seems

to diminish resistance, and the patient usually dies from some intercurrent disease.

Treatment.—As the patients have no initiative, and seem to make a habit of spending the time contemplating their misery, it is advisable to insist on their leading social lives. Injections of an active extract of pituitary gland should be given whenever possible, since the effect is much more certain than oral administration, together with thyroid gland by the mouth. Under this treatment, diminution of fat occurs frequently, a case under observation having fallen from 20 stone to 16 stone in 6 months. To obtain this result, a suitable diet should also be adopted, and perhaps the undernutrition is most easily attained by ordering the patient to eat raw food only. The improvement in the mental condition is not so great as in that of the body. When thrombosis occurs in the veins of the lipomata, rest must be ordered along with a drug, such as sodium citrate, which diminishes the coagulability of the blood by reducing the amount of calcium absorbed.

3. DYSTROPHIA ADIPOSO-GENITALIS (FRÖHLICH'S SYNDROME)

Hypopituitarism in the adult leads to adiposis dolorosa (Dercum's disease), whilst the same change in the pituitary gland occurring in early life stops the normal development of the reproductive organs, and then the symptoms of castration become added to those of hypopituitarism.

Pathology.—The disease is the result of diminished activity of the pituitary gland, due either to atrophy of that gland or destruction by some tumour originating in it or in the immediate vicinity.

Symptoms.—The chief symptom is an increase in adipose tissue, which may be distributed in any way, along with an infantile shape and size of the external and internal organs of reproduction. In women menstruation is either absent or irregular. The other symptoms due to pituitary change, such as polyuria, increased tolerance for dextrose and depressed temperature, may or may not be present.

Prognosis.—This depends upon the cause of the hypopituitarism. When produced by pressure of a malignant growth, the disease runs a rapid course; if, on the other hand, destruction be due to a cyst or some other non-malignant tumour the condition need not necessarily shorten life.

Treatment.—Treatment is on the same lines as that of adiposis dolorosa. If there be definite evidence of a tumour, which radiograms taken at intervals show is increasing in size, operation should be performed, for although the risk is great it is justifiable when it offers the only chance of prolonging life.

4. DIABETES INSIPIDUS

Definition.—An increase in the secretion of urine, without any distinct increase of the normal solid matters or the presence of any abnormal constituents.

Ætiology.—It is alleged that the disease is commoner amongst males than females in proportion of 2 to 1; this may be due to the fact that

syphilitic meningitis occasionally damages the pituitary, and syphilis is commoner amongst men than women. Some cases which appeared to be hereditary have been recorded.

Pathology.—The disease is due to some interference with the internal secretion of the posterior part of the pituitary gland, sometimes the result of trauma, sometimes to a tumour in the immediate neighbourhood which may interfere with the blood supply. Occasionally at the autopsy the pituitary gland itself does not present any morbid change, whilst a lesion is found in the mid-brain. It seems probable that it is this type of case which fails to respond to treatment with pituitary extract.

Symptoms.—The onset may be sudden, and timed as following some emotional disturbance, but more frequently it develops slowly. The symptoms are polyuria and intense thirst. The quantity of urine secreted may rise to 20 pints or more in the 24 hours. The colour is very pale yellow, sometimes with a faint greenish or bluish tint. The specific gravity is only slightly above that of distilled water.

The polyuria leads to disturbed sleep, and in spite of a moderate appetite the patient loses weight and becomes restless and depressed.

Course.—The course of the disease is usually protracted. The patient dies either from some intercurrent infection, or emaciation becomes extreme and the patient develops coma before death, a coma dissimilar to that produced by fat intoxication in diabetes mellitus.

Diagnosis.—The differential diagnosis between diabetes insipidus and diabetes mellitus depends upon the presence of sugar in the urine in the latter disease, provided a normal diet is given. Polyuria occurs in chronic interstitial nephritis, but usually there is a trace of albumin in the urine, and often a hypertrophied heart and raised blood-pressure. When doubt exists, the excretion of phenolsulphone-phthalein may be used as a test. The writer has seen a few cases of polyuria which have been associated with and due to the development of a habit of drinking much coffee. The polyuria ceased when the coffee was reduced. So-called hysterical polyuria may simulate diabetes insipidus for a time. In the former, the polyuria is usually of short duration and is accompanied by other manifestations, but in our opinion there is grave doubt whether this condition is not the result of some temporary alteration in the activity of the pituitary gland. A radiogram of the skull shows a change in the sella turcica in a small percentage of cases of diabetes insipidus. When present it is good diagnostic evidence; the absence of this change may be disregarded.

Treatment.—Treatment must depend upon the cause of the disease. Injections of extract of the posterior lobe control the polyuria for a number of hours—often about 6, but repeated injections do not cure, but seem to supply the material which the gland fails to elaborate, and alleviate symptoms. The extract of the posterior lobe of the pituitary gland contains substances which have several actions. One of the substances causes contraction of the uterus and is used by obstetric physicians for that purpose. A second substance, called vasopressin, causes contraction of plain muscle and leads to a great rise of blood-pressure. It has been asserted that this latter substance also controls the cells of the kidneys and prevents diuresis in diabetes insipidus. But there are some reasons for believing that the substance which acts upon the blood vessels is not identical with that which acts upon the

kidneys. Until the substance controlling diuresis has been isolated, it will be wise for the physician to try various extracts of pituitary, in order to ascertain which of these controls the diuresis for the maximum time in each case. As the *Spirochæta pallida* is one of the causes of destruction of the gland, the Wassermann test applied to blood and cerebro-spinal fluid should be carried out without delay, and, if positive, appropriate anti-syphilitic treatment administered. Cases have improved while on large doses of thyroid extract. The dependence of the pituitary upon the thyroid remains an unknown factor, and perhaps it is wise to try the effect of thyroid by the mouth when it is impossible to carry out regular hypodermic injections of pituitary extract. The majority of observers find pituitary extract administered by the mouth is useless. It is scarcely necessary to add that any restriction of the amount of fluid given to the patient is an abuse of authority.

O. LEYTON.

ABNORMAL GROWTH

Growth depends upon many factors, only a certain number of which are known at present. Although Lunin, a physiologist, stated in 1881 that casein, carbohydrates, certain fats, salts and water were insufficient to maintain healthy life, he was a prophet crying in the wilderness, and it was only later that the accessory factors in food-stuffs were recognised as essential. These substances have been termed "vitamins."

Without entering into a discussion as to their action, it is recognised that the infant needs at least five for normal growth. Probably the administration of the vitamins along with food-stuffs is insufficient; their absorption, too, is essential. Growth depends also upon the equilibrium of the internal secretions of the many glands and other tissues in the body. We have seen that excessive secretion of the cortex of the suprarenal or the anterior lobe of the pituitary gland is often associated with precocity and abnormal growth. In the same manner atrophy of these tissues may lead to lack of development, which has been termed "Infantilism"—a term far from satisfactory, since it is not an infantile but a puerile condition that results: the ratio of head, trunk and limbs is not that of an infant but rather of an individual before puberty. So far this condition has been found associated with morbid changes in the pituitary, suprarenal cortex and also thyroid, kidneys, pancreas and perhaps intestinal flora.

PITUITARY.—(1) Overgrowth due to hypertrophy, see Acromegaly, p. 476. (2) Retarded growth due to atrophy, see Dystrophia Adiposo-genitalis, p. 478. (3) Infantilism.

INFANTILISM.—(*a*) *Brissaud type.*—This type presents—besides the ordinary attributes of infantilism—certain signs of partial thyroid insufficiency, not to be confounded with myxœdema resulting from total thyroid insufficiency. The principal characteristics of this infantilism are—smooth face, protruding eyes, thick lips, fat round cheeks, fine hair, poor eyebrows and eyelashes, large head compared with the body, stomach slightly prominent, infantile pelvis, thick limbs due to a fatty cushion which covers all the body and hides the muscles and bones, arrested development of the epiphyses, delayed

appearance of ossification, delay or absence of second teeth, absence of hair on the pubis and axillæ, rudimentary sexual organs, high voice, larynx little prominent, thyroid gland generally small, and childish mind.

(*b*) *Lorain type.*—This is perhaps due to a similar cause. This type presents the following characteristics: The body is small, but the limbs are no longer those of a child. There is no disproportion between the head (which is small) and the rest of the body. The facial features are well-modelled, the neck is long, the shoulders broad and the muscles (being rid of childish fatness) are well-formed. The stomach is not prominent. The pelvis is narrow, and the lower limbs long and well-formed. Generally the epiphyses are atrophied. The voice is pitched high. Finally, if they lack the hairiness of a male (for they have no hair on the face, and little on the pubis and axillæ) they have, however, well-formed sexual organs, not very large but well-proportioned to the rest of the body. In short, they are men in miniature, since their body has undergone the change from an infant to an adult.

SUPRARENAL CORTEX.—(1) *Hypertrophy.*—Precocity, see p. 453.

(2) *Atrophy.*—Probably progeria, *i.e.*, retarded growth with early senilism. The characteristic features of the condition are the absence of subcutaneous fat, which allows the muscles, cartilages, bones, veins and tendons to be outlined with remarkable clearness; the absence of hair except fine grey hair, on the scalp, eyebrows and eyelids; the skin is dry and thin, the nails short and flat, the stature is short, the milk teeth are retained, and the sex glands undeveloped. The senile peculiarities have been found at autopsy, too, the blood vessels being those of an old man—thickened and hard.

THYROID.—See Cretinism, p. 468.

RENAL DWARFISM.—Dwarfism, associated with bone deformities, has been described in interstitial nephritis beginning in early childhood. In seven cases recently collected, the average was 12 inches below the normal height for the age of the patient. Along with the lack of growth, changes in bone occur, which lead to genu valgum, and this is a fairly rapid development. In many ways the changes in the bones are similar to those of rickets. The onset of the disease is insidious, whilst the termination is from uræmia. Renal disease may or may not be associated with want of development of the sex glands.

PANCREATIC DWARFISM.—Retarded growth, associated with defective pancreatic secretion, has been described. In one case a youth of nearly 19 years old had suffered from chronic diarrhœa for 9 years, and had the appearance of a boy of 10, the voice being shrill and genitals undeveloped. The administration of pancreatic extract controlled the diarrhœa, he gained 23 lb. in weight and grew 5 inches in 3 years, whilst the voice changed to that of a man and the sex organs developed.

ARRESTED GROWTH OF UNKNOWN ORIGIN.—*Infantilism.*—No satisfactory explanation has been offered to account for the lack of growth which results in the adult (normal in all respects) attaining only 24 inches in height. One must draw a very definite distinction between dwarfism and infantilism, for the dwarf may produce offspring which attain normal proportions. A certain number of dwarfs remain puerile. The "Lorain" type seems but slightly different.

POLYGLANDULAR SYNDROME

The interdependence of one tissue upon another makes it easy to understand how over or under activity of one internal secreting gland may lead to changes in other glands and tissues. It seems probable that when methods of investigation become more elaborate, polyglandular syndrome will be found to be much commoner than disease of only one of the internal secreting glands. Polyglandular syndrome will naturally depend upon which gland is primarily affected, and to what extent the other glands are involved. The cortex of the suprarenal appears to be easily affected, and among the cases of this syndrome excessive growth of hair, with slightly abnormal distribution, is quite common. The pituitary gland and the thyroid gland are linked fairly closely. It is generally accepted that in the condition called Dercum's disease both of these glands are affected ; but there is considerable difficulty in deciding whether the depression of the activity is primarily of the pituitary or of the thyroid. A knowledge of the main changes which follow over or under activity of the internal secreting glands is of help in deciding which glands are at fault in any specific case ; nevertheless surprises at autopsies are not infrequent.

THE SEX GLANDS

THE TESTES

There is conclusive evidence that the testes supply an internal secretion in addition to the manufacture of spermatozoa. This evidence is based upon the changes which follow the removal of the testes in young animals and young human beings, and also from the experimental introduction of testicular tissue into female animals.

The testis consists of two essential types of cells : the interstitial cells of Leydig, and those forming the convoluted tubes. Spermatozoa arise from the latter. Some think that the internal secretion is derived from the interstitial cells alone, while others think that, in addition to germinating spermatozoa, the convoluted tubes produce an internal secretion as well. An academic question of considerable interest arises as to whether premature sexual development, along with secondary sexual characteristics, ever occurs from testicular hypertrophy, or whether the substance which causes the overgrowth of the testes also causes the other changes simultaneously. Precocious development of the testes is associated with hypertrophy of the suprarenal cortex, and sometimes with tumour of the pineal gland.

Insufficiency, atrophy, removal, or destruction of the testes before puberty leads to failure of development of male characteristics : the body becomes fat and large, the voice remains of high pitch, and the hair scanty. This suggests that the internal secretion of the testes is essential for the normal activity of other internal secreting glands, such as the pituitary, the suprarenal, and the thyroid ; in other words, the katabolites of some cells appear to be

the anabolites of other cells, and no type of cell can lose its activity without other cells suffering.

Transplantation of testicular tissue has been performed with alleged success, but it is difficult to understand in what manner, since the testicular tissue is replaced by fibrous tissue in a comparatively short time. So far the preparation of an active principle for therapeutic use has eluded investigators.

THE OVARIES

It is not customary to include diseases of the ovary, which are numerous, in a text-book of medicine, but since changes in the internal secretion of that organ may have a profound effect upon general health, some reference, even if brief, seems advisable.

It is generally accepted that, even before puberty, the ovary itself produces an internal secretion; indeed, this seems proved conclusively by the effect of the removal of the gland in animals and in human beings: the subject loses many of the female characteristics, and may develop some of those of the male, and also fat. The mature ovary, in addition to the foregoing, produces an internal secretion which regulates menstruation, and is a factor in parturition.

O. LEYTON.

SECTION VIII

DISEASES OF THE DIGESTIVE SYSTEM

DISEASES OF THE MOUTH

ORAL SEPSIS [1]

ORAL sepsis is the condition in which excessive bacterial activity occurs in the mouth. Apart from actual infection in connection with the teeth and gums, it develops whenever insufficient attention is paid to the cleanliness of the mouth. Thus particles of food may stagnate between the teeth and under bridges and other fixed dental work, as well as in connection with plates which are not removed and washed with sufficient frequency. Dental fillings, caps and crowns, which have not been accurately fitted, may allow small accumulations of stagnant and decomposing matter, which are fertile sources of oral sepsis, to collect.

The mouth should be thoroughly examined in every patient, from whatever condition he may be suffering, but with special care in all digestive disorders, and in those conditions which will be presently described as possible sequels of oral sepsis, even if the patient says he has never suffered from toothache and that he regularly visits the dentist. The examination is most simply done with a small electric torch and a wooden spatula, which is burnt directly after use. In patients who wear tooth-plates, the mouth should be examined both before and after their removal. Each tooth and the gum surrounding it should be carefully inspected. The presence of tartar and red swollen gums indicates that some infection is present. In doubtful cases the patient should be sent to a dentist for an expert opinion, and if no obvious disease is found, radiograms should be taken, as they alone can show with certainty the existence of septic foci under apparently well-fitting crowns and fillings, and at the roots of teeth which are otherwise perfectly healthy, and they make it possible to determine with great accuracy the extent of any periodontal infection.

DENTAL HYGIENE

Neither dental decay nor dental sepsis occurs if the teeth are always kept free from food between meals. The teeth should, whenever possible, be thoroughly cleaned immediately after each meal, and no food should be taken between meals. If the teeth are brushed straight across, the food is removed from the outer surfaces but not from the spaces between the teeth. If they are brushed with a circular or up and down motion, the gums are

[1] I am indebted to Mr. A. L. Spencer-Payne for help in revising this section

injured and there is a tendency to push them away from the necks of the teeth. Where the gum is already inflamed and loose, as is often the case in pyorrhœa, the food will be brushed under the loose gum and the condition aggravated. The correct method is to sweep the brush in one direction only. On the outer or cheek surfaces the brush should be used with a twisting motion from the gums towards the teeth, *i.e.* downwards in the upper jaw and upwards in the lower jaw. When sweeping the inner or tongue surfaces of the teeth the brush is held perpendicularly, so that only the end comes into use; it is pulled downwards in the upper jaw and upwards in the lower jaw. Special care should be taken to reach the back and sides of the last molars or wisdom teeth. The neck of the tooth should be kept clean by wiping with small swabs of wool in curved dental tweezers.

The tooth brush should have a small head, a straight handle, the rows of bristles should be spaced, and the bristles on the tip should be shaped into a groove, so as to take the contour of the teeth when it is used perpendicularly for the inner surfaces.

Normally the gums completely fill the spaces between the teeth, but when they begin to recede, as in pyorrhœa, these spaces are no longer filled and food collects between the teeth. This food cannot be removed by a tooth-brush. The brushing must then be followed after each meal by the use of a tooth-pick, and preferably of metal, with a very fine blade bent at an angle so that it will pass readily between the molar teeth, followed by a strong spray, which will force water between the teeth and clear the spaces of food.

Patients with inflamed gums or pyorrhœa should also massage the gums with the forefinger and thumb from the gum towards the teeth after using the brush and before using the spray, and the dried gum margin should be painted with tincture of iodine once a day, using curved dental tweezers and a very small swab of wool for the purpose.

Artificial teeth should never be worn at night, but should be kept in antiseptic. In addition to this, they should be very thoroughly scrubbed with a brush and soap and water, so far as is possible after every meal.

Children should be given food which requires thorough mastication, as soft food, which can be swallowed without chewing and with the production of little or no saliva, is likely to cause stagnation of sticky carbohydrate material between the teeth.

At the end of each meal some fluid should be drunk, or some fresh fruit, the acid of which excites the flow of saliva, should be eaten in order to keep the teeth clean. The alkaline saliva neutralises the acid of the fruit and prevents it from damaging the teeth. Mouth-breathing in children should be corrected by direct treatment of nasal obstruction and by respiratory exercises. The teeth should be examined twice a year, even when there is no reason to suppose that anything is abnormal, so that tartar can be removed, early caries dealt with, and pyorrhœa alveolaris recognised and treated in its earliest stage.

(1) Pyorrhœa Alveolaris; Chronic Periodontitis

Ætiology and Pathology.—Stagnation of food mixed with pyogenic organisms between the teeth leads to inflammation of the edge of the gums —marginal gingivitis. The toxins produced by the organisms destroy the

attachment of the muco-periosteum to the neck of the tooth, and a pocket develops between the tooth and the gum. The margin of the alveolar process is then slowly destroyed as a result of rarefying osteitis, until it may finally be replaced by granulation tissue. Stagnation of infective material in the pocket leads to gradual extension of the disease and aggravation of the gingivitis. Much pus is produced, the condition at this stage being commonly known as pyorrhœa alveolaris. In some cases, however, advanced destruction of the tooth socket occurs with little gingivitis or pus formation.

Symptoms.—In marginal gingivitis the edge of the gum of one or more teeth is red, swollen and bleeds with abnormal ease when brushed, the first part to be affected being usually the interdental papillæ. When pyorrhœa alveolaris has developed, pockets are present round the teeth, and pus can generally be seen exuding from the edge of the gum; even when none is seen on first examining the mouth, beads of pus appear if the edges of the gum are pressed. In chronic cases the teeth are often loose. Reflex salivation occurs, and an excessive quantity of mucus is secreted by the small mucous glands of the mouth. The accumulation of decomposing food, débris and pus in the pockets round the teeth produces an unpleasant taste in the mouth, most marked on waking in the morning, and this is also a common cause of foul breath. It is rare for any pain to develop, and the slight discomfort which may be present is generally insufficient to induce the patient to consult a dentist.

The inflamed condition of the gums often leads to a general stomatitis, and sometimes to chronic pharyngitis and tonsillitis. Pyorrhœa alveolaris does not by itself produce chronic superficial glossitis, but it predisposes to that condition in syphilitic patients, especially if they drink and smoke excessively. Periodontitis in the upper jaw may lead to infection of the maxillary antrum, and infection of any of the other nasal sinuses may occur. The danger of pulmonary complications following general anæsthesia is greatly increased if the mouth is in a septic condition.

Most of the pus which is constantly forming round the teeth is swallowed; the amount may be very considerable, as the ulcerated area round each tooth may be as great as half or even one square inch. During the day, the pus and bacteria are so diluted by what is eaten and drunk that they cannot do much damage, most of the bacteria being destroyed by the hydrochloric acid in the stomach. During the night, however, when no hydrochloric acid is secreted and nothing is eaten or drunk, the pus and organisms which are constantly swallowed with the saliva may infect the stomach and intestines. Pyorrhœa alveolaris is thus an important factor in the production of chronic gastritis, enteritis, colitis, appendicitis and gastric and duodenal ulcer, although one or more additional factors are necessary for the production of each of these diseases, as many people with pyorrhœa alveolaris suffer from no digestive disturbance. Duodenal catarrh, secondary to oral sepsis, is sometimes a cause of infection of the biliary passages and pancreas. When oral sepsis is associated with achlorhydria, it may be a factor in the development of Addison's (pernicious) anæmia and subacute combined degeneration of the spinal cord.

In some individuals the local reaction is sufficient to prevent the passage of toxins and organisms from the infected gums into the circulation. In many cases, however, toxins are absorbed. Areas of subinfection may also result

from the passage of bacteria into the circulation and thus further increase the toxæmia. General ill-health follows, and it may be accompanied by septic anæmia and chronic slight pyrexia. Predisposed individuals may develop rheumatoid arthritis, fibrositis, neuritis, and less frequently iridocyclitis, and even septicæmia and infective endocarditis. Other forms of joint disease, such as gout and osteo-arthritis, are often aggravated by the toxins resulting from oral sepsis. The development of gastric and duodenal ulcer, appendicitis and cholecystitis, as a sequel to oral sepsis is probably primarily due to toxæmia produced in this way, the ascending or surface infection for swallowed organisms being generally secondary. Various disorders of the skin, such as chronic eczema, urticaria, rosacea and erythema may also occur. The causal connection between these conditions and pyorrhœa alveolaris is shown by their temporary aggravation after injecting an overdose of autogenous vaccine and in some cases after extracting the teeth.

Treatment.—Local treatment by scaling, massage of the gums to expel débris from the pockets, and irrigation of the pockets with hydrogen peroxide often checks suppuration; but the pockets remain, and patients should be instructed in the care of their teeth or recurrences are certain to occur. Kataphoresis, vaccine treatment and eradication of the pockets by cutting away the gum, or treating the pockets with ammoniacal silver nitrate followed by formalin, are also of value, but a complete and permanent cure is almost impossible except in very early cases. Palliative treatment should be reserved for cases in which only local symptoms are present, but even then the teeth should be removed before too much destruction of the alveolar processes has taken place for comfortable dentures to be made, and also if the teeth are loose or the pockets very deep.

When pyorrhœa alveolaris has led to disease in other parts of the body than the mouth, palliative treatment is useless and dangerous. The teeth should be removed after thoroughly cleaning the pockets, but it is often wise to give a few doses of autogenous vaccine first in order to reduce the danger of an acute exacerbation of symptoms, which might otherwise result from the absorption of toxins from the large bare surfaces left after removal of the teeth.

Extraction should not be postponed because a patient is seriously ill; it is no more reasonable to wait until improvement occurs when the symptoms are due to septic teeth than to postpone an operation for acute appendicitis, and I have seen more than one death result from this unreasoning fear of extraction. A general anæsthetic should be given and all the diseased teeth should be removed at the same time. An exception, however, should be made in the case of such conditions as Addison's anæmia and rheumatoid arthritis, in which it is safer to remove two or three teeth at a time under a local anæsthetic to avoid the risk of a severe general reaction. Although the masticatory power of artificial teeth is only about one-fifth of that of normal teeth, indigestion is unlikely to result if care is taken to avoid tough meat and hard food. Even in the absence of artificial teeth no disturbance of digestion follows if only soft food is taken. The removal of the teeth does not invariably result in the complete eradication of the disease, as radiograms may still show small areas of rarefying osteitis, from which it may be possible to obtain cultures of streptococci, which continue to give rise to general symptoms. Scraping the diseased bone away, followed by the use of an autogenous

vaccine is the most satisfactory treatment for such residual foci of infection.

(2) Dental Caries

Ætiology and Pathology.—Dental caries is caused by the action of organic acids produced by bacterial decomposition of stagnating carbohydrate food. Progressive destruction of the tooth substance occurs until the pulp cavity is exposed. Mouth-breathing is an important cause of caries in children, as it dries the mouth and tends to increase the decomposition of the food débris in contact with the teeth.

Symptoms.—Carious teeth are tender and their presence renders mastication painful. The patient therefore avoids using the affected teeth, and this favours the deposit of tartar and the stagnation of food. If many teeth are affected the food is bolted, so that indigestion is likely to occur owing to insufficient mastication, quite apart from the infection of the alimentary canal caused by swallowing septic material from the mouth. The irritation produced by the decomposition of stagnant food around the teeth gives rise to marginal gingivitis and pyorrhœa alveolaris. Oral sepsis produced in this way is of much more importance than that caused by the caries itself, as the quantity of decomposing material and bacteria swallowed from dental cavities is comparatively small, and no local absorption of toxins or bacteria can occur so long as the pulp cavity is not reached. When the latter becomes infected, absorption of poisons is likely to lead to enlargement of the cervical glands, especially in children, and the chronic inflammation produced in this way is a common precursor of tuberculous infection of the glands. Inflammation of the pulp spreads to the periodontal membrane and may finally produce an alveolar abscess.

Dental caries is the most common cause of toothache, and pain is often referred to various situations more or less remote from the teeth. In all cases of trigeminal neuralgia a thorough examination of the teeth should therefore be made.

Treatment.—Dental cavities produced by caries should be filled at the earliest possible moment, but if this cannot be efficiently done the teeth should be removed, as tender teeth which prevent proper mastication are a much greater source of danger than the absence of teeth, even in very young children. Removal of all the teeth in children may cause narrowing of the dental arch and consequent crowding of the permanent teeth, but this can be easily remedied by treatment, whereas the septic condition of the mouth caused by extensive caries may lead to permanent ill results.

(3) Apical Infection

Ætiology.—Apical infection is infection of the apex of the root of a tooth. This can only occur if its pulp is dead, except in rare cases of extensive caries.

Symptoms.—Apical infection may be acute or chronic. In the former an alveolar abscess forms; this gives rise to the usual symptoms and signs of inflammation. Chronic apical infection, on the other hand, frequently gives rise to no pain or discomfort and no signs recognisable on ordinary examination. It can then only be recognised in a good radiogram.

Treatment.- In cases of only moderate severity the pulp canal should be opened and sterilised with ammoniacal silver nitrate followed by formalin, or the infected area beyond the root apex can be ionised through the pulp canal with iodine or zinc chloride. In more advanced cases, and in all in which serious secondary symptoms are present, extraction should be performed without delay and the socket should be curetted.

STOMATITIS

Catarrhal Stomatitis

Ætiology.—Catarrhal stomatitis is common in ill-nourished children during dentition, and in association with gastro-intestinal disturbances. In adults it may result from excessive consumption of alcohol or highly-seasoned food or excessive smoking. It is sometimes present in the specific fevers, and may also be caused by septic teeth.

Symptoms.—The gums and lips are often affected alone: in other cases the whole mouth, including the tongue, is involved. The mucous membrane is red and dry, but excess of mucus may be secreted by the small buccal glands. The tongue is swollen and furred.

The mouth is uncomfortable, and occasionally actual pain is present, especially on mastication. The general health is unaffected.

Treatment.—The teeth should be cleaned with special care, and the tongue kept as free as possible from fur by scraping. A mouth wash should be used after each meal, and borax and glycerine should then be applied to the inflamed parts.

Thrush

Ætiology.—Thrush is most common in weak, emaciated infants with gastro-intestinal symptoms, who have been fed with an unsuitable diet, and whose mouths have not been kept clean. Acid fermentation of food remnants leads to catarrhal stomatitis, and this is likely to be followed by thrush. Thrush may occur in epidemic form in badly managed institutions, being spread by dirty feeding bottles. The disease may also occur in enfeebled adults in the late stages of tuberculosis, cancer and diabetes, and in severe febrile infections.

Pathology.—Thrush is caused by infection with *Oidium albicans*, a fungus, the filaments of which form a dense felt-work in the superficial epithelial layer of the mucous membrane.

Symptoms.—Thrush generally appears first on the tongue, and then on the cheeks, lips, hard palate, tonsils and pharynx. In rare cases the entire buccal mucous membrane is covered, and the infection may even spread to the vocal cords, œsophagus and stomach. It begins as slightly raised, pearl-white spots, which gradually grow and then coalesce. The white material can be readily detached, leaving either intact mucous membrane, or, in more severe cases, a bleeding and ulcerated surface.

Diagnosis.—Adherent milk curds may superficially simulate thrush. In aphthous stomatitis the white patches are at first vesicles and then definite ulcers, and salivation is present in contrast to the dry mouth in thrush. A definite diagnosis can only be made with the aid of the microscope.

Treatment.—Thrush should be prevented by keeping the mouth clean and babies' bottles sterilised. When once developed it is most important to improve the patient's general health as well as to give local treatment. The mouth should be washed with sodium sulphite solution (1 drm. to 1 oz.), after which the thrush can be easily scraped off.

Ulcerative Stomatitis

(*a*) Aphthous (or Vesicular) Stomatitis.

Ætiology.—Aphthous stomatitis occurs especially in children under 3, either alone or associated with some febrile or digestive disorder.

Symptoms.—The aphthæ consist of small slightly raised vesicles, each surrounded by a red areola. Within 24 hours the vesicles rupture, leaving grey ulcers, 2 to 4 mm. in diameter, with bright red margins. The ulcers heal rapidly. They occur especially on the inner surface of the lips, the edges of the tongue, and the inside of the cheek; in severe cases the pillars of the fauces may be affected.

The mouth feels sore, and the child is unwilling to take food. Salivation is frequently present.

Treatment.—The mouth must be carefully cleaned after meals and washed with potassium chlorate solution (grs. x ad ℥i). Borax and glycerine should then be applied. In severe cases the ulcers may be treated with silver nitrate.

(*b*) Follicular Stomatitis.

Ætiology.—Follicular stomatitis may occur at any age, but especially in nursing women.

Symptoms.—The mucous follicles of the lips and cheeks become inflamed and swollen; the epithelium over them breaks down, and ulcers, 3 to 5 mm. in diameter, result. They may cause no trouble, but more commonly they give rise to a considerable amount of pain on taking food, and to reflex salivation.

Treatment.—The ulcers heal rapidly after being touched with silver nitrate.

(*c*) Mercurial Stomatitis.

Ætiology.—Stomatitis may occur when large doses of mercury are taken, especially in individuals already suffering from oral sepsis. Some people are especially susceptible to mercurial poisoning, and develop stomatitis after taking a comparatively small quantity.

Symptoms.—The gums become sore, red, swollen and finally ulcerated; mastication is painful. Salivation occurs, and the salivary glands may be enlarged, tender and painful. The tongue is swollen, and the neighbouring lymphatic glands are often enlarged. The breath is foul, and the patient complains of a metallic taste. Formerly, when mercury was given with less care than at present, the teeth often became loose, and the pharynx affected; but these complications are now rare.

Treatment.—The administration of mercury should at once be discontinued. The bowels should be well opened by giving salts in order to facilitate the elimination of the mercury present in the body. Potassium chlorate (grs. x) should be taken three times a day; it has the advantage of being re-excreted into the mouth by the salivary glands.

(*d*) Ulcero-membranous Stomatitis.

Ætiology and Pathology.—Severe ulcero-membranous stomatitis occurred in epidemic form among the troops in England and France during the war. It is comparatively rare in civilians. It appears to be caused by infection with the same spirilla and fusiform bacilli which Vincent found in the form of pharyngitis known as Vincent's angina.

Symptoms.—All parts of the mouth and pharynx may be involved, but the margins of the gums are specially liable to be affected. The gingivitis which results is generally more severe than that caused by pyorrhœa alveolaris, and pockets of pus do not develop. The stomatitis is similar to that caused by mercury, and the gums may be so swollen and bleed so readily that scurvy is simulated. The breath is fœtid, and the gums may be sufficiently tender to make mastication painful.

The disease generally runs a chronic course, but is sometimes acute. It generally does not give rise to any severe constitutional disturbance, but may occasionally do so.

Treatment.—The stomatitis rapidly disappears with treatment by injection of neo-salvarsan or allied arsenical preparations.

Gangrenous Stomatitis

Synonyms.—Cancrum Oris; Noma.

Ætiology—This rare disease occurs in children, especially girls, and especially between the ages of 2 and 5; it is rare except under very insanitary conditions. It generally develops during convalescence from an acute fever, especially measles, and less frequently scarlet and typhoid fever. No specific organism has been found.

Symptoms.—A sloughing ulcer develops on the inside of the cheek or on the gums; it rapidly spreads and leads to brawny induration of the skin of the cheek. Occasionally it heals spontaneously, but more frequently it perforates the cheek or spreads to the tongue, chin, jawbone or eyelid and eye.

Cancrum oris is accompanied by severe constitutional symptoms, the patient being prostrated with a high temperature and rapid pulse; diarrhœa or broncho pneumonia frequently follows, and death generally occurs between 7 and 10 days of the onset.

Treatment.—The only adequate treatment is to destroy the diseased part as completely as possible with the cautery.

DISEASES OF THE SALIVARY GLANDS

FUNCTIONAL DISORDERS

Ptyalism

Definition.—Excessive secretion of saliva.

Ætiology.—The flow of saliva is increased by reflexes originating in the mouth and also in more distant situations. Thus all pathological conditions in the mouth and its neighbourhood, such as stomatitis, cancer of

the tongue and carious teeth, especially if associated with pain, are accompanied by salivation. The irritation of the mouth caused by excessive smoking gives rise to ptyalism. Trigeminal neuralgia, whatever its cause, is frequently associated with a reflex flow of saliva. Mechanical irritation of the œsophagus causes a secretion of saliva; this is well seen in the salivation which results from the passage of a tube into the stomach, and when a large bolus of food or a foreign body becomes lodged in any part of the œsophagus. The same reflex is the cause of the salivation, which is a common symptom in achalasia of the cardia and in cancer of the œsophagus.

When the acidity of the gastric contents is abnormally high, an impulse is conveyed by the vagus to the salivary centre in the medulla, and reflex salivation results; consequently ptyalism occurs at the height of digestion in many cases of duodenal ulcer.

The salivation which may occur during menstruation and in early months of pregnancy is also probably reflex in origin.

Salivation due to any of the causes already described may be exaggerated or perpetuated by auto-suggestion. This hysterical ptyalism is often complicated by a spitting or swallowing tic; the latter is always accompanied by aerophagy, so that flatulence is produced.

Ptyalism is also caused by the specific stimulating action of certain drugs, such as pilocarpine, and also by drugs, such as the iodides and mercury, which are partially excreted by the salivary glands, the cells of which they irritate.

Symptoms.—Excessive salivation may interfere with digestion, by diluting the gastric juice, the acid of which is also to some extent neutralised by the sodium bicarbonate it contains. Every time saliva is swallowed some air passes with it into the stomach, which may therefore become distended with swallowed air. For this reason ptyalism is a common cause of aerophagy. It may also cause waterbrash (see p. 510).

Treatment.—In order to cure ptyalism the primary cause must be discovered and removed. As purely symptomatic treatment belladonna should be given; 5 minims of the tincture taken three times a day half an hour before meals is sufficient in the majority of cases, but occasionally larger doses are required. The drug has the additional advantage of diminishing the secretion of gastric juice when gastric hypersecretion is the primary cause; in such cases oxide of magnesia taken after meals also diminishes the flow of saliva, by neutralising the excess of acid in the stomach. Hysterical ptyalism can be cured by psychotherapy.

Xerostomia

Ætiology.—The dry mouth, which is constantly present in fevers, especially typhoid fever, is due mainly to deficiency in the psychical, chemical and mechanical stimuli to salivary secretion. It is probable that the toxins of the diseases also exert some direct inhibitory action on the gland-cells. Depressing emotions, and loss or perversion of taste, which may occur when the tongue is furred, result in diminution in the psychical secretion, and atropine paralyses the secretory nerve-endings. The secretion of saliva is also diminished when excessive quantities of fluid are lost by other channels, as in diabetes and severe diarrhœa. Diseases of the salivary glands them-

selves, such as mumps, result in diminished secretion. Severe xerostomia occasionally develops without any obvious cause. Xerostomia is also a common result of sleeping with the mouth open; in this case there is of course no deficiency in the salivary secretion.

Symptoms.—Deficient secretion of saliva causes the mouth to become dry and septic, as particles of food remain between the teeth, where they undergo bacterial decomposition. The tongue is furred and there is often an unpleasant taste in the mouth. It is difficult to chew the food sufficiently, and the appetite is impaired as a result of the condition of the mouth and the difficulty in tasting the food. The insufficiently chewed food is likely to irritate the stomach. In severe cases, dysphagia occurs and speech becomes difficult. The absence of digestion of starch is of no great importance, owing to the amylolytic functions of the pancreatic and intestinal juices.

Treatment.—A diet should be chosen which stimulates the flow of saliva as much as possible; acids are most active, then salt and bitter substances, whilst sweet substances have very little action. The food should be given in as appetising a form as possible, and masticated very thoroughly. If the saliva is only slightly deficient, dry biscuits should be taken at each meal. The taste of a bitter mixture taken immediately before meals may directly stimulate the flow of saliva, and pilocarpine should also be tried, but it is rarely of much use, unless a sufficiently large dose is given to cause unpleasant symptoms, such as sweating. Great care should be taken to keep the teeth clean, and the mouth should be washed after each meal.

ORGANIC DISORDERS

Specific Parotitis: Mumps (see p. 287)

Parotitis

Ætiology.—Acute parotitis is almost always due to infection ascending Stenson's ducts from the mouth, when the latter has become septic owing to the absence of chewing and normal salivation in patients who have been taking a fluid diet during a febrile illness, especially typhoid fever and cholera, or who have been starved on account of œsophageal obstruction, or in the treatment of gastric ulcer. Now that the importance of keeping the mouth clean in illnesses of every kind has become more widely recognised, and prolonged starvation is very rarely used in the treatment of gastric ulcer, acute parotitis has become comparatively rare. I have seen several attacks of subacute parotitis occur in the course of four years in a young woman with tuberculous mesenteric glands, and a similar condition has been described in Hodgkin's disease. It may also occur as a complication of salivary calculi.

Symptoms.—Both parotid glands are generally affected, except in mild cases when the condition is often unilateral. The glands are enlarged and tender. The skin is stretched and shiny. In slight cases the inflammation gradually subsides; in severe cases suppuration takes place, the skin over the glands becomes œdematous, the neighbouring lymphatic glands are enlarged, the temperature is high, and severe constitutional symptoms are present. The mouth is dry and very difficult to keep clean; the tongue is covered with

a thick, dry fur. The mouth of Stenson's duct is everted and forms a small red nodule, from which a bead of turbid fluid or actual pus can sometimes be squeezed. In rare instances the non-suppurative form of acute parotitis becomes chronic. The parotid glands are permanently enlarged and secrete no saliva. I have also seen a similar chronic parotitis follow a subacute attack, for which no explanation beyond a mild degree of oral sepsis could be found.

Treatment.—The mouth should be kept clean with the greatest care. Pain is relieved by the application of an ice-bag, and the flow of saliva should be promoted by means of chewing-gum. If suppuration occurs the glands must be incised.

ARTHUR F. HURST.

DISEASES OF THE TONSILS

ACUTE TONSILLITIS

Tonsillitis has been classified as superficial, follicular or lacunar, and parenchymatous, according to the degree in which the various parts of the gland bear the brunt of the inflammation; the distinction, however, is not a definite one, as the entire organ is necessarily inflamed.

Ætiology.—The disease is rare in children below the age of 5 or 6, and after middle age; and it is commonest in spring and autumn. It is predisposed to by general ill-health, overwork and a polluted atmosphere; the escape of sewer-gas from defective drains is undoubtedly a cause, and the infection may be carried by water or milk. It occurs as a regular symptom of scarlet fever, measles and diphtheria. There is a very close connection between rheumatism and tonsillitis, and it was formerly believed that tonsillitis was of rheumatic origin; but it is now generally recognised that both acute rheumatic fever and chronic rheumatic pains in joints and muscles are frequently caused by septic infection through the tonsils. Unhealthy conditions of the tonsils due to previous inflammation strongly predispose to further attacks by causing adhesions in the crypts or supratonsillar fossæ, and between the tonsils and the pillars and plicæ, thus promoting the retention of secretion; previous partial removal acts in the same way.

Symptoms.—The symptoms are those of a feverish attack, together with a sore throat; the former often appear before the latter, and only examination of the throat reveals the cause of the disturbance. The temperature may rise to 103° or 105° F., and there is a variable degree of malaise, backache, headache and pain in the limbs. The soreness of the throat radiates to the ear, and is increased by attempts to swallow; the voice becomes thick, the breath foul, and the submaxillary and upper cervical glands are tender and swollen.

The tonsils are swollen, and their purple-red colour extends to the pharynx, palate and uvula—the latter frequently being œdematous. The surface of the tonsils is usually spotted over with yellowish masses of secretion which have exuded from the crypts; sometimes this secretion becomes confluent on the tonsils and occasionally, though rarely, it spreads beyond their surface—it is soft and readily wiped away. The tongue is coated, and the fauces covered with tenacious mucus. There is usually constipation, and

the urine is scanty and high-coloured, but not ordinarily albuminous. Albuminuria is, however, an occasional complication, as are pericarditis, endocarditis and suppurative otitis media.

Diagnosis.—The diagnosis from diphtheria is important, and sometimes difficult. The latter is more gradual and asthenic in onset, with less pain, less fever and a more rapid pulse, and the urine frequently contains albumin. The membrane of diphtheria is greyish-white rather than yellowish, and frequently spreads to the pillars and soft palate; whereas the exudation of tonsillitis rarely spreads, and never to any great extent, beyond the surface of the tonsils. The diphtheritic membrane is adherent and, when detached, leaves a raw bleeding surface, while that of tonsillitis is readily removed and more often discrete. In cases of doubt a bacteriological examination should always be made, and an injection of antitoxin should be given while waiting for the result.

Treatment.—The patient should be kept in bed in a warm well-ventilated room, an initial dose of calomel, 2 to 4 grains, should be administered and followed by a saline aperient. Externally, warmth is usually more comforting than cold, and a hot fomentation applied to the neck and covered by a large pad of cotton-wool gives some relief. Internally, especially if the fauces are clogged with tenacious mucus, a warm alkaline lotion, such as Dobell's solution, may be used with advantage, either by means of a spray or a rubber ball-syringe; but, if the inflammation is so severe that the patient is unable to open the mouth without pain, the lotion should only be used as a mouth-wash; gargling is, of course, only possible in very mild cases. Lozenges containing chlorate of potash, guaiacum or formalin may be employed. Of internal medication, sodium salicylate holds the favourite place in doses of 15 grains every 3 hours, and later three times a day; or aspirin, 10 grains, may be used instead; potassium chlorate in 15-grain doses, three or four times daily, appears to be helpful, especially in the follicular variety; and guaiacum, in the form of mistura guaiaci, was at one time in high repute. The patient must be encouraged to absorb as much nourishment as his dysphagia permits, and he will usually find that soft semi-solids are easier to swallow than liquids; there is room for ingenuity and resource in the provision of a suitable diet, such as junket, baked custard, ice-cream, meat jellies and soups thickened with corn-flour or arrowroot. An iron and quinine mixture may be given when the acute symptoms have subsided.

PERITONSILLAR ABSCESS OR QUINSY

Ætiology.—This is an acute affection due to the formation of an abscess outside the tonsil caused by septic secretions in the supratonsillar fossa or in the depths of a crypt bursting through the thin capsule of the tonsil into the surrounding loose areolar tissue. This process is favoured by adhesions obstructing the mouth of the supratonsillar fossa or the crypts, and, therefore, previous tonsillitis and imperfect surgical removal are predisposing causes. The abscess is usually situated above and external to the tonsil, but in rare cases is behind it.

Symptoms.—The affection is unilateral; but sometimes the opposite side is attacked, as the first recovers. It begins with a feeling of malaise,

fever, often a rigor, and severe pain radiating from one side of the throat up to the ear and into the neck; the cervical glands are enlarged and tender, and the neck stiff. Dysphagia is intense, the tongue thickly coated, and the breath foul. The mouth cannot be opened widely, and a good light is required for examination, when the typical large deep-red swelling is to be seen bulging one side of the soft palate. Pus forms in 2 to 4 days and, if left alone, will eventually burst, usually through the soft palate; relief is then immediate, but occasionally the opening closes prematurely and the abscess refills.

Complications.—Although one of the most painful and distressing of acute diseases, complications are uncommon, and death is very rare; it has occurred from rupture of the abscess, and inspiration of the pus, during sleep. Severe hæmorrhage may take place after spontaneous or surgical evacuation of the abscess when, as the blood may come from the internal carotid or from a branch of the external carotid artery, ligature of the common carotid is called for. The swelling has been known to spread to the larynx, and to necessitate tracheotomy. Suppuration of the cervical glands is a rare complication; pneumonia, septicæmia and pyæmia are also uncommon.

Treatment.—The general treatment is the same as that of severe acute tonsillitis, and the pain often calls for an occasional injection of morphine. Pus is probably present as soon as the swelling has assumed a well-defined rounded form, still more so if there is a boggy area in the centre. The abscess should be opened without delay, for this cuts short the attack and diminishes the risk of complications; but it does not always give immediate complete relief when there is marked cellulitis of the surrounding tissues. After the application of cocaine, a narrow sharp-pointed knife is introduced with the cutting edge upwards and the blade held in the sagittal plane; it is made to puncture the swelling at its most prominent part, and to enlarge the incision by cutting upwards as it is withdrawn. The knife should not be passed to a depth exceeding about $\frac{3}{4}$ inch; if pus is not struck, a sinus-forceps is introduced into the wound and pushed backwards until the pus is found, when it is opened widely to assist the evacuation. After the disease has subsided, removal of the tonsil is advisable, in order to prevent recurrence; it will usually be found that the gland has become adherent and requires dissection to ablate it completely.

CHRONIC TONSILLITIS

Chronic inflammation of the tonsils may, from the clinical point of view, be divided into two groups: Chronic Parenchymatous Tonsillitis or "enlarged tonsils," and Chronic Follicular Tonsillitis.

Chronic Parenchymatous Tonsillitis

Enlarged tonsils in children are nearly always associated with adenoids; but adenoids are often found in children whose tonsils are not enlarged.

Ætiology.—This is similar to that of adenoids. The condition occurs chiefly in children between the ages of 5 and 15; but it frequently persists into adult life, although normal healthy tonsils atrophy about puberty and hypertrophy does not take place *de novo* after that age. The affection may

be the result of repeated colds or a sequela of scarlet fever, diphtheria, measles or whooping-cough.

Symptoms.—The symptoms are not easy to separate from those caused by the concomitant adenoids, if the latter be present; but it is certain that chronic inflammation of the tonsils can affect the ears, and that gastro-intestinal disturbances and appendicitis are produced by the septic secretion squeezed out of the tonsils during deglutition. Recurrent attacks of follicular tonsillitis are common; and the cervical glands are frequently enlarged, may break down and suppurate, or may become tuberculous.

The objective appearances are very various, and it is extremely difficult to estimate the size, or even the healthiness, of a tonsil by inspection. Slightly enlarged tonsils may be prominent and may readily meet on gagging, while big tonsils are often largely buried in the palate or hidden beneath the plica triangularis—in which case a bulging can be seen at the side of the soft palate corresponding to the site of the upper pole.

Treatment.—For children with slight degrees of tonsillar hypertrophy palliative measures may be tried; an open-air, country life, preferably at the seaside, with cod-liver oil, malt, or iodide of iron, and a nasal lotion for the accompanying adenoids; paints are of doubtful utility, Mandl's solution (iodine, grs. vj, potassium iodide, grs. xij, peppermint oil, ℥ij, glycerine, ℥i) is perhaps the best.

The tonsils should be removed when there have been repeated attacks of tonsillitis, after a quinsy, with any affection of the middle ear, when there is chronic enlargement of the cervical glands, and when rheumatic fever or chorea has occurred. It is usual now to remove the tonsils, if at all enlarged, when adenoid hypertrophy calls for operation in young children, because it is so often found that they subsequently increase in size and necessitate a second operation. When chronic cervical adenitis is present, and is not due to some other obvious cause, such as pediculosis or dental caries, the tonsils should be removed whether they appear diseased or not; in these cases about one-third of the tonsils are tuberculous, and this latent tuberculosis cannot be recognised by inspection, many of these tonsils, indeed, being quite small.

The reader is referred to surgical works for details of the operation, but it may be said here that, if a tonsil requires removal, it must be removed completely in its capsule, for the deeper portion of a diseased tonsil is quite as unhealthy as the superficial; trouble in the remaining portion is very common, and the previous operation only adds to the surgeon's difficulties. Nevertheless, the greater number of tonsils, and in children an overwhelming majority, can be quickly and certainly removed entire with the guillotine; removal by dissection is a far more formidable operation, and should be reserved for those tonsils which are adherent as a result of repeated inflammation, past quinsy, or previous incomplete operation.

Chronic Follicular Tonsillitis

In older subjects, when fibrosis has followed the hypertrophy, the stenosed crypts become filled with yellowish-white caseous masses. The patient complains of an offensive taste, foul breath, often of recurrent attacks of sore throat, and of gastric disturbances. Not infrequently various forms of chronic

toxæmia, such as fibrositis or osteo-arthritis, are induced by absorption from these septic foci. In many cases the tonsils are quite small; they may look healthy, but pus can be squeezed out of the crypts on applying pressure at the anterior pillar by means of a flat instrument.

Treatment.—The treatment in the more marked cases is removal, and here dissection is often necessary. There are, however, a good many patients who have only a few unhealthy crypts in the tonsils; these may often be cured by passing a fine galvano-cautery point down to the fundus, several applications being usually necessary. The patient may also be shown how to clean out the secretion with a cotton-wool mop on a fine wooden applicator, and to paint the inside of the crypt with Mandl's solution.

VINCENT'S ANGINA

Ætiology.—This affection is believed to be due to two organisms, the bacillus and spirillum of Vincent growing in symbiosis; these organisms may be found in many ulcerative conditions of the mouth and throat, but their constant presence in this affection points to their specific character. The invasion of the throat is secondary to periodontal infection of the gums. It occurs especially in debilitated persons and under insanitary conditions and, though rare in civil life, was rather common during the Great War in some camps and barracks.

Symptoms.—The attack begins insidiously, with malaise, general pains and a temperature of 100° to 101° F. The pain in the throat is slight, but the glands on the affected side become enlarged and tender, and the breath is usually offensive. The affection is nearly always unilateral.

At first there is a patch of soft, yellowish detachable membrane on the affected tonsil which, in a day or two, comes partially away, exposing an ulcer with a well-defined margin. By the end of a week the membrane ceases to form, and the ulcer begins to heal. The ulceration may be quite deep in severe cases, but is ordinarily limited to the tonsil, and very seldom spreads to any distance from it.

Complications are very rare.

Diagnosis.—The disease is particularly interesting by reason of its liability to imitate diphtheria in its early stage, and syphilitic ulceration later. In both cases the discovery of numerous spirilla and fusiform bacilli in smear-preparations—they are difficult to cultivate—will help the physician to the correct diagnosis; but these organisms may also be found in tertiary ulceration, and the Wassermann reaction is occasionally positive in Vincent's angina. The subacute onset, the raised temperature and the tenderness of the glands aid the differentiation from syphilis; and from diphtheria, the milder constitutional symptoms, the extremely localised lesion, the soft friable character of the membrane and the absence of the Klebs-Loeffler bacillus.

Prognosis.—Death hardly ever occurs.

Treatment.—As the condition ordinarily clears up in a few days, it is difficult to estimate the effects of treatment. The usual remedy is the topical application of tincture of iodine after cleaning with peroxide of hydrogen. Liquor arsenicalis has been recommended as a mouth-wash, but it is poisonous if swallowed; it is better to apply it on a swab. Good results have been

reported from the local application of a solution of salvarsan, which may also be administered intravenously. Attention must be paid to the treatment of the gums and teeth.

HAROLD S. BARWELL.

DISEASES OF THE PHARYNX

DIVERTICULA (see p. 511)

ACUTE CATARRHAL PHARYNGITIS

This is not a very well-defined affection, and is usually accompanied by acute rhinitis on the one hand, and by laryngitis on the other; the tonsils also often participate in the inflammation.

Ætiology.—The affection is generally due to catching cold; it is also caused by traumatism of any kind and by the irritation of hot fluids, corrosives or chemical vapours, and it forms a part of various acute infectious fevers, such as measles, German measles, scarlet fever, influenza and typhoid.

Symptoms.—The discomfort varies from a tickling sensation, or the feeling of a lump in the throat, to severe dysphagia. The voice is husky and thick, and the cervical glands tender and somewhat enlarged. There is slight fever and general malaise.

The pharynx is to a varying degree red and swollen, especially at the sides behind the posterior faucial pillars, where the swelling forms the so-called "lateral bands." The palate is swollen and relaxed, and the uvula elongated. The posterior wall is often covered by a film of tenacious mucus.

Treatment.—The patient should stay in a warm room and avoid the irritation of smoking, talking, alcohol or irritating foods. Calomel, 2 to 4 grains should be given, and followed by a saline aperient. Aspirin, or sodium salicylate, is helpful, and, as the naso-pharynx is involved, the nose should be syringed with a warm saline lotion which may also be applied to the pharynx as a spray.

ACUTE SEPTIC PHARYNGITIS

By this term is implied a series of severe infective inflammations of the throat, including erysipelas of the throat, œdematous, phlegmonous and gangrenous pharyngitis and laryngitis, and angina Ludovici. Any classification must necessarily be a clinical one, based on the severity of the symptoms and their localisation, for they can be produced by a variety of micro-organisms, though they are usually caused by the *Streptococcus pyogenes*. These severe inflammations are fortunately uncommon, and most often, though by no means invariably, occur in debilitated or alcoholic persons.

Symptoms.—These vary greatly with the severity of the infection, which ranges from a mild inflammation to the most severe septic intoxication. They include malaise, sore throat, dysphagia, hoarseness and dyspnœa. The temperature in some cases rises to 105° or 106° F.; but in many of the worst cases it is hardly raised at all, and may be subnormal. Pleurisy, pneumonia and pericarditis may ensue, or death may result from asphyxia; but the

worst cases die from general toxæmia and heart failure, even within 24 hours of the onset of the disease.

The objective appearances, also, are very variable. The pharynx and palate are of a deep purplish-red, and there may be sloughy patches or pseudo-membrane. The entire mucosa may be enormously swollen, and the œdema may involve the upper aperture of the larynx and produce asphyxia. The sublingual region is sometimes occupied by a peculiar brawny swelling, of a hardness like wood, which spreads downwards into the neck to a variable extent, and is known as "angina Ludovici."

Treatment.—The patient must be in bed and well nursed, and every care must be used to ensure that he takes as much nourishment as possible. Polyvalent anti-streptococcic serum is sometimes very successful, and should be given early in a large dose (40 to 50 c.c.). Hot fomentations to the neck and inhalations of steam are comforting. Œdema of the upper aperture of the larynx should be treated promptly by scarification; free incisions should be made with a curved bistoury guided by the finger, and tracheotomy under local anæsthesia must not be delayed, if dyspnœa be severe or not relieved by scarification. For angina Ludovici a deep incision should be made, in the middle line, as all anatomical landmarks have disappeared, and an attempt should be made to find pus with the finger or a director.

RETRO-PHARYNGEAL ABSCESS

There are two forms—(1) Acute, and (2) chronic.

1. The acute form is a rare affection. It occurs in children up to the age of 3 or 4, but is far more frequently met with in the first 12 months. It is due to suppuration in the prevertebral glands, situated behind the posterior pharyngeal wall, which retrogress and disappear in life later. The abscess results from absorption of sepsis from the nares, naso-pharynx, or fauces, and is sometimes secondary to an infectious fever.

Though rare, the condition is an important one, for it may easily remain unrecognised in a young infant, and it is usually fatal if left unopened. The symptoms are fever and restlessness, a hoarse cry and croupy cough, with difficulty in swallowing and dyspnœa. Such symptoms should arouse a suspicion of retro-pharyngeal abscess, which may be seen on inspection as a rounded swelling of the posterior pharyngeal wall. The abscess is often very large, and must be freely opened in such a way as to avoid aspiration of the pus, without an anæsthetic, and with the child firmly held, either on the side with the face directed somewhat downwards, or on the back with the head hanging almost vertically. Recovery is rapid, and no after-treatment is required beyond attention to the enfeebled general health.

2. The chronic form, also, is found most frequently in children, but generally after the third year. It is of tuberculous origin, and is due either to tuberculosis of the prevertebral glands, or to caries of the cervical spine. The latter should be carefully excluded, for this abscess should on no account be opened through the mouth, as septic infection of the diseased bone will occur. The chronic glandular abscess, however, may be successfully opened and curetted by this route, though some surgeons prefer to treat them all by an incision behind the sterno-mastoid.

CHRONIC PHARYNGITIS

The symptoms of discomfort in the throat in the conditions grouped as chronic pharyngitis bear little relationship to the intensity of the changes seen on examination. Many people, especially heavy smokers, complain of no discomfort, in spite of showing decided chronic inflammation; whereas others, in particular dyspeptic or anæmic women or those at the menopause, suffer great discomfort, with no apparent local abnormality. Indeed, in many cases the condition is better described as pharyngeal hyperæsthesia.

Ætiology.—The causes of chronic pharyngitis are most often found in nasal disease, which produces inflammation of the pharynx by causing mouth-breathing, and by the irritation of discharges; incorrect production of the voice is an important factor which is often in its turn dependent on nasal obstruction. Unhealthy conditions of the teeth or tonsils are further causes, as are the inhalation of irritating dust and vapours in various occupations, tobacco smoke, and over-indulgence in alcohol. A long list of constitutional affections are active in the ætiology, such as gout, rheumatism, dyspepsia, anæmia, cardiac disease, cirrhosis of the liver, chronic bronchitis and pulmonary phthisis.

Symptoms.—The discomfort may take the form of aching, fullness, or feeling of a lump, a hair, or a pricking. The voice has a dead tone, and there is usually much hawking and frequent swallowings. The sufferer often becomes depressed, and fears that he has cancer of the throat. The unpleasant sensations are markedly lessened after a meal.

The mucosa of the pharynx and palate is thickened, and there is a loss of the finer modelling of the faucial pillars; the uvula is elongated, often slightly œdematous at its edges and tip, and fails to retract on phonation. The posterior wall is covered by a film of mucus, which puckers up and becomes more obvious on touching it with a probe or swab. The wall of the pharynx is traversed by enlarged venules, and sometimes it is set with slightly raised pink lenticular nodules of lymphoid tissue, constituting the well-known *granular pharyngitis*. In other cases two elongated masses of lymphoid tissue appear behind and parallel to the posterior pillars; these are the "lateral bands," and this form is called *lateral pharyngitis*. *Pharyngitis sicca* is a dry glazed condition usually dependent on rhinitis sicca or atrophic rhinitis, and occasionally the crust formation of the latter disease extends to the pharynx, causing a genuine *atrophic pharyngitis*.

Treatment.—The most important part of the treatment consists in the detection and alleviation of the cause, and should begin with a careful examination of the nasal passages. Cases of pharyngeal hyperæsthesia without obvious local changes are often harmed, rather than helped, by local treatment which directs attention to their trouble. Tobacco should be given up, and alcohol in concentrated forms, indeed the latter should be abandoned completely in plethoric patients and where the pharynx is congested; this type of patient is benefited by a morning dose of sulphate of soda or magnesia, a teaspoonful in a glass of hot water while dressing, or by one of the natural mineral waters. When the pharynx is dry, or covered with tenacious mucus, an expectorant mixture gives relief, such as, vinum ipecacuanhæ, ℥xij, vinum antimoniale, ℥v, iodide of potash, grs. iij, syrup of tolu, ʒi, water,

℥i, three times a day. The throat may be sprayed with a hot alkaline saline lotion, and the same may be, with greater advantage, syringed through the nostrils. Of local applications in the form of paints, iodine is the most generally useful, and may be applied daily by the patient as Mandl's solution: iodine, grs. vi, potassium iodide, grs. xij, peppermint oil, ♏ij, glycerine, ℥i; a 5 to 10 per cent. solution of resorcin in glycerine may be employed, or, if a more astringent effect is desired, iron-alum ℥i, in glycerine, ℥i; or the physician may himself apply, once or twice a week, nitrate of silver, grs. x to xxx to the ounce of water. In many cases, the galvano-cautery is of great value; it acts as a counter-irritant and astringent, and should be applied *lightly* and with caution. *Prominent granulations may be destroyed and enlarged venules obliterated by this means, but deep eschars should not be produced, and only a few applications should be made at one sitting.*

KERATOSIS PHARYNGIS

In this condition a number of sharply defined projecting white or yellow nodules occupy the surface of the tonsils; they also occur, though less profusely, scattered over the lingual and naso-pharyngeal tonsils and on any lymphoid granules in the pharynx. They occur at any age after childhood, and usually in persons in a poor state of health. The causation is unknown; the nodules consist of heaped-up epithelium and detritus containing numerous micro-organisms of the kind ordinarily present in the mouth. They sometimes disappear quickly, in other cases they remain for many months, or they may frequently recur. They produce no symptoms, or at most a slight discomfort, and are of interest chiefly because they are frequently mistaken for the exudation of chronic follicular tonsillitis. Once seen they can, however, be recognised at a glance, for they are hard and adherent, discrete and prominent, and occur beyond the limits of the tonsils, on the pharynx and base of the tongue. They are usually discovered accidentally by the patient, who is naturally alarmed at their appearance. They are quite harmless, and local treatment is useless, for they are removed with difficulty and usually recur; it is wise to reassure the patient by telling him these facts and, if any treatment be required, to trust to attention to the general health, a holiday and change of air.

SYPHILIS

The *primary* chancre occurs on the fauces, occasionally on the pillars, palate or pharyngeal wall, but usually on the tonsil. In this situation the disease is apt to pass unrecognised, for the symptoms are usually slight and the lesion masked by the general inflammation of the tonsil; the typical induration is often absent, but there is always a characteristic bubo behind the angle of the jaw.

Secondary Syphilis

Secondary manifestations in the fauces are a part of the normal course of the general disease and are intensely contagious.

Symptoms.—The subjective disturbances are usually limited to dryness and discomfort. Objectively there are two types of lesion, erythema and mucous plaque. The former is a patchy, dusky red rash, with well-defined margins, somewhat symmetrical, and affecting especially the anterior pillars and soft palate. It is particularly associated with the early secondary symptoms; whereas the mucous patch may be present at the same time or may be found later, together with tertiary manifestations. The mucous plaque occurs on the soft palate, tonsils and pillars; in appearance it is a dusky, slightly raised patch, with a sharply defined red margin, the surface is covered by a delicate milky-white layer of superficial necrosis resembling a "snail-track" or, if rather thicker, looking as if it had been touched with nitrate of silver.

Diagnosis.—The appearances just described are so characteristic that they are of great help in the diagnosis of the general affection; if their nature should be misinterpreted, other secondary symptoms nearly always co-exist to establish the correct diagnosis.

Treatment.—General treatment quickly cures these secondary lesions, though they may reappear during the first two or three years. Of local treatment, abstinence from tobacco and alcohol is important, as are the careful use of a tooth-brush after every meal and the employment of a mouth wash, such as peroxide of hydrogen or chlorate of potash.

Tertiary Syphilis

Tertiary lesions usually occur between the seventh and fourteenth year after infection, but may rarely be found within a few months or may make their appearance at any later time throughout the patient's life.

Symptoms.—Two principal forms may be described—(1) superficial ulcer, and (2) gumma.

1. The *superficial ulcer* may attack any part of the fauces, the posterior wall, tonsils, pillars or palate, a favourite site being the junction of the uvula with the edge of the soft palate. It has a flat base, with a smooth yellowish necrotic surface, and a well-defined red margin, devoid of swelling or infiltration, and of a peculiar "serpiginous" contour as though marked out by segments of a series of circles.

2. A *gumma* is a localised infiltration which rapidly breaks down and exposes a deeply excavated circular ulcer covered with a thick yellow slough. One favourite site is on the posterior pharyngeal wall above the level of the palate, and another on the posterior aspect of the soft palate; in the latter situation nothing is seen from the mouth except a general dusky swelling of the palate until perforation suddenly occurs and irremediable damage has been done. After severe gummatous ulceration the resulting cicatricial contraction may bind the palate to the pharyngeal wall and partly or completely shut off the naso-pharynx from the mouth.

Of subjective symptoms, dysphagia may be very severe; nasal obstruction is present when the naso-pharynx is occluded by swelling or scarring; the voice is altered to a dead tone when there is nasal obstruction, or to the characters of a cleft-palate articulation if a perforation of the palate has occurred.

Diagnosis.—From an ulcerating malignant growth the diagnosis may be

a matter of difficulty, especially as in syphilis the dysphagia may produce marked cachexia and loss of weight. The gummatous ulcer is excavated, covered by a dirty yellow adherent slough, its margin only moderately thickened, often overhanging, and surrounded by an area of deeply congested mucous membrane: the base of an epitheliomatous ulcer presents a nodular "cauliflower" aspect, and its edge is thick and everted; palpation with the finger is of great value, for the peculiar hardness of an epithelioma is highly characteristic. The superficial tertiary ulcer is usually easily distinguished from lupus, the ulcerations of which are surrounded by and dotted over with the characteristic granules, and the lesions of which occur on a pale mucous membrane, while manifestations of lupus are to be found elsewhere. Tuberculous ulceration of the fauces is superficial, but is more intensely painful than the superficial syphilitic ulcer, and is a terminal event in advanced pulmonary tuberculosis. Actinomycosis, when it attacks the region of the tonsil, closely resembles an ulcerating gumma, especially as it improves under administration of iodides; the detection of the characteristic yellow granules will lead to their microscopical examination and recognition.

Treatment.—The most energetic general treatment may be called for to prevent perforation of the palate or severe cicatricial deformity. Local treatment consists chiefly in the use of antiseptic mouth-washes and gargles. Orthoform by insufflation is helpful when there is dysphagia. The local application of 3 grains of calomel, sublimed by a spirit-lamp and insufflated daily from a glass tube, is to be recommended in severe cases of ulceration.

LUPUS AND TUBERCULOSIS

Lupus occurs most frequently in young women. It usually shows evidence of having spread from the nasal passages, and attacks first the uvula and soft palate, whence it spreads to the faucial pillars. It appears as a patch made up of minute reddish nodules, each containing the typical "apple-jelly" centre; the surrounding mucosa shows no sign of inflammation. A progressive superficial ulceration gradually occurs, and may cause destruction of the uvula and part of the soft palate, while elsewhere scarring becomes evident and may finally result in considerable deformity. The subjective symptoms are limited to a feeling of stiffness and discomfort. The diagnosis is generally easy from the characteristic appearance, the chronicity and the presence of lupus in the nares and on the skin. Syphilis is more rapid and does not spare the bony palate, which is never attacked by lupus. Lupus in the pharynx is far more amenable to treatment than in the nose, and may be expected to improve under the general anti-tuberculous régime of good food and open air; arsenic in full doses is very valuable, beginning with 5 minims of liquor arsenicalis three times a day, and increasing the dose gradually to 15 minims. Tuberculin has proved disappointing. Of local measures, massive patches of infiltration may be curetted, but multiple puncture with a fine galvano-cautery point is the most useful method.

Apart from the latent tuberculosis of the tonsils associated with cervical adenitis, which has been referred to under chronic tonsillitis, tuberculous

disease of the pharynx is a rare affection; it occurs as a late and terminal complication of advanced consumption. The onset is acute; the affected parts, especially the soft palate and faucial pillars, are covered with numerous tiny grey tubercles on a bright red mucosa which soon break down to form multiple superficial ulcers with a flat greyish yellow base. Pain is intense and swallowing becomes well-nigh impossible; treatment must be directed to alleviating the distress with insufflations of orthoform, lozenges of cocaine or morphine, hypodermic injections of morphine or heroin, and saline and nutrient enemata.

INNOCENT TUMOURS

Papillomata are fairly common on the uvula, soft palate and faucial pillars and tonsils. They are small pedunculated warty growths and are easily removed. A flat sessile papilloma in this region must be regarded with suspicion as a possible early epithelioma and should be promptly excised by an elliptical incision around the site of origin.

Angiomata occur in the soft palate. Removal is a formidable matter and must be performed by incisions wide of the tumour, but should be avoided when possible. Electrolysis and galvano-cautery or diathermy puncture are preferable methods of treatment.

Dermoid cysts, teratomata and *mixed tumours*, resembling those found in the parotid, are occasionally observed.

MALIGNANT TUMOURS

Epithelioma attacks the tonsils, soft palate or pharynx; the lower pharynx behind the cricoid plate is often affected in females and at a younger age than is usual in cancer. Sarcoma usually originates in the tonsil and the cervical glands are secondarily involved, though generally somewhat late in the disease. In the earlier stages, malignant tumours of the tonsil resemble simple hypertrophy and may easily escape attention; in many cases enlargement of the cervical glands is the first symptom, and in such the tonsil should always be remembered as a possible site of the primary disease; palpation with the finger is of great service in its detection, the firm hard feel of a tumour distinguishing it from simple enlargement. Malignant tumours of the tonsil and palate may be removed through the mouth by cutting wide of the growth with a knife and a pair of scissors, or with a diathermy knife; application of the latter to bone causes a slow aseptic necrosis, which may be made use of deliberately if the bone be involved. Splitting the cheek gives little or no more space and is unnecessary. Tumours situated lower down, in the pharynx, may be reached by the operation of lateral pharyngotomy. In this operation an incision is made along the anterior border of the sterno-mastoid, and joined by another below the jaw, and the pharynx opened in front of the carotid sheath; the mandible may also be divided. The cervical glands should be cleared out. Removal is only feasible when the growth is distinctly limited. Of palliative measures, diathermy may be used to remove the mass of the tumour, check fungation, and relieve symptoms. Oral hygiene, including the removal of all unhealthy

teeth, antiseptic sprays and insufflation of orthoform and anæsthesine for dysphagia, will do much to relieve the severity of the symptoms. Palliative tracheotomy, or gastrostomy, if required, should not be too long deferred.

The technique of the application of radium to tumours of the throat has made great advances in the last few years, and has produced apparent cure in some cases and diminution of the growth in many others. Two methods are employed, either separately or in conjunction, namely, the implantation of radium needles or of tiny capsules containing radium emanation, and the application of a wax collar containing radium plates. The technique of deep X-ray therapy has also improved greatly, damage to superficial structures being avoided by adequate screening and by "cross-fire" methods. Good results have been reported, though for epithelioma it appears to be less helpful than radium.

HAROLD S. BARWELL.

DISEASES OF THE ŒSOPHAGUS

NERVOUS DISORDERS OF THE ŒSOPHAGUS AND DEGLUTITION

PARALYSIS OF DEGLUTITION MUSCLES

When the soft palate is paralysed, as in diphtheritic neuritis, the naso-pharynx cannot be shut off from the rest of the pharynx during the act of deglutition. Part of the food is consequently propelled into it instead of into the œsophagus, and fluids may escape through the nostrils. At the same time the normal rise of pressure in the pharynx does not occur, and dysphagia results. In bulbar paralysis the tongue, palate and pharyngeal muscles are paralysed, and swallowing becomes impossible.

Unilateral lesions of the vagus do not affect deglutition, but bilateral lesions of the bulbar nuclei or of the peripheral nerves cause dysphagia, as the striated muscle fibres of the upper third of the œsophagus lose their tone and contractility, though the automatic activity of the unstriated fibres of the lower two-thirds is unaffected. When the irritability of the medulla is greatly depressed, as in deep coma, a similar dysphagia results.

SPASM OF THE ŒSOPHAGUS

Ætiology.—Spasm of the œsophagus occurs most frequently as a local reflex complicating organic disease, the most common of which is cancer. It forms the most characteristic symptom of hydrophobia. Hysterical spasm may occur at the entrance to the œsophagus in suggestible individuals, but it is rarely sufficient to cause serious dysphagia.

Treatment.—Hysterical spasm can be relieved by the passage of a bougie to show that the passage is clear, but the underlying psychological factors which caused the symptom to develop require treatment by psychotherapy. Some relief to the spasm caused by organic disease is gained by the use of belladonna, and the food should be fluid and chemically unirritating.

Achalasia of the Pharyngo-Œsophageal Sphincter (Plummer-Vinson Syndrome)

Pathology.—In the voluntary initiation of swallowing, the food is thrown to the back of the pharynx. The sphincter at the junction of the pharynx and œsophagus, which is normally closed, then relaxes and allows the bolus to enter the œsophagus, along which it is carried by active peristalsis. In this condition the sphincter does not relax, so that swallowing can only occur with difficulty. As it is almost always associated with atrophic streptococcal inflammation of the mucous membrane of the tongue, which spreads back to the mouth of the œsophagus, it seems reasonable to suppose that the latter has led to inflammation and degeneration of Auerbach's plexus in the region of the sphincter, exactly analogous to what occurs in achalasia of the cardia. The toxæmia resulting from the streptococcal infection leads to secondary anæmia and sometimes splenomegaly.

Symptoms.—The patient gradually finds difficulty in initiating the process of swallowing, especially solids. This is associated with glossitis of the kind often associated with Addison's anæmia, and progressive anæmia of a secondary non-Addisonian type. The spleen is often enlarged. The X-rays reveal no abnormality, and the œsophagoscope shows nothing more than an atrophic inflammation of the mucous membrane in the neighbourhood of the sphincter.

Treatment.—Dental sepsis, which may have led to the glossitis, should be thoroughly treated, and a hydrogen peroxide mouth-wash should be frequently used. A mercury bougie should be introduced into the œsophagus and passed from time to time until the dysphagia disappears. The anæmia responds to treatment with iron and arsenic, but in severe cases transfusion is required. Liver diet is without effect.

Achalasia of the Cardia: so-called Cardiospasm

Ætiology.—Achalasia of the cardia may begin at any age, but most commonly in adults, and males and females are equally affected.

Pathology. The hypertrophy of the muscular coat of the œsophagus which is always present in this condition indicates that violent efforts must have been made to overcome some obstruction. As no organic obstruction is ever found, the cardiac sphincter after death being of normal size, it is clear that the obstruction must be functional. Since the suggestion was first made that this was due to a spasm of the cardiac sphincter, the condition has been generally known as cardiospasm. As the symptoms may be present without intermission for many years before death, a considerable degree of hypertrophy of the cardiac sphincter would result from the long-continued spasm. In very few autopsies, however, has there been any hypertrophy, and in a case in which the cardiac sphincter, which is normally about 1 inch long and corresponds with the whole of the abdominal œsophagus, was exposed by operation, the muscle was found to be unusually thin.

I believe that the obstruction is due to achalasia (α, not; χαλάω, I relax), or absence of the normal relaxation of the cardiac sphincter, which should

occur when each peristaltic wave reaches it (Figs. 14 and 15). Food stagnates in the œsophagus, which dilates as more and more collects in it; the distension of the œsophagus acts as a powerful stimulus to peristalsis, which is excessively violent and continues at intervals throughout the day. This is the cause of the hypertrophy.

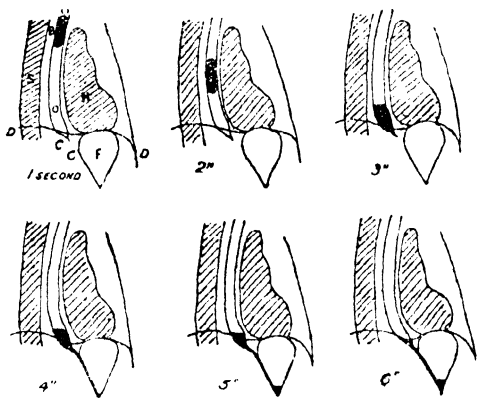


FIG. 14.—Diagrams of normal swallowing as seen with the X-rays in successive seconds. OO, œsophagus; B, bolus of food; CC, cardiac sphincter; DD, diaphragm; S, spine; H, heart; F, gas-containing fundus of stomach.

Further evidence that the condition is due to achalasia rather than spasm is afforded by the fact that, although strong peristaltic waves are unable to overcome the obstruction, the weight of an indiarubber tube filled with mercury is sufficient to cause it to drop through the cardia into the stomach, the actual passage through the cardia being often inappreciable to the hand which holds the mercury tube, and the tube can be withdrawn with equal ease; it is not gripped, as the finger is gripped when it enters or is withdrawn from a spasmodically contracted anal sphincter.

Rake and Stokes have shown that the condition is due to degenerative changes occurring in Auerbach's plexus between the circular and longitudinal muscular coats of the cardiac sphincter. The degeneration is a sequel of inflammation, which spreads from the mucous membrane from a primary œsophagitis, or results from blood-borne infection.

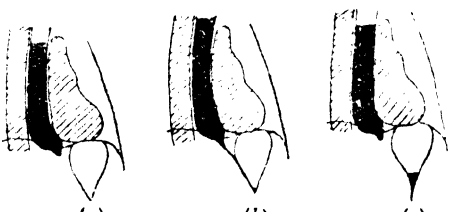


FIG. 15.—Drawings from a case of dilated œsophagus secondary to achalasia of the cardiac sphincter. (*a*) Dilated œsophagus filled with an 8-inch column of opaque food; sphincter closed. (*b*) Opaque food passing into stomach through sphincter which has opened after additional food has raised column in œsophagus above 8-inch height. (*c*) Return to condition of (*a*) after excess of food over the 8-inch column has entered stomach.

The dilated œsophagus may be able to hold as much as a pint, and its circumference may exceed 6 inches.

Symptoms.—Achalasia of the cardia generally develops gradually, a slight attack, lasting for a day or two, being followed by a period of freedom for a few days, or even several weeks or months; other attacks then occur at gradually shorter intervals, until finally the condition becomes permanent. The patient feels as if the food "sticks"; he often recognises that the obstruction is beneath the lower end of the sternum, but sometimes the sensation is felt in the upper part or middle

of the chest. Sometimes actual pain is produced. Salivation occurs in every case.

As a rule the patient voluntarily relieves his discomfort within a few minutes of finishing a meal by bringing up the greater part of what he has eaten mixed with saliva. He can generally do this quite easily, but occasionally requires to produce a vomiting reflex by tickling his throat; in neither case is there any nausea.

The weight of the column of food in the dilated œsophagus after a meal is sufficient to force a small proportion of the fluid present through the cardia as a very narrow stream; but as soon as the weight of the column falls below a certain point, generally about 8 inches, or the individual lies down, the pressure becomes insufficient, and the flow ceases (Fig. 15). Consequently food stagnates in the œsophagus for an indefinite period, and a considerable quantity can be removed from it even after a fast of twenty-four hours.

The œsophagoscope shows that the entry to the cardiac sphincter, which is approximately at the level of the diaphragm, is completely closed. The mucous membrane may be normal, but it is often red and inflamed, especially in the lowest part of the œsophagus, and there may be superficial erosions, which are secondary to the stasis.

The general health at first remains perfectly good in spite of the fact that weight is rapidly lost. After a certain amount of weight is lost, a condition of equilibrium develops; though extremely small quantities of food reach the stomach, the patient loses no more weight, and though he is less strong than formerly, he may continue to live in this condition for many years and reach old age.

Diagnosis.—The patient's description of his symptoms is generally so characteristic that a diagnosis of œsophageal obstruction can be made with a considerable degree of probability. This is confirmed by means of an X-ray examination, which must in the early intermittent stage be made during an attack, when the situation of the obstruction at the cardiac orifice is at once apparent. It is next necessary to ascertain whether this is due to achalasia or to cancer, as non-malignant strictures are extremely rare, except as a result of caustic poisoning, when a history is generally obtainable and the obstruction is found to extend for some inches upwards instead of being strictly confined to the cardiac sphincter. The intermittent character of the early attacks, the absence of serious constitutional symptoms in spite of rapid loss of weight, the comparatively early age at onset with many patients, and, in cases in which an early diagnosis has not been made, the long duration of the illness and enormous dilatation of the œsophagus point to achalasia rather than to growth. Occult blood is generally present in the stools in cancer, but never in achalasia of the cardia. The even outline of the shadow and the localisation of the obstruction to the cardiac sphincter in achalasia differ from the more irregular outline and the more extensive area of obstruction in cancer. Further evidence is the ease with which a mercury tube passes through the cardia in achalasia in contrast with the complete obstruction offered to its passage by a growth.

Prognosis.—If the condition is recognised at the onset of symptoms, a permanent cure often results from treatment, but if treatment is only instituted when the obstruction has become continuous and the œsophagus greatly dilated, cure as distinct from mere relief of symptoms is less likely

to be obtained. In the absence of treatment death has occurred at an early stage in very acute cases; but more often the patient survives for a considerable period, even for 40 years.

Treatment.—The simplest and most effective treatment is by means of a mercury tube. The tube has a rounded end with no holes in it, the diameter of the larger being 24-gauge. It is half-filled with mercury, the upper end being closed. The tube drops through the cardia; it requires no pushing, and can be easily managed by the patient himself. It is kept in position for a quarter of an hour on each occasion at first, but later it can be withdrawn directly after it has entered the stomach. The patient feels relieved, and realises that "the passage is clear" as soon as it is withdrawn. It should be passed immediately before meals; the food then enters the stomach without difficulty. In very early cases the tube may only need to be passed once. Generally, however, the tube has to be passed before each meal at first, then once a day, and gradually less often, till finally it is only used at rare intervals when the patient feels that some slight obstruction is returning. In chronic cases, which are always associated with secondary œsophagitis, the patient should make an effort to evacuate any food which is still present in the œsophagus a quarter of an hour after the end of each meal. Whether he is successful or not, he should then drink about 5 ounces of water, and after a minute evacuate this; the dilated œsophagus is thus kept clean, and the œsophagitis is rapidly overcome. In the only case I have seen in which the mercury tube did not give sufficient relief, and forcible distension with a rubber bag proved useless, great improvement followed longitudinal division of the cardiac sphincter in the same way as the pyloric sphincter is divided in Rammstedt's operation for hypertrophic stenosis in infants.

Waterbrash

Ætiology.—Waterbrash may persist for years without any other evidence of indigestion, but it is generally associated with some form of functional or organic gastric disease, and particularly with conditions, such as duodenal ulcer, which are associated with hyperchlorhydria, probably because they also give rise to reflex hypersecretion of saliva.

Symptoms.—At a certain interval after a meal, which varies in different cases, but is fairly constant for each individual, an uncomfortable sensation of constriction, which may amount to severe pain, is felt deeply beneath the lower end of the sternum. This may be accompanied by profuse salivation. Relief occurs only on bringing up a few mouthfuls of clear fluid, which is generally described by the patient as being like water, though it sometimes contains a good deal of mucus. The fluid rises into the mouth with little or no effort and without nausea.

The fluid must come from the œsophagus and not from the stomach, as even when the previous meal was large and has only been finished within an hour, no food is present in the regurgitated material, which is alkaline in reaction and has all the characters of pure saliva.

When the flow of saliva is moderately excessive, it runs down the œsophagus without the patient's knowledge and without the aid of actual swallowing; the cardiac sphincter is naturally closed, and the fluid therefore collects above it in the lower end of the œsophagus. The morning vomiting

of alcoholic individuals is due to a similar process, although it is accompanied by more violent vomiting efforts. In this case the fluid consists of saliva mixed with a considerable proportion of pharyngeal and œsophageal mucus, as catarrhal pharyngitis and œsophagitis are frequently associated with the catarrhal gastritis of alcoholic patients.

Treatment.—Waterbrash requires no special treatment, as it is rapidly relieved by adequate treatment of the primary condition.

DIVERTICULA OF THE PHARYNX AND ŒSOPHAGUS

Ætiology and Pathology.—Diverticula may develop from the anterior wall of the middle third of the œsophagus by the traction resulting from adhesions between inflamed glands near the bifurcation of the trachea and the wall of the œsophagus; these "traction diverticula" are generally less than an inch in depth and rarely give rise to symptoms. A diverticulum, which has given rise to no symptoms, is occasionally discovered at the lower end of the œsophagus during a routine radiographic examination. Its origin is generally obscure, but in one of the three cases I have seen it was associated with achalasia of the cardia.

Pressure diverticula are rare, but are of considerable clinical importance. They occur only in adults, and always develop at the muscular gap on the posterior wall of the pharynx between the upper and lower divisions of the inferior constrictor of the pharynx, at the level of the cricoid cartilage. They are really diverticula of the pharynx and not of the œsophagus, though they have generally been described as œsophageal. The lower division of the inferior constrictor of the pharynx forms a sphincter surrounding the entrance to the œsophagus. It is closed at rest, but opens during each act of deglutition the moment the food reaches it. If for any reason it does not open, the food is forced against the weak spot on the posterior wall of the pharynx immediately above the sphincter. A pouch of mucous membrane may thus be formed; it becomes progressively larger towards one side, owing to the accumulation of food in it, until it may finally measure as much as 5 inches in depth and be large enough to contain over a pint of fluid, in which case it may extend into the posterior mediastinum. Its wall is formed of mucous membrane and submucous tissue without any muscular covering.

Symptoms.—Diverticula of the pharynx sooner or later cause progressive dysphagia. The patient complains of obstruction in the neck when he swallows, and a small quantity of food is regurgitated at varying intervals after meals. As the sac increases in size, the symptoms become more marked owing to obstruction of the œsophagus by the distended diverticulum, which finally forms a prolongation of the pharynx, the œsophagus opening as a transverse slit out of its anterior wall. Increasing quantities of food are brought up, mixed with a large amount of mucus, and food eaten several days before may be recognised. The patient becomes steadily more emaciated. Distension of the sac often causes pain, which is relieved when it is emptied. An irritable cough is often present, and dyspnœa may result from pressure on the trachea. A large diverticulum containing food may form a

visible tumour in the neck, generally on the left side, which can be emptied by pressure, the food returning into the pharynx.

The size, shape and exact position of the diverticulum can be recognised with the X-rays after a barium meal.

Treatment.—The only satisfactory treatment of a pharyngeal diverticulum is excision.

ACUTE ŒSOPHAGITIS

Ætiology.—Acute catarrhal œsophagitis may occur in various acute infective diseases, such as scarlet fever, and it may also complicate cancer of the œsophagus and spread from acute pharyngitis. In 5 per cent. of fatal cases of diphtheria the inflammation has spread from the fauces into the œsophagus, and in very rare cases the membrane extends as far as the cardia. The impaction of a foreign body in the œsophagus may cause local suppuration. Acute inflammation results from swallowing boiling water or corrosive poisons, taken by accident or in attempted suicide; owing to the delay caused to the passage of the œsophageal contents by the narrow cardiac sphincter, the lower end is the part most affected, the upper extremity being next most seriously injured.

Symptoms.—In mild cases there may be no symptoms, but more or less dysphagia is generally present; in severe cases deglutition is so painful that the patient may be afraid to swallow his saliva or relieve his urgent thirst by drinking. There may also be constant pain beneath the sternum. Attempts to swallow often prove unsuccessful owing to reflex spasm, the food being brought up at once. Mucus is expectorated, together with blood and pus in severe cases.

Treatment.—In severe cases nothing should be given by mouth, but saline solution must be injected by the rectum or under the skin. Morphine is required for the pain. When the pain begins to subside, olive oil in half-ounce doses can be given by the mouth, and after a short time fluids may be sipped after each dose of oil. Solid food should not be given until swallowing no longer causes pain. If an X-ray examination shows that a stricture is developing, bougies should be regularly passed as soon as the acute inflammation has subsided; but in spite of their use complete obstruction necessitating gastrostomy is likely to occur in severe cases following corrosive poisoning.

CHRONIC ŒSOPHAGITIS

Ætiology.—Chronic œsophagitis results from the constant swallowing of irritants, the most important of which are strong alcoholic drinks, and from septic conditions of the teeth and naso-pharynx. It is also a common sequel of stasis of food in the œsophagus, especially that caused by achalasia of the cardia.

Symptoms.—As the condition is almost always associated with chronic pharyngitis and gastritis, it is generally impossible to isolate the symptoms of one of them from the others. The morning vomiting of alcoholics, which so often precedes the development of symptoms due to the hepatic condition in cirrhosis of the liver, is to a great extent caused by œsophageal catarrh.

Treatment.—The œsophagitis quickly disappears when the sources of irritation are removed by the patient becoming teetotal and all septic foci in the mouth being removed.

NON-MALIGNANT STRICTURE

Ætiology.—Stricture of the œsophagus is in rare cases congenital; the middle part of the œsophagus may be represented by a fibrous cord, or the lower part may open into the trachea or into one of the bronchi. Acute traumatic œsophagitis is the chief cause of fibrous stricture, but it may also very rarely result from the healing of a simple ulcer, from the acute œsophagitis of fevers, and from syphilis.

Pathology.—Cicatricial stenosis generally occurs at the lower end of the œsophagus, but sometimes also at the top, and occasionally at the bifurcation of the trachea.

Treatment.—Fibrous strictures must be dilated by the passage of bougies of gradually increasing size. In severe cases, they should be guided into the stomach by a piece of string, previously swallowed, threaded through their lower end. There is a constant tendency to recur, so a bougie must be passed at regular intervals. I have seen a well-developed boy of 10, who had been fed entirely through a gastrostomy, which had been made a few days after birth on account of congenital stricture of the œsophagus.

CANCER

Ætiology.—Primary cancer of the œsophagus occurs with about half the frequency of primary cancer of the stomach. Over 70 per cent. of cases of cancer of the œsophagus occur in men, but cancer of the lower end of the pharynx is most frequent in women.

Pathology.—A large proportion of growths of the œsophagus are epitheliomata. They are about equally common at the upper extremity of the œsophagus, at the level of the bifurcation of the trachea and at the cardia, these being the three narrowest parts, the mucous membrane being consequently most subjected to friction by coarse food. It is often impossible to say whether an epithelioma at the upper end of the œsophagus is a primary growth of the pharynx, from which it has spread into the œsophagus, or whether it is a primary growth of the œsophagus and has spread into the pharynx. Ulceration occurs at an early stage. Accumulation of food in the œsophagus above the obstruction leads to progressive dilatation, and the efforts of the œsophageal musculature to overcome the obstruction result in hypertrophy, but the dilatation and hypertrophy are comparatively slight, except in cancer of the lower end, as when the obstruction is higher up vomiting occurs so quickly that very little food can accumulate.

Symptoms.—Dysphagia is almost always present and is the first symptom in a large majority of cases. Most frequently a patient in perfect health one day experiences a slight discomfort on swallowing; soon he notices that his food seems to stick for a moment before passing on into his stomach.

The difficulty becomes slowly but steadily more marked, with rare intermissions lasting for a few meals or at most for a few days. The patient often manages to swallow his food by chewing more thoroughly, by taking smaller mouthfuls, and by drinking after each mouthful is swallowed; but more and more effort is required, until after a period, which is generally between 1 to 4 months, but may be as long as a year, solid food ceases to pass at all and is brought back into the mouth a few seconds later. The patient generally localises the position of obstruction correctly, but he sometimes thinks that it is in the upper third when it is really in the lower third. The difficulty in swallowing continues, until after an average of 8 months there is complete obstruction to the passage of fluids as well as solids.

Pain only occurs in 40 per cent. of cases; it is most frequently absent when the growth is in the lowest third of the œsophagus. It occasionally begins a few days before or simultaneously with the dysphagia, but it more commonly is not noticed until the latter has been present for 1 or 2 months. The pain may only be present during deglutition, disappearing as soon as the food passes the obstruction. It is situated at the level of the obstruction, and often passes through to the back.

Regurgitation of food almost always occurs sooner or later; it generally begins between 1 and 2 months after the onset of symptoms and is rarely delayed as long as 6 months.

When the growth is situated in the upper third of the œsophagus the food is violently ejected out of the mouth, or even from the nose after a coughing effort. When the middle or lower third is involved the food regurgitates without effort into the mouth, and the regurgitation may occur immediately after meals. If the œsophagus is dilated, food may be regurgitated any time up to 2 hours after being swallowed. The food is completely undigested and always contains mucous saliva, often in considerable quantity. Regurgitation of saliva only occurs when the obstruction is sufficient to interfere with the swallowing of fluid as well as of solid food. Salivation may be continuous. The regurgitation of the contents of the dilated œsophagus gives relief to any discomfort or pain which is present at the time. The regurgitated material sometimes contains blood and pus, and may be very foul; occasionally several ounces and in rare cases a large quantity of blood is vomited.

Progressive emaciation occurs owing to the small amount of food which is taken, and when obstruction is complete the loss of weight is very rapid. The appetite may remain good, and hunger may be very distressing in the early stages, but this becomes less marked as the disease progresses. Severe thirst, with dryness of the mouth, is sometimes present, and fœtid breath is common when there is extensive ulceration. Small hard glands are often felt in the neck, especially just above the inner end of the clavicle and beneath the lower jaw.

The vagus or recurrent laryngeal nerves, especially of the left side, may be involved, and one, or rarely both, vocal cords may consequently be paralysed. Pressure on the cervical sympathetic may cause contraction of the pupil, with slight enophthalmos and narrowing of the palpebral fissure on the affected side. Compression of the trachea or the main bronchi by the tumour or by secondary glands may cause hoarseness, coughing and dyspnœa. Perforation into the trachea or a bronchus gives rise to a paroxysm

of coughing and dyspnœa whenever food is swallowed, and death from broncho-pneumonia or gangrene of the lung is likely to occur. Perforation into the pleural cavity may produce empyema, but a serous pleural effusion may develop without perforation.

Diagnosis.—In a large proportion of cases it is possible to make a definite diagnosis from the history and from the information obtained with the X-rays, which should always be used without delay in cases of dysphagia. Before giving the opaque meal the thorax should be examined from every direction in order to exclude an aneurysm, although in the very rare cases in which this causes dysphagia other more characteristic symptoms generally make the diagnosis clear. Occasionally a growth of the œsophagus throws a shadow with the X-rays, but this is rarely at all obvious until the symptoms have been present for a considerable time; more frequently secondary deposits in glands form abnormal shadows in the posterior mediastinum. With the aid of an opaque meal the X-rays show the exact position of any narrowing of the lumen of the œsophagus, the degree of dilatation above the obstruction, and the degree of obstruction, but spasm may cause the latter to appear complete though it is found to be incomplete after death.

The diagnosis of a growth of the cardia from achalasia has already been considered (p. 509). The presence of hard glands in the neck makes the diagnosis of cancer extremely probable in cases of œsophageal obstruction. In the rare cases in which the history and the X-rays leave the diagnosis in doubt, and especially in early cases, an examination should be made with the œsophagoscope, by means of which the exact nature of the obstruction can generally be recognised.

There is rarely much difficulty in diagnosing between an elipitheoma of the cardiac end of the œsophagus, which may spread upwards but never spreads downwards into the stomach, and a primary carcinoma of the cardiac end of the stomach, which almost invariably involves the cardiac orifice sooner or later. With the former the dysphagia is the first symptom: with the latter anorexia, pain after food, vomiting, loss of weight and strength, and increasing pallor appear before the dysphagia, and the vomiting is at first acid in reaction and only becomes alkaline later when the food can no longer reach the stomach. The X-rays show a filling defect in the stomach when the tumour is gastric in origin, and sooner or later a mass can be felt high up under the left costal margin.

Prognosis.—Death occurs between 2½ months and 2½ years after the onset of symptoms, the most common period being between 6 and 12 months. It is most frequently due to broncho-pneumonia, exhaustion from starvation being the next most common cause.

Treatment.—The radical treatment of cancer of the œsophagus by excision of the growth has very rarely been successful, but with the recent advances in thoracic surgery the outlook is becoming more hopeful, as the diagnosis can generally be made at a much earlier stage of development than in cancer of the stomach or colon.

The first question to consider in most cases is whether a gastrostomy should be performed; the operation saves the patient from starvation, and if it is not postponed until too late the immediate mortality is small. It is rare, however, for the patient to survive very long, the results differing in this

way from those of gastro-jejunostomy for pyloric cancer and colostomy for intestinal growths. When the disease appears to be progressing slowly, and for any reason the use of Souttar's spiral metal tube is impracticable, a gastrostomy or jejunostomy should be advised as soon as difficulty is experienced in swallowing fluids.

When the growth involves the centre of the œsophagus, Souttar's tube should be introduced through an œsophagoscope, if necessary after preliminary dilatation of the stricture by bougies. Its lower end reaches beyond the lower extremity of the growth, whilst the upper funnel-shaped end rests on its proximal margin. The tube can be left *in situ* until the end.

Treatment by radium and deep X-rays sometimes prolongs life to a slight extent, but no case of cure has been recorded.

The food should be fluid or semi-fluid, and should be taken in small quantities at frequent intervals. Some patients are able to swallow raw eggs whole, as the egg white appears to relieve spasm so that the egg passes intact into the stomach. A dessertspoonful of olive oil taken before each feed often helps its passage through the stricture. When swallowing is painful, an injection of a small dose of atropine with morphine should be given half an hour before each feed.

ARTHUR F. HURST.

DISEASES OF THE STOMACH

EXAMINATION OF THE STOMACH

MOTOR FUNCTIONS

(*a*) SIZE, SHAPE AND POSITION.—*Inspection* of the abdomen may reveal the outline of the stomach in thin patients, especially if pyloric obstruction has led to excessive activity of peristalsis. *Palpation* under similar circumstances often makes it possible to feel the lower border of the stomach. It may also reveal the presence of a tumour, the size, shape, position and mobility of which should be estimated. When the gastric contents can be splashed with unusual ease on abdominal palpation or on shaking the patient, the approximate size and position of the stomach can be determined from the area in which the splash is best heard with a stethoscope. *Percussion* may give some idea as to the quantity of gas in the stomach, but it cannot help in the determination of its size, shape or position; *auscultatory percussion and friction* have been shown by means of the X-rays to be quite valueless for examining the stomach.

X-rays.—The size, shape and position of the stomach can be readily and accurately determined, both in the vertical and horizontal position, by means of the X-rays after a meal of porridge containing 3 ounces of barium sulphate. By palpation during the screen examination, its mobility can be investigated, and the presence of adhesions and areas of tenderness recognised.

(*b*) TONE.—*Splashing and succussion* can be obtained in an individual with relaxed abdominal muscles and a stomach with normal tone. They give no information as to the presence of atony.

X-rays.—Owing to the adaptation of the stomach to the volume of its contents, there is little difference in the upper level of the semi-fluid chyme as seen with the X-rays in the erect position whether the volume be 5 ounces or 2 pints, and the greater curvature is only slightly depressed as the stomach is gradually filled. When the stomach is hypotonic, this adaptation to the volume of its contents does not occur; the food drops to the most dependent part, the upper level of the contents slowly rising and the greater curvature becoming more dependent as the volume increases. It is very important to distinguish this condition from the distension without hypotonus caused by the continuous presence of fluid or fluid and food in the stomach in pyloric obstruction or an ulcer near the pylorus. In this condition the opaque meal appears to fall to the bottom of a large stomach, but closer investigation shows that it is really falling through a large quantity of fluid already present in the stomach, which throws no shadow, but the upper horizontal level of which can be recognised at the normal distance below the diaphragm. If the examination is repeated after emptying the stomach of its resting contents with a stomach tube, the tone is found to be normal and no dilatation is present.

(*c*) PERISTALSIS.—*Inspection and palpation.*—In unusually thin women normal peristalsis is occasionally visible, but in the majority of cases the presence of visible peristalsis indicates organic pyloric obstruction. The patient should be examined immediately after a meal; in doubtful cases peristalsis can be rendered more obvious by massage. At a stage preceding that in which peristalsis is visible, it may often be felt as a periodic hardening, if the hand is kept for some time gently pressing upon the right side of the abdomen a little above the umbilicus.

X-rays.—Deficient peristalsis cannot be recognised with certainty by any method except the X-rays. In pyloric obstruction the peristaltic waves can be seen to commence in the fundus instead of in the centre of the body, and to lead to unusually great depression in the outline of the organ at a period considerably earlier than that in which it becomes visible through the abdominal wall. Reversed peristalsis generally indicates organic pyloric obstruction, but I have also seen it in cases of chronic appendicitis and lesser curvature ulcer with gastric stasis but no obstruction. Irregular peristalsis, and especially peristalsis which begins in the normal position but disappears as it passes along the greater curvature before the pylorus is reached, is very suggestive of malignant infiltration.

(*d*) RATE OF EVACUATION.—*Splashing and succussion.*—The stomach should be completely empty in less than 6 hours after dinner. If, therefore, splashing and succussion can be elicited 6 hours after such a meal, it may be concluded that stasis is present. This may be due either to atony if the erect position has been maintained, feeble peristalsis, or pyloric obstruction. If, however, these signs are present 12 hours after dinner—at 8 a.m., for example, if dinner was taken at 8 p.m.—organic pyloric obstruction is present, unless there is an ulcer in the neighbourhood of the pylorus, as this may cause continuous secretion of gastric juice, so that the stomach is never empty, although there is no great delay in the passage of the food into the duodenum.

Stomach-tube.—When the symptoms or physical signs suggest the possibility of pyloric obstruction, it is essential to investigate the case by means of a stomach-tube. A dinner, which should include meat and lettuce or celery,

sweets and a dozen raisins, is given at 9 p.m., and Senoran's evacuator is passed at 9 a.m., nothing having been taken in the interval. After removing the fasting contents of the stomach, it should be thoroughly washed out with water. In normal individuals less than 50 c.c. of colourless or bile-stained gastric juice are found; no gross food residue is present, and even microscopically no meat fibres and only occasionally a little vegetable débris, together with a few leucocytes and bacteria derived from the mouth, are found. In atonic dilatation the stomach is always empty 12 hours after a meal. In chronic gastritis, especially when due to alcohol, a small quantity of thick alkaline fluid, consisting mainly of swallowed saliva and pharyngeal and œsophageal secretion, may be present. In the continuous secretion which results from an ulcer near the pylorus, even in the absence of obstruction, a small quantity of very acid fluid without any food residue is found. When an ulcer has led to organic obstruction, starch granules and vegetable débris, but no meat fibres, are present, in addition to some acid fluid; the quantity of the latter is much increased if the ulcer is still active, as hypersecretion then occurs in addition to stasis. Large numbers of budding yeasts and sarcinæ are found microscopically. In malignant obstruction the gastric contents are thicker and contain débris of both vegetable and animal food; free hydrochloric acid is absent, and lactic acid is often present. Many bacteria, but comparatively few yeasts and sarcinæ, are present.

X-rays.—Careful examination before the opaque meal is given may show that a considerable quantity of fluid is present in the fasting stomach; its upper horizontal level can be seen under the gas in the fundus, and splashing can be observed if the patient shakes himself. If, after an opaque meal, the shadow of the stomach is still visible 6 hours after a barium meal, nothing having been taken in the interval, stasis is present; after 9 hours it is probably, and after 12 hours it is certainly, due to organic pyloric obstruction.

Chemical Functions

The chemical functions of the stomach can only be adequately investigated by means of a test-meal. The old-fashioned test-breakfast is less satisfactory than the modern fractional test-meal, which provides information respecting the characters of the resting-juice and post-prandial secretion, the secretory response throughout the period of gastric digestion, the secretion of mucus, the regurgitation of bile and duodenal contents, and also allows of an accurate estimate of the rate of emptying. The patient, who should have taken no food since the night before, swallows the tube (the best form being Ryle's modification of that introduced by Einhorn) in the morning. The resting-juice is withdrawn and measured, its bile and mucus content noted, and the free and total acidity determined; the presence of gross food residue or a positive starch reaction is diagnostic of pyloric stenosis. After withdrawal of the resting-juice the patient drinks 1 pint of oatmeal gruel, and small specimens of gastric contents are withdrawn with a syringe at intervals of a quarter of an hour until the stomach is empty. The free and total acidity in each specimen is estimated, Topfer solution and phenolphthalein being the respective indicators customarily employed. The time of disappearance of the starch, which may precede complete emptying, is deter-

mined by adding iodine to the successive samples. The free and total acidity are plotted as curves upon a chart.

One hour after the beginning of the meal a larger fraction (20 c.c.) should be removed for the quantitative estimation of active hydrochloric acid, *i.e.* the quantity of free and organically combined hydrochloric acid. Two equal portions of filtered gastric contents, to the first of which excess of sodium carbonate solution is added, are evaporated to dryness and ignited at a low red heat until charring is complete. The chlorides are estimated in each portion by Volhard's method, the first giving the total chlorides and the second the mineral chlorides, the difference being the active hydrochloric acid, the normal quantity of which varies between 0·1 to 0·2 per cent.

Lactic acid may be recognised by Uffelman's reagent (30 c.c. 1 per cent. carbolic acid with a few drops of ferric chloride solution), which it changes from blue to canary yellow. An ethereal extract of the gastric contents must be used, 5 c.c. of gastric contents being shaken with 30 c.c. of ether.

Microscopical examination of the resting-juice may reveal the presence of red corpuscles, leucocytes, very rarely fragments of mucous membrane or growth, sarcinæ in non-malignant pyloric obstruction, and the Boas-Oppler bacilli in malignant cases. The discovery of leucocytes is only of importance if their number is obviously in excess of the number present in a specimen of spittle obtained at the same time, as in the large majority of cases they have all been swallowed with saliva. True excess of leucocytes indicates the presence of gastritis or carcinoma. When the resting-juice or some or all of the fractions of a test-meal are red owing to the presence of blood, a bleeding ulcer or carcinoma is present. Specks of blood in otherwise blood-free specimens are generally of no importance, being due to accidental contamination.

Occult blood.—Apart from the obvious presence of blood in the stools (melæna), "occult blood" may be recognised by chemical means (see p. 562).

ARTHUR F. HURST.

FUNCTIONAL DISORDERS OF THE STOMACH

MOTOR DISORDERS

ATONY; ATONIC DILATATION

Ætiology.—Atony of the stomach, together with the dilatation to which it gives rise, is often diagnosed on insufficient grounds, but the X-rays have shown that it is in fact a comparatively rare condition. It is most commonly associated with neurasthenic dyspepsia, and it is also an occasional sequel of infections, especially influenza and typhoid fever, and of all conditions leading to malnutrition.

Symptoms.—The chief symptom is an uncomfortable sensation of fullness during and after meals, which leads to progressive diminution in the amount of food taken, the patient thereby hoping to diminish his discomfort, but actually increasing the atony by starving his nervous and muscular tissues. In uncomplicated cases pain and vomiting are never present.

Diagnosis.—The diagnosis of functional atonic dilatation depends, firstly, upon the estimation of the size and tone of the stomach, and, secondly, upon its differentiation from the atony and dilatation which occur in organic pyloric obstruction when the compensatory hypertrophy proves insufficient.

Treatment.—Rest in the recumbent position is not only valuable for the exhausted nervous system, but it also places the atonic stomach in a condition of mechanical advantage, especially if the patient lies on his right side. In slight cases it is only necessary to lie down for an hour after each meal; in advanced cases the patient should at first remain in bed all day, and should lie on his right side while he eats and for an hour after each meal.

An ordinary mixed diet should be given, but the bulk of the meals should be as small as is compatible with the provision of a proper amount of nourishment, and fluids should be drunk only when the stomach is empty. A glass of milk may be taken on rising in the morning, a glass of milk an hour before lunch, one or two cups of tea at 5 p.m., and a glass of milk last thing at night. In severe cases, no fluid at all should be drunk for some days; the meals should be quite dry, and saline solution given by rectum.

Strychnine is often of use, as it improves the appetite, though it is doubtful whether it has any direct effect upon the gastric tone, and it should not be given to patients suffering from severe neurasthenia. It may be combined with dilute hydrochloric acid (15 minims), if there is deficiency in gastric secretion, and with a bitter such as gentian, which stimulates the appetite. In excitable patients, and in patients who find it difficult to lie quietly in bed for a sufficient period, small doses of bromide and arsenic should be given.

In uncomplicated cases, lavage is likely to do more harm than good, but in severe cases complicated by chronic gastritis, lavage with small quantities of plain water may be of use. Gastro-enterostomy is absolutely contra-indicated.

Acute Dilatation

Ætiology.—After abdominal operations with or without peritonitis, and much less frequently in the course of acute and chronic infections, especially pneumonia, the stomach suddenly becomes greatly dilated owing to a complete loss of tone. The acute dilatation leads to obstruction of the duodenum by the mesentery at the point where the latter crosses it, so the dilatation is greatly increased.

Symptoms.—The abdomen is very distended, large quantities of dark but not fæcal fluid are vomited, and the patient rapidly becomes very collapsed.

Treatment.—The stomach should be kept empty by aspirating through a Ryle tube kept continuously in position, however ill the patient may be. Nothing should be given by the mouth, but saline solution should be injected into the rectum or subcutaneously. In severe cases a jejunostomy should be performed, the patient being fed through the stoma till the stomach contracts to its normal size.

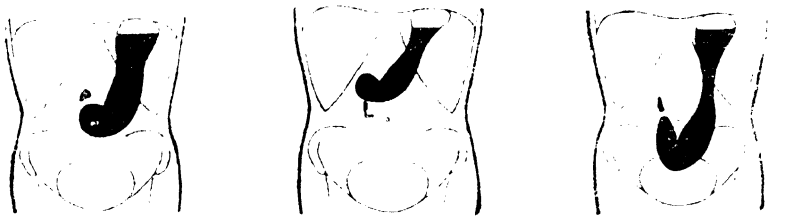
Hypertonus

Ætiology.—Hypertonus is most commonly associated with very active peristalsis, rapid evacuation, and hyperchlorhydria. The condition is

congenital and often familial, and constitutes the "hypersthenic gastric diathesis" (p. 524), which is the essential predisposing cause of duodenal ulcer (p. 543).

Symptoms.—Hypertonus does not itself give rise to symptoms. If, however, an individual with the hypersthenic gastric diathesis becomes neurasthenic, or develops duodenal ulcer, some of his symptoms are caused by the hypertonus. A comparatively small quantity of food is sufficient to produce a rise in intragastric pressure, which results in a feeling of fullness, independent of the nature of the food, but varying in degree with its bulk and the rapidity with which it is eaten. The rapid evacuation of the stomach which commonly occurs when it is hypertonic gives rise to a feeling of emptiness and hunger about three hours after meals; immediate relief occurs when anything is eaten or drunk.

Diagnosis.—Hypertonus can only be diagnosed with certainty by means of the X-rays. In the erect position the stomach is diagonal (Fig. 16 (*b*)) or



(*a*) Average normal stomach. (*b*) Short stomach in healthy man without symptoms. (*c*) Long stomach in athletic young man without symptoms.

FIG. 16.—Variations in length of stomach in healthy individuals.

even horizontal, instead of almost perpendicular as in most normal subjects Fig. 16 (*a*)), and the pyloric vestibule, instead of the greater curvature of the body of the stomach, is its lowest part, being situated a considerable distance above the umbilicus. Peristalsis is either normal or exaggerated, and the pylorus tends to be relaxed, so that the stomach empties itself with unusual rapidity. The only condition with which confusion may arise is a leather-bottle stomach, in which the infiltrated stomach is similar in size and shape; no peristalsis, however, is seen, the very rapid evacuation depending upon the fact that the infiltrated pylorus is dilated and incompetent.

Treatment.—Apart from the treatment of any condition with which hypertonus may be associated, it is important that regular intermediate feeds should be taken in addition to the ordinary meals, in order that the stomach should not be empty for too long a period at a time. Belladonna is the only drug which has the effect of diminishing excessive tone, but a tablespoonful of olive oil taken before meals helps to prevent the too rapid evacuation of the stomach.

SPASM: SPASMODIC HOUR-GLASS STOMACH

Ætiology.—Spasm of a narrow band of circular muscle fibres may be produced reflexly by a gastric or duodenal ulcer, chronic appendicitis, or

cholecystitis. An ulcer on the lesser curvature is the most common of the causes, the position of the spasm corresponding with that of the ulcer.

Symptoms and Diagnosis.—The spasm in the centre of the stomach leads to the production of an hour-glass stomach. There are no characteristic symptoms, but the spasm is often the only objective gastric sign which is present in the dyspepsia of chronic appendicitis and gall-stones. It is important to be able to recognise the functional nature of the condition, as many needless operations for supposed organic hour-glass stomach have been performed as a result of misinterpreting the appearance seen with the X-rays. A spasmodic stricture varies in degree during a single and at different examinations, and it never gives rise to sufficient obstruction to cause stasis for 6 hours or increased peristalsis in the proximal segment. A spasmodic stricture differs from the orthostatic stricture often seen in gastroptosis by persisting when the patient lies down, and by its disappearance on vigorous massage and sometimes after the administration of atropine.

Vomiting

Ætiology.—(*a*) *Central vomiting.*—Vomiting is only rarely under the control of the will. But a person who has vomited a number of times owing to some central, reflex or toxic cause, may suggest to himself that certain circumstances will invariably cause him to vomit. The hysterical vomiting which results is a common sequel of vomiting due to other causes.

Various emotions, especially those of disgust and fear, may result in vomiting, especially in individuals with an abnormally excitable nervous system. This vomiting may occur as a result of incidents which subconsciously revive the memory of an emotion which on some particular occasion caused vomiting. Thus a woman who on one occasion vomited as a result of terror in a railway carriage, subsequently vomited whenever she travelled in a train and after a time in any vehicle and even in closed places, such as a church, from which she could not readily escape. The vomiting was associated with a vague feeling of fear, but not consciously with the incident which was the primary cause.

Certain organic nervous diseases, such as cerebral tumour and meningitis, are frequently accompanied by vomiting, which may also occur in compression and in concussion caused by injury. This is due partly to increased intracranial pressure, and partly to direct irritation of higher parts of the brain, from which impulses pass to the vomiting centre. In the case of cerebral tumour the relief of intracranial pressure by trephining may, therefore, cause the vomiting to cease.

(*b*) *Reflex vomiting.*—Reflex stimulation of the vomiting centre is the most common cause of vomiting. The most important source is the stomach itself, irritation of the mucous membrane by abnormal constituents of the gastric contents, whether introduced in the food or resulting from bacterial decomposition, being a frequent cause. Gassing was a common cause of vomiting during the Great War, some of the irritant gas being dissolved in the saliva, which was secreted in excess and then swallowed. Over-distension with food, especially if it occurs rapidly, as when a big meal is bolted, or if it continues for an abnormally long period as a result of pyloric obstruction,

has the same effect. In all these cases more or less relief to the local symptoms results from vomiting.

Painful stimulation of any afferent nerves, but particularly of those passing from abdominal viscera, such as occurs in the attacks of pain associated with gastric ulcer, in biliary and renal colic and in intestinal obstruction and peritonitis, often causes vomiting. Tickling the fauces is a common method of inducing vomiting; vomiting may also be excited reflexly from the lungs in phthisis and from the heart when it is dilated, and the vomiting of migraine is in most cases a reflex from the eyes.

Sea-sickness is caused by a reflex arising from abnormal stimulation of the semicircular canals. The vomiting in diseases of the ear, in which the semicircular canals are directly or indirectly involved, as in Ménière's disease, is of similar origin. The vomiting of early pregnancy is probably reflex; when persistent it is, I believe, always hysterical and therefore curable by psychotherapy.

(c) *Toxic vomiting.*—Some emetics, such as apomorphine, cause vomiting by direct irritation of the vomiting centre, and this is also the cause of post-anæsthetic vomiting. Other emetics, such as warm water containing salt, and copper and zinc sulphate, act reflexly from the stomach, and are consequently only effective when they are swallowed, whilst drugs, such as tartar emetic and ipecacuanha, act in both ways.

Poisons produced in the body, as in uræmia, Graves' disease and Addison's disease, may irritate the vomiting centre. In uræmia, however, the action is partly reflex owing to the excretion into the stomach of toxins which should be excreted by the kidneys. The bacterial toxins in acute fevers, especially scarlet fever, often excite vomiting. Toxic vomiting differs from central vomiting and some cases of reflex vomiting in being almost invariably preceded by nausea.

Treatment.—The only treatment of vomiting is to remove the cause. In toxic cases, and those due to reflexes from the stomach itself, complete evacuation by the stomach tube gives relief. As purely symptomatic treatment, the most useful drugs are dilute hydrocyanic acid, 3 to 6 minims of which should be given in 1 drachm of water, and chloretone, 5 grains of which can be given in a cachet and repeated, if necessary, three or four times at intervals of 2 hours. Chloretone is particularly useful for sea-sickness. It tends to produce drowsiness and may cause considerable malaise; it is therefore unsuitable for frequent administration.

Regurgitation

Regurgitation of small quantities of food into the pharynx and less often into the mouth without effort and without nausea occurs in various forms of dyspepsia. It is often accompanied by a scalding sensation in the pharynx. Regurgitation is frequently associated with flatulence due to aerophagy, the unsuccessful efforts made by the patient to bring up wind when no excess is present in the stomach resulting in regurgitation of some of its fluid contents. It must be distinguished from regurgitation of saliva from the œsophagus—so-called waterbrash (p. 510). No special treatment is required beyond that of the primary condition; the momentary discomfort is relieved by drinking some water or taking a little sodium bicarbonate.

Rumination

Synonym.—Merycism.

Ætiology.—Rumination is a very rare condition, which may occur in several members of the same family. It occasionally develops as a result of imitation, and is most frequent in neurotic individuals, in epileptics and in the insane. It generally begins between the ages of 12 and 20.

Symptoms.—Rumination consists in the return into the mouth of successive portions of a considerable part of the gastric contents after the completion of a meal. The food is chewed again and then swallowed; the process is not at all distasteful and appears quite natural to the patient. This serves to distinguish rumination from regurgitation; moreover, it is never associated with dyspepsia.

Treatment.—In some cases suppression of rumination makes the patient feel unwell. When this is not the case, an attempt should be made to control it by an effort of will. Food should be eaten slowly, and fluids taken as much as possible apart from meals.

SECRETORY DISORDERS

I. Hyperchlorhydria and Hypersecretion

(*a*) *Physiological hyperchlorhydria: the hypersthenic gastric diathesis.*—If the results obtained with a fractional test-meal in 100 normal individuals are plotted, the 80 showing the greatest resemblance to each other may be taken to represent the "average normal," as shown by the shaded area in the diagrams (Bennett and Ryle, pp. 528 and 547). Of the 100 individuals, 8 showed such an excess of the average normal that they can be regarded as having hyperchlorhydria. The majority of healthy individuals with hyperchlorhydria have also hypertonus (p. 520), the continued condition being known as the hypersthenic gastric diathesis. This does not in itself give rise to symptoms, but is an essential predisposing cause of duodenal ulcer (p. 542), and when an individual with the diathesis happens to become neurasthenic, his symptoms assume a special form which is the result of the unusually active motor and secretory functions of his stomach.

(*b*) *Reflex hyperchlorhydria.*—Whereas hyperchlorhydria is only present in about 10 per cent. of normal individuals, it is found in about 55 per cent. of patients with chronic appendicitis and 20 per cent. of those with cholecystitis, with or without gall-stones. It is probable, therefore, that chronic inflammation of the appendix and the gall-bladder leads reflexly to hyperchlorhydria. Reflex hyperchlorhydria may sometimes occur in gastric ulcer, but the hyperchlorhydria of duodenal ulcer precedes its development, and is just as marked after the ulcer has healed as when it is in the height of its activity, so that it is almost certainly a cause rather than a result of the ulcer.

(*c*) *Toxic hyperchlorhydria.*—Excessive smoking increases the secretion of hydrochloric acid, especially in individuals in whom the secretion is already above the average. Consequently smoking is often an accessory factor in the development of duodenal ulcer. Experimentally pilocarpine has been shown to stimulate the secretion of gastric juice.

Symptoms and Treatment.—Hyperchlorhydria does not itself give rise to symptoms and therefore, if accidentally discovered, it requires no treatment. Its presence in duodenal ulcer, in some cases of chronic appendicitis and chronic cholecystitis, and in some cases of neurasthenic dyspepsia, is responsible for certain symptoms present in these conditions, and in the treatment of these conditions a diet is selected which produces a minimal secretion, and drugs are given which inhibit secretion or neutralise some of the acid present. It is, however, more rational to discuss the symptoms and treatment of the individual diseases rather than those of the hyperchlorhydria, which is only one feature in them and which does not give rise to symptoms or call for treatment when present alone.

(*d*) *Hypersecretion.*—When a gastric or duodenal ulcer is situated sufficiently near the pylorus to interfere either directly or reflexly with its normal functions delay in evacuation occurs. Consequently the stimulation to gastric secretion is prolonged, and the curve obtained with a fractional test-meal has a characteristic "climbing" character. When the obstruction is insufficient to cause a twelve-hour stasis of food, the difficulty in evacuation may still lead to the accumulation of a large volume of acid juice in the morning, which is evacuated when the tube is passed in the fasting patient before the test-meal is given. Paroxysmal hypersecretion is present in one form of tabetic gastric crisis.

II. Achylia Gastrica, Achlorhydria and Hypochlorhydria

By achylia gastrica is meant the complete absence of secretion of hydrochloric acid by the stomach; strictly speaking it should also mean that no pepsin is secreted, but in most cases a small quantity is found in the gastric contents. By achlorhydria is meant the absence of free hydrochloric acid from the stomach throughout a fractional test-meal. This may be due to achylia gastrica, or to the presence of excess of the alkaline secretion of the pyloric vestibule or of regurgitated duodenal contents leading to the complete neutralisation of the free acid, whether this is secreted in normal or diminished quantity. The two conditions can be distinguished by estimating the quantity of combined hydrochloric acid in the one-hour fraction of the test-meal; this is more or less greatly increased if achlorhydria is due to neutralisation of the acid by excess of alkaline fluids. Achlorhydria is also caused by the presence of excess of mucus in the gastric contents; if the test-meal is repeated after washing the stomach out, free acid is found to be present, often in normal amount.

Hypochlorhydria is the condition in which free hydrochloric acid is still present in one or more fractions of a test-meal, but the curve obtained is lower than the lower limit of the variations present in 80 per cent. of normal individuals.

Ætiology.—(*a*) *Achylia Gastrica.*—(i) A large majority of cases of achylia gastrica are congenital and constitutional. It may occur in infants and is present in about 1 per cent. of normal young adults. It is often familial, being present in several members of a family in one or more generations. It may be regarded as an inborn error of function, as it is not associated with any recognisable changes in the gastric mucous membrane, though secondary

gastritis may result from the lack of the normal diluting and antiseptic properties of the gastric juice.

(ii) Achylia gastrica, as distinct from the achlorhydria caused by the presence of excess of mucus, is a rare sequel of prolonged and severe chronic gastritis, in which atrophy of the mucous membrane eventually occurs. It occurs as a temporary result of acute gastritis; secretion rapidly becomes normal again except in the severe toxic cases, in which the mucous membrane is more or less destroyed by the irritant. If the patient survives, permanent achylia is present.

(iii) In rare cases the complete inhibition of secretion, which is produced by fear and other depressing emotions, remains after the cause has apparently disappeared, but in all probability the mental disturbance is still present though in a less obvious form.

(*b*) *Achlorhydria.*—(i) The most important cause of achlorhydria is cancer of the stomach. It is present in about 60 per cent. of cases, and is due partly to excess of blood and other alkaline secretions from the surface of the growth, but mainly to the associated chronic gastritis (*vide* p. 540). Achlorhydria is also common in syphilis of the stomach.

(ii) Achlorhydria is often present in chronic gastritis. In these cases it is a result of neutralisation with excess of mucus, and of obstruction to the mouths of the ducts by adherent mucus.

(iii) After a gastro-enterostomy the entrance of the alkaline duodenal contents from the proximal limb of the jejunum and the rapid escape of acid through the distal limb lead to complete achlorhydria in the majority of cases, unless the operation was performed for duodenal ulcer: as the hyperchlorhydria associated with that condition is a cause and not a result of the ulcer, the large quantity of acid still secreted is sufficient to prevent complete neutralisation and the production of achlorhydria.

(*c*) *Hypochlorhydria.*—All conditions leading to achlorhydria, except of course constitutional achylia, may also cause hypochlorhydria. It is also sometimes present in neurasthenia and chronic infections, such as tuberculosis, owing to the absence of appetite, which normally calls forth the initial secretion of gastric juice at the beginning of a meal, together with actual inhibition of secretion caused by repugnance for food.

Symptoms and Diagnosis.—When the deficient secretion of gastric juice is secondary, the symptoms to which it gives rise are to a great extent obscured by those of the primary condition. No doubt some of the symptoms of gastritis and cancer of the stomach are a result of the hyposecretion which is present, as the administration of hydrochloric acid often improves the digestion in such cases. The same is true with regard to the indigestion of neurasthenia in which hyposecretion is found. The part taken by hyposecretion in the production of the symptoms in these conditions can best be judged from a consideration of constitutional achylia gastrica, all the symptoms of which are due to the deficient secretion of gastric juice.

Constitutional achylia gastrica may be completely latent and discovered accidentally. There may be a history dating from childhood of repeated attacks of diarrhœa, of abdominal discomfort with anorexia, and nausea. In adult life these attacks tend to become more frequent and severe. They are generally brought on by a hurried meal or by an unusually large or

indigestible one. In the intervals between the attacks the patient is often not completely comfortable, and there is sometimes a permanent distaste for meat, which also tends to upset the patient more than any other food. The discomfort comes on immediately after meals and lasts for an hour or two, the duration depending upon the amount of food taken. Though nausea is common, there is generally no vomiting. Flushing of the face during meals and even permanent rosacea are often caused by achylia gastrica.

In many cases chronic diarrhœa is present, either alone or associated with the gastric symptoms just described.

In uncomplicated cases there is no tenderness and nothing abnormal is found on physical examination. The X-rays sometimes show that the stomach is short and high and empties itself with extreme rapidity owing to the relaxed condition of the pyloric sphincter. Owing to this the patient may complain of a sinking feeling about 3 hours after meals, which is at once relieved by taking more food

A test-meal shows that the gastric contents are small in bulk, viscid, neutral or alkaline in reaction, and contain no free hydrochloric acid. Before accepting a diagnosis of achlorhydria the test-meal should be repeated after washing out the stomach. In very rare cases the psychical effect of the passage of the tube inhibits the secretion of gastric juice on the first occasion, but this never occurs a second time. More frequently the excessive quantity of alkaline saliva swallowed when the tube is passed neutralises any free acid which is present in cases in which the latter is deficient though not really absent. This, again, does not occur when the meal is repeated. In almost all cases of chronic gastritis, whether due to alcohol or not, in which achlorhydria is found, this is due to the neutralisation by alkaline mucus of the acid which is still secreted, though perhaps in diminished quantity; when therefore the meal is repeated after washing away the alkaline mucous fluid present in the fasting stomach, achlorhydria is found to be no longer present. Very rarely in cancer a small quantity of free acid is found to be still present if the meal is repeated after washing out the stomach.

Diagnosis.—Before accepting a diagnosis of constitutional achylia the possibility of cancer, atrophic gastritis, or much more rarely of syphilis must be considered. In many cases there is nothing in the history of the symptoms to suggest the presence of any of them, and achylia is quite frequently discovered in the course of a routine examination of a patient suffering from one of the diseases of which it is an important predisposing factor. The diagnosis from atrophic gastritis is impossible, except in some cases from the history, as constitutional achylia is frequently complicated by the presence of secondary gastritis, so that excess of mucus is produced. If the gastric contents contain blood obvious to the naked eye, cancer is probably present; occult blood should be looked for in the stools, as it is generally found in cancer of the stomach even when it is absent from the gastric contents, and it is rare in constitutional achylia, though it may be present with severe chronic gastritis.

If the X-rays show that the stomach is small and empties itself with abnormal rapidity, either constitutional achylia or the leather-bottle type of gastric carcinoma is present; in the latter the outline of the stomach may be irregular, and peristalsis is weak or even absent, the rapid evacuation being due to pyloric incompetence from a rigid and dilated sphincter. In all cases of cancer, except the leather-bottle type, the stomach is normal in size or

dilated, evacuation is often delayed, and in most cases some irregularity in the outline can be recognised.

Complications. — Addison's (pernicious) anæmia and subacute combined degeneration of the spinal cord are invariably associated with complete achlorhydria, which is due to constitutional achylia in the large majority of cases (Fig. 17), but in a small minority to chronic gastritis, gastro-enterostomy, complete gastrectomy, and cancer of the stomach. The achlorhydria is the primary condition; there is consequently often a history of chronic diarrhœa or other symptoms to which it has given rise, dating for months or years before the onset of anæmic or nervous symptoms, and in several cases the existence of achylia has actually been known during this time. The achlorhydria allows the duodenum to become infected with streptococci from the mouth and the increased alkalinity of the contents of the small intestines leads to their invasion with *B. coli* from the colon. The hæmolytic poisons produced in the intestines give rise on absorption to the destruction of the blood and changes in the bone marrow, and the neurotoxic poison gives rise to the degeneration of the spinal cord. The frequent occurrence of Addison's anæmia and subacute degeneration of the cord in more than one member of a family is due to the familial occurrence of achylia gastrica. A complete blood examination should be made in every case of achylia, even if the patient is not pale and has no symptoms of anæmia, as by this means Addison's anæmia has in rare instances been diagnosed at a very early stage when the hæmoglobin percentage was 70 or more. The presence of achlorhydria permits the intestines to be infected with abnormal ease. A secondary ascending infection explains the frequency of achlorhydria in chronic cholecystitis and gall-stones (40 per cent.), and chronic appendicitis (33 per cent.). A streptococcal infection of the bowel secondary to achlorhydria also accounts for the fact that achlorhydria or hypochlorhydria is present in over 30 per cent. of cases of rheumatoid arthritis.

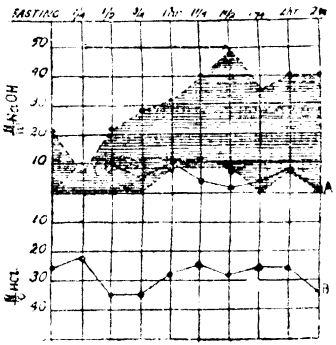


Fig. 17. — Fractional test-meal in case of Addison's anæmia. A, total acidity; B, amount of N/10 HCl required to produce free acid; shaded area represents the limit of free HCl in 80 per cent. of normal individuals.

Treatment. — The food should be chewed until it is quite fluid. All raw vegetables, such as salads and pickles, and other food which cannot be chewed to a fluid consistence must be avoided. Very little meat should be eaten, and neither game nor ripe cheese allowed. Plenty of cream and butter should be given. If chronic gastritis, whether primary or secondary to the achylia, is present, the diet should at first be much more strict.

The only drug of real value is hydrochloric acid, but if hyposecretion and not complete achylia is present, a bitter mixture containing sodium bicarbonate taken before meals may stimulate secretion. Large quantities of hydrochloric acid should be given, and the treatment continued for the rest of the patient's life in all cases of constitutional achylia. Small quantities of acid are required as symptomatic treatment for the hypochlorhydria

of neurasthenia, chronic infections, chronic gastritis with true achlorhydria and cancer. In chronic gastritis the secretion of gastric juice sometimes returns when the condition improves; test-meals should therefore be given from time to time to see whether it is necessary to continue the administration of the acid.

In Addison's anæmia and subacute combined degeneration of the cord, in which it is important to replace the absent acid as completely as possible, as much as 2 drachms of dilute hydrochloric acid (B.P.) should be given in 10 to 15 ounces of water three times a day. The first doses should be taken fasting, one hour before breakfast, when no food is present in the stomach to neutralise any of the acid; the second and third doses should be taken with lunch and dinner. With the addition of sugar and orange or lemon-juice the acid solution is a quite agreeable beverage. Pepsin (5 gr.) may be added in powder form to the acid taken at meals, though it is very rarely absent, and often not greatly diminished in quantity even in complete achylia gastrica. When the achylia is not associated with any serious disease 1 drachm of dilute acid 3 times a day is generally sufficient, and in some cases 30 or 40 minims may be enough to control such symptoms as diarrhœa.

SENSORY DISORDERS

Anorexia

Definition. Loss of appetite.

Anorexia occurs in chronic gastritis and cancer of the stomach, and in toxæmic conditions, such as acute fevers, tuberculosis and cancer. It is often present when for any reason the tongue is dry or furred. It is an extremely common symptom in neurasthenia, in which it is due in part to the depressed condition of the nervous system and in part to dietetic restrictions, often made by the patient himself with the object of relieving his dyspepsia. Neurotic girls sometimes take too little to eat for fear of becoming fat. In all such cases the diminution in the quantity of food eaten leads to a corresponding diminution in the appetite, until in severe cases the condition known as *anorexia nervosa* finally develops, the patient taking little or no food and becoming excessively emaciated. This is really a form of *hysterical anorexia*, which may also result from the perpetuation of the loss of appetite which may temporarily follow severe emotional disturbance. In other cases it is associated with psychasthenia; the initial refusal of food is caused by some phobia or obsession, and the complete loss of appetite which follows is perpetuated as an hysterical symptom.

Treatment.—The anorexia of neurasthenia can only be overcome by persuading the patient to eat more. This is often very difficult and requires considerable tact. A strong-willed nurse is a great help, and food should be given at short intervals throughout the day. As soon as the patient begins to eat an increased quantity, the appetite returns. In severe cases of hysterical anorexia complete isolation is essential, together with vigorous psychotherapy in the form of explanation of the psychological origin of the anorexia, persuasion to eat and re-education of the appetite.

Nausea

Ætiology.—Nausea most commonly precedes vomiting, and is relieved when the stomach is emptied. It may, however, occur as an independent symptom, particularly in women; the majority of such cases occur in chlorotic girls or at the climacteric. Although the significance of the symptom is not clear, it must be regarded in these cases as of nervous origin; probably it is often hysterical and due to the perpetuation by auto-suggestion of nausea, which originally resulted from the emotion of disgust, although the actual exciting incident may have been forgotten. Nausea may be the only symptom in achylia gastrica, chronic gastritis, or even in the earliest stage of carcinoma of the stomach; it may be the chief complaint in chronic appendicitis, cholecystitis, and infection of the intestines with worms. It is occasionally the most prominent symptom in early tuberculosis and in the commencement of pregnancy. All these possibilities should be excluded before regarding it as of nervous origin. The urine should be carefully examined, as nausea is occasionally an early symptom of nephritis and of infection of the urinary tract, and in men it may result from prostatic disease.

Symptoms.—The nausea may be constant or periodic; it is often quite independent of the kind or nature of the food taken. The patient may wake up with severe nausea, which makes it difficult for him to take any food during the day. Moreover, he often thinks the symptom is due to gastric disease, and he consequently reduces the amount of food he takes; severe loss of weight may result. The nausea is often increased by emotional disturbances, and may be less troublesome when the mind is fully occupied.

Treatment.—If all organic causes can be excluded, the only effective treatment is to remove the patient from his home surroundings and insist upon a proper quantity of food being taken. An attempt should be made to find the emotional disturbance which may have been the exciting cause of the symptom, as a convincing explanation of this is likely to lead to the disappearance of the nausea.

GASTRIC FLATULENCE; AEROPHAGY

Flatulence, or the presence of excess of gas, may occur simultaneously in the stomach and the intestine, but in many cases it is confined to the stomach and less frequently to some part of the intestines.

Ætiology.—In each case flatulence may be due to (*a*) excessive production of gas by fermentation or putrefaction. (*b*) the introduction of excess of air by aerophagy, or (*c*) deficient elimination.

(*a*) Fermentation in the stomach is never sufficiently excessive to give rise to flatulence unless pyloric obstruction is present. Deficient hydrochloric acid does not itself result in increased bacterial activity in the stomach; thus flatulence is not a symptom of achylia gastrica, in which the rate of evacuation is often increased. But the type of fermentation depends upon the quantity of hydrochloric acid present; in non-malignant pyloric obstruction, especially if it is due to an active ulcer, hypersecretion is present.

and acetic acid fermentation occurs, with abundant production of carbon dioxide, whereas in cancerous obstruction, in which the secretion of gastric juice is deficient, butyric and lactic acid fermentation, sometimes associated with the putrefaction of proteins, occurs, and much less gas is evolved. In the former case the gas is odourless; in the latter offensive.

(*b*) **Aerophagy** is the commonest cause of flatulence. It is generally associated with nervous dyspepsia, but it also occurs with organic diseases, such as gastric and duodenal ulcer and cholecystitis, and the pain in angina pectoris frequently causes aerophagy. The patient feels some slight discomfort in the stomach, which he thinks is due to "wind" and which he imagines he can "disperse" by eructation; as there is really no excess of gas present, the attempt proves unsuccessful, but results in the swallowing of air. After half a dozen or more attempts have been made without success, air being swallowed on each occasion, the stomach becomes so distended with air that an attempt is at last successful. The excessive salivation, which often occurs in gastric disorders associated with hyperchlorhydria and in septic conditions of the mouth and naso-pharynx, also leads to flatulence, as air is swallowed with each mouthful of saliva. The severest cases of aerophagy occur independently of dyspepsia in women who are intensely neurotic; the symptom is then hysterical. A little saliva with a large quantity of air is swallowed until the stomach is distended, when it is noisily pumped backwards and forwards between the stomach and œsophagus by spasmodic movements of the diaphragm, and periodically expelled with a loud report.

(*c*) **Deficient elimination of gas** occurs when absorption is diminished owing to catarrh or to the obstruction of the portal circulation which occurs in cirrhosis of the liver and heart failure; swallowed air and the gases produced by fermentation are insufficiently absorbed, and severe flatulence results.

Symptoms.—The most common symptom resulting from gastric flatulence is a sensation of fullness in the upper part of the abdomen, especially under the left costal margin. The abnormal accumulation of gas in the stomach pushes up the diaphragm; this may cause palpitation and pseudo-anginal attacks. Dyspnœa results in individuals who are predisposed by such conditions as asthma and cardiac weakness, and flatulence may also be the immediate cause of an attack of true angina pectoris, though more frequently the angina gives rise to aerophagy.

Diagnosis.—When a patient complains of "flatulence" it is first necessary to ascertain whether excess of gas is really present. This can be done most readily and accurately by means of the X-rays, as it is often difficult to distinguish by percussion whether an accumulation of gas is in the stomach or in the splenic flexure of the colon.

Pseudo-flatulence may be due in neurotic individuals to spasm of the diaphragm: a sensation of great distension is suddenly experienced, and the abdomen becomes so enlarged that the clothes have to be loosened. The distension disappears as suddenly as it came, without eructation or passage of flatus; it also disappears under an anæsthetic and on firmly compressing the whole of the abdomen for some minutes. The absence of excess of gas in the stomach can at once be detected with the X-rays, which also show the low position of the diaphragm and the absence of respiratory movements. The condition can be cured by teaching the patient to breathe properly with his diaphragm.

Pseudo-flatulence is more often due to the patient misinterpreting the sensation of fullness which is caused by the increased intragastric pressure produced by sudden distension of the stomach, especially if it is of the hypertonic form, with excess of food and drink which have been too rapidly consumed. There is no abdominal swelling or increase in gastric resonance, and the patient is unable to bring up any gas, but the condition is often complicated by aerophagy.

The gas brought up in cases of aerophagy is odourless and tasteless; when caused by putrefaction in malignant pyloric obstruction it is offensive, and this may occasionally be the first symptom of a growth. Aerophagy is probably present if eructation is frequently repeated; the diagnosis is certain if it occurs six or more times in rapid succession, as fermentation cannot give rise to such a large quantity of gas. Eructation occurring before breakfast in the absence of pyloric obstruction is always due to aerophagy, as there is nothing in the stomach from which gas could be produced. The diagnosis can be confirmed by means of the X-rays, with which it is easy to watch the whole process of ærophagy.

Treatment.—The treatment of flatulence due to excessive fermentation consists in removing the cause. When flatulence is due to aerophagy, it is generally only necessary to explain to the patient the cause of his trouble in order to cure him. He should be told not to eructate, however much he may desire to do so. If he finds it very difficult to restrain himself, he should open his mouth or clench his teeth upon a cork, whenever the desire is very strong, as it is then difficult to swallow air, though any excess of gas in the stomach can be expelled. When aerophagy is due to dyspepsia, this requires appropriate treatment. Momentary relief, sufficient to help the patient to forgo eructation, can generally be obtained by sipping hot water or chloroform water, or by taking a few drops of a carminative, such as oil of cinnamon or peppermint, on a lump of sugar, but the use of spirits for this purpose should be prohibited.

In severe cases of hysterical aerophagy, isolation is required. A stomach-tube can be passed periodically and kept in the stomach for some minutes, the patient having previously been told that the treatment will give her permanent relief; but with intelligent patients simple explanation and persuasion are equally effective and more satisfactory than gross suggestion of this kind, as there is much less liability to relapse.

GASTRIC SYMPTOMS OF FUNCTIONAL NERVOUS DISORDERS

Neurasthenic or Nervous Dyspepsia

Ætiology.—Most neurasthenic patients suffer from indigestion, partly as a result of their abnormally irritable nervous system and partly as a result of depressing emotions, mental and physical overwork, and the other factors concerned in the production of neurasthenia, as these tend in themselves to inhibit the motor and secretory functions of the stomach.

Symptoms.—The gastric symptoms in neurasthenia are characterised by their extreme irregularity, the patient feeling very ill one day and quite

well the next without any obvious reason for the change. The most constant complaint is of vague abdominal discomfort, which rarely amounts to actual pain. It is generally worst in the morning and improves towards evening, but in some cases the symptoms increase when the patient becomes more fatigued towards evening. The discomfort is worse after meals, a sensation of fullness being felt as soon as a small quantity of food has been eaten, but it may be present to a less extent before breakfast. It has little relation to the amount or the kind of food, differing in that way from the discomfort of organic gastric disorders; it is increased by worry or excitement, while some new interest, whether it be a change of surroundings, a game, a conversation, or a new medicine, leads to its temporary disappearance. Nausea sometimes occurs, but vomiting is unusual. Most patients complain of flatulence, which is more commonly due to aerophagy than to excessive fermentation, but may be nothing more than the result of misinterpreting the sensation of fullness, no excess of gas being present (see Flatulence, p. 530). The appetite is always diminished, though it varies considerably from day to day (see Anorexia, p. 529). As insufficient food is taken, the nervous system becomes more depressed; this reacts again on the digestion, a vicious circle being produced.

Examination of the stomach may show that atonic dilatation (p. 519) is present. The secretion of gastric juice may be diminished as a result of the neurasthenia. If neurasthenia develops in a patient with the hypersthenic gastric diathesis, the symptoms are likely to be those of hypertonus (p. 520) and hyperchlorhydria (p. 521). Constipation is almost constantly present. The abdominal muscles may be tense, so that examination may be difficult, but there is never any great degree of tenderness, and what is present is diffuse and variable in position rather than localised and constant. In other cases the abdominal muscles are weak, and symptoms due to visceroptosis may be present in addition to those of uncomplicated neurasthenic dyspepsia.

The gastric symptoms are always associated with other symptoms of neurasthenia, such as headache, backache and insomnia, and the anorexia leads to progressive loss of weight and strength. The abdominal discomfort may be accompanied by flushing of the face, palpitation and coldness of the extremities. The patient is generally depressed and pessimistic; he pays great attention to all his bodily functions, constantly looking at his tongue, taking his temperature and examining his fæces. His account of his symptoms is full of details, and he often has some theory to account for them, believing himself to be suffering from "acidity," "uric acid," or "liver," or fearing that he is afflicted with cancer.

Treatment.—The patient's confidence can only be gained after a very thorough examination. He can then be told that he has no organic disease, and that with perseverance he will get well. The general neurasthenic condition first requires attention; for this mental and physical rest, followed by graduated exercise, and sufficient food to overcome the inanition, which is generally present, are the chief indications. Pleasant surroundings, cheerful companions and appetising food are of great importance, and consequently strict isolation is not required. The treatment of the stomach itself depends upon the condition of the motor and secretory functions, and has already been described.

Hysterical Dyspepsia

Ætiology.—When symptoms, such as anorexia, nausea, vomiting, and abdominal pain, have been caused by emotional disturbance, or by gastritis, gastric ulcer, chlorotic dyspepsia, appendicitis, or other organic cause, they may continue or recur as the result of suggestion after the original cause has disappeared. They are then hysterical symptoms.

Symptoms.—Hysterical vomiting occurs during or immediately after meals; it is effortless and generally unaccompanied by nausea, so that a patient may vomit the meat and vegetables and immediately afterwards be ready to eat the sweets, which he may manage to retain. The stomach is generally only partially emptied, so that nutrition is preserved, but in rare cases nothing is retained, and severe emaciation, together with the changes in the urine which result from starvation and have erroneously been ascribed to acid intoxication, result. The diet has often no effect, vomiting being as frequent with milk alone as with a full diet.

When the vomiting of early pregnancy, which is probably reflex in origin, occurs after every meal instead of only in the morning, and when it persists after the eighth week, it is often called the "pernicious vomiting of pregnancy." It has generally been regarded as toxic on account of certain changes in the urine and associated symptoms. I am convinced, however, that it is always hysterical, as in my experience it can invariably be cured by psychotherapy with great rapidity. The changes in the urine—excess of organic acids and a rise in the ammonia index (the proportion of nitrogen present as ammonia compared with that as urea) are entirely secondary to the starvation and dehydration which result from persistent vomiting. However marked these changes may become—and I have known the ammonia index rise from the normal 5 to 28—and however severe the so-called toxic symptoms may be, such as dry, black tongue, and a pulse as rapid as 160, these all disappear within 24 or 48 hours with psychotherapy in the form of explanation and persuasion, without either suggestion or any drug treatment. The condition must of course be distinguished from the vomiting which begins in the later stages of pregnancy and is only one symptom of some obviously toxic condition such as eclampsia or acute yellow atrophy of the liver.

Hysterical gastralgia is a not uncommon symptom in girls who have previously suffered from genuine gastric pain as a result of chlorosis or gastric ulcer. It is very irregular in its relations to the time and character of meals; it may occur before as well as after breakfast, and may be absent after a very indigestible meal, during which the patient has had her mind distracted. It is accompanied by very diffuse deep tenderness, which may be associated with a large area of cutaneous hyperæsthesia, probably always produced by suggestion on the part of the observer, as its situation and extent can be easily varied from day to day by suggestion. The gastralgia may be associated with vomiting, which does not always relieve it.

Treatment.—A patient with hysterical vomiting should be kept in bed and isolated. After the primary cause has been discovered and explained to the patient, he should be made to realise that now that this has disappeared, his stomach has simply developed a bad habit, which it must be educated to

give up. In the large majority of cases complete recovery rapidly ensues. If, however, improvement is slow, the patient should be given an additional helping of any food he vomits, even if this has to be repeated two or three times. In hysterical gastralgia, rest in bed, isolation, full diet and psycho-therapeutic conversations generally effect a rapid cure. (See also Aerophagy, Anorexia and Nausea.)

Migraine and Gastric Crises of Tabes

For the Gastric Symptoms of Migraine, see p. 1548; and for the Gastric Crises of Tabes, see p. 1500.

Anæmic Dyspepsia

Ætiology.—Anæmic dyspepsia is very common between the ages of 15 and 30. Though much more frequent among females, exactly the same condition may occur in males. It is in part due to improper food, and it occurs especially among girls of the poorer classes, whose diet consists largely of bread and butter and tea, with little or no meat or green vegetables. I do not regard the so-called chlorotic blood-picture as a necessary factor, as I am convinced that it is no more a constant sign of the condition known as chlorosis than the dilated heart or digestive symptoms: two patients may complain of exactly the same symptoms and both get rapidly well with the same treatment, although one has typically "chlorotic blood" and the other has perfectly normal blood. Severe cases of anæmic dyspepsia have, however, become less common during the last fifteen years, corresponding with the almost complete disappearance of severe chlorosis.

Pathology.—The gastric symptoms in chlorosis are mainly due to the irritable condition of the central nervous system. Digestive processes which would normally be unfelt are consequently perceived.

Symptoms.—Almost all chlorotic patients suffer from gastric symptoms. In slight cases an uncomfortable sensation of fullness is felt high in the epigastrium immediately after meals. In severer cases, in which the digestive symptoms are the most prominent, the discomfort is replaced by actual pain. This is often followed by vomiting of a portion of each meal, with some relief to the pain. Nausea is either absent or slight, and the appetite is often unaffected, though the patient generally limits the amount of food she eats in an unsuccessful attempt to diminish the pain. The pain and sickness are quite independent of the amount and nature of the food, fluids producing as much discomfort as solid food. The symptoms are aggravated by exercise, and violent exertion may give rise to pain and sickness, even if no food has been taken for some hours. The pain is partially relieved by lying down, and rest in bed prevents the occurrence of pain and sickness. Constipation is invariably present, and its relief produces some temporary improvement in the gastric symptoms.

Deep tenderness is well marked but diffuse, extending over the whole of the upper part of the abdomen. A large area of cutaneous hyperæsthesia, which is most marked or confined to the left side, is often found; but as many of these patients are highly suggestible, I am inclined to think that

this is invariably hysterical, being unconsciously suggested by the observer. Rigidity of the rectus muscles is either absent or slight in comparison with the degree of pain; it tends to disappear if the patient's attention is distracted during the examination.

The heart may be more or less dilated as a result of the chlorosis, but when the digestive symptoms are well marked, the circulatory and other symptoms of chlorosis are generally less obvious.

Chlorotic dyspepsia is sometimes associated with acute gastric ulcer; most of the symptoms which are commonly ascribed to acute gastric ulcer are due to the associated anæmic dyspepsia, with the exception of hæmatemesis, which never occurs in uncomplicated chlorosis.

Diagnosis.—Gastric symptoms in a young woman are more likely to be due to chlorosis than gastric ulcer, unless hæmatemesis occurs, in which case an acute or much less probably a chronic ulcer must be present. Chlorotic dyspepsia also differs from gastric ulcer, with which it was formerly very often confused, in the absence of any relation between the severity of symptoms and the nature and quantity of the food, and in the marked influence of exercise, which may even produce symptoms when the stomach is almost empty. Rigidity is generally more marked and tenderness more localised in gastric ulcer than in chlorosis, especially if the examination is made when the pain is at its height.

Early phthisis may give rise to almost identical symptoms, so that the chest should always be carefully examined, even if there is no other symptom pointing to pulmonary disease.

The severe pain and sickness which sometimes occur in chlorosis may lead to the idea that appendicitis is present. But the temperature never rises even a fraction of a degree; there is no local tenderness in the right iliac fossa, if care is taken to avoid suggestion, and Bastedo's inflation sign (see p. 614) is always negative.

The characteristic blood-picture is an important aid in diagnosis when it is present, but its absence is of small importance.

Treatment.—The first essential is that the patient should stay in bed until at least a fortnight after all digestive symptoms have disappeared.

However severe the pain and vomiting have been, the patient should be given a full diet at once. Even if she has been having nothing but milk for months, the combination of rest in bed and a full diet frequently causes the pain and vomiting to disappear within 2 or 3 days and sometimes even on the first day. Very rarely is it necessary to give only soft food for the first few days, but even in the worst cases the patient should be taking three good meals a day before the first week is over. It is advisable to explain to the patient that her stomach is quite capable of digesting all kinds of food, if she stays in bed and takes the medicine which will be given her: if she has already had dietetic and other treatment, it can be added that this has prepared the stomach for the greater demands which are now to be made upon it.

Twenty grains of iron and ammonium citrate with 3 minims of liquor arsenicalis and sufficient sodium sulphate to keep the bowels regular should be given in a mixture three times a day after meals, or an iron and arsenic preparation may be injected subcutaneously on alternate days.

ARTHUR F. HURST.

ORGANIC DISEASES OF THE STOMACH

HÆMATEMESIS

Ætiology.—Hæmatemesis results most frequently from gastric and duodenal ulcer. It occurs, generally in smaller quantities, in cancer of the stomach. The term *gastrostaxis* was applied to the hæmorrhage which was supposed to occur, especially in chlorotic girls, in the absence of any organic lesion; but it is probable that very small, rapidly healing and often multiple acute ulcers, which readily escape detection both at operation and post-mortem, are present in such cases (see Acute Ulcer). Sometimes the mucous membrane appears at operation to "weep" blood, and the slightest touch causes hæmorrhage; this condition is generally due to hæmorrhagic gastritis resulting from some infection or intoxication, such as chronic appendicitis. There is no evidence that vicarious menstruation from the stomach ever occurs, although hæmatemesis is rather more common during menstruation than in the intervals. Hæmatemesis may result from congestion of the mucous membrane in cirrhosis of the liver and rarely in heart failure, and bleeding from the stomach is a common symptom of splenic anæmia. It may also occur in the hæmorrhagic diathesis; it is then generally preceded and accompanied by purpura and often by hæmorrhages from the nose, kidneys or other organs, but in some cases it may be the sole manifestation of the condition. Finally, blood from the naso-pharynx, mouth, œsophagus and lungs may be swallowed and vomited.

Diagnosis.—The possibility of malingering should be considered in hysterical girls if nocturnal hæmatemesis occurs during menstruation; the absence of blood from the fæces would confirm such a suspicion. Direct examination of the nose, gums and pharynx excludes the possibility of the blood coming from these sources. Hæmatemesis may be distinguished from hæmoptysis by the fact that in the former the blood is generally dark, partly coagulated and mixed with more or less food, whereas in the latter it is bright red, frothy and unclotted; in the former the symptoms may point to gastric disease, in the latter to disease of the lungs or the heart; in the former the presence of occult blood in the stools and sometimes melæna is a constant sequel and the hæmorrhage is not often repeated, whereas in the latter the stools contain no blood and the patient generally continues to expectorate blood-tinged sputum for several days. In chronic ulcer and carcinoma of the stomach a history of other gastric symptoms can always be obtained. In cirrhosis of the liver symptoms of chronic gastritis are present and the liver is generally hard and enlarged. When hæmatemesis occurs without other symptoms an acute ulcer is generally present, if splenic anæmia can be excluded by the absence of splenomegaly and leucopenia. The number of blood-platelets should also be estimated, as if they are deficient the diagnosis of the hæmorrhagic diathesis should be considered, even if no hæmorrhages have occurred in other situations.

Treatment.—The patient should be kept in the supine position, and should not leave his bed even to micturate or defæcate until there has been no hæmorrhage for 48 hours. In order to keep him completely at rest

it is generally advisable to inject morphine. An alkaline powder, consisting of equal quantities of the tribasic phosphates of magnesium and calcium, should be given at frequent intervals in order to neutralise any gastric juice, which otherwise digests the clot directly it forms over the bleeding point. Nothing else should be given by mouth for 12 hours; small quantities of dilute citrated milk may then be drunk, as described in the treatment of gastric ulcer, but if hæmorrhage recurs starvation should be continued for 3 days and saline solution administered by rectum. No addition should be made to the milk diet until at least 48 hours after the disappearance of occult blood from the stools. An enema should be given the third day after the hæmorrhage if the bowels have not been opened.

If the hæmorrhage is gastric and not duodenal in origin and continues to a dangerous extent, a stomach tube attached to Senoran's evacuator should be passed; the stomach is emptied and then washed with successive half-pints of iced water until the latter is no longer tinged with blood, when a drachm of adrenalin chloride (1 in 1000) may be left in the stomach with as little water as possible. If the hæmoglobin falls below 40 per cent., the patient should be transfused.

ACUTE GASTRITIS

(*a*) Acute Catarrhal Gastritis

Ætiology.—Acute catarrhal gastritis is caused by chemical irritation of the mucous membrane of the stomach. A large and indigestible meal, especially if the patient is already suffering from chronic catarrh, excess of strong alcohol and an overdose of an irritating drug are common causes. In many cases the irritant is a toxin produced by the action of bacteria outside the body or in the stomach, the organisms being introduced in the food or water, several individuals being often simultaneously affected. The toxins of uræmia and those produced in influenza, scarlet fever, septicæmia and other acute infections may be excreted into the stomach and give rise to gastritis. The chlorine and other fumes introduced by the Germans in the war often resulted in the production of acute gastritis, the symptoms of which were overshadowed by the more serious pulmonary symptoms: in some cases hæmatemesis and in several others occult blood was present, showing the severity of the lesion.

Symptoms.—The symptoms start acutely soon after the entrance of the irritant into the stomach, but they may be postponed for several hours when the attack is due to a toxin produced by decomposition within the stomach. A sensation of fullness and discomfort is felt in the epigastrium; heartburn is common, and in severe cases there is acute pain; tenderness is diffuse and generally only moderate in degree. The abdomen may be distended. The appetite is completely lost, but thirst is excessive. The tongue is covered with a thick dirty fur, and there is an unpleasant bitter taste in the mouth. The patient constantly eructates, and the gas brought up is often foul-smelling. Vomiting, preceded by nausea, almost always occurs and gives more or less relief to the discomfort and pain. The food eaten at the previous meal is first rejected, mixed with mucus with but little or no

gastric juice; subsequently mucus with saliva, which is generally secreted in excess, bile, and occasionally small quantities of blood, are vomited. Severe constipation is present unless the irritant has also acted upon the bowels, in which case there is diarrhœa. The vomited matter contains no free hydrochloric acid, but is generally acid in reaction owing to the presence of lactic, butyric and other fatty acids; the saliva and mucus present may, however, give it an alkaline reaction. Microscopically leucocytes, epithelial cells, bacteria and sometimes blood are found.

The patient is pale, prostrated, and complains of headache and thirst. These symptoms are most marked in infective cases, when the patient may also be drowsy and even delirious. The temperature is generally slightly raised, but it may be high, especially in children, and the pulse is rapid. The urine is concentrated and may contain a trace of albumin. Herpes labialis is sometimes present.

Diagnosis.—In severe pyrexial cases the symptoms may simulate the onset of an acute infection, such as typhoid fever, but the rapid improvement soon makes the diagnosis clear. I have seen cases in which the pain, tenderness and rigidity were so severe that considerable doubt was felt at first whether a gastric ulcer might not have perforated.

Prognosis.—Recovery generally takes place within 24 or 48 hours, but in toxic and infective cases the acute symptoms may persist for several days, at the end of which they may suddenly disappear. Occasionally the condition passes into chronic gastritis, or the stomach may remain irritable for a considerable period. Acute gastritis often gives rise to complete achylia, even if no symptoms follow the acute attack.

Treatment.—The patient should be kept warm in bed with hot fomentations on the abdomen. If the stomach is not spontaneously emptied, vomiting should be induced by drinking half a pint of warm water, in which 1 drachm of sodium bicarbonate has been dissolved; when this fails the stomach should be washed out.

Chloroform water often relieves the nausea; castor oil, followed, if necessary, by a saline aperient should be administered if there is constipation. No other drugs need be given except in the rare cases in which very severe pain persists after the stomach is empty, when an injection of morphine may be required. Nothing but water, which may be flavoured with tea or lemon, should be taken until all the acute symptoms have disappeared; sweetened arrowroot made with water may then be given, and, as the appetite returns and the tongue cleans, dilute citrated milk, farinaceous food, eggs, and lastly fish, chicken and meat can be added to the diet. If the appetite does not return by the end of a week, an acid and bitter mixture should be given. A test meal should be given when the patient is convalescent, as if achylia has developed the continuous use of hydrochloric acid may prevent the development of various complications at a later date.

(*b*) Acute Suppurative Gastritis

Ætiology.—This very rare disease is due to the invasion by streptococci, or less frequently pneumococci, staphylococci or *B. coli*, of the submucous tissue through a carcinomatous ulcer, or still more rarely through a chronic ulcer or the wound left after an operation on the stomach. In exceptional

cases the point of invasion cannot be recognised. The condition may also occur in pyæmia, anthrax and small-pox.

Symptoms.—Epigastric pain and tenderness are severe. Vomiting is always present; the vomited matter may contain pus owing to the rupture of a localised abscess into the lumen of the stomach. Peritonitis generally supervenes in the course of 2 or 3 days. The general symptoms present are those common to severe infections.

Prognosis.—A local submucous abscess may burst inwards and spontaneous cure result, but more commonly it ruptures outwards, producing general peritonitis. Diffuse suppurative gastritis always ends in peritonitis.

Treatment.—In very rare cases a localised abscess has been treated successfully by operation.

(c) Acute Phlegmonous (Toxic) Gastritis

Ætiology.—Phlegmonous gastritis results from the ingestion of irritant poisons, such as concentrated acids and alkalis, arsenic, antimony and phosphorus.

Symptoms.—The local symptoms are similar to those of acute suppurative gastritis, except that the vomited matter frequently contains blood and sometimes sloughs. The patient is collapsed and may become comatose, the exact symptoms depending upon the nature of the poison.

Prognosis.—Death frequently occurs from shock, general peritonitis, or the effect of the poison on other parts of the body. If the patient recovers, the mucous membrane is always more or less atrophied, and pyloric obstruction frequently develops.

Treatment.—An attempt should be made to dilute and neutralise the poison. When this is impossible the stomach should be washed out. Morphine should be injected to relieve pain and to keep the patient quiet.

CHRONIC GASTRITIS

Ætiology.—Chronic gastritis is generally due to repeated or long-continued chemical or mechanical irritation of the gastric mucous membrane. The most common chemical irritant is alcohol, which is most harmful when taken in a concentrated form on an empty stomach. Less frequently excess of strong tea or coffee, curry and other spices, and drugs, such as purgatives, mercury, copaiba and creosote, cause gastritis. Prolonged contact of less irritating food may have the same effect; consequently very large meals, food taken late at night, and stasis due to pyloric obstruction lead to catarrh. The irritating and infective secretions swallowed in pyorrhœa alveolaris, chronic pharyngitis, tonsillitis and sinusitis, and by children with adenoids, are common causes. Coarse food and food which is insufficiently masticated, owing to rapid eating or lack of teeth, lead by mechanical irritation to gastritis.

Chronic catarrh may also follow acute gastritis. It is very common in carcinoma of the stomach, and may also occur in very chronic cases of ulcer. Lastly, it is a common result of phthisis, especially in the later stages, and

of the congestion of the mucous membrane in diseases of the heart, lungs and liver.

Symptoms.—The symptoms develop very gradually or begin after an acute attack. A sensation of pressure and fullness is felt in the epigastrium immediately after meals; it is often accompanied by pain between the shoulders. It is most severe and prolonged after large meals, and may be absent when only fluids are taken. It is relieved by eructation and vomiting, and the patient sometimes makes himself vomit by putting his fingers in his throat. Tenderness is slight and ill-defined. Heartburn and acid eructation are rare, except in the early stages. A test meal shows the presence of mucus in every fraction. In chronic cases achlorhydria is often present; this is partly a result of the thick layer of mucus which sticks to the surface of the gastric mucous membrane, blocking the mouths of the glands, and partly of the neutralisation by the alkaline mucus of any free acid which gains access to the lumen of the stomach. Consequently a second test meal given immediately after thorough lavage of the stomach often shows that the acid is secreted in normal or almost normal quantity. In rare cases true achylia results from atrophy of the mucous membrane caused by prolonged and severe chronic inflammation. The size of the stomach and its motor functions are generally normal. The appetite is generally poor, the tongue is furred, chronic pharyngitis is present, especially in alcoholic cases, the patient complaining of an unpleasant taste in the mouth, and the breath is foul. Nausea, often accompanied by salivation, is common; it may be followed by vomiting of small quantities of half-digested food and mucus. In alcoholic gastritis vomiting in the early morning is frequent, and the patient has no appetite for breakfast; the vomit consists of alkaline, mucous fluid, largely composed of saliva and swallowed secretion from the inflamed pharynx and œsophagus.

The general health may remain good for years, but in chronic cases the patient is thin and sallow and complains of a feeling of slackness, general malaise, headache and insomnia, the symptoms varying with the condition of the stomach, and he frequently becomes hypochondriacal.

Diagnosis. Chronic gastritis should only be diagnosed if a test-meal has shown that excess of mucus is secreted by the gastric mucous membrane. If there is wasting, cancer may be simulated; in such cases an X-ray examination often settles the diagnosis. The presence of occult blood in the stools is uncommon in chronic gastritis but constant in cancer, and the good effect of dieting is lasting instead of temporary. The definite relationship between the amount of discomfort and the quantity and quality of the food distinguishes catarrh from nervous dyspepsia, in which the symptoms are also more irregular. The presence of excess of mucus in the vomit or after a test-meal is conclusive evidence against uncomplicated nervous dyspepsia, but only if it is certainly of gastric origin and not swallowed.

Prognosis.—A patient with chronic gastritis is always liable to attacks of acute and subacute gastritis, and the excessive vulnerability of the mucous membrane may persist to a less extent after the chronic condition has disappeared.

Treatment.—Everything concerned in the production of the condition must be removed as far as possible. The teeth should be put into perfect order and artificial ones supplied when necessary. When the tongue is

furred, it should be frequently cleaned in order to remove the unpleasant taste from the mouth and improve the appetite. The food should be thoroughly masticated and eaten at regular hours; the last meal should be taken three hours before going to bed. The patient should rest for at least half an hour after meals, and whenever he is at all tired for half an hour before meals. Alcohol should be entirely prohibited. Tea must be weak and freshly brewed, and coffee only drunk if mixed with an equal quantity of milk. All condiments must be avoided, as well as tough meat, skins and pips of fruit, salads, pickles and green vegetables, except in the form of purées. In severe cases it may be necessary to start with a stricter diet, which is gradually increased in the manner described in the treatment of gastric ulcer.

The diet and regular life at an inland health resort are often useful, drinking of the saline and alkaline waters probably contributing to the good results.

A bitter and alkaline mixture before meals increases the appetite and stimulates the secretion of gastric juice. If true achylia is present, as distinct from achlorhydria caused by neutralisation with excess of mucus, hydrochloric acid should be given (see p. 528). Achlorhydria secondary to the excess of mucus should be treated by washing out the stomach every morning before breakfast. The best solution for the purpose is hydrogen peroxide; the oxygen given off dislodges the mucus from the surface of the mucous membrane and perhaps stimulates the secretion of gastric juice. As improvement takes place the strength of the hydrogen peroxide can be gradually increased from 1 to 4 drachms to the pint, as less froth is produced. The treatment should be continued until no more mucus is washed away and a test meal shows that none is present in any fraction and free acid is again present. The bowels should be kept regular by taking honey, fruit jelly, stewed fruit, from which pips and skins must be carefully separated, and purées of green vegetables, but aperients should be avoided if possible. The constipation present is often due to dyschezia, which should be treated by re-education. If these means are insufficient, liquid paraffin should be given, and, if necessary, an infusion of senna pods.

GASTRIC AND DUODENAL ULCER

Pathology.—An ulcer of the peculiar type found in the stomach occurs nowhere else in the body except in the duodenal bulb and the part of the jejunum immediately adjoining the stoma of a gastro-jejunostomy. The one common feature of these three situations is the presence of gastric juice. But gastric juice will not digest the normal mucous membrane. Only if a small area of mucous membrane has had its vitality so lowered that it can no longer resist digestion does a superficial erosion form, which may develop into an acute ulcer, and ultimately into a typical chronic gastric or duodenal ulcer. The impaired vitality is probably always the result of the action of toxins, which are generally of bacterial origin. The most important sources are the teeth, tonsils, nasal sinuses and the appendix. Bacterial toxins produced by pyorrhœa alveolaris and by root infection may be excreted by the gastric or duodenal mucous membrane after absorption into the blood stream and may lead to local necrosis, just as the toxins produced by burns may in rare instances damage the duodenal mucous membrane. In 24 hours very large quantities of pus are produced by the

ulcerated areas in pyorrhœa alveolaris, and as all of this is swallowed, it can hardly be doubted that it leads to secondary infection of gastric and duodenal ulcers, especially in the night, when it is no longer diluted by the food, and when the bacteria are less likely to be destroyed by acid gastric juice. Septic foci in the tonsils, pharynx and nasal sinuses probably act in the same two ways. The association of chronic appendicitis with both acute and chronic gastric and duodenal ulcer is too common to be a coincidence, and the greatly diminished tendency to relapse, especially of acute ulcers, following removal of the appendix without interfering with the ulcer, shows that the appendicitis is the primary condition. Chronic infection of the gall-bladder is probably another cause of gastric and duodenal ulceration. When streptococci isolated from the deeper layers of chronic ulcers are inoculated into animals they produce ulcers in a large proportion of cases—much more frequently than streptococci obtained from other sources. Moreover, the streptococci obtained from infected teeth or tonsils of patients suffering from chronic gastric or duodenal ulcer have the same effect. This indicates that although these streptococci cannot be recognised by their cultural properties they have acquired a special destructive action on the gastric and duodenal mucous membrane.

The occurrence of ulceration is rare in comparison with the frequency of the various exciting causes just described, because it is unlikely for an acute ulcer to become chronic unless the stomach has the physiological characteristics which predispose to the production of gastric or duodenal ulcer. There appears to be something in the nature of an "ulcer diathesis," which makes certain individuals and sometimes two or more members of the same family liable to develop a chronic gastric or a duodenal ulcer throughout their lives. It may depend upon a peculiar anatomical configuration of the smallest arterioles, or less probably upon deficient alkalinity of the tissues, either of which would interfere with the healing of an acute ulcer. In addition to this general ulcer diathesis, there appears to be a special gastric ulcer diathesis associated with a long stomach, and a duodenal ulcer diathesis associated with hyperchlorhydria and a short and rapidly emptying stomach, a condition I have called the "hypersthenic gastric diathesis." As a consequence of the latter the duodenal bulb is kept constantly filled with exceptionally acid chyme, and neutralisation with the alkaline duodenal juice is impossible; even when the stomach is empty, gastric juice continues to be secreted, and passes rapidly into the duodenum without being diluted and partially neutralised by admixture with food.

The tendency to develop a duodenal ulcer is increased by excessive smoking; the nicotine apparently acts through the autonomic nervous system and increases the hypermotility and hyperchlorhydria.

Chemical irritants, such as alcohol, especially when taken on an empty stomach, vinegar, the acids of unripe fruits, and mustard, pepper and curry, taken in excess, interfere with the healing of an acute or chronic ulcer. Insufficiently masticated food, and hard indigestible particles, such as pips and skins of fruit, fibres of raw vegetables, such as celery, and nuts have a similar effect.

One of the oldest theories of the origin of gastric ulcer was that the occlusion of small blood vessels led to local anæmia of the mucous membrane, which allowed digestion by the gastric juice to occur. It seems not unlikely

that vasomotor spasm may be one factor, as something of this kind could alone explain the undoubted influence of sudden change of temperature in the production of relapses of gastric and especially of duodenal ulcer.

Acute Ulcer

Ætiology.—Acute ulcer, especially of the stomach, occurs most frequently under the conditions already described. It was formerly most common among anæmic young women, but owing to the much smaller incidence of chlorosis in recent years it is now almost as common in young men, and it may also occur in later life.

Symptoms.—Acute ulcer gives rise to no symptoms unless it causes hæmorrhage, which is often profuse but very rarely fatal, or, in exceptional cases, perforation. Hæmorrhage or perforation occurring without any previous indigestion is thus usually due to an acute ulcer. In some cases it may be associated with the dyspepsia caused by chronic appendicitis, or gastritis secondary to oral or pharyngeal infection, but the gastric symptoms are not caused by the ulcer.

Prognosis.—Acute ulcers can develop into chronic ulcers, but the majority heal rapidly, leaving so small a scar that neither pyloric obstruction nor any deformity in the shape of the stomach results. There is a great tendency to relapse, but the patient is able to take a full diet without discomfort between the attacks.

Treatment.—For the treatment of the hæmorrhage, see Hæmatemesis. The diet should be rapidly increased until everything but obviously indigestible food is taken. The patient should be kept in bed until 3 weeks after the cessation of hæmorrhage and pain. The teeth should be put in good order, and the patient should be taught to eat slowly and chew thoroughly. If the tonsils are infected they should be enucleated, and any other source of infection in the nose or pharynx should receive treatment. If the appendix or gall-bladder is diseased, it should be removed, but a gastro-jejunostomy should on no account be performed for an acute ulcer. Iron and arsenic should be given if anæmia is present.

Chronic Gastric Ulcer

Ætiology.—Men are rather more often affected than women, but when on the lesser curvature giving rise to hour-glass stomach they are rare in men; no age is exempt, but most cases occur between 30 and 50.

Symptoms.—The onset is generally insidious, the symptoms first appearing after big or indigestible meals, and gradually becoming more easily produced. The pain, which is often burning in character and may be very severe, is situated in the middle of the epigastrium and may radiate upwards and to the back; it is much more marked after indigestible food, and generally disappears with a milk diet. In ulcers situated near the cardia it begins almost immediately after meals, and in pre-pyloric ulcers 2 or 3 hours after, intermediate intervals indicating an ulcer on the lesser curvature of the stomach. The pain generally disappears spontaneously after about an hour. It is completely relieved by emptying the stomach by vomiting or by a tube, and by alkalis; food generally produces less complete relief than

with duodenal ulcer. Partial relief is generally also obtained on lying down and by warm applications to the epigastrium. A small area of tenderness, the position of which is constant for each case, is present in the epigastrium, and occasionally to the left of the spine, especially when the ulcer has eroded the pancreas. The tenderness is greater than in any other gastric disease, and is most marked or only present when there is spontaneous pain. It is associated with rigidity of the left rectus. A definite area of cutaneous hyperæsthesia is rarely present, except in young women, in whom the possibility that it has been produced by unconscious suggestion on the part of the observer in the course of his examination should always be remembered.

With increasing pain vomiting appears; it occurs at the height of the pain, a small quantity of acid fluid with a little well-digested food being brought up. As a result of dieting the vomiting generally becomes less frequent, but if the pain is severe it is often self-induced by the patient.

Occult blood is frequently found in the stools and vomited material, but disappears rapidly when the patient is dieted. In a much smaller proportion of cases obvious hæmatemesis occurs; when the blood is abundant it is bright in colour and the stools are tarry; when less abundant it is coffee-coloured and mixed with food and is only recognisable in the stools by chemical examination. Melæna may also occur without hæmatemesis. The appetite is good at first, but fear of pain may lead to diminished intake of food, with consequent loss of weight and weakness; in some cases, however, the relief given by food encourages the patient to eat heartily. The tongue is clean, but constipation is commonly present.

In uncomplicated cases there may be some delay in evacuation owing to reflex achalasia of the pyloric sphincter. A spasmodic stricture is often observed with the X-rays in the centre of the stomach, when the ulcer is situated on the lesser curvature. Conclusive evidence as to its position is always obtainable by the discovery of a "niche" or diverticulum filled with opaque salt, which has found its way into the crater of a chronic ulcer; this is always the site of the maximum degree of deep tenderness.

A test meal gives no constant result, but hyperchlorhydria is much more common than in normal individuals. In very chronic cases hypochlorhydria and even achlorhydria may be present, but these are due to associated chronic gastritis, and a second test meal given after the ulcer has healed shows a considerable increase in acidity and often hyperchlorhydria, as the treatment also leads to the disappearance of the gastritis.

Diagnosis.—Hæmatemesis or the presence of occult blood in the stools excludes all other gastric disorders except cancer. The possibility of cirrhosis of the liver, in which the gastric symptoms are those of chronic gastritis and have none of the regularity of those caused by ulcer, and splenic anæmia, in which no other gastric symptoms occur, should always be considered in a case of hæmatemesis. In cancer occult blood is constantly present in the stools in spite of diet, free hydrochloric acid is absent in 60 per cent. of cases; a chronic ulcer may give rise to a palpable tender tumour, but less frequently than cancer, in which anorexia and wasting out of proportion to the diminished intake of food are also likely to be present. In nervous dyspepsia the pain and tenderness are irregular in position, time of onset, and relation to the quantity and quality of food, and are

less constantly relieved by alkalis. In chronic gastritis discomfort rather than pain is present; it generally begins directly after meals, and there is no localised tenderness. For the diagnosis of duodenal from gastric ulcer, see Duodenal Ulcer. The gastric symptoms associated with cholecystitis and chronic appendicitis may simulate ulcer, but the relation of the pain to the nature and time of meals is less regular, and less relief is given by alkalis; tenderness is present over the gall-bladder or in the right iliac fossa respectively in addition to the epigastrium. It should be remembered that cholecystitis and still more frequently chronic appendicitis may be associated with gastric ulcer. With good technique it ought always to be possible to settle the diagnosis of a chronic ulcer by means of the X-rays.

Complications.—Perforation may lead to general peritonitis or a localised abscess; if the perforation occurs slowly, especially if it is posterior, adhesions develop, which occasionally give rise to pain. It is rare for a gastric ulcer to be situated sufficiently near the pylorus to cause obstruction on healing. The cicatrisation of a large ulcer in the body of the stomach may cause hour-glass constriction. Very chronic ulcers may in rare instances become carcinomatous, but such ulcers may form definite tumours without being malignant. Earlier onset of pain, which is less liable to temporary improvement, increased severity of pain and disappearance of heartburn in the case of cancer, and increased frequency of vomiting point to the probable onset of one of these complications.

Chronic Duodenal Ulcer

Ætiology.—The ætiology of chronic duodenal ulcers is much the same as that of chronic gastric ulcers, but the greater frequency in men than in women is much more marked. Although acute ulcers appear to be less common in the duodenum than the stomach, chronic ulcers occur three or four times more frequently in the duodenum.

Symptoms.—The earliest symptom is generally a sense of discomfort or fullness 3 hours after the largest meals. This is gradually replaced by pain, which occurs between 2 and 4 hours after every meal, the interval being longer the larger the meal. It frequently wakes the patient in the early part of the night, particularly if the last meal was finished less than 3 hours before going to sleep. It is generally situated in the middle line, rather nearer the umbilicus than the ensiform cartilage; it may radiate to the right or be situated on the right side only; in rare cases it is on the left. The pain is often associated with a feeling of hunger and is relieved by taking food; it is therefore commonly known as "hunger-pain." It is also relieved by alkalis and when the stomach is emptied by means of a tube or by vomiting; vomiting is, however, rare in uncomplicated cases, though regurgitation of mouthfuls of scalding, very acid, fluid may occur when the pain is at its height. Periods of hunger-pain lasting some weeks or months alternate with periods of more or less complete freedom from symptoms. The attacks are much more common in cold weather than in hot, but the autumn and early spring are generally more trying months than winter. Attacks are liable to be brought on suddenly by exposure to cold, by worry, an indigestible meal, or excessive smoking or drinking.

Hæmorrhage may never occur, but in the majority of cases occult blood is found from time to time in the stools. Severe hæmorrhage is less frequent; it always results in melæna, and may also give rise to hæmatemesis. The appetite remains good and the patient does not lose weight or strength.

The stomach is found by the X-rays to be short, the greater curvature rarely reaching the level of the umbilicus, and the stomach empties itself with unusual rapidity. In chronic cases reflex achalasia of the pyloric sphincters may lead to delayed evacuation and consequent increase in size of the stomach, the greater curvature of which then reaches below the umbilicus, but after successful medical treatment the high position and rapid evacuation return unless some organic narrowing follows the healing of the ulcer. Irregularity in the outline of the duodenal bulb, due partly to the deformity caused by the ulcer itself and partly to secondary spasm, is always found, and affords conclusive evidence that an ulcer has been present, but unless it is tender or a definite mark is seen the deformity may be due simply to the scar of a healed ulcer. Constipation is almost invariably present. A test-meal generally shows the presence of hyperchlorhydria (Fig. 18); if a low curve is obtained with a fractional test-meal this is generally due to associated gastritis and is replaced by a high curve if the meal is repeated when treatment has resulted in healing of the ulcer and disappearance of the gastritis.

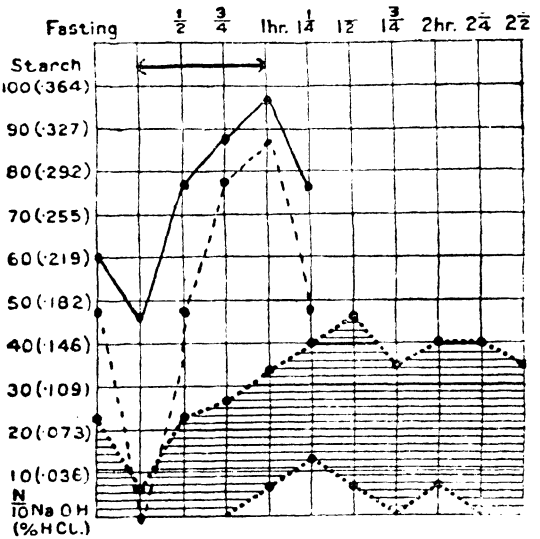


FIG. 18.—Fractional test-meal in case of duodenal ulcer, showing hyperchlorhydria and rapid evacuation. Continuous line, total acidity; dotted line, free HCl; shaded area, limits of free HCl in 80 per cent. of 100 healthy students.

Diagnosis.—When the symptoms have only been present for a short time an actual ulcer is not as a rule present, but a pre-ulcerative duodenitis, which is likely to result in ulcer if not adequately treated. Excessive smoking and over-fatigue may give rise to almost identical symptoms in individuals with the hypersthenic gastric diathesis, but the X-rays show no deformity of the duodenal bulb and occult blood is absent from the stools.

The diagnosis from gastric ulcer depends upon the later onset of pain, the greater relief on taking food, the rarity of vomiting, the characteristic hyperchlorhydria curve obtained with a fractional test-meal, the frequent situation of pain and tenderness to the right of the middle line, the more

frequent periods of complete freedom from symptoms, and the results of X-ray examination. The symptoms may closely resemble those of cholecystitis, but in the latter condition the pain is much less regular in its time relations, and tenderness over the gall-bladder and pain referred to the right shoulder are frequently present. In rare cases cancer and syphilis of the stomach may produce similar symptoms, but the X-ray examination and test-meal prevent a mistake in diagnosis.

COMPLICATIONS.—The inflammatory swelling round a large ulcer may lead to obstruction, the first symptom of which is generally vomiting. When vomiting is present and the stomach is found by the X-rays to be enlarged instead of small and to empty itself slowly, medical treatment must be prolonged, and even then may fail to give complete relief, as organic pyloric obstruction may follow the healing of the ulcer.

Perforation may occur and lead to general peritonitis, or, much less commonly, to a localised abscess. Sub-diaphragmatic abscesses due to duodenal ulcer are always to the right of the suspensory ligament; they may contain gas in distinction to those due to appendicitis, which are always free from it. Duodenal ulcers differ from gastric ulcers in showing no tendency to become malignant. This is probably due to the absence of the powerful peristaltic waves which rub hard particles of food against an ulcer in the stomach.

TREATMENT OF CHRONIC GASTRIC AND DUODENAL ULCER

As soon as a definite diagnosis of a chronic ulcer has been made, the patient should be kept in bed until there is strong evidence that the ulcer has healed. It is rare for this to occur in less than 4 weeks, and in very large and chronic ulcers 8 or 12 weeks may be required. For the treatment of hæmatemesis and the rules for commencing feeding after it, see Hæmatemesis (p. 537).

As a preliminary to the treatment of the actual gastric or duodenal ulcer the teeth should be put into perfect condition, and any infected focus in the nose or throat should be treated; throughout the treatment the mouth should be kept absolutely clean. If definite chronic appendicitis is present the appendix should be removed, but no operation should be performed on the stomach itself unless the ulcer is very large or is giving rise to mechanical difficulties owing to hour-glass contraction or pyloric obstruction.

The patient should be kept warm in bed throughout the treatment but he should get up every day to have a bath and to open his bowels, the difficulties with which are greatly reduced if a bed-pan can be avoided. No smoking should be permitted during the period of strict treatment.

The object of treatment is to reduce the secretion of gastric juice as much as possible, and to keep the hydrochloric acid in the stomach completely neutralised throughout the day, and, what is almost invariably neglected, throughout the night. The evidence is conclusive that free hydrochloric acid prevents an ulcer healing, whatever additional factors may have contributed towards its production in the first instance. At the same time as much food as possible is required to maintain the patient's nutrition.

especially when he has lost much weight, as is often the case with gastric, though rarely with duodenal, ulcer. Finally, the food should be as unirritating in its mechanical and chemical characteristics as possible.

Between 5 and 7 ounces of milk are given every other hour from 8 a.m. to 10 p.m. inclusive. To each feed 10 grains of sodium citrate, which combines with the lime in the milk and consequently prevents the formation of irritating clots by the rennin of the gastric juice and is also a valuable alkali, dissolved in 1 or 2 drachms of emulsio magnesiæ, are added; the latter contains 5 grains of oxide of magnesia to the drachm. This has the advantage over sodium bicarbonate in having four times its neutralising power, in giving off no carbon dioxide, which is liable to distend the stomach on reacting with the hydrochloric acid, in having a mild aperient action, and in producing a very much smaller secondary increase in secretion after the initial neutralisation than sodium bicarbonate, which is the most powerful stimulant of gastric juice in existence. The milk can be flavoured with tea, coffee or cocoa, and in cases requiring prolonged treatment the monotony of the diet can be relieved by the substitution of an equal quantity of custard, junket or arrowroot, to which apple or other fruit jelly may be added, for some of the feeds, and potato, artichoke or other vegetable purée for others, the latter having the advantage of containing vitamins, which help to prevent the patient's general health from deteriorating. Immediately before four of the feeds half an ounce of olive oil is taken. This inhibits the secretion of gastric juice; at the same time it supplies a digestible and absolutely unirritating food of very high nutritive value in a concentrated form. Immediately before three other feeds and last thing at night $\frac{1}{200}$ grain of atropine sulphate, or more if the patient can take it without unpleasant symptoms developing, which has a similar inhibiting effect, is given, and 2 or 3 ounces of cream are added to the morning feed.

With this treatment free acid is generally absent from the stomach throughout the day, except before breakfast and after 3 p.m. One drachm of tribasic magnesium phosphate should be given on waking, half an hour after the 3, 4 and 5 p.m. feeds and last thing at night, and at any other time the patient feels any "acidity." If the bowels act too much, some of this can be replaced by the corresponding calcium salt. They both have the advantage of not giving rise to alkalosis in spite of acting as efficient alkalis in the stomach. They can therefore be used in cases of renal insufficiency, though no sodium citrate nor magnesia is permissible.

If the ulcer is in the neighbourhood of the pylorus and is giving rise to any obstruction, continuous hypersecretion of gastric juice will occur throughout the night. It is then impossible for the ulcer to heal, and in the past it has been supposed that such cases required operation. But the obstruction is generally due entirely or in great part to surrounding œdema and inflammatory swelling and pyloric achalasia, and in such cases, if the ulcer can be caused to heal, any scarring produced is insufficient to give rise to obstruction. At 11 p.m., immediately before the last alkaline powder is given, the stomach is completely emptied by Senoran's evacuator; if not more than 2 ounces of fluid are present on two consecutive nights this can be discontinued. A double dose of atropine sulphate is then given in order to inhibit the further secretion of gastric juice. In most cases the continued nocturnal secretion is rapidly controlled by this treatment. Before

commencing treatment in any cases of partial pyloric obstruction the blood urea should be estimated.

If the patient is constipated, the dose of magnesia should be increased, and if the bowels are not opened on 2 consecutive days, an enema should be given. If diarrhœa occurs, the dose of magnesia should be reduced and that of tribasic calcium phosphate reduced.

The strict treatment just described should be continued until for 3 weeks the patient has had no spontaneous pain, no trace of tenderness has been present, no occult blood has been found in the stools, and the X-rays no longer show the presence of an ulcer crater. The pain and tenderness generally disappear within 48 hours; the other signs of healing appear considerably later, the exact time depending upon the size and age of the ulcer and its proximity to the pylorus.

The diet can now be rapidly increased until at the end of a week everything is taken with the exceptions I shall presently enumerate. Minced meat should be avoided, as the patient should be taught the importance of chewing his food so thoroughly that it is fluid in consistence by the time he swallows it; this has the further advantage that the food is mixed with a sufficient quantity of alkaline saliva.

It is not difficult to cause an ulcer to heal by suitable treatment in bed, but the predisposing exciting cause, which led to the ulceration, may still be present and persist for many years. Special precautions are therefore required to prevent a recurrence, and it is advisable to give written instructions for the patient to follow.

The teeth, which should have been put into thoroughly good condition at the commencement of treatment, should in addition be overhauled twice a year so that the slightest tendency to pyorrhœa alveolaris or apical infection can be kept in check. The patient should eat slowly and masticate thoroughly; it is a good plan to give him solid food during the last days he remains under strict observation, so that he may get into the habit of eating slowly, for when the habit is once acquired, it is easy to continue in the same way. It should be impressed upon busy men that when they have no time to sit down to a proper meal it is better to drink some milk or eat some chocolate than to bolt some less digestible solid food. Tough meat, new bread and other articles of diet which cannot easily be chewed to a fluid consistence should be prohibited. Thus the patient should avoid the pips and skins of fruit, whether raw, cooked, or in jam, cake or puddings, and pickles, salads and all uncooked vegetables, such as celery; green vegetables are best given as purées with butter. No strong tea or coffee, no aerated drinks and no alcohol should be allowed, except a very little diluted whisky with meals for those who feel the need of it. Condiments, vinegar and unripe and acid fruit, high game, sausages, curry and made-up dishes should be prohibited. Ices and very cold and very hot drinks should be sipped and kept sufficiently long in the mouth for them to approximate to the body temperature when they reach the stomach. The patient should only be allowed to smoke in moderation. He should remain strictly on this régime until he has been free from symptoms for 2 years, and should follow it in a modified form for the rest of his life.

The bowels should be kept regular; this can be done most conveniently by means of light oxide of magnesia, which should be given after each meal,

as it helps to neutralise the free acid in the gastric contents. The most convenient way to take it is in a fluid preparation, containing 5 grains of magnesia to the drachm, from half a drachm to half an ounce being required as a dose. If the magnesia is insufficient to control the constipation, a tablespoonful of liquid paraffin may be given after one or more meals.

If hyperchlorhydria is present, it is advisable for a time to continue to give a tablespoonful of olive oil half an hour before meals to reduce the acidity. Patients should always have an alkaline powder by them, so as to be able to take just enough to keep themselves perfectly comfortable at the slightest suspicion of gastric discomfort. They should be warned of the danger of recurrence, and should be told to go to bed on a milk diet at the first indication of a return of symptoms. If they do this, treatment for 24 hours is often sufficient to ward off an attack. If, on the other hand, they wait until the symptoms become fully developed, a prolonged stay in bed will be required.

An operation should be advised under the following circumstances :

1. At the earliest moment after a perforation.
2. For pyloric obstruction without symptoms of active ulceration.
3. For pyloric obstruction with symptoms of active ulceration, which is still found to be present after 3 weeks of medical treatment.
4. For a gastric ulcer causing organic hour-glass contraction sufficiently severe to produce 6-hour stasis in the proximal segment.
5. When the symptoms recur after one or more courses of thorough medical treatment followed by adequate after-treatment ; the number of such courses which may be tried depends upon such circumstances as the age, social position, occupation and place of residence of the patient ; thus the older a patient, the better his social position, the less strenuous his occupation and the less important occasional absences from business, and the warmer and more equable the climate, the less urgent is the necessity for operation. In my experience recurrence is very unusual in the absence of pyloric obstruction, if the ulcer has once completely healed, all septic foci have been removed, and the after-treatment is conscientiously carried out.
6. As it is very rare for death to occur from a single gastric hæmorrhage, no operation should be performed, except when severe hæmorrhage recurs more than once, especially in patients past middle age and it appears probable that the blood comes from a sclerotic vessel which cannot contract. An attempt should then be made to excise the ulcer or, if this is impossible, to ligature the bleeding point ; failing this also, a series of sutures should be tied round the ulcer so as to cut off as much as possible of its blood supply. Whenever possible, it is best to wait until the patient has got over the initial collapse following a severe hæmorrhage ; the patient should be transfused before, and if necessary, a day after the operation.
7. When for any reason, such as the persistence of pain or of occult blood in the stools, it appears possible that a growth is present, the abdomen should be explored, and unless a growth can be excluded with certainty, partial gastrectomy should be performed.

If the ulcer is in the pyloric region, but not otherwise, gastro-enterostomy is sufficient. For ulcers situated in other parts of the stomach, partial gastrectomy appears to be the most satisfactory operation. A gastro-gastrostomy is the ideal operation for organic hour-glass contraction.

After any operation for gastric or duodenal ulcer, the patient should follow out exactly the same after-treatment as after medical treatment, or various ill results, the most serious of which is the production of a gastro-jejunal or a jejunal ulcer, may ensue.

TUBERCULOSIS OF THE STOMACH

Tubercle of the stomach is very rare. In miliary tuberculosis the mucous membrane may be involved, but no symptoms are produced. In advanced pulmonary tuberculosis a tuberculous ulcer may form, generally near the pylorus. The symptoms are *indistinguishable from the dyspepsia common* in such cases, unless hæmatemesis occurs; this may, however, be due to the presence of a simple ulcer. I have seen one case in which the symptoms and radiological signs suggested the presence of a simple ulcer on the lesser curvature which was becoming malignant; achlorhydria was present and occult blood was found in the stools. Partial gastrectomy was performed; an ulcer was found and the surrounding mucous membrane was thickened as a result of a definitely tuberculous infection, which appeared, however, to be secondary to a simple chronic ulcer.

SYPHILIS OF THE STOMACH

Syphilis of the stomach is probably less rare than is generally supposed. In one specimen spirochætes were actually discovered (McNee). It has been recorded as developing at any time between 4 and 40 years after infection. A gummatous infiltration of the submucous tissue occurring on the lesser curvature near the pylorus may form a tumour suggestive of a chronic ulcer or cancer; in either case it may produce pyloric obstruction or an hour-glass stomach. Free hydrochloric acid may be absent, and occult blood is occasionally found in the stools, but obvious hæmorrhage is rare. The possibility of syphilis should always be considered when symptoms suggestive of cancer are present; even if there is no history or other evidence of syphilis the Wassermann reaction should be tested. The diagnosis would be confirmed by the rapid improvement with anti-syphilitic treatment in spite of the failure of other measures. In one case typical symptoms of duodenal ulcer were present, but no improvement had followed prolonged treatment of the usual kind. Achlorhydria was then discovered to be present instead of the hyperchlorhydria of duodenal ulcer, and there was no duodenal deformity; the Wassermann reaction was positive, and rapid recovery followed anti-syphilitic treatment.

CARCINOMA OF THE STOMACH

Ætiology.—Carcinoma of the stomach occurs most frequently between the ages of 40 and 60, and is rare before 30 and after 70. It is twice as common in men as in women. Sarcoma occurs with one-fortieth the fre-

quency of carcinoma; males and females are equally affected, and the disease is relatively more frequent under the age of 30 than carcinoma.

Clinical and pathological evidence shows that carcinoma may occasionally develop from chronic gastric ulcer; thus in about 6 per cent. of chronic ulcers excised by operation, which appear innocent to the naked eye, small areas are found in the margin which show microscopical evidence of malignant degeneration, and in about 16 per cent. of cases of obvious carcinoma there is pathological or clinical evidence that the disease followed a simple chronic ulcer (Stewart). I believe that a considerable proportion of the remaining cases are a sequel of chronic gastritis, which was either latent or caused comparatively trivial symptoms. The achlorhydria is not a result of the carcinoma, but of the gastritis which is always found involving the part of the mucous membrane not attacked by the growth. Carcinoma generally involves the lesser curvative or pre-pyloric area, less commonly the fundus in the neighbourhood of the cardia and the pyloric canal, and rarely other parts of the stomach.

Symptoms.—When an individual above the age of 40, who has hitherto had a good digestion, suddenly begins to suffer from gastric symptoms, the possibility of cancer should always be considered. In about one-fifth of the cases a long history of dyspepsia, suggesting gastric ulcer, is present, the local symptoms having recently altered in character and become continuous instead of more or less intermittent; at the same time the general symptoms become more marked. The patient suffers from epigastric discomfort or pain immediately or soon after meals. After a time the pain, which is generally dull and distressing, but not very acute, becomes continuous, but it is still aggravated by meals. In a small proportion of cases the pain comes on two or three hours after meals and is relieved by food, thus simulating duodenal ulcers, but there are never spontaneous remissions of symptoms and achlorhydria is generally present. At an early stage the appetite diminishes, the patient having a special repugnance for meat. This may be the first symptom, but in exceptional cases the appetite is maintained for a time. Anæmia and nausea occasionally precede all other symptoms by some months. Flatulence is commonly present, the gas brought up being at first odourless, but subsequently foul. Vomiting is generally present sooner or later; it is very abundant, and occurs at long intervals when the pylorus is involved; in cancer of the cardiac end of the stomach it immediately follows swallowing. Vomiting is commonly preceded by pain and nausea, both of which it temporarily relieves, but less completely than in gastric ulcer. The vomited matter contains blood more often than in gastric ulcer; it may have the appearance of "coffee grounds." Vomiting of blood alone is rare; but in a very large proportion of cases blood constantly oozes from the surface of the growth, so that one or more of the specimens obtained with a fractional test-meal may be obviously blood-stained, and all are likely to contain occult blood. The oozing is unaffected by diet, so that occult blood is generally present in every stool examined, however carefully the patient is dieted. The growth sooner or later involves the pylorus in a considerable proportion of cases; the special symptoms then present are described in the article on pyloric obstruction.

The patient rapidly loses strength and weight, the emaciation being more than can be accounted for by the vomiting and diminished intake of food.

In the late stages the disappearance of subcutaneous fat, loss of elasticity of the skin, œdema of the abdominal wall, back and ankles, and anæmia give the patient a characteristic cachectic appearance.

In the earlier stages nothing abnormal is found on abdominal palpation; but sooner or later a hard, moderately tender tumour is generally felt. It is often most palpable when the stomach is empty; but may only become obvious after meals.

The X-rays often show an irregular filling defect in the outline of the stomach, which coincides with the tumour if one is palpable, and often involves the greater curvature; the normal progress of the peristaltic waves is interrupted, sometimes before any obvious deformity is present.

If there is the slightest reason to suspect cancer a fractional test-meal should be given. The resting-juice often contains pus cells in excess of the leucocytes present in a specimen of spittle obtained at the same time, and even if the specimen is not obviously blood-stained red corpuscles are generally found on microscopical examination. In 60 per cent. of cases complete achlorhydria is present, and in at least another 20 per cent. there is hypochlorhydria; in most cases secondary to ulcer free acid is present, sometimes actually in excess. If achlorhydria is present, but not otherwise, the resting-juice generally contains lactic acid.

Secondary deposits frequently occur in the liver, and the symptoms they give rise to may be the most prominent clinical manifestation. Direct spread to the peritoneum and omentum is frequent, and irregular abdominal masses due to this cause are often palpable; ascites may occur as a result of the malignant peritonitis. A small gland just beneath the insertion of the left sterno-mastoid muscle is occasionally involved, and less frequently deposits may occur in the inguinal glands. The growth may spread along the urachus to involve the umbilicus, where a hard nodular mass can be felt. A rectal examination should always be made, as a deposit is not infrequently present in the recto-vesical or recto-vaginal pouch at a comparatively early stage.

Perforation may occur, general peritonitis being usually prevented by the presence of old adhesions, so that a local abscess forms; less frequently the colon becomes involved and a gastro-colic fistula results, the patient then rapidly dying from emaciation due to constant fæcal vomiting and severe diarrhœa.

Other terminal complications are suppurative gastritis, pylephlebitis, suppurative parotitis, thrombosis, septic pneumonia, empyema and infective endocarditis.

Diagnosis.—Apart from the history and the discovery of a tumour, the X-ray examination is the most important means of distinguishing a growth from other gastric disorders. Occult blood is present in the stools for prolonged periods in many cases of ulcer, but achlorhydria is rare, and in the few cases of very chronic lesser curvature ulcer in which there is no free acid, it generally appears if the meal is repeated after washing out the stomach. Moreover, the characteristic X-ray appearance of an ulcer crater is quite different from the appearance produced by a growth. In gastric ulcer, the pain only begins at an interval after meals, and if present when food is taken it is at any rate temporarily relieved, whereas in cancer the pain begins directly after meals and is never relieved by food. Addison's

(pernicious) anæmia may closely simulate a growth of the stomach; the presence of occult blood in the stools is distinctive of the latter and does not occur in the former; the megalocytosis, high colour index, and positive indirect but negative direct van den Bergh's test of Addison's anæmia are in striking contrast with the absence of megalocytes, normal or low colour index, and negative van den Bergh's test of cancer, however severe the anæmia is. It should be remembered that an extensive growth may be present even with a hæmoglobin percentage of 100, and on the other hand that in extremely rare cases true Addison's anæmia may develop as a result of the achlorhydria associated with cancer of the stomach.

Prognosis.—The average duration of life after the appearance of the first symptom is 9 months. Temporary improvement may occur as a result of rest and careful dieting. Death is most frequently due to exhaustion; in other cases it results from one of the complications already mentioned.

Treatment.—Medical treatment is only palliative. The patient should be allowed to eat what he likes, but small, frequent and nutritious meals are most suitable. The mouth and tongue should be kept as clean as possible. Drugs must be employed for the relief of pain, and in the later stages injections of morphine are generally essential, and there should be no hesitation in giving very large doses.

If pyloric obstruction is present, the abdomen should be explored without delay, as even if a radical operation is impossible, gastro-jejunostomy produces marked, though only temporary, improvement. Apart from this indication, laparotomy should never be performed unless there is a distinct chance of removing the whole tumour. The presence of secondary deposits anywhere in the body and any marked degree of cachexia render the attempt quite useless. The most favourable cases are those in which a probable diagnosis has been made in the absence of a tumour or in the presence of a comparatively small, localised and movable one. At the operation a considerable margin of normal stomach and the lymphatic glands in the neighbourhood should be simultaneously removed.

PYLORIC OBSTRUCTION

Ætiology.—Pyloric obstruction is due in the vast majority of cases to the results of duodenal ulceration or to cancer. A duodenal ulcer situated in close proximity to the pylorus may as a result of the œdema and vascular engorgement at its edges lead to obstruction, which disappears when the ulcer heals. Sometimes more or less permanent obstruction is produced by contraction of the fibrous tissue formed by the cicatrisation of the ulcer. As gastric ulcers are much less common than duodenal ulcers and are generally situated on the lesser curvature some distance from the pyloric canal, they rarely cause pyloric obstruction.

Cancer of the stomach rarely if ever originates in the pyloric canal, but in the majority of cases a growth beginning in the lesser curvature spreads so as finally to involve the pylorus. Syphilis of the stomach is a rare cause of pyloric obstruction. In infants obstruction may result from hypertrophy of the pylorus.

Spasm is often stated to give rise to pyloric obstruction, but the evidence

that it can do so is inconclusive, except in the hypertrophic pyloric stenosis of infants. On the other hand, there is no doubt that achalasia of the pyloric sphincter is a common result of duodenal ulcer, and less frequently of a lesser curvature ulcer, chronic cholecystitis and chronic appendicitis; it gives rise to definite obstruction, which is, however, intermittent, and never causes prolonged stasis or great distension. External pressure very rarely gives rise to pyloric obstruction, and simple adhesions between the pylorus and the neighbouring viscera do not, as a rule, interfere with the passage of food into the duodenum. In exceptional cases, however, cholecystitis may lead to such strong and extensive adhesions with the pylorus that a certain amount of obstruction results. Gastroptosis never causes pyloric obstruction (*vide* Visceroptosis, p. 671).

Symptoms.—In the early stages attacks of severe pain may occur at varying intervals after meals owing to the violent peristalsis of the stomach in its attempt to overcome the obstruction. Later, nothing more than an unpleasant sense of fullness is experienced, especially after meals, but if frequent vomiting or treatment by lavage prevents the stomach from being much distended, attacks of pain are likely to persist. With an ordinary diet vomiting occurs regularly every day, but this characteristic symptom is less marked if the patient takes a bland diet which leaves little or no solid residue. The vomiting generally occurs first in the afternoon or evening; but in the later stages, when dilatation has supervened, large quantities are vomited several times a day and often during the night. Articles of food may be brought up which have been eaten many hours or even days before. The odour is yeasty in non-malignant, and rancid in malignant cases. In malignant obstruction, excessive fermentation and putrefaction may give rise to very offensive eructation, and in rare cases this is the first symptom noticed by the patient. Wasting is progressive, and the tissues become abnormally dry and inelastic; in malignant cases a cachectic appearance is added to the simple starved appearance of non-malignant obstruction. The patient has generally little appetite, but complains of great thirst. The urine is scanty, and obstinate constipation occurs.

Pyloric obstruction occasionally gives rise to tetany and to symptoms of uræmia, especially in individuals with inefficient kidneys, as shown by an increase in the blood-urea. The symptoms are apparently partly of a true uræmic character and partly a result of alkalæmia, which is only in part due to the loss of hydrochloric acid in vomiting.

In addition to the symptoms already enumerated, others depending upon the cause of the obstruction, such as gastric ulcer or carcinoma, are, of course, also present.

Pyloric obstruction leads to distension of the stomach. The signs of this, together with the methods of distinction between the malignant and non-malignant cases, are considered in the section on the investigation of the alimentary canal.

Treatment.—The treatment of pyloric obstruction is gastro-jejunostomy. It is useless to waste time in well-marked cases with lavage or other medical treatment, as the improvement which follows operation is immediate and progressive. The immediate mortality of the operation can, however, be greatly reduced by preliminary medical treatment for a few days. The stomach is completely emptied every night by Senoran's evacuator. Small

quantities of custard, junket, and similar soft easily digestible foods are given during the day, but nothing to drink, saline solution being given by rectum or, if necessary, subcutaneously. By this means the tone of the stomach rapidly improves and the danger of severe intoxication due to alkalosis or other causes is overcome.

When the obstruction is only partial, and an active ulcer is present, the effect of medical treatment of the ulcer should be tried, as the obstruction is largely due to the surrounding inflammation, which disappears when the ulcer heals, and if the ulcer is not very large the scar produced may give rise to no obstruction.

ARTHUR F. HURST.

CONGENITAL HYPERTROPHY OF THE PYLORUS

Synonym.—Hypertrophic Pyloric Stenosis.

Definition.—This is a disease of early life, formerly believed to be a rarity, but now recognised as of not uncommon occurrence. It consists essentially in a great thickening of the pylorus, leading to gastric stasis, with all the symptoms that result from such a condition.

Ætiology.—The pathogeny of the disease is still obscure. The theory that it is simply a congenital malformation is not in harmony with the clinical facts, and the most generally accepted view is that it results from an over-action of the pyloric sphincter, the consequence of a lack of co-ordination between the gastric and pyloric mechanisms. There is some reason to suppose that the Anglo-Saxon and Teutonic races are more affected by the disease than the Latin, but it is exceptional to get a history of other cases having occurred in the family. Boys are affected at least four times as often as girls, and in a remarkably high proportion the patient is the first child of the family.

Pathology.—The most striking change is an immense thickening of the pylorus, due to overgrowth of its circular muscle-fibres. The stomach is dilated, its muscular coat somewhat hypertrophied, and the mucous membrane in a state of catarrh. The other post-mortem appearances are those usually met with in inanition.

Symptoms.—The child has usually been born at full time, after a natural labour, and in the majority of cases has been breast fed. For a week or two or longer all goes well, and then vomiting sets in. The vomiting is "projectile" in character, the stomach contents being violently shot out. The vomit is usually larger in quantity than the last meal, and is often mixed with mucus; the presence of any blood in it is very rare. Meanwhile the child steadily loses weight, but does not look really ill, and maintains his strength and activity. The bowels are obstinately constipated, and the motions small and dark.

The most characteristic sign of the disease is the presence of *visible gastric peristalsis*. On inspection of the abdomen waves of contraction can be seen sweeping across its upper part from left to right. Sometimes three such waves can be seen at once, each being about the size of a golf ball. The waves may not be seen unless the child has recently been fed, and if they are sluggish in appearing a little gentle stimulation below the left costal margin will often succeed in eliciting them. In many cases the overgrown

pylorus can be felt as a tumour by pinching up the deep structures in the right hypochondrium. Sometimes, however, it is so tucked up under the liver that it cannot be felt.

Complications and Sequelæ.—The complication most to be dreaded is the supervention of an infective diarrhœa, which in these cases is very apt to prove fatal. Some degree of acidosis is also apt to develop in severe cases. There are no sequelæ of the disease; if recovery takes place, it is complete and permanent, and indeed, many of the patients ultimately attain a degree of health and development beyond the average. The hypertrophy of the pylorus disappears.

Course.—The course of the disease varies greatly in different cases, and depends also to a large extent upon the treatment adopted, but unless operation is resorted to, it is always prolonged and recovery gradual. Even when the vomiting ceases, the weight may for long fail to rise, and the child may remain in a state of inanition, during which intercurrent disease may easily supervene.

Diagnosis.—This should not be difficult, provided the existence of the disease is remembered. The vomiting is distinguished from that of indigestion by its projectile character, and the coexistence of constipation is characteristic. The great diagnostic, however, is the presence of the visible peristalsis, and in the absence of this it is unwise to conclude that the disease is present. Mild cases of pyloric spasm may simulate true stenosis, but in these the symptoms are less severe, and definite waves of peristalsis are absent. The patient is often a girl. Stenosis of the duodenum from congenital malformation may simulate pyloric stenosis, but the symptoms in the duodenal cases date *from birth*, and bile is present in the vomited matter.

Prognosis.—It is very difficult to estimate the chances of recovery or the relative merits of different forms of treatment statistically. Much depends upon the severity of the particular case, but in general it may be stated that no case is so severe that recovery is impossible. Cases treated in private do much better than those seen in hospital.

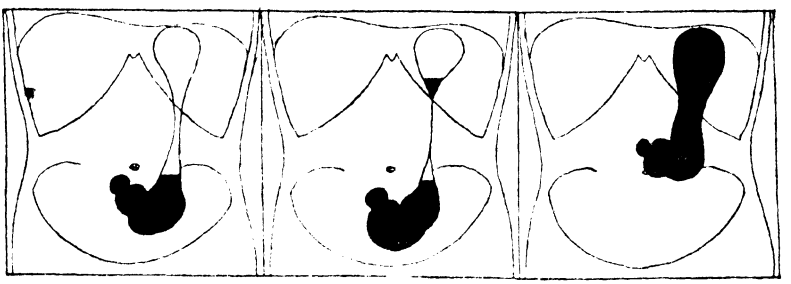
Treatment.—There are two methods of treatment—medical and surgical. Medical treatment consists in washing out the stomach once or twice daily with warm water, and carefully regulating the feeding. If breast milk is not available, dilute peptonised milk is the best substitute, and should be given in quantities of one or two ounces every 2 or 3 hours, depending upon the degree of vomiting. Drugs are of no help. If under this treatment the vomiting ceases, and the weight begins to rise, good and well. If not, or if the symptoms have set in early and with great severity, operation should be had recourse to, Rammstedt's plan of splitting the pylorus longitudinally being the procedure to be preferred.

ROBERT HUTCHISON.

HOUR-GLASS STOMACH

Ætiology.—*Functional hour-glass stomach* occurs when atony is associated with ptosis of the stomach (orthostatic form). The sagging of the dropped organ when food enters it is so great that the lumen of its body is obliterated; when more food is eaten it is held up in the proximal segment of the stomach. The obstruction disappears on lying down (Fig. 19). When a gastric ulcer

is situated in the body of the stomach a spasmodic stricture may occur, which varies in degree from time to time, and disappears when the abdominal muscles are vigorously contracted. A less persistent spasm may occur as a reflex result of duodenal ulcer, disease of the gall-bladder, and appendicitis. *Organic hour-glass stomach* results from cicatrisation of a gastric ulcer (Fig. 20),

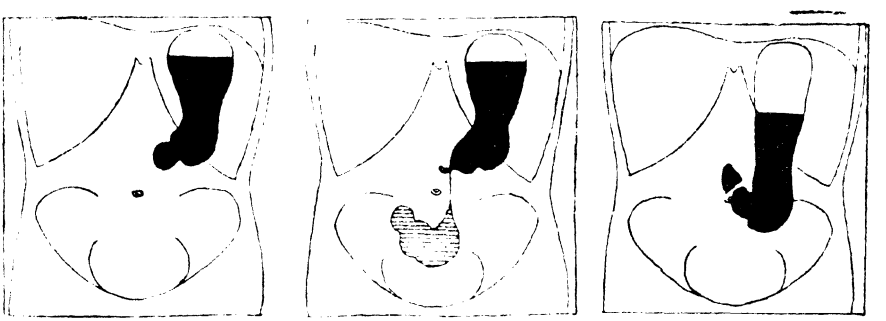


(*a*) (*b*) (*c*)

FIG. 19.—Orthostatic hour-glass constriction in dropped and hypotonic stomach. (*a*) Stomach partially filled; (*b*) hour-glass formed by weight of food in lower segment of stomach; (*c*) hour-glass constriction disappears with disappearance of ptosis on lying down.

and very rarely from syphilis or cancer. This condition is much more common in women than men.

Symptoms.—The symptoms of orthostatic and spasmodic hour-glass stomach are respectively those of atony and of the primary organic disease. In organic hour-glass stomach a history pointing to the existence of a chronic



(*a*) (*b*) (*c*)

FIG. 20.—Organic hour-glass constriction of stomach. (*a*) Immediately after opaque meal, before anything has passed into lower segment; (*b*) Lower segment now filled; crater of chronic ulcer on lesser curvature filled with barium. (*c*) After gastro-gastrostomy.

gastric ulcer for many years can almost always be obtained. The symptoms are similar to those of pyloric obstruction due to ulcer, with the exception that the amount vomited is generally less, and greater relief is obtained on lying down. Visible peristalsis cannot be observed, unless the proximal segment is unusually large. The X-rays are the only reliable method of

diagnosis: the constriction can be seen whether the patient is standing or lying down, and in the former position the neck passes from a point somewhat above and to the right of the lowest part of the proximal segment. In most cases the crater formed by the ulcer on the lesser curvature can also be recognised.

Treatment.—In organic hour-glass stomach an anastomosis should be made between the upper and lower segments of the stomach (gastro-gastrostomy). Gastro-jejunostomy and partial gastrectomy should never be performed, unless pyloric obstruction is also present, in which case gastro-jejunostomy is required in addition to a gastro-gastrostomy.

ARTHUR F. HURST.

DISEASES OF THE INTESTINES

EXAMINATION OF THE INTESTINES

SIZE, SHAPE AND POSITION OF THE COLON

THE cæcum and iliac colon are the only parts of the bowel which are always palpable under normal conditions. In very thin individuals and in patients with very lax abdominal muscles the whole colon, except the splenic flexure and the pelvic colon, can often be felt. Apart from these conditions, the colon may become palpable when in a state of spasm or when filled with hard fæces, and tumours involving it can often be recognised by abdominal examination. In all intestinal cases a rectal examination must be made, as by this means not only the rectum but also part of the pelvic colon can be palpated. For a thorough investigation of the size, shape and position of the whole colon in the erect as well as the horizontal postures an X-ray examination after a barium meal is essential. The pelvic colon, and less frequently the descending and iliac colon, cannot always be seen satisfactorily, as they may only be full in the early morning, and defæcation empties them completely before it is convenient to make an examination. In such cases a barium enema renders all parts of the colon easily visible; the artificial distension produces a considerable amount of distortion, the error due to which can be overcome by making an additional examination after most of the fluid has been allowed to escape.

MOTOR FUNCTIONS

(*a*) *Palpation.*—In all cases of chronic constipation an abdominal and rectal examination should be made. It is important that no medicine or enemata should have been taken for 24 hours, but before this the colon should be emptied by whatever means are most effective. The abdomen and rectum can then be examined in order to ascertain whether there is an accumulation of fæces in any part of the large intestine after an attempt has been made to open the bowels without artificial assistance. An accumulation of fæces in the cæcum and ascending colon or in the transverse colon indicates stasis in these situations. If more than a very small quantity is found in the rectum and the patient has no desire to defæcate, dyschezia can

be diagnosed. On the other hand, if the rectum is almost or completely empty, the constipation must be due to delay in the passage through the intestines, except in the somewhat rare cases of dyschezia in which there is inability to pass fæces from the pelvic colon into the rectum; a mass of hard fæces can then generally be felt through the anterior wall of the rectum.

(*b*) *The charcoal method.*—By giving two or three charcoal lozenges with some food 8 hours after defæcation and observing after what interval black fæces are passed, the total time taken in their passage through the alimentary canal can be ascertained. If, for example, a patient's bowels have been opened at 8 a.m., charcoal should be given at 4 p.m. the same day. If some of the charcoal is not passed at the latest the second morning after it was taken, the patient must be regarded as constipated. The method has, however, the great disadvantage of giving no indication as to the part of the bowel in which stasis occurs.

(*c*) *X-ray examination.*—The only reliable means of determining whether a patient is suffering from chronic intestinal stasis, and of ascertaining exactly what parts of the alimentary canal are at fault, is a series of examinations with the X-rays.

Examination with the fluorescent screen gives much more information than is obtainable from radiograms. If the bowels are not spontaneously opened, an enema should be given on two consecutive mornings, on the second of which the opaque meal is taken. It is very important to discontinue the use of all aperients for at least 48 hours before the first examination, as the intestinal functions might otherwise be observed whilst still under their influence instead of under natural conditions. No more aperients and no enemata should be used till the examination is finished, but the patient should make an attempt each morning to open the bowels naturally. If the attempt is successful, the stools should be examined in order to ascertain whether any of the salt has been evacuated. During the whole period of the examination the patient should follow his usual occupations and take his ordinary diet, in order that the activity of the bowels may be investigated under natural conditions. An examination should be made in the morning and evening of each day until all or most of the barium sulphate has been passed in the fæces or has reached the rectum.

(*d*) *Barium enemata.*—Although an opaque meal is the best means of obtaining information of the motor functions of the colon, an opaque enema generally gives earlier and more exact information concerning the possible presence of a stricture, especially in the pelvic colon, which cannot often be satisfactorily examined by the former method. A suspension is made by adding barium sulphate to a mixture of a pint and a half of water with 1½ ounces of acacia mucilage. The patient lies on his back, and the fluid is run in from a funnel at a pressure of between 1 and 2 feet through a tube introduced just within the rectum. It often reaches the cæcum in a minute and almost invariably within 5 minutes. Patients rarely experience any difficulty in retaining the fluid until the examination is complete, when part can be run out through the tube by which it was introduced, the rest being evacuated in the ordinary manner.

An organic stricture of the colon generally obstructs the passage of the fluid, the shadow ending at the seat of the obstruction, which can be overcome only incompletely or not at all by waiting an additional 10 minutes, by increasing

the pressure of injection, by massage and by changes in posture. The flow of the enema is often prevented in cases of growth, long before there is any clinical evidence of obstruction; the bowels may still act normally, or diarrhœa may be present, and an opaque meal may pass through the whole colon without delay. This is probably due to the occurrence of a spasmodic contraction of the bowel, which occurs at the seat of obstruction as soon as the enema reaches and distends the part immediately below it. An opaque meal or, more readily, an opaque enema may show the presence of a filling defect in the colon caused by a growth. It also shows the exact length and position of strictures due to other causes, and it is the only way in which the presence of diverticula can be definitely determined.

Examination of Fæces

The consistence, smell, colour and reaction of the stools should be noted, abnormal acidity indicating excessive fermentation and abnormal alkalinity excessive putrefaction. The presence of mucus, blood or pus indicates organic disease; if the two former are intimately mixed with the stools, the blood being only present in an altered condition recognisable by chemical means, but not by the microscope, they probably come from the small intestine: the larger the fragments of mucus and the brighter the colour of the blood the lower is their source. The presence of pus always indicates disease of the colon, as any produced in the small intestines is digested. The presence of excess of undigested meat or vegetable food should be noted.

Pale, bulky stools generally indicate the presence of excess of fat. It is important to ascertain whether this is chiefly in the form of neutral fat, as in pancreatic insufficiency, or in the form of fatty acids and soaps, as in deficient absorption caused by obstruction of the lacteals with normal pancreatic digestion. This can generally be decided by microscopical examination, but in doubtful cases an accurate chemical analysis should be undertaken.

Microscopic examination may reveal the presence of blood corpuscles, pus, amœbæ or their cysts and the ova of intestinal worms in addition to fragments of animal and vegetable food which have escaped digestion.

Occult blood.—When blood is swallowed or is derived from an ulcer or growth in the stomach or an ulcer in the duodenum, it is evacuated in the stools partly as acid hæmatin and partly as hæmatoporphyrin. Both also appear in the stools when the blood originates in the colon unless diarrhœa is present, when the blood does not remain in the bowel long enough for the former to be converted into the latter. The chemical tests for "occult blood"—traces of blood insufficient to produce any change in the appearance of the fæces—depend upon the conversion of a substance with little or no colour, such as guaiac or benzidine, into a coloured substance when oxidised by hydrogen peroxide in the presence of a carrier, such as hæmatin. Hæmatoporphyrin, which contains no iron, does not give the reaction. The spectroscopic examination of the stools should also be used, as traces of hæmatoporphyrin, which is occasionally present in the absence of acid hæmatin, would otherwise escape recognition. Moreover, a positive spectroscopic finding is valuable confirmation of a positive chemical

reaction, as, although it is much less sensitive, there is less chance of error.

Before examining the stools, the patient is given a hæmoglobin-free diet. Chlorophyll should also be excluded, as it gives a feebly positive guaiac reaction and its many-banded spectrum may cause confusion in the spectroscopic examination. A charcoal biscuit is given with the first meal on the restricted diet, and the first and subsequent stools passed when the fæces are no longer blackened by the charcoal are examined. For the guaiac and spectroscopic tests a small amount of fæces is macerated with glacial acetic acid into a thin paste. An equal quantity of ether is then added to extract the pigment; the ethereal extract is poured off, some being kept for the spectroscopic examination. Two or three drops of tincture of guaiac are added to the remainder; a small quantity of ozonic alcohol is then poured in, and a change of colour is looked for at the junction of the two fluids. A "positive reaction" is one in which a deep blue colour rapidly appears; a "feebly positive" reaction is one in which the colour is faint purple, bluish, or greenish.

A positive guaiac reaction signifies the presence of occult blood, and a positive spectroscopic examination shows that it is present in fairly considerable quantities. A negative guaiac reaction proves the absence of occult blood, except occasionally at the end of a period of hæmorrhage, when the spectroscopic test may alone be positive, as the traces of blood still present may then be completely converted into hæmatoporphyrin, which gives a characteristic spectrum, but does not give the chemical reactions.

In the absence of hæmorrhoids and of bleeding from the mouth, throat and nose, the presence of occult blood is strong evidence that ulceration is present in the stomach or intestines. When symptoms pointing to gastric or duodenal ulcer and gastric carcinoma are absent, a suspicion of cancer of the intestine receives important confirmation.

A bacteriological examination of the stools should always be made in cases of diarrhœa, with or without colitis. The presence of a relative excess of streptococci, or the presence of abnormal varieties of the *B. coli*, or of enteric, parenteric, dysentery and tubercle bacilli, may be discovered. If a sigmoidoscopic examination is made, a swab should be taken for bacteriological examination directly from the mucous membrane; if any mucus is seen, this should be taken for the purpose. In doubtful cases the agglutinating power of the patient's blood for the bacteria isolated from the stools should be tested.

Sigmoidoscopic Examination

In all cases in which there is any possibility of organic disease of the pelvic colon or rectum a sigmoidoscope should be passed after a preliminary digital examination. No special preparation is required, but the patient should endeavour to get his bowels emptied as completely as possible before the evacuation without the aid of aperients or enemata. The sigmoidoscope is passed most satisfactorily without an anæsthetic in the knee-elbow position. If digital examination is painful owing to inflammation of the anal canal, a cocaine sempule should be applied in order to anæsthetise it before the sigmoidoscope is passed.

Arthur F. Hurst.

FUNCTIONAL DISORDERS OF THE INTESTINES

CONSTIPATION

Definition.—Constipation may be defined as a condition in which none of the residue of the first meal taken after defæcation is excreted within the next 48 hours.

Ætiology and Pathology.—Constipation may be due to (1) the passage through the colon being delayed, whilst defæcation is normal—*colic constipation*; (2) the evacuation from the pelvic colon being inadequately performed, whilst the passage through the colon is normal—*dyschezia*; and (3) insufficient formation of fæces.

1. *Colic constipation.*—Delay in the passage of fæces through the intestines is due to their motor activity being deficient, or to the force required to carry the fæces to the pelvic colon being excessive. The motor activity of the colon may be deficient owing to weakness of its musculature, deficient reflex activity, inhibition, or uncontrolled and irregular action. Weakness of the musculature may be due to congenital hypoplasia, which is the cause of the constitutional constipation from which several members of a family may suffer; acquired hypoplasia, which is the cause of senile constipation and the constipation which may follow such local diseases as dysentery; and functional insufficiency without structural change, as in all conditions leading to malnutrition and general ill-health. The reflexes which maintain intestinal activity may be deficient owing to the stimulation being too weak on account of want of exercise or lack of mechanical and chemical stimulants in the food, or to deficiency in hormones, particularly in hypothyroidism. They are also deficient when the excitability of the mucous membrane is impaired as a result of long-continued irritation by purgatives. The inhibitory sympathetic nerves may be stimulated centrally by depressing emotions, and reflexly in painful diseases and injuries of any part of the body, but particularly of the abdominal and pelvic viscera.

Constipation may result from painful spasm, induced reflexly by the presence of an irritant in the colon of a patient with an abnormally excitable nervous system, due most frequently to neurasthenia (*enterospasm, spastic constipation*). The irritant which gives rise to the exaggerated reflexes is in most cases hard fæces, which have been retained as a result of constipation, caused by insufficient and unsuitable food and too little exercise. The reflex may also be excited by disease in other parts of the abdomen, especially chronic appendicitis. Similar spasmodic contractions of the intestines occur as a result of excessive smoking, and in lead poisoning.

The work to be done by the intestinal musculature is excessive when the consistence of the fæces offers more than the normal degree of resistance owing to insufficient consumption of water or its excessive loss in the urine or sweat, and when there is a diminution in the intestinal lumen owing to organic stricture or pressure exerted from without.

2. *Dyschezia.*—Dyschezia is due to a want of proper proportion between the power of expelling the fæces from the pelvic colon and rectum, and the force required to do this completely. It may therefore be due to inefficient defæcation, or to an obstacle to efficient defæcation, such as abnormally

hard and bulky fæces and strictures of the rectum and anal canal. Dyschezia due to inefficient defæcation is the most common cause of severe constipation, and is generally of nervous origin. It often originates in neglect to respond to the call to defæcate owing to laziness, insanitary conditions of the w.c., or false modesty. The rectum gradually dilates so that an increasing quantity of fæces is needed to produce the adequate internal pressure required to give the sensation of fullness, which is the natural call to defæcation. Finally the sensation is lost completely. But the patient is still capable of emptying his rectum if he tries. He has, however, by now often convinced himself that he cannot get his bowels to open unless he takes enemata or such enormous doses of aperients that the fluid fæces practically act as enemata. He thus suggests to himself that his rectum is powerless to act by itself, true hysterical dyschezia being produced.

Dyschezia may be due to various other causes, such as weakness of the voluntary muscles of defæcation, the assumption of an unsuitable position during defæcation, and voluntary inhibition from fear of pain in diseases of the anus and the neighbouring organs. But whatever the primary cause, the final result is the same. The incomplete evacuation of the rectum results in an accumulation of fæces and consequent atony and dilatation of the rectum.

Congenital deficiency of the muscle-sense of the rectum is the cause of the dyschezia of infants, in whom the slight additional distension produced by the introduction of a finger or a piece of soap into the rectum results in an adequate stimulus. In the majority of cases the muscle-sense develops when the infant grows older; but this is occasionally the starting-point of dyschezia which lasts through life. The rectal muscle-sense is abolished or defective in diseases of the spinal cord, in which the defæcation centre itself or the fibres connecting it with the brain are involved.

3. The third great class of constipation is due to the quantity of fæces formed being insufficient to produce an adequate stimulus in the pelvic colon and rectum, and to a less extent in the rest of the colon. The insufficient bulk of fæces is due to an inadequate quantity of food residue reaching the colon as a result of anorexia or of œsophageal or pyloric obstruction, or to excessive digestion of food, the result of a "greedy bowel."

Symptoms.—Many people regard themselves as ill if they do not have one action of the bowels a day; but this is really nothing more than a question of convenience, being found to suit the habits and diet of the majority of civilised people. Perfect health may be maintained by individuals who defæcate regularly two or three times a day, and by others who obtain an evacuation once in 2, 3 or more days. The latter, so long as defæcation, when it does occur, is complete, can no more be regarded as diseased than those otherwise normal people, whose hearts beat only forty or fifty times a minute. The majority, however, although they may suffer no inconvenience for a considerable time, finally develop symptoms due to fæcal accumulation, gradually increasing quantities of fæces being retained. For practical purposes, therefore, an individual may be considered constipated if his bowels are not opened at least once in every 48 hours. A less frequently recognised variety of constipation is that in which insufficient fæces are excreted, although the bowels may be opened every day—a condition analogous to retention of urine with overflow.

It is important to distinguish the symptoms of constipation from those of the conditions which may give rise to it. There is no doubt that neurasthenia, insanity, epilepsy, asthma, nephritis, diabetes, painful pelvic disorders and many other diseases may be greatly aggravated by constipation. Apart from these conditions, headache, mental and physical fatigue, vertigo, anorexia, and pigmentation of the skin may result directly from intestinal intoxication and the reflex effects of constipation. Toxic symptoms rarely develop unless stasis occurs in the cæcum and ascending colon, in which the fæces are still soft. Reflex symptoms, on the other hand, occur chiefly in dyschezia as a result of the pressure produced by hard fæces. The latter differ from the former by their almost instantaneous disappearance on defæcation. Fæcal retention is a common cause of intestinal flatulence and colic. In rare cases a fæcal tumour and fæcal obstruction occur. A fæcal accumulation in the rectum may cause hæmorrhoids, pruritus ani, catarrhal and ulcerative proctitis and neuralgic pains in the back, down the legs, and in the female pelvic organs. Hard fæces make defæcation painful, and their passage may give rise to anal ulcers.

Diagnosis.—It is comparatively rare for a patient to consult a doctor on account of constipation without having already attempted to cure himself with aperients. But no accurate diagnosis can be made until it has been ascertained whether he is actually constipated at all. The symptoms generally ascribed to auto-intoxication caused by intestinal stasis are often really produced by purgatives, which lead to the absorption of excess of toxic material by hastening the half-digested contents of the small intestine into the cæcum, where fermentation and putrefaction are consequently increased, and by causing the contents of the transverse, descending and pelvic colon to be fluid instead of solid, so that absorption of toxins continues throughout the length of the bowel instead of in the cæcum and ascending colon alone. In spite of his probable protests the patient is instructed to see what happens if no drugs are taken for 3 days, an effort being made to open the bowels each morning. In most cases he loses his abdominal pain and his so-called toxic symptoms. The bowels are often opened daily, in which case a diagnosis of *hysterical pseudo-constipation* can be made—hysterical because the patient had suggested to himself, as a result of faulty education combined with the reading of pernicious advertisements, that he was constipated and required aperients to keep himself well, whereas a little psychotherapy, in the form of explanation of the physiology of his bowels and the origin of his symptoms, and persuasion to try to open his bowels each morning without artificial help, result in a cure. In many cases, however, the patient does not succeed in opening his bowels, although he may feel more comfortable than when he was taking drugs. A second abdominal and rectal examination should now be made. If no sign of organic disease is present, and the rectum is found to be filled with fæces, dyschezia can be diagnosed. In spite of this the patient has no desire to open his bowels; a normal individual would feel an urgent call to defæcation under such conditions, but the rectum has been allowed to dilate by being constantly full of fæces and the call to defæcation is no longer felt.

In severe cases it is advisable to examine the intestinal functions with the X-rays, a barium meal being given after the patient has discontinued taking aperients (*Fig.* 21). Ileal stasis should only be diagnosed if no trace of barium

has reached the cæcum 6 hours after the opaque meal, or if a considerable quantity of barium-containing chyme is still in the end of the ileum 10 hours after the meal. If most of the barium is still in the cæcum and ascending colon at the end of 24 hours, stasis is present, even if a little has passed to the more distant parts of the colon; but a faint shadow of the cæcum is often visible in normal individuals even 3 days after the meal. If the splenic flexure was reached in 24 hours, and the greater part of the barium is in the transverse colon at the end of 48 hours, there must be stasis in this part of the bowel.

Treatment.—Under no circumstances should the patient fail to make an effort to open his bowels after breakfast, even if he feels no desire to do so, and a call to defæcation felt at any other hour in the day should be obeyed at once, at whatever inconvenient time it may occur. Sufficient time should always be spent over the act of defæcation, and it is often advisable to pay two visits to the closet at short intervals. In order to prevent the temptation to hurry over defæcation the closet should be clean, devoid of smell, and properly warmed in winter. In dyschezia a footstool 9 inches lower than

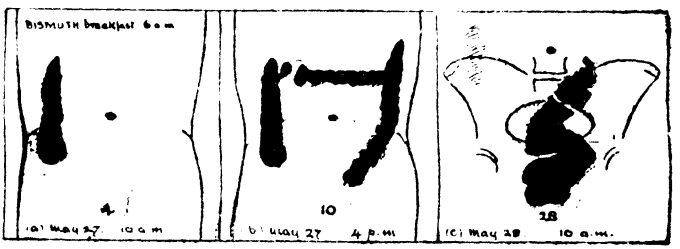


FIG. 21.—Dyschezia in a girl of 17, whose bowels had not been opened for 5 weeks when admitted to hospital. (First case of constipation ever examined with X-rays: February 1907.)

the seat should be provided, and in severe cases the patient should crouch over a bed-pan placed on the floor. In many cases of dyschezia no treatment is required beyond explaining to the patient the nature and cause of his condition, and persuading him to give up aperients and to make an effort to empty his rectum, which he must realise is quite capable of doing its work.

It is most important to see that sufficient food is taken, as constipation is often as much due to its insufficient quantity as to its unsuitable quality. The diet should contain an increased proportion of vegetable foods, especially those which contain much cellulose, organic acids and sugar. Fresh or dried fruit should be taken three times a day, and green vegetables or salad should be eaten at lunch and dinner. Stewed prunes taken at breakfast, the number being regulated according to the degree of constipation, are especially valuable. Porridge and cream and wholemeal brown bread are also useful. Care should be taken that sufficient fluid is drunk; a glass of cold water taken on rising in the morning often helps the bowels to act after breakfast.

The majority of cases of constipation can be cured without drugs if proper treatment is instituted at a sufficiently early stage. In dyschezia

purgatives are either absolutely useless or they only have an effect when fluid stools are produced, a considerable quantity of fluid and nutritive material being thereby wasted. In the treatment of diseases which are aggravated by coexisting constipation, purgatives should be regularly given. They are also useful for making the stools soft when defæcation is painful as a result of inflamed hæmorrhoids or anal ulcer and in diseases of the pelvic organs, and when straining at stool is accompanied by danger, as in patients liable to cerebral hæmorrhage. In those cases of constipation due to other causes, in which non-medical treatment proves insufficient, purgatives must also be used, but an effort should be made to dispense with drugs at the earliest possible moment. The stool produced by an aperient should be normal in size and consistence; the dose should be so regulated that one stool is passed every day and the desire to defæcate is felt immediately after breakfast. An infusion of senna pods in cold water is particularly useful, as the dose can be regulated from day to day by the patient; an attempt should be made at intervals to reduce the number used by one at a time, until finally none may be required. The aperient should cause no pain or discomfort, and should not irritate the intestinal mucous membrane sufficiently to produce any inflammatory change. If it is probable that the purgative will be required permanently, one such as aloes, cascara or senna should be chosen, which is likely to maintain its good effect without any increase in the dose being required.

In constipation due to a greedy colon the bulk of the fæces must be increased by the administration of some unirritating substance, such as liquid paraffin or agar-agar, which passes through the intestines without undergoing decomposition or absorption. Liquid paraffin is particularly valuable when the fæces are hard and dry; it is therefore useful in other varieties of constipation besides that due to a greedy colon, as fæces always become hard and dry as a result of their abnormal retention in the bowel. In dyschezia also the soft stools which result from its use are expelled with less difficulty than ordinary fæces. From 1 drachm to 1 ounce should be taken immediately after meals two or three times a day.

The majority of cases of moderately severe constipation are more or less cumulative, excess of fæces being always present in the large intestines. It is therefore necessary that the colon should be completely evacuated before other methods of treatment are adopted. This can best be done by washing the colon out with a pint and a half or two pints of warm water run into it from a douche can at low pressure through a tube inserted just beyond the anal canal. In rare instances the rectum can only be emptied by means of the finger.

It is essential in treating dyschezia to keep the rectum and pelvic colon empty, so that they may in time regain their normal tone and contractile power. This can be accomplished by the use of enemata of water or glycerine every morning, but only if a prolonged attempt to defæcate naturally has proved unsuccessful. The bulk of the water enemata and the strength of the glycerine enemata should be gradually reduced. As a rule the tone and contractile power slowly return and a cure finally results.

Regular exercise in the open air is one of the most important means of preventing constipation, especially in individuals who follow a sedentary occupation. When any of the voluntary muscles of defæcation are weak, considerable benefit can be gained by the performance of Swedish exercises

every morning and evening. Special attention should be devoted to the levator ani muscles, especially in women in whom the pelvic floor has been injured during parturition, and in cases in which there is any tendency to prolapse on straining at stool (*vide* p. 676). If constipation is due to want of activity of the intestinal musculature, the condition of the latter may be improved by deep abdominal massage. This should be directed particularly to the part of the colon in which the X-rays have shown that stasis occurs. Its efficacy is greatly increased if the first treatment is given during an X-ray examination, as the masseur can then see the exact position of the colon and can find what manipulations have most effect upon it.

DIARRHŒA

Definition.—Diarrhœa is a condition in which fluid stools are passed. Defæcation generally occurs several times in the day, but mere frequency of defæcation is not diarrhœa, for this may even be associated with constipation. The bulk of fæces excreted in 24 hours is generally excessive, but this again is not an essential factor, as excessive fæces are occasionally formed when the passage through the alimentary canal is not abnormally rapid. The one essential factor in diarrhœa is the abnormally rapid passage of the food residue through the alimentary canal; diarrhœa is therefore the direct counterpart of the form of constipation which I have called colic constipation.

Ætiology.—1. Excessive Stimulation of Motor Activity.—The most common cause of diarrhœa is the presence in the food of excess of the mechanical and chemical stimulants of intestinal activity. Thus over-indulgence in green vegetables, salads, and still more frequently fruit, is a familar cause. Chemical irritants may also be swallowed in decomposing food, as in some cases of fish and meat poisoning, but food more often causes diarrhœa by giving rise to a bacterial infection of the intestine than by the introduction of pre-formed toxins. Diarrhœa very frequently results from the habit of taking aperients, either in excess of what is required for the correction of chronic constipation, or even when the bowels left to themselves would act quite normally. Thus many of the symptoms often ascribed to constipation are really due to the diarrhœa caused by purgatives, as it results in the absorption of excess of poisons from the too fluid fæces.

Chronic diarrhœa is most commonly due to infection with some pathogenic organism which gains access to the intestines in contaminated food or water. Acute diarrhœa is most frequently the immediate result, but it often becomes chronic, or it disappears temporarily and is followed by recurrent acute attacks, which may be separated by periods of constipation. In some cases the infection is derived from a septic focus in the mouth, nose or pharynx, and in rare cases chronic appendicitis is the source of a chronic infection of the colon. Some infective bacteria, such as the paratyphoid group, act chiefly on carbohydrates and may lead to excessive fermentation. Others, such as streptococci and various anaerobes, act on proteins and lead to putrefactive diarrhœa. Intestinal carbohydrate dyspepsia (*vide* p. 582) only rarely gives rise to diarrhœa in spite of the excessive growth of enterococci, but deficient digestion of proteins, either resulting from gastric or pancreatic insufficiency, may lead to a non-infective putrefactive diarrhœa. Deficient digestion of

fat owing to pancreatic insufficiency or obstruction to the outflow of pancreatic juice in obstructive jaundice occasionally leads to *fatty diarrhœa*, which must be distinguished from *chylous diarrhœa* in which excess of fatty acids and soaps are passed owing to obstruction of the lacteals by disease of the mesenteric glands.

Diarrhœa is often gastric in origin. This *gastrogenous diarrhœa* may occur when the gastric juice is deficient or absent. An abnormal number of organisms reaches the intestines in these circumstances, as the partial protection afforded by the bactericidal action of the hydrochloric acid in the stomach is lost. As the connective tissue of meat and the cellulose of vegetables are normally softened by the hydrochloric acid of the gastric juice, undigested lumps of meat and fragments of vegetable leave the stomach and pass through the small intestine to the colon, where they are liable to undergo bacterial decomposition. The irritation of the mucous membrane of the intestines by the insufficiently divided fragments of food and by the products of bacterial decomposition leads to diarrhœa, which may become aggravated by secondary entero-colitis if the irritation is sufficiently intense or prolonged. Similar gastrogenous diarrhœa may occur after the performance of a gastro-jejunostomy, the food leaving the stomach with such rapidity that the intestines are overwhelmed with undigested and irritating food.

Lastly, chemical stimulants to intestinal activity may be produced in the body and excreted into the colon; this is the cause of diarrhœa in uræmia, Graves' disease and septicæmia.

2. Over-excitability of the Neuro-muscular Mechanism which controls the Intestinal Movements.—(*a*) *Lienteric or post-prandial diarrhœa.*—Under normal conditions the entry of food into the empty stomach gives rise to a gastro-colic reflex, which is the chief stimulus to the movements of the colon. In most individuals this is only followed by defæcation after breakfast, as the pelvic colon is then full, and the sudden passage of fæces from it into the rectum gives rise to the call to defæcation. Sometimes the gastro-colic reflex is abnormally active. This may only manifest itself after breakfast; a formed stool is passed first, but in the course of the next half-hour or hour one or more loose stools are passed in addition. In severer cases the bowels are also opened after dinner and less frequently after lunch, the stools again being often soft or fluid, in contrast with the first stool passed in the day, which is generally solid.

(*b*) *Nervous diarrhœa.*—It is not uncommon for a fright to result in the immediate passage of a semi-fluid stool. In some patients, who are often not otherwise neurotic, attacks of diarrhœa occur whenever they are in any place where it would be awkward for them to relieve themselves: when this has once happened, it is likely to recur under similar circumstances, largely owing to fear that it will do so. Lienteric and nervous diarrhœa are often associated together, a patient suffering from the former being particularly likely to feel an urgent desire to defæcate if he is at a dinner party or in a railway carriage without a lavatory.

Diarrhœa, whatever its cause may be, tends to be worse after meals, especially breakfast, and it is occasionally also influenced by nervousness; it is important, therefore, to exclude some other primary cause before diagnosing a case as one of pure lienteric or pure nervous diarrhœa.

(*c*) *Irritable colon.*—When the mucous membrane of the colon is in-

flamed or ulcerated, any mechanical or chemical stimulant is likely to produce an excessive reflex response, so that the diarrhœa which is probably already present is aggravated. Apart from this, many people, who have lived in the tropics and have suffered there from dysentery, or diarrhœa due to some less defined cause, continue to be liable to diarrhœa for many years after their return to a temperate climate.

Symptoms.—The chief and often the only symptom of diarrhœa is the abnormally frequent passage of abnormal stools. In severe cases of diarrhœa discomfort or even pain is felt over the whole of the lower part of the abdomen for a short time before the bowels are opened. It may be followed by a sensation of soreness, but the abdomen is neither tender nor rigid, and warm applications generally relieve it. Occasionally severe colic occurs, which may be temporarily relieved each time the bowels are opened or flatus is passed. The passage of a large and watery stool is often followed by a feeling of exhaustion and faintness, which may be accompanied by sweating and coldness of the extremities and occasionally even by syncope.

In severe cases of acute diarrhœa and in persistent cases of chronic diarrhœa the nutrition suffers and the patient loses weight; sometimes an extreme degree of emaciation results. When the diarrhœa is associated with abnormal bacterial activity in the intestines, especially if this is of the putrefactive type, more or less severe symptoms of intestinal intoxication, indistinguishable from those which are sometimes associated with severe intestinal stasis, may develop.

Diagnosis.—When a patient complains of diarrhœa, it is first necessary to ascertain whether the passage of fæces through the intestines is really taking place with abnormal rapidity. Many people think that frequent defæcation, particularly if the stools are in part fluid, is sufficient evidence that diarrhœa is present, whereas this is by no means necessarily the case. The stools of every patient supposed to be suffering from diarrhœa should be examined; if they are of a uniform semi-solid or fluid consistence, true diarrhœa is probably present, whereas numerous stools, if they are small and solid, and fluid stools containing small solid fragments suggest a diagnosis of *pseudo-diarrhœa*. In a doubtful case 2 or 3 charcoal lozenges should be given with some food immediately after the bowels have been opened in the morning; each stool is now examined, and the time which elapses before black fæces are passed is noted. If charcoal is seen in the stools within 12 hours true diarrhœa is present; if in less than 4 hours, the small intestine must be involved as well as the colon. If no charcoal appears within 48 hours, constipation and not diarrhœa is present. A series of X-ray examinations after a barium meal affords a more accurate method of determining the rate of passage through the alimentary canal, and it has the advantage of showing in what part of the bowel the rate is excessive.

The most common cause of pseudo-diarrhœa is dyschezia: although the rectum is never properly emptied, the patient may feel a constant desire to open his bowels, and as a result of his efforts a very small quantity of hard fæces may be passed. If, as is often the case, the constant presence of fæces in the rectum gives rise to catarrhal proctitis, more or less mucus is passed in addition. In slight cases there may be nothing more than a thin layer of mucus over the hard lumps of fæces; in severer cases a larger quantity of fluid mucus, which is often stained brown, is passed either alone or with hard

particles of fæces. In all such cases the discovery of solid fæces in the rectum, immediately after the bowels have been opened, should remove any further doubt as to the diagnosis. A growth of the rectum or pelvic colon and less frequently a growth in other parts of the colon, though rarely on the proximal side of the splenic flexure, may lead to pseudo-diarrhœa, fæces being retained above the growth, whilst the serous and often blood-stained exudation from its surface, and mucus produced by the irritant action of the exudation on the mucus membrane below it, are passed at more or less frequent intervals, so that the patient regards himself as suffering from diarrhœa. The character of the stool should at once make it obvious that further examinations by means of the sigmoidoscope and with the X-rays after a barium meal and a barium enema are required, even if nothing abnormal is felt in the abdomen or on rectal examination.

When it is known that genuine diarrhœa is present, it is next necessary to determine whether it is due to a functional or an organic cause. The history is often a great help; lienteric or nervous diarrhœa dating from childhood, especially if other members of the patient's family are similarly affected, is almost certainly either functional or due to constitutional achylia gastrica.

A very acute onset suggests that the cause is some toxic or infective agent, whereas a more gradual onset of chronic diarrhœa in a middle-aged individual, who has hitherto been regular or constipated, suggests the presence of a growth. A careful abdominal and rectal examination should be made in every case; the former may reveal the presence of a tumour or an abnormally dilated or contracted condition of the colon; by means of the latter the existence of ulcerative colitis may be recognised, as well as the presence of a growth in the rectum or pelvic colon. In doubtful cases a sigmoidoscopic examination should also be made before deciding that the diarrhœa is functional in origin, as the mucous membrane of the accessible part of the colon is almost always involved when diarrhœa is due to some form of colitis.

The examination of the stools is of the greatest importance, as it gives valuable indications for treatment as well as helping in diagnosis. The presence of mucus, blood or pus indicates either some form of colitis or a growth. Excess of vegetable residue is often recognisable in fermentative diarrhœa and of animal residue in putrefactive diarrhœa, when these are due to deficient digestion of carbohydrates or proteins respectively. The fæces are often frothy, and have an acid smell and reaction when fermentation is excessive; they may be alkaline and have a putrefactive odour when excessive putrefaction is present.

The stools passed when fat is insufficiently digested or absorbed are easily recognised by their pale colour and enormous bulk. If the excess is in the form of neutral fat, the stools are oily (fatty diarrhœa), and pancreatic insufficiency can be diagnosed; on giving a fat-free diet, excess of striated meat fibres and vegetable residue is still present. This condition is, however, very rare in the absence of jaundice indicating obstruction of the common bile-duct. More frequently most of the fat is present as fatty acid and soaps (chylous diarrhœa), showing that pancreatic digestion is normal, but that absorption is deficient owing to obstruction of the lacteals by tuberculous, simple inflammatory, or secondary malignant disease of the mesenteric glands.

In most cases the stools become perfectly normal on a fat-free diet, the digestion of meat and vegetable food being unaffected. Almost all the calcium in the food combines with fatty acid to form calcium soap in this condition; the blood calcium is consequently diminished, and tetany may result. In children growth is greatly impaired, and the long bones are soft and may bend, with the production of various deformities.

A bacteriological examination should always be made, in the hope that the nature of any infection which is present may be discovered.

Prognosis.—If thorough treatment is instituted from the onset, the prognosis of diarrhœa is good, unless it is due to some serious organic disease. If, however, it is neglected, strict treatment must be continued for a prolonged period in order to be successful. This is particularly the case when the diarrhœa is infective in origin.

The tendency to lienteric and nervous diarrhœa often remains throughout life, though considerable improvement and even a cure can result from treatment. Unlike other forms of diarrhœa, they rarely affect the general health, and are chiefly troublesome on account of the inconvenience they cause.

Treatment.—*Acute Diarrhœa.*—If a patient is seen within 12 hours of the onset of an attack of acute diarrhœa due to food poisoning, he should be given from ½ to 1 ounce of castor oil to clear the irritant material out of the small as well as the large intestine, unless the diarrhœa is so severe that it appears probable that this has already occurred. No food should be given for 24 hours, or even longer in severe cases, but the patient may drink as much water as he likes. Arrowroot made with water should then be given, but nothing else until the diarrhœa has ceased. Milk, junket, bread and butter, and milk puddings are next allowed, after which a gradual return should be made to an ordinary diet, the speed with which this is done depending on the severity of the case. The only drugs which are of real use in acute diarrhœa are opium and its alkaloids. If the diarrhœa shows no signs of abating after 24 hours, some preparation of opium, morphine or codeine should be given, the dose being regulated according to the severity of the diarrhœa and the general condition of the patient, but sufficient must be given to stop the diarrhœa in 48 hours.

Chronic Diarrhœa.—In all cases of chronic diarrhœa recovery occurs most rapidly if the patient remains in bed during the first few days of treatment. In many instances diarrhœa, which may have been present for months, disappears in a few days and the patient may even become constipated. Unless, however, other treatment is instituted, the diarrhœa is very likely to return as soon as he gets up again. As the improvement which results from staying in bed is due in part to the rest and in part to warmth, it is important for the patient to avoid over-exertion and to keep his abdomen warm by means of a woollen binder for a considerable period after the symptoms have disappeared. Exposure to cold should be avoided as much as possible, and if the patient feels chilled at any time he should have a hot bath and go to bed at once; by this means he is likely to prevent a recurrence. Patients who have recently suffered from chronic diarrhœa should never go to the tropics, and they should even avoid visiting the southern parts of Europe, as a slight intestinal attack from bad food is likely to have much more serious results with them than in an individual who has not before suffered from any intestinal disorder.

The successful treatment of chronic diarrhœa depends upon the recognition of its cause. The treatment of diarrhœa which is secondary to organic disease of the intestines, such as colitis and cancer, is considered elsewhere.

1. Excessive Stimulation of the Intestinal Movements.—Whatever the actual cause of the diarrhœa it is important to avoid anything which could produce mechanical irritation of the colon. The food should be thoroughly chewed, and anything, such as new bread, cheese and tough meat, which is difficult to break up completely, should not be eaten. The patient must avoid all raw vegetables in salads and pickles, and cooked green vegetables are only allowed as purées. The pips and skins of fruit, whether raw, cooked or in jam, and currants, raisins and lemon peel in puddings and cakes must be avoided.

In *fermentative diarrhœa* all food containing starch and cellulose should at first be completely excluded from the diet. When the diarrhœa has stopped, cellulose-free starch, such as arrowroot, may be given, but no potatoes, white bread or rice for 3 or 4 weeks, and no vegetables containing a greater quantity of cellulose until still later. A lacto-vegetarian diet is most suitable for *putrefactive diarrhœa*. Capsules of *B. acidophilus* should be given three times a day between meals. No meat should be allowed until the diarrhœa has ceased for 4 weeks, and high game or over-ripe cheese should not be eaten for many months.

Fatty and chylous diarrhœa stops at once on a fat-free diet. In severe cases, in which obstruction of the lacteals is present, it may be necessary for the patient to continue with this diet for the rest of his life.

Gastrogenous diarrhœa rapidly improves on the diet already described as suitable for putrefactive diarrhœa, but a relapse is certain to follow a return to an ordinary diet unless hydrochloric acid is given (see Achylia Gastrica).

2. Nervous and Lienteric Diarrhœa.—Nervous diarrhœa is often completely uninfluenced by diet, but drugs, which diminish the activity of the gastro-colic reflex either peripherally or centrally, are very effective. A mixture containing 5 grains of potassium bromide and 5 minims of tincture of belladonna taken immediately before meals is all that is required in mild cases; in severer cases a small dose of codeine should be added. The exact dose of each drug must be varied to suit each patient, as different individuals react very differently to these drugs, especially to belladonna. When the diarrhœa has been completely controlled, the quantity of each drug should be gradually reduced; then the doses before lunch and dinner and finally that before breakfast can be discontinued. In most cases it is still advisable to allow the patient to have the medicine or a pill containing belladonna and codeine always with him, so that he can take a dose before going to a dinner party or any other occasion, when he fears that he will have diarrhœa. He soon learns to trust so thoroughly in his pill that it probably acts more by suggestion than in any other way, and the dose can accordingly be progressively reduced until it is infinitesimal.

As in many cases of diarrhœa due to other causes the bowels act most frequently after meals, the treatment just described is often of use in conjunction with that required for the primary condition.

Arthur F. Hurst.

Epidemic Diarrhœa in Children

Synonyms.—Summer Diarrhœa; Infective or Infectious Diarrhœa; Acute Gastro-Intestinal Infection; Acute Ileo-Colitis; Cholera Infantum.

The form of diarrhœa here spoken of is one of the chief scourges of infant life, though certainly much less common than formerly. It prevails epidemically in the third quarter of the year, although sporadic cases may be met with at any time, and in hot seasons may become widespread, especially in large towns. It chiefly affects children below the age of 5, but is most fatal in the first year. Boys are more susceptible than girls.

Ætiology.—It is generally agreed that the disease is caused by infection with micro-organisms; but in spite of much research the bacteriology is by no means clear. It would appear that all cases are not due to the same organism, and amongst those which have been isolated from the stools in different epidemics are the *Proteus vulgaris*, the *Bacillus coli*, streptococci, the *B. enteritidis*, Morgan's bacillus, and various strains of dysentery bacilli. Any of these, or several of them in combination, seem to be capable of inducing the affection, given the predisposing conditions. Of the latter by far the most important is a sustained high temperature (60° F.) of the air and, particularly, of the soil. As was pointed out long ago by Ballard, it is when the temperature recorded by the four-foot earth thermometer reaches 56° F. that cases begin to occur. Such a temperature probably provides the conditions necessary for the growth of the infecting organism.

Next in importance as an ætiological factor must be put the influence of unhygienic surroundings, such as dirt, overcrowding, a contaminated milk supply, and want of cleanliness in feeding utensils. The infection is probably often conveyed by dust, and flies may act as carriers.

Any digestive derangement in the child may predispose to infection, and bottle-fed infants are specially liable. The disease appears to be to some degree contagious, and if introduced into a ward is apt to spread to unaffected infants. The influence of age and sex have already been referred to.

Pathology.—The changes found after death may be surprisingly slight, considering the severity of the disease, and vary materially in different cases and epidemics. As a rule the mucous membrane of the stomach and intestines is in a condition of "mucous catarrh." There may also be areas of congestion, with here and there small petechial hæmorrhages. The lymphoid tissue of the alimentary canal is often swollen, and in severe and protracted cases the solitary follicles in the colon and lower ileum may exhibit superficial ulceration.

Other organs, such as the liver and kidneys, show fatty or parenchymatous degeneration, whilst the lungs are often congested and œdematous, with, in protracted cases, patches of broncho-pneumonia in the lower lobes.

Symptoms.—The clinical picture is often very complicated, and if it is to be understood it is essential to realise that the disease is a general infection and not merely a disorder of the alimentary canal. The supervention of secondary "food intoxications," acidosis or nephritis, with their own clinical manifestations, tend still further to perplex the observer and make it impossible for him to decide to what extent the symptoms are due to the primary infection or to these secondary developments

The disease may start insidiously, with a gradually increasing diarrhœa; or the onset may be abrupt, with a rapid rise of temperature and early prostration. The diarrhœa is not necessarily a pronounced feature, and the worst cases are often those with fewest stools. The character of the motions varies: but in the early stage they are usually green, slimy and ill-digested, becoming dark and watery later. In the choleraic cases they are of the profuse "rice-water" type. When the colon is affected, visible mucus and blood may be passed with much straining. The discharges are usually attended by colicky pain and the passage of flatus. Vomiting is generally present at the onset, but varies greatly in amount. The temperature is always elevated at some period of the disease, but the height, duration and course of the pyrexia are very inconstant. Hyperpyrexia may supervene towards the close in fatal cases. Prostration and circulatory failure are early features, and are shown by depression of the fontanelle, pallor, pinched features, an inelastic skin and coldness of the extremities. Where "intoxication" is a factor, consciousness becomes impaired, and the infant passes into a state of stupor, with intervals of restlessness, which may result in complete coma, sometimes terminating in convulsions. If acidosis is present, the respiration may show the characters of "air-hunger."

The urine is scanty, highly acid and contains a little albumin and a few hyaline casts. Acetone bodies may be present.

Course.—The course of the disease varies greatly. In the severest cases, especially those of the choleraic type, death may ensue within a few hours of the first onset of symptoms. In the milder forms the acute symptoms last for 2 or 3 days, and then gradually the prostration passes off and the stools assume a normal character. Only too often, however, the improvement is but partial, and the child lapses into a marasmic condition, with continued looseness of the bowels, from which recovery may only take place gradually as cooler weather arrives. In all cases relapses, brought on either by re-infection, by meteorological conditions, or by injudicious feeding, are extremely common and apt to prove fatal.

In children above the age of 2 the disease usually assumes a milder form—prostration is not so severe and the range of temperature lower. Vomiting, also, is a less prominent symptom than in infants. Complete recovery is more frequent, and relapses and the continuance of the disease in a chronic form are rare.

In the special type of the disease commonly spoken of as "cholera infantum" the invasion is always abrupt, with a rise of temperature, followed by profuse vomiting and purging. Prostration is marked from the outset. The stools are frequent and large, and though greenish and slimy at first quickly become watery, colourless and almost odourless. Thirst is intense, and the infant rapidly becomes shrunken and dehydrated. Death usually ensues in a few hours, and is commonly attended by hyperpyrexia.

Diagnosis.—The diagnosis has to be made from simple non-infective diarrhœa. At first the differentiation may be impossible, but continued high temperature, early prostration and failure of rapid improvement on stopping food point to an infective origin. Epidemic prevalence is also in favour of the more severe variety. The nervous symptoms may simulate those of meningitis, but in case of doubt a lumbar puncture will determine the diagnosis. Very acute cases, in which the colon is much involved, may

resemble intussusception, but in the latter the onset is more dramatically sudden, the vomiting, collapse and passage of blood greater, and fever less, whilst in epidemic diarrhœa abdominal rigidity and tumour are absent.

Prognosis.—It is impossible to give any estimate of the fatality of diarrhœa, as it depends greatly on the type of the disease, and on the age, general condition and surroundings of the child, besides varying greatly in different epidemics. The younger the infant, and the poorer its general nutrition, the worse is the outlook. The existence of rickets also greatly aggravates the danger. The frequency of the stools is of less importance in estimating the chance of recovery in any given case than the amount of prostration and the degree of inelasticity in the skin. Cases with prolonged high temperature and those of the choleraic type usually do badly. Persistence of vomiting also is a bad sign.

Treatment.—Unfortunately there is no specific treatment, and the principles to be aimed at are: (1) to stop the infection; (2) to eliminate and neutralise toxins; (3) to combat collapse; (4) to arrest the vomiting and purging.

1. In attempting to stop further infection, general hygienic measures are of great importance. Whenever it is possible, the child should be removed from a town, and isolated in a large, airy and well-ventilated room. Napkins should be removed and disinfected as soon as they are soiled, and the greatest cleanliness should be observed in regard to the feeding utensils and the nurse's hands.

If the case comes under observation early, an initial purge of castor oil or, if there be much vomiting, of calomel should be given to clear away decomposed matter from the bowel. Milk, which is the vehicle of infection, should at once be stopped, and so long as the symptoms are severe, the diet should be limited to plain water, albumin water, barley water, weak tea, rice-water, 7½ per cent. glucose, or weak broths, all of which may be given freely.

2. In order to favour the elimination of toxins, the action of the skin and kidneys should be promoted as much as possible. To this end, if the skin be very inelastic, tepid packs are useful, and these may be continued, if necessary, for several hours on end. If the urine be scanty, a few drops of sweet spirits of nitre may be administered, and water should be given freely.

In the early stages of the disease no attempt should be made to arrest the diarrhœa entirely, as the retention of poisons would then be favoured. In addition to the initial purge, irrigation of the colon is a valuable aid in removing toxic material. Normal saline administered at a temperature of 100° F. through a long rectal tube or large-sized red rubber catheter is the best solution to employ.

The direct neutralisation of the toxins is, unfortunately, not at present practicable, as no efficient antitoxic serum for the disease has yet been found.

3. Collapse has to be obviated by saline infusion and the use of stimulants. Four ounces of normal saline may be injected under the skin of the flank every 6 hours.

Of stimulants, one of the best is alcohol. Ten to 15 drops of brandy may be given in a little water every 3 or 4 hours, or oftener; it should not

be added to the feeds. Camphor is also useful, and is best given dissolved in olive oil (1 in 15 or 1 in 30). Five minims of this solution may be injected under the skin as often as is thought necessary, or a few drops of spirits of camphor may be given by the mouth. If the collapse is extreme, recourse may be had to the mustard bath.

4. The arrest of the vomiting and especially of the diarrhœa is really a secondary object of treatment. For the vomiting, lavage of the stomach is the best treatment, particularly in the early stages, and a poultice may be applied to the epigastrium. Drugs are of little help, but small repeated doses of calomel (*e.g.* $\frac{1}{6}$ grain every hour for six doses) are sometimes useful. Chloretone in 1-grain doses may also be used cautiously. Iced champagne diluted with an equal quantity of soda water is sometimes of service.

As has already been pointed out, no active steps should be taken to arrest the diarrhœa at the onset. If it continues, however, and seems to be contributing to the exhaustion, one may try to reduce the frequency of the stools. In the early stages, small repeated doses of castor oil are useful for this purpose, and later, when the tongue is clean, bismuth, chalk, catechu and other astringents, as in the case of simple diarrhœa, may be used. A powder composed of 5 grains of bismuth carbonate, with $\frac{1}{6}$th grain each of Dover's powder and calomel, is also a frequent prescription at this stage. Opium should not, however, be given at the outset, and it is best withheld so long as prostration is marked and the temperature high. When prescribed, it may be given in the form of the tincture in the proportion of 1 minim for every year of the child's age. It is specially indicated when the motions are frequent and attended by much colic and tenesmus. In cases of the choleraic type, with much vomiting and profuse purging, morphine may be given hypodermically with great advantage. The dose for a child of 1 year is $\frac{1}{60}$th grain, with which $\frac{1}{600}$th grain of atropine may be combined. This may be repeated in an hour if the symptoms have not abated.

"Intestinal antiseptics" are of little help, and may easily be injurious. The best are salicylate of bismuth, salol and resorcin. If the stools are very watery, nitrate of silver is the most powerful astringent.

After the acuter symptoms have passed off one must return very gradually to ordinary diet. Milk should be given at first malted or fully peptonised and freely diluted with lime water, or condensed or desiccated milk (*e.g.* Glaxo) or one of the patent foods (*e.g.* Allenburys) may be used in place of it. A feed may be given every 4 hours, and water between if the child is thirsty. Any return of the vomiting or diarrhœa must be the signal for again giving up milk in any form. During convalescence change of air and mild iron tonics are of service in restoring the child to complete health. Relapses, which are frequent, must be guarded against with the greatest care.

ROBERT HUTCHISON.

DIARRHŒA IN THE TROPICS

Ætiology.—Diarrhœa is a very common complaint in the tropics, and may only indicate some ordinary simple disturbance, such as bad food, indiscretions in diet, chills, etc. On the other hand, many of the more serious bowel maladies often start with a simple diarrhœa, and it is important

therefore to examine the stools to determine if any specific parasite be present or not.

The intestinal flagellates, such as *Giardia lamblia, Trichomonas hominis* and *Chilomastix mesnili*, have been incriminated by some as causes of diarrhœa, and it is difficult to deny the statement. Threadworms, *Enterobius vermiculatus*, and some of the flukes, *Heterophyes heterophyes* for example, also cause diarrhœa.

Diagnosis.—The stool must be examined for protozoal and other parasites before deciding upon the diagnosis.

Treatment.—If a simple ordinary diarrhœa, then a dose of castor oil with tincture of opium is all that is required in most instances, with, in more severe cases, rest in bed for a day or two and a milk diet.

Hill Diarrhœa

Definition.—A peculiar form of diarrhœa occurring among the inhabitants of the hills in India and other parts of the world. Characterised by the passage of pale-coloured frothy stools in the mornings, with dyspeptic symptoms and much flatulence.

Ætiology.—The condition is not known to occur outside the highlands of India, Europe and South America. An elevation of 6000 feet is the most favourable to its development. Both sexes and all ages are liable. The exact cause is unknown. Crombie believed the condition to be primarily a dyspepsia, the diarrhœa being secondary.

Symptoms.—The diarrhœa comes on in the morning, a few days after the patient arrives at the hill station. The stools are copious, and of a very pale colour. For the rest of the day the patient feels quite well, only, however, to undergo a similar attack the next morning and so on. The flatulence which accompanies the diarrhœa is often troublesome and very uncomfortable.

Diagnosis.—This is easy, and can hardly be mistaken for anything else, unless it were the commencement of sprue in a person infected with that disease, travelling to the hills.

Prognosis.—This is quite good, but real sprue has been known to follow hill diarrhœa. A person subject to the latter should not for this reason risk too many visits to the hills.

Treatment.—Cases often become acclimatised and recover spontaneously. The patient should rest, preferably in bed for a day or two, and take nothing but milk. A drachm of liq. hydrarg. perchlor. may be given 15 minutes after food. If these means do not suffice the patient must return to the plains.

Sprue

Synonyms.—Cochin-China Diarrhœa; Psilosis; Ceylon Sore Mouth, etc.

Definition.—A subacute inflammatory condition of the mucous membrane of the alimentary canal, associated with wasting, anæmia, peculiar white frothy stools and various lesions of the tongue and buccal mucosa.

Ætiology.—The disease is found in the tropics and subtropics. It is especially common in China, Cochin-China, India, Ceylon, Java, the Federated Malay States, and in Porto Rico in the West Indies. Europeans

living in the endemic areas are specially prone to infection: natives also suffer. Both sexes are affected equally. The definite cause is still unknown. Monilias have been described in the disease, but are probably only secondary contaminators. A hot damp climate appears to be essential, or at any rate to favour the production of the disease. Some deficiency in food has also been suggested, and a local house infection has been mentioned. This would indicate some infectious agent, or that the conditions necessary for acquiring the disease existed in that individual place. *Strongyloides intestinalis* was also once suspected, but there is no proof that such infections have anything to do with the disease. Sprue has been noted to follow, or to be superadded fairly frequently upon, amœbic dysentery.

Pathology.—The intestines are much thinned and the tissues generally wasted and anæmic. The changes in the mucous membrane of the bowel consist of shrinkage of the villi, round-celled infiltration, dilatation of the vessels of the submucosa, and the formation of slight fibrosis. As the changes progress, the villi and glands may entirely disappear, the atrophy becoming extreme. In addition, there may be small cystic dilatations of the follicles and even small abscesses in places. Finally, areas of the mucosa, chiefly in the lower end of the ileum and in the colon, become eroded, and definite ulceration may be seen. The changes described may be general throughout the bowel, but more often the condition is patchy and unequally distributed. The pancreas may show some fatty and granular changes with inflammatory infiltration of the connective tissue; the liver is atrophied. The tongue shows denudation of the epithelium with subacute inflammatory changes analogous to those of the bowel; yeasts may be seen invading the lesions.

It can readily be understood then, that with such a condition of the mucosa of the bowel, absorption must be seriously interfered with, and this perfectly explains the clinical conditions found. The pancreatic juice is defective in quantity and quality, the fat-splitting ferment especially, as large amounts of fat are passed in the motions, the total fats often reaching as high as 70 to 80 per cent. or over. Normally the fat in the stools is neutral fat 1, fatty acids 2, or 1–2. In sprue the relationship of the two is changed to neutral fat 1, fatty acids 5, or 1–5, or even higher. This helps to differentiate sprue from pancreatic disease (cancer of pancreas, etc.), where the neutral fat may be as high as 15, fatty acids 1, or 15–1. Bile is secreted in ordinary amounts, but the normal colouring matter, the bilirubin, is either not formed, or is changed in the intestine into leuco-urobilin, and this accounts for the peculiar white stools seen in the disease.

Symptoms.—The disease begins insidiously, the patient generally complaining of feeling tired easily, with listlessness and loss of energy. This is at first put down to climatic reasons, but later, a morning looseness of the bowels appears, necessitating an earlier rise from bed than usual. After breakfast there may be a further call and then for the rest of the day no more trouble. The weight begins to fall, and friends of the sufferer may note the colour of the face is gradually altering. The colour of the stools also changes, from the ordinary brown or yellow, to a white chalk-like appearance. The stools may be intimately mixed with bubbles of gas which give them a frothy appearance. Affection of the tongue, though sometimes completely absent, is usually a marked feature of the disease. The organ becomes very

painful and small spots or vesicles form on it and also on the buccal mucous membrane of the gums and cheeks. Ordinary diet can no longer be taken on account of the diarrhœa, and drinking and smoking often have to be stopped, on account of the pain they engender in the mouth. If the patient be not treated and stay in the endemic zone, he quickly gets worse, the emaciation becomes more marked and he finally passes into a chronic cachectic or marasmic condition, with a blood showing extreme anæmia, and dies.

When the malady follows on dysentery the onset is equally insidious, the dysenteric stools gradually changing their colour to a dirty white and becoming very bulky. The tongue and mouth then become affected and the condition becomes one of typical sprue, the stools in such cases still showing considerable amounts of mucus.

Physical examination reveals a great diminution of the liver area, with a peculiar loose flabby condition of the abdominal wall. The blood in the early stages shows moderate anæmia, later, in what may be described as the hæmolytic type of the disease, the count may fall to below 1,000,000 per c.mm. Hæmic murmurs are then met with in the cardiac region. The leucocytes are normal or decreased, the hæmoglobin being as a rule equally reduced and giving a colour index of 1. There are some cases, however, where the blood closely resembles pernicious anæmia.

Course.—This will largely depend on the treatment the patient receives. This if suitable will cut short the disease in many instances, and may even cure it. In many cases, however, the disease is a very chronic one, lasting for years.

Diagnosis.—The cardinal signs of sprue are—(1) Loss of weight, generally marked. (2) Diarrhœa with white frothy stools, chiefly occurring in the mornings. (3) Tongue and mouth lesions. (4) Anæmia. (5) Shrinkage of the liver. With these signs present there should be no difficulty in diagnosis. Ordinary pancreatic disease, however, simulates it closely—interstitial pancreatitis, and cancer of the pancreas must also be borne in mind. Syphilis also may be mistaken, the tongue lesions resembling those of sprue in some instances. The bald tongue of syphilis often shows leucoplakia as well and the fissures are often transverse and deep. Both diseases may coexist. If this be suspected a Wassermann reaction should be done and, if positive, novarsenobillon should be given. Dysentery has been mistaken, but only by the uninitiated or superficial observer.

Prognosis.—This may be summed up in a word. It is good, if the patient be under 40 and will put himself under strict dietetic restrictions; bad, if he be 50, or older, though even in these cases much may be done by diet; many of these cases die, however, from the disease, the strictest treatment being of no avail.

Treatment.—The cause of the disease being unknown, little can be done to prevent its onset. If any signs appear, a removal from the endemic area to a temperate climate is at once indicated.

The treatment is one of diet, not of drugs. The patient must be put strictly to bed, and should be placed on milk alone, commencing with 3 pints a day given in feeds every two hours. It may be given raw, or diluted with lime water or barley water, or some of it may be peptonised. Rest is essential, and in most cases, after a week a distinct change for the better

appears, the diarrhœa disappearing and the tongue lesions subsiding. If the diarrhœa persists, Pulvis bataviæ—a lime preparation—may be administered in ʒi doses three times a day. When the bowels begin to function normally the milk is gradually augmented until as much as 7 pints a day are taken. The weight then begins to increase, and a solid stool, but still very white, is passed daily. After 6 weeks, a little arrowroot may be cautiously tried, and if this does not disagree, an egg can be beaten up in the milk, and the carbohydrate constituent of the diet gradually increased. Tapioca, sago, corn flour and semolina can all be given. About this time, *e.g.*, 3 months after commencing treatment, a change from the 2-hourly feeds may be made, a little more being given at the ordinary meal-times, with a reduction between. The patient may also be allowed up for an hour or two in the afternoon, and if all still go well (return of normal colour to stools, increase of weight, improvement of the anæmia), a gradual transition to a simple white meat diet—milk, fish, eggs, breast of chicken—is introduced. This must be continued for a year or more. If possible, sprue cases in England should go abroad to the Canary Islands for the winter, as this is a very bad time for them at home owing to the damp, cold and wet conditions which prevail. Little set-backs are from time to time experienced, and their cause, in many instances, is impossible to determine. The patient should not return to the tropics, or at any rate to any of the endemic foci. Recently, Dr. Harold Scott, having found that there is a deficiency of calcium in the blood in sprue, has suggested giving parathyroid gland and calcium as a routine treatment in the disease. The parathyroid is given in doses of $\frac{1}{10}$ of a grain twice daily, with calcium lactate grs. xv, 3 times a day. Some cases have done very well on this. A meat treatment has been suggested, but neither this, nor treatment with santonin, recommended by some, has given any success in the hands of the writer. The success claimed is due no doubt to the rest in bed. In the hæmolytic type of the disease with severe anæmia, whole blood transfusions have given excellent results in a series of cases belonging to the writer (Low and Cooke). A consideration of the morbid anatomy of the disease indicates how important are rest and simple diet.

No alcohol is allowed during the treatment, nor should it be taken afterwards either. Smoking is also contra-indicated.

G. Carmichael Low.

INTESTINAL CARBOHYDRATE DYSPEPSIA

Ætiology.—Intestinal carbohydrate dyspepsia is a common condition depending upon impairment in the digestive functions of the intestines independent of organic disease. Gastric and pancreatic digestion are generally normal, and no excess of proteins and fats is present in the stools. The digestion of starch, which is begun by the ptyalin of the saliva and amylopsin of the pancreatic juice, should be completed by the diastatic ferment of the succus entericus. If this is deficient or if the softening of cellulose and its partial digestion by bacterial activity in the colon is incomplete, excess of starch, generally accompanied by excess of cellulose, appears in the fæces. Normally the small quantity of starch which reaches the colon

is rapidly digested. When excess is present, the normal enterococci multiply and produce large quantities of gas by their action on the starch. The excess of enterococci is not a result of infection, but is secondary to the carbohydrate indigestion, and disappears when the starch in the diet is so reduced in quantity that it can be dealt with by the saliva and pancreatic juice.

Symptoms.—Intestinal flatulence gives rise to borborygmi and to a sensation of fullness and pressure. As in the erect position gas from the transverse and descending colon collects in the splenic flexure, where the distension may cause palpitation and dyspnœa by pushing the diaphragm upwards, the discomfort is often mistaken by the patient for gastric flatulence and he consequently makes an effort to relieve himself by eructation; as there is no excess of gas in the stomach, his efforts result in aerophagy. Apart from this, the gas chiefly accumulates in the pelvic colon, so that discomfort is felt in the lower part of the abdomen. Distension of the intestines acts as a stimulant to their contractions, so that flatulence is often associated with colic, which is at once relieved by passing flatus. The discomfort caused by intestinal flatulence is a common cause of insomnia.

Microscopical examination of the stools shows the presence of excess of undigested starch, and generally also excess of vegetable débris, which can be recognised on simple inspection. On incubating the stool in a closed vessel connected with a gas-collecting bottle, a considerable quantity of odourless gas is evolved, and the stools, which are acid when passed, may become still more acid. A normal stool gives off no gas on incubation, and in putrefactive diarrhœa the alkaline stools evolve foul-smelling gas and become still more alkaline. On cultivation the stools are found to contain the normal number of *B. coli*, but a great excess of enterococci. No pathogenic organisms are found, and no toxic symptoms occur.

Diagnosis.—Patients tend to regard a sensation of fullness in the abdomen as invariably due to flatulence; if it is not felt in the region of the stomach, it is generally ascribed to excess of gas in the intestines. This explanation is often correct, the patient misinterpreting his sensations less frequently in the case of the colon than with the stomach. The only symptom, however, which proves conclusively that a sense of fullness in the abdomen is due to intestinal flatulence is its disappearance as a result of passing an excessive quantity of flatus. When a patient with symptoms pointing to the presence of excess of gas under the left dome of the diaphragm finds that the passage of flatus gives him relief, but eructation does not, it is probable that the cause is a collection of gas in the splenic flexure: by means of the X-rays it is easy to ascertain whether excess of gas is present in this situation, especially if the position of the stomach is defined by the consumption of an opaque meal.

Though intestinal flatulence is generally due to intestinal carbohydrate dyspepsia, other possibilities must be considered. Most of the gas in the stomach in patients with aerophagy is expelled by eructation, but if air continues to be swallowed when the stomach contains no food, some of it passes into the small intestine, in which it is partly absorbed, but the rest reaches the colon and is finally expelled from the rectum as almost odourless flatus.

Deficient absorption of gas probably occurs in catarrhal colitis. Ab-

sorption is greatly diminished from the intestines in cirrhosis of the liver and in heart failure. It ceases entirely when the venous circulation is completely arrested: this is the cause of the extremely rapid distension which occurs when part of the bowel is strangulated in intestinal obstruction.

In constipation a part of the colon may contract so firmly upon the fæces it contains that the gas which is behind it cannot pass; retention of gas then occurs in addition to retention of fæces.

Treatment.—Intestinal carbohydrate dyspepsia at once disappears if the quantity of starch in the diet is sufficiently reduced. In slight cases all that may be necessary is to take no potatoes. In others, rice and other starchy puddings must be prohibited and the quantity of bread reduced. If, as is often the case, the stools also contain obvious excess of vegetable débris, salads must be avoided, and it may be necessary to give all green vegetables in the form of purées. It is unnecessary to restrict the consumption of sugar, the digestion of which is unimpaired.

It is doubtful whether the use of diastatic ferments really aids in the digestion of starch, as they are likely to be more or less completely destroyed by the acid in the stomach. As purely symptomatic treatment the administration of half an ounce of powdered charcoal two or three times a day is very useful, as it absorbs any excess of gas which may be present in the colon. A tablespoonful taken before or after dinner may act as an hypnotic by absorbing the intestinal gas, which has hitherto led to disturbed nights and even severe insomnia.

ARTHUR F. HURST.

ENTEROGENOUS CYANOSIS

Alterations of the colour of the circulating blood, resulting in cyanosis, are in the majority of instances due to the deficient oxygenation of the hæmoglobin. Of recent years, however, research has established the existence in rare cases of a cyanosis due to the presence of two other compounds of hæmoglobin, sulphæmoglobin and methæmoglobin.

Synonyms.—Various names have been employed to designate this affection: Enterogenous Cyanosis; Microbic Cyanosis; and Sulphæmoglobinæmia and Methæmoglobinæmia.

Pathology.—The condition of sulphæmoglobinæmia is certainly associated with the intestinal abnormality; and where drugs of the aniline group, nitrites and potassium chlorate can be excluded the same is probably true of methæmoglobinæmia. Wallis' observations point to the presence of a nitrite-producing bacterium, the result of whose action is the production and entrance into the circulation of a strong reducing body, which attacks the hæmoglobin, sulphæmoglobin or methæmoglobin being subsequently formed.

Symptoms.—The two conditions present very much the same clinical phenomena. In both, the prominent feature is the existence over long periods of a cyanosis not due to any of the more usual causes, often varying in intensity, but occasionally continuous for years. Whether intermittent or continuous the general health suffers; weakness of the muscular system, fainting attacks, dizziness and severe headache. In the more prolonged cases the patients may be reduced to the last stages of exhaustion. The

sufferers from sulphæmoglobinæmia almost without exception are obstinately constipated; methæmoglobinæmia, on the contrary, is usually associated with diarrhœa.

The colour of the face, mucous membranes, ears, lips, and hands is leaden blue, or blue with a mauve tinge, and the association of this tint with extreme muscular weakness, and the absence or slight degree of dyspnœa is very striking. In the intermittent cases the rapid change from a normal tint to the cyanotic colour or the reverse is remarkable. Apart from its colour, the blood is often normal, both in the number of red cells and in the amount of the hæmoglobin; but in the more severe examples there is deficiency in both respects. Nausea, vomiting and attacks of abdominal pain are also recorded; in one case two abdominal operations were undertaken for the relief of the pain before the condition was recognised. The fainting fits are occasionally alarming, since the patient may remain in a collapsed semi-comatose state for several hours. In spite of the severity of the disease in these cases there is seldom a fatal issue, although so far complete recovery has not often been observed.

Diagnosis.—In the absence of other causes of cyanosis the condition may be suspected, and suspicion converted into certainty by examination of the blood with the spectroscope; in some cases this can be done by inspection of the webs of the fingers or the lobes of the ears. But although so different from the spectra of all the other hæmoglobin derivatives that it is easy to say one or other is present, the spectrum of sulphæmoglobin is so similar to that of methæmoglobin that it will require expert spectroscopy to distinguish them. The varying association of diarrhœa and constipation affords valuable indication.

Treatment.—Successful treatment has been directed to the intestinal affection; some cases of methæmoglobinæmia have been relieved by a prolonged milk diet; in one case a single meal of meat caused a return of the cyanosis. Sulphæmoglobinæmia has always been benefited by careful purgation, but in most instances this has not been sufficient in itself. Vaccines made from Wallis' nitrite-producing bacterium were efficacious in one case, but failed in others. In the attacks of collapse oxygen administered through an inhaler has proved of benefit; but, as would be expected, does not materially or permanently diminish the cyanosis.

HUGH THURSFIELD.

ORGANIC DISEASES OF THE INTESTINES

COLITIS

Inflammation of the colon may be general or localised to one segment. Thus inflammation of the cæcum (typhlitis), cæcum and ascending colon, pelvic colon (pelvic colitis), rectum (proctitis), or pelvic colon and rectum (pelvi-rectal colitis) may occur alone, but except in the case of the two last localisation is rarely absolute.

Although enteritis very frequently causes secondary colitis, the reverse is relatively rare, as infection and irritating material from the ileum must

pass along the colon before it is evacuated, whereas the ileo-cæcal sphincter prevents the spread of infection from the cæcum to the ileum.

The inflammation is generally limited to the mucous membrane, but it occasionally involves the deeper tissues and may spread to the peritoneum (pericolitis). The inflammation may be catarrhal or ulcerative, and chronic or acute.

Acute Catarrhal Colitis

Ætiology.—Acute catarrhal colitis occurs most frequently as a result of food poisoning. It may occur alone or associated with acute gastritis and enteritis. It may also be a symptom of specific fevers and various toxæmias, especially uræmia.

Symptoms.—The chief symptom is diarrhœa, the stools being frequent, fluid and offensive; they contain mucus, sometimes traces of blood, but no excess of food residue, unless the small intestine is simultaneously affected. Abdominal discomfort is present and paroxysms of colicky pain are frequent. In severe cases there may be well-marked general symptoms with a high temperature and a rapid pulse. As a rule the condition rapidly improves, but it may develop into chronic colitis.

Treatment.—Nothing but water should be taken by mouth during the first 24 hours; arrowroot, with the addition of sugar, but not milk, may then be given, but no further change in the diet is permissible until the diarrhœa has ceased, after which the return to normal diet should be gradual. The addition of a tablespoonful of powdered charcoal to each feed hastens recovery and reduces intestinal flatulence. No attempt should be made to stop the diarrhœa for the first 24 hours, but if it continues after that, opium may be given. The pain can be much relieved by the use of warm applications. The patient should be kept strictly confined to bed until the diarrhœa has ceased for 24 hours.

Chronic Catarrhal Colitis

Ætiology.—The most common cause of chronic catarrhal colitis is the habitual use of purgatives, which are frequently taken even in the absence of constipation. Infection of the bowels with pathogenic organisms, introduced in the food or water, or coming from some septic focus in the mouth, pharynx or appendix may cause a chronic, infective, catarrhal colitis, which may also be the sequel of an attack of acute colitis or the colitis of some specific infection, such as amœbic or bacillary dysentery.

Symptoms.—Diffuse discomfort and a sensation of fullness are commonly present in the lower part of the abdomen. Slight attacks of colic may occur, but in many cases there is no actual pain. The abdomen is often somewhat distended and tender. In many cases the catarrh is confined to one part of the colon, such as the cæcum or pelvic colon. The discomfort is generally worse after meals and is relieved if the bowels are well opened. In infective cases and those following an attack of acute colitis there is generally diarrhœa, mucus and occasionally traces of blood being found in the fluid stools, but there is no excess of food residue in uncomplicated cases.

The presence of mucus in the stools is often regarded as sufficient evidence

that colitis is present. But it is a function of the healthy mucous membrane to secrete mucus to protect itself against mechanical and chemical irritants. Consequently the unformed, clear mucus passed with hard fæces in constipation, and especially in dyschezia, does not indicate that colitis or proctitis is present, and the same is true of the mucus passed with fluid stools when irritating aperients have been taken. Only if mucus is passed with soft stools when no purgative has been given, can it be regarded as of any diagnostic importance. On the other hand, pus and red blood corpuscles both indicate the presence of some organic condition, though the possibility of hæmorrhoids as the source of the latter must, of course, be remembered.

Treatment.—The teeth should be put into good order and any other source of infection should be removed. The food must be thoroughly masticated and should be of an unirritating character. The use of purgatives should be avoided as much as possible, though liquid paraffin is often useful, as it makes the stools soft. In infective colitis capsules of *B. acidophilus* should be taken, and an autogenous vaccine may prove of value if definitely pathogenic organisms have been isolated from the stools. Belladonna should be given before meals with the addition, if diarrhœa persists, of codeine.

Muco-Membranous Colic; (Muco-Membranous Colitis)

Definition.—In neurotic individuals constipation is sometimes associated with the constant or intermittent passage of membranes of coagulated mucus and with attacks of pain, the condition being known as muco-membranous colic. This name is preferable to "mucous colitis," because mucus is passed in excess in all cases of colitis whether membranes are formed or not, and to muco-membranous colitis, except in the comparatively rare cases in which true inflammation of the colon is actually present.

Ætiology.—Muco-membranous colic occurs five times more frequently in women than in men. It generally begins between the ages of 20 and 45, but may occur at any age, and it is much more common among the educated classes than among ordinary hospital patients.

Pathology.—Two predisposing factors are invariably present—constipation, and the abnormally irritable nervous system which is characteristic of neurasthenia. Retention of fæces in an individual with an abnormally irritable nervous system may result in reflex over-activity of the motor and secretory fibres of the colon, leading respectively to painful spasm and to excessive secretion of mucus. If over-activity of the motor fibres occurs alone, colospasm results; this is analogous to pure spasmodic asthma. In other cases the spasm is associated with increased secretion of mucus. If the mucus is retained sufficiently long, coagulation takes place and a membrane forms. This is analogous with the formation of Curschmann's spirals in asthma. In most cases no actual catarrh is present unless the condition has been injudiciously treated with irritating purgatives or injections, when the membranes contain degenerated epithelial cells and leucocytes instead of being formed of almost pure mucus.

Symptoms.—In many cases the patients constantly suffer from chronic abdominal discomfort and pass membranes. In other cases definite attacks, which are sometimes brought on by depressing emotions, occur at intervals of weeks or months; the pain may be confined to the attacks, or there may

be abdominal discomfort in the intervals. It is, however, not uncommon for the presence of membranes in the stools to be the only symptom.

The pain is situated most frequently in the left flank and iliac fossa and just above the pubes; at the same time the descending and iliac colon are often tender and can be felt as a contracted cord, in which scybala can sometimes be distinguished. Less frequently there is pain and tenderness in the cæcum and ascending colon, which are felt to be more firmly contracted than usual; the condition may then closely simulate appendicitis, but no relief follows appendicectomy. The passage of fæces and membranes or of the latter alone, whether spontaneously or as the result of treatment, generally gives relief.

The constipation present in the intervals becomes much more severe during an attack. The stools consist of hard, small scybala, which may occasionally be moulded into thin or flat pieces owing to anal spasm.

The mucus is excreted as very thin membranous shreds, which may form tubular casts of the colon with a diameter of anything up to an inch and a half. They are often called skins by the patient and have been mistaken for tape-worms; they are sometimes rolled into a ball, which can only be disentangled by washing in water. The mucus may be transparent like ordinary mucus or opaque like fibrin; its colour is grey-white, but it is often stained by fæces and rarely by blood. The membranes may be passed alone or with scybala.

Muco-membranous colitis is occasionally secondary to the constipation which results from cancer of the intestine; it is therefore important to make a sigmoidoscopic examination in all cases in which no tumour has been felt by abdominal palpation or by digital examination of the rectum. In uncomplicated cases the mucous membrane is either normal or shows a very slight degree of catarrh. Symptoms of neurasthenia are generally present, and the patient always tends to become depressed and hypochondriacal.

Intestinal sand.—The passage of intestinal sand is almost always associated with muco-membranous colic. Small quantities of sand, which would otherwise escape detection, can often be discovered by running water on to the fæces placed in a muslin bag until the greater part is washed away. True intestinal sand must be distinguished from the false sand formed of wood-cells, which is sometimes passed by individuals who have eaten a large quantity of pears and more rarely of bananas. True intestinal sand is composed of pale yellow or reddish-brown granules, very irregular in shape and never crystalline. Their most characteristic constituents are the insoluble calcium soaps of palmitic and stearic acids; an approximately equal quantity of calcium phosphate is also present.

Prognosis.—Muco-membranous colic is a very chronic condition, and may persist as long as 30 years. If treatment is begun at an early stage, recovery generally follows, but when it has been present for many years the outlook is very unfavourable, and even if improvement occurs, the likelihood of a relapse is considerable.

Treatment.—A patient suffering from muco-membranous colic should be treated with the object of removing the two underlying factors—the abnormal condition of the nervous system and the constipation. It is very important to discourage him from making minute investigations of his stools; he should be told to be satisfied if he feels better without looking

to see how much mucus is passed. He may feel perfectly well in spite of the presence of mucus; but he will often only remain so for as long as he is unaware that he is passing it.

The constipation requires treatment by diet, massage, drugs and enemata. The best results are generally obtained with a generous mixed diet containing a plentiful supply of those articles which have already been described as useful in uncomplicated constipation on account of their chemically stimulating properties, but excluding raw vegetables in salads and pickles, fibrous vegetables such as celery, and the skins and pips of fruit. Mustard, pepper and spices of all kinds should be prohibited. Smoking should be restricted, and in severer cases should be entirely prohibited.

At the commencement of treatment any accumulation of fæces in the colon must be removed. This can best be done by enemata; in severe cases 6 ounces of paraffin should be injected in the evening and retained during the night. Once the colon is empty, the reaccumulation of fæces can often be prevented by the administration of liquid paraffin in order to soften the stools. If this does not result in the passage of a satisfactory stool each day, the further treatment depends upon whether the stasis is in the proximal part of the colon, in which case a mild aperient, such as infusion of senna pods, is required, or in the pelvic colon, when treatment by enemata without aperients is indicated.

As in the case of uncomplicated spastic constipation, belladonna is the most useful drug for combating the intestinal spasm; small doses of bromide may also be given to diminish the irritable condition of the nervous system When the pain is severe it may be necessary to add codeine to the belladonna.

Local treatment of the mucous membrane of the colon by means of douches should only be used in cases in which other treatment has failed to give relief. As the patients are always self-centred, it is of the utmost importance to avoid encouraging them to concentrate upon their bowels and their excreta by irrigating the colon unless this is absolutely necessary. Intestinal lavage can be given at home; but it is generally more effective at one of the spas, such as Châtel-Guyon, Harrogate, Llandrindod Wells, Bath or Buxton, at which there are special facilities for carrying out the treatment.

Normal saline solution should be used if the treatment is given at home, and injections of soap and water, antiseptics and astringents should be avoided, as they tend to aggravate the condition by irritating the mucous membrane. At the various spas the natural waters are generally used for the purpose.

Ulcerative Colitis

Ætiology.—Ulcerative colitis is a condition which occurs sporadically in England and other countries in which dysentery is not epidemic. Young adults are most frequently affected, and the disease is equally common in men and women. It is infective in origin, and from the very close similarity it bears to bacillary dysentery it seems probable that the unknown organism which causes it must be closely related to the *Bacillus dysenteriæ*. In rare cases this organism has been isolated, and it has often been found in institutional epidemics of colitis and in the epidemic colitis of infants, conditions which are clinically and pathologically very similar.

Ulceration of the colon also occurs in rare cases of uræmia, probably as a

result of the excretion into the large intestines of toxins, which cannot be excreted by the diseased kidneys, and in mercurial poisoning. The rectum and pelvic colon may become ulcerated as a result of infection with gonococci, tubercle bacilli, streptococci or other organisms introduced per anum or invading them from neighbouring organs. None of these conditions should be included under the name of ulcerative colitis. The ulceration of the colon which occurs in typhoid and paratyphoid fevers is also of course distinct.

Pathology.—The primary change is an acute inflammation of the mucous membrane of the colon. Patches of localised necrosis then occur, and the gradual separation of the necrotic tissue leads to superficial ulceration. The floor of the ulcers is formed by the submucous or muscular coat, the ulcers tending to spread superficially rather than deeply.

Symptoms.—The onset is sometimes acute with severe diarrhœa and fever. More commonly it is subacute or insidious, the first symptom noticed being the passage of blood and mucus with or without diarrhœa. Even in cases which appear to begin acutely a history can often be obtained of slight intestinal irregularity, with the occasional passage of mucus or blood, for many months or even several years before the onset of severe symptoms.

Diarrhœa is always present; as many as 20 stools may be passed in the day. The stools are generally fluid and small in bulk. Blood, pus and mucus are passed in each, and often also alone without any fæces. In quiescent periods they may appear to be absent, but chemical and microscopical examinations show that this is not the case. Blood may be passed in large quantities alone; but it is generally mixed more or less intimately with the mucus and pus. It is bright red, and never produces black tarry stools, such as are seen with gastric and duodenal ulcer. It is mostly fluid; but small clots are often present. The mucus is unformed, and may be clear or opaque owing to the presence of pus; membranes are never passed. In most cases small collections of pus are easily recognised with the naked eye in addition to that mixed with the mucus and fluid fæces.

Abdominal discomfort is often, but not always, present. Actual pain is rare except immediately before defæcation, when colic may occur; this disappears as soon as the bowels are opened, especially if flatus is also passed. Tenesmus is unusual, and only occurs if the anal canal is involved. The abdomen is sometimes slightly distended, but in many cases it is retracted. Tenderness is often completely absent, even in severe cases, but pressure over the colon may cause discomfort. If the tenderness is considerable, the inflammation has generally spread to the peritoneum and local peritonitis is present; this is most commonly observed in the right iliac fossa and left iliac fossa. A moderate degree of muscular rigidity is often present in severe cases, especially when there is any local peritonitis.

Digital examination of the rectum is only painful in the rare cases in which the anal canal is inflamed. The thickened mucous membrane and the ulcers are readily felt with the finger when the rectum is involved.

A sigmoidoscopic examination should always be made. An anæsthetic is never required, and if the sigmoidoscope is carefully introduced under visual guidance without inflation, and only as far as it goes without difficulty, there is no danger. The mucous membrane is bright red, thick and sometimes granular. It bleeds very readily when touched, and small submucous

hæmorrhages are frequently seen. Its surface is covered with blood-stained, purulent mucus, some of which should be removed on a sterile swab for bacteriological examination. Superficial ulcers are invariably present; but in early cases they may be so small that they are difficult to recognise. Later they are large, and are sometimes so extensive that only small islets of mucous membrane are left, which may feel like small, flat polypi on rectal examination, the floor of the ulcers being mistaken for the surface of the mucous membrane. The ulcers are always superficial, with irregular edges; the thick mucous membrane is not undermined. The floor of the ulcers appears greyish-yellow when the blood and mucus are wiped from their surface.

In acute cases, and in acute exacerbations of more chronic cases, irregular fever is generally present. Apart from this, the patient has generally a good appetite. The constant diarrhœa leads to progressive emaciation and weakness; but in mild cases the patient may feel so well that he is unwilling to undergo treatment in bed. The loss of blood leads to secondary anæmia, which may be severe; the amount of hæmoglobin is often only 50 per cent. of normal, and may fall to 20 per cent.

Complications.—In the course of healing strictures, which may be multiple and of considerable length, may develop, especially in cases of long standing. A narrowing can sometimes be recognised with the sigmoidoscope, but the exact degree and localisation can only be discovered with the aid of an opaque enema. The symptoms generally do not alter with the development of the strictures, as the stools are so fluid that they pass without difficulty through the narrowed bowel. A case which resists treatment should therefore be examined for stricture, as, if one is found, a short-circuiting operation may be required.

In other cases healing is associated with the development of multiple minute polypi: this is probably the most common cause of polyposis of the colon. This condition may give rise to no symptoms, but the polypi are liable to become malignant. In my experience the application of deep X-rays invariably results in the complete disappearance of multiple polypi of this kind.

General peritonitis is a very rare complication, and is not due to perforation but to direct spread of infection through the wall of the colon. Localised abscesses are still more unusual.

Occasionally non-suppurative multiple arthritis develops, which is strictly analogous to the arthritis which may follow bacillary dysentery.

Diagnosis.—The association of blood in the stools with pus and mucus indicates the presence of ulcerative colitis, or a growth of the pelvic colon or rectum.

A growth can be excluded by rectal and abdominal palpation, and by the sigmoidoscope. Even if the growth is too high to be reached by the instrument its presence is rendered very probable when the accessible part of the colon appears normal, and blood, mucus and pus are seen coming from the inaccessible part.

If the patient has been in the East the possibility of dysentery should be considered, and even in the absence of such a history it is possible that a patient may have become infected by a dysentery-carrier living with him. Mucus obtained direct from the surface of an ulcer during the sigmoidoscopic

examination should therefore always be examined bacteriologically, and the agglutinating power of the patient's serum should be tested against various strains of *B. dysenteriæ*. The sigmoidoscopic appearance of the mucous membrane in bacillary dysentery and ulcerative colitis is identical, but in the latter condition the serum very rarely agglutinates *B. dysenteriæ*. Amœbic dysentery is, however, so distinct that a definite diagnosis can easily be made by the use of the sigmoidoscope alone. Small, round, red elevations are seen on the otherwise normal-looking mucous membrane, corresponding with the collection of broken-down material in the submucous tissue caused by the invasion of *Entamœba histolytica*. In the centre of each elevation is a depressed yellowish ulcer where the submucous abscess has broken through the mucous membrane.

Prognosis.—Very acute ulcerative colitis may cause death in a few weeks. More commonly the condition becomes chronic, with periodic acute exacerbations, and thus approximates to the ordinary form of ulcerative colitis, in which the onset is insidious and the course very prolonged. Death generally results from cachexia, owing to the prolonged diarrhœa and constant loss of blood. With adequate treatment, however, recovery is the rule.

Treatment.—If a sigmoidoscopic examination is always made when a patient passes blood or mucus in his stools, or is suffering from diarrhœa, the cause of which is not obvious, ulcerative colitis can often be recognised at such an early stage that recovery will be rapid. More commonly, long-continued treatment is required, and no case should be regarded as cured until a further sigmoidoscopic examination has shown that all ulceration has disappeared and the mucous membrane is no longer inflamed.

The patient should be kept warm and recumbent in bed until no blood has been passed for a week, the bowels are not opened more than twice a day, and no ulceration and no inflammation can be seen with the sigmoidoscope. But the patient should continue under strict treatment till the mucous membrane appears to be perfectly normal, and he should be careful about his diet and keep his stools soft with liquid paraffin for several years, as the danger of recurrence remains for a prolonged period.

An abundant but light mixed diet should be given, as the stomach and small intestines are rarely involved. The food must be thoroughly masticated. Everything which could irritate the colon mechanically should be prohibited; vegetables are only allowed if they have been passed through a fine sieve, and no fruit except the juice or in the form of jellies.

The colon should be irrigated every day with tannic acid solution. An injection of a pint and a half of warm water should be given half an hour before, in order to clear away as much fæces, blood and mucus as possible; this should only be retained for about 5 minutes. The same quantity of the tannic acid solution (gr. i–ij to the ounce) is then run in very slowly at a pressure of not more than 12 inches of water through a tube introduced not more than 1½ inches beyond the anus, with the patient in the knee-elbow position. The fluid should be retained for gradually longer periods up to half an hour.

When the patient is very ill, as a result of long-continued loss of blood from the colon, transfusion of blood is of great value.

In my experience vaccine treatment has generally very little effect, doubtless because of the extreme difficulty of discovering the organism which

is really responsible for the colitis. If it can be identified with certainty, vaccination may be tried in addition to, but never as a substitute for other treatment. Sources of infection such as apical dental abscesses or pyorrhœa alveolaris should be thoroughly treated.

The intravenous injection of 50 to 100 c.c. of polyvalent anti-dysenteric serum daily for a week or 10 days may result in extremely rapid healing of the ulcers. The treatment is often so effective that the period of treatment is shortened from several months to a few weeks. In spite of the severe general reaction which occasionally takes place, serum should therefore be tried in every case. It may also be effective when given subcutaneously, but the treatment must be continued for a longer period.

The administration of half an ounce of finely powdered charcoal two or three times a day leads to the absorption of gas, and a great diminution of any colic which is present, as the latter is caused by intestinal flatulence. At the same time if the stools are offensive, they become odourless.

In chronic cases and in severe acute cases the question of operation requires consideration, if little or no improvement occurs after 3 or 4 weeks of strict medical treatment, but with the medical treatment described above I have seen very few cases in recent years in which surgery was required. The only operation likely to prove successful is appendicostomy, or, if the appendix has already been removed, a valvular cæcostomy, which allows the introduction of fluid through a catheter, but not the escape of fluid fæces. The colon should be washed out continuously for 48 or 72 hours with saline solution introduced drop by drop through a catheter and allowed to escape from a bed-pan, upon which the patient lies. After this the colon is washed out with plain water once a day, and when all the fluid has escaped an antiseptic solution is introduced and allowed to escape when the patient wishes. The stoma should not be allowed to close until the sigmoidoscope has shown that the mucous membrane has completely healed. In my experience improvement after operation is not as a rule more rapid than under purely medical treatment, and the mortality is over 20 per cent., whereas in a consecutive series of 25 cases treated medically, many of extreme severity, recovery occurred in all but one.

TUBERCULOUS ENTERITIS AND COLITIS

Ætiology.—Miliary tubercles may be present in the intestines in general tuberculosis, but they have no clinical importance. Primary infection of the bowels from tuberculous milk is not infrequent in children, but is comparatively rare in adults. Secondary infection from swallowing tuberculous sputum is very common, ulceration being present in 50 per cent. of fatal cases of pulmonary tuberculosis, in some of which, however, it is probably due to pyogenic organisms and not to the tubercle bacillus. The lower end of the ileum, the appendix and the cæcum are the parts most frequently affected.

Symptoms.—In many cases no symptoms are present, although extensive ulceration may be found post mortem. Tuberculous enteritis should be suspected in children suffering from diarrhœa with fever, abdominal distension, enlarged glands, anæmia, wasting and weakness. It should also be

suspected when pulmonary tuberculosis is associated with diarrhœa, especially if abdominal pain and tenderness are present. But the diagnosis can only be made with certainty if tubercle bacilli are found in the stools, and with a considerable degree of probability if blood is passed. In the absence of abdominal pain the diarrhœa in advanced phthisis is generally due to the achlorhydria which is commonly present.

Perforation of a tuberculous ulcer is rare owing to the adhesions which form between the coils of intestine. Cicatrisation of an ulcer may lead to single or multiple strictures of the small intestines; as these are incomplete, and the contents of the bowel are fluid, obstruction is rarely produced. External adhesions and the formation of bands may, however, lead to acute intestinal obstruction. Tuberculous ulceration of the last few inches of the ileum may produce reflex dyspepsia similar to that caused by chronic appendicitis. In such cases the terminal ileum is tender and may be thickened; the stools generally contain occult blood, and there is often mild intermittent pyrexia. At a later stage small intestine peristalsis may become visible, and palpable stiffening of a coil of ileum, which disappears with a loud gurgle, sometimes occurs, although the bowels may remain regular until acute obstruction supervenes.

Hyperplastic tuberculosis of the cæcum is a very rare condition, in which the ileo-cæcal sphincter and a small part of the ileum may also be involved. Chronic intestinal obstruction and the presence of a hard, mobile, non-tender tumour give rise to suspicions of cancer, which can only be dispelled after exploration. It is rarely associated with tuberculous foci elsewhere and does not ulcerate, so that no pyrexia occurs and tubercle bacilli do not appear in the stools.

Treatment.—The treatment is that of tuberculosis in general, combined with the dietetic restrictions required for non-tuberculous colitis. Hyperplastic tuberculosis of the cæcum should be excised as soon as it is recognised.

CANCER OF THE COLON

Ætiology.—Primary columnar-celled carcinoma of the colon attacks men and women with equal frequency. It is most common between the ages of 40 and 65, although cases have been recorded in early childhood.

Pathology.—Only 3 per cent. of cases of intestinal cancer affect the small intestine. Of the remainder 60 per cent. are in the rectum and at the pelvi-rectal flexure, and 20 per cent. in the iliac and pelvic colon. Nearly half of the remainder are in the cæcum and ileo-cæcal region.

Extension to the peritoneum and secondary deposits in the lymphatic glands, liver and other organs occur later and rather less frequently with cancer of the intestine than with cancer in most other situations, obstruction occurring in more than 50 per cent. of cases before the glands are involved. The prospect of a radical cure by operation, if an early diagnosis is made, is therefore comparatively good, even when large portions of the intestine are involved. The rectum has a moderate supply of lymphatics, and gives operative results intermediate between the worse gastric and better intestinal cases.

Symptoms.—The possibility of cancer of the intestine should be con-

sidered whenever an individual above the age of 35, whose bowels have previously been regular, develops, without change of diet or habits, constipation or diarrhœa, or when a patient of the same age, who is habitually constipated, becomes more so without obvious reason. Constipation occurs earliest in the common annular form of intestinal cancer, which narrows the circumference of the bowel while the actual size of the growth is still very small. Less obstruction is caused by papillomatous carcinoma, which forms a friable and ulcerated mass, projecting into, but not obliterating, the intestinal lumen; constipation is at first intermittent and relieved by purgatives, which gradually become less effective and cause more pain. Enemata are generally of use for a longer period, but they also finally fail to act. Sometimes, however, there is persistent diarrhœa from the start, especially when the growth is situated in the pelvic colon. More frequently the initial constipation is interrupted by attacks of diarrhœa. In the majority of cases the constipation becomes steadily more severe until it ends in complete obstruction, which is sometimes hastened by the impaction of a hard mass of fæces in the narrowed lumen.

The stools do not generally differ in shape from those seen in ordinary constipation. Occasionally thin pieces, resembling the fæces formed in some cases of spastic constipation, are passed, especially when the growth is in the pelvic colon or in the rectum; they sometimes owe their shape to spasm of the anal sphincter, produced reflexly by the growth or by the irritating discharge from its surface; but I have also seen ribbon-shaped fæces appear through a stricture 6 inches from the anus during a sigmoidoscopic examination. The stools in cancer of the rectum and lower part of the pelvic colon generally contain obvious blood, pus and mucus; they may closely simulate those of simple ulcerative colitis, but fragments of more or less solid fæces can often be recognised, whereas in ulcerative colitis the fæces are always fluid. When the growth is proximal to the middle of the pelvic colon blood can rarely be recognised with the naked eye, but occult blood can always be found by the guaiac test; the spectroscope often shows that acid hæmatin as well as hæmatoporphyrin is present in contrast with the occult blood of gastric and duodenal origin, which only gives the former spectrum unless the quantity present is unusually great.

Vague discomfort in the lower part of the abdomen is often present, sometimes without any irregularity of the bowels, and slight attacks of colic occur when constipation becomes severe; but they rarely reach any great intensity until the obstruction is almost complete. In some cases, especially in cancer of the cæcum, hepatic flexure and splenic flexure, the pain always travels in a definite direction to a certain point, where the patient occasionally feels a rumbling sensation; this generally corresponds with the situation of the growth. When the pelvic colon is involved, the pain is always below the umbilicus and often most marked on the left side.

The over-activity of the colon above the obstruction leads to hypertrophy of its musculature. When the obstruction becomes complete, failure of the muscle ultimately occurs, and extreme paralytic distension results; ulceration and perforation, especially of the cæcum, may follow.

When the obstruction is sufficient to give rise to severe colic, strong, spasmodic contractions or "stiffening" of the intestine are often visible and palpable. They never occur in the colic associated with lead poisoning or

colitis, and only very rarely with obstruction due to simple impaction of fæces.

General symptoms of cancerous cachexia are generally absent in the early stage; they are most marked when the growth is extensive or much ulcerated, and when frequent small hæmorrhages have occurred. Progressive loss of weight and strength and increasing anæmia are the chief general symptoms; the appetite is often diminished, but the occasional association of a good appetite with progressive emaciation is, in the absence of pyrexia, very suggestive of a growth. The nutrition suffers most, and anæmia is most marked when the tumour is proximal to the splenic flexure, whereas obstructive symptoms are generally more severe when the distal part of the colon is involved.

In about 40 per cent. of cases a tumour is palpable when the patient is first seen, either on abdominal or rectal examination. In some of the remainder the growth is inaccessible to palpation, owing to its situation at the splenic flexure; in others the tumour is too small to be palpable. It is often impossible to reach a growth in the lower end of the pelvic colon or at the top of the rectum either by abdominal or rectal examination. In such cases the sigmoidoscope alone makes an early diagnosis possible. If acute obstruction is not an early occurrence, the growth develops into a large and easily palpable tumour, which invades the neighbouring peritoneum and viscera. The tumour often varies in size from time to time, as it is formed not only by the growth itself, but partly by impacted fæces or by thickened peritoneum and adherent coils of intestine, with perhaps a localised abscess. The disappearance of a tumour after treatment with purgatives or enemata does not therefore mean that cancer is absent, even if its disappearance is associated with improvement in the symptoms. For a mass of fæces can become impacted above a cancerous stricture and produce obstruction, which may be partially relieved when the fæces are removed. A diagnosis of cancer can only be excluded when the disappearance of the tumour is accompanied by complete and lasting cure of all the symptoms. The tumour produced by a growth is hard; it is rarely very tender, unless complicated by local peritonitis. When situated in the ascending, descending or pelvic colon it is generally fixed; in the cæcum and transverse colon it is frequently very movable.

The X-rays often afford considerable help in diagnosis. The shadow of the colon may be visible as far as the seat of obstruction unusually soon after the opaque meal; little or no barium may pass beyond this point for a considerable time. The passage of an opaque enema is often obstructed at a period in the disease when an opaque meal is not delayed. In some cases, especially when an enema is used, the actual narrowing of the intestine can be observed. When a tumour is present the combination of abdominal palpation and X-ray examination shows whether any delay in the passage of fæces occurs in the neighbourhood of the tumour, and whether the latter arises from some part of the alimentary canal. It is important to note, however, that the X-rays may completely fail to give any evidence of a growth until some months have elapsed since the onset of symptoms

In exceptional cases symptoms are produced by complications before the intestinal functions become affected. Thus secondary deposits in the brain may cause cerebral symptoms sufficient to overshadow everything

else, and an abscess developing in connection with a stercoral ulcer above the obstruction, or general peritonitis resulting from perforation of a similar ulcer may constitute the earliest clinical manifestation.

Diagnosis.—The diagnosis depends upon the history combined with the results of abdominal and rectal palpation, examination of the stools for visible or occult blood, and with the sigmoidoscope and X-rays. A tumour in the right iliac fossa may be caused by an inflammatory mass developing round a small chronic appendicular abscess and by hypertrophic tuberculous disease of the intestine as well as by cancer. In the left iliac fossa confusion with an inflammatory mass in connection with acquired diverticula of the colon is not infrequent, but a barium enema almost invariably reveals the presence of the latter. The chronic obstruction caused by a local band of adhesions may simulate that caused by a growth, the difficulty being increased by the fact that the stools generally contain occult blood

Treatment.—Cancer of any part of the large intestine proximal to the middle of the transverse colon is best treated by the removal of all the colon up to an inch beyond the growth, an ileo-colostomy being simultaneously performed. Beyond this point resection of the growth, with a sufficient margin on each side, with end-to-end anastomosis is more satisfactory. If obstruction is present, the operation should be performed in two stages, excision being only performed after the patient recovers from a preliminary colostomy or short-circuiting operation.

DIVERTICULA OF THE COLON

Diverticulosis : Diverticulitis

Ætiology and Pathology.—Diverticula of the colon generally occur in individuals who have for many years taken aperients for constipation. Diverticula are uncommon above the middle of the descending colon, and increase in number and size as the lower end of the pelvic colon is approached, but they are very rare in the rectum owing to the thickness of its muscular coat.

Diverticula generally develop after the age of 40 and occur with equal frequency in men and women. Owing to the atrophy of the muscular coat of the colon, which occurs in old age, pressure from within produces diverticula more readily than in earlier life. The presence of fat diminishes the resistance of the intestinal wall to pressure from within, so that diverticula are especially likely to occur in the obese, and often form in the appendices epiploicæ.

A large number of diverticula are generally present; some are so small that they are barely visible to the naked eye, whilst others attain a diameter of half an inch. They very rarely become larger, as secondary pathological changes interrupt their growth. In the walls of the smaller diverticula all the coats of the bowel are represented. As they grow larger the muscular layer gradually disappears and the mucous membrane frequently becomes atrophied.

Symptoms.—*Diverticulosis*, the simple presence of diverticula of the colon, is a very common condition and gives rise to no symptoms. Their inflammation—*diverticulitis*—and still more inflammation of the surrounding

peritoneum—*pericolitis*—give rise to a variety of symptoms. Most frequently the patient complains of discomfort in the lower part of the abdomen and, after a time, of attacks of colic, which gradually increase in severity and in frequency. The discomfort is generally most marked in the left iliac fossa. At the same time the constipation, from which the patient has generally suffered for many years, becomes more severe. Aperients aggravate the pain, which is relieved to some extent by the passage of flatus or fæces. Mucus may be present in the stools, and pus cells can occasionally be discovered on microscopical examination, but both obvious and occult blood are generally absent.

The temperature is sometimes slightly raised, and in acute exacerbations it may be very high and accompanied by severe constitutional symptoms with polymorphonuclear leucocytosis.

The bladder is often irritable, the patient having to pass urine with abnormal frequency; this is due to adhesions between the colon and the bladder. At a later stage cystitis occurs, and in very rare cases gas and fæces are finally passed *per urethram* owing to the development of a vesico-colic fistula, diverticulitis being a more common cause of this condition than cancer of the colon.

Tenderness is always most marked in the left iliac fossa and occasionally also immediately above the pubes. The rigidity of the abdominal wall over the tender area may make it difficult to palpate the colon, but in most cases it is possible to feel the irregularly thickened and extremely tender iliac colon. Digital examination of the rectum generally reveals nothing abnormal; the sigmoidoscope cannot often be passed beyond the pelvi-rectal flexure or an inch or two farther, the bowel at this point appearing to be abnormally fixed and its lumen narrowed. Very rarely the minute mouths of diverticula can be seen at the lower end of the affected portion of the pelvic colon.

An opaque meal shows that there is generally little or no delay in the passage through the bowel till the iliac colon is reached. The presence of diverticula can often be recognised when the opaque meal reaches the affected part, as some of it enters and remains in them after the rest has been evacuated. In all cases a barium enema should also be given, as whenever diverticula are present their number and localisation can be more accurately determined in this way than by any other method. They may be discovered directly the enema is given, but more often only after it has been evacuated, a double row of small rounded shadows representing the diverticula being then seen in the position of the iliac and pelvic colon. They often remain visible for several days.

Diagnosis.—Discomfort and colicky pain in the lower part of the abdomen in middle-aged and elderly patients, especially if associated with increasing constipation, should raise the suspicion of diverticulitis as well as of a growth of the colon. If the pain is most marked in the left iliac fossa, if it is associated with bladder irritability, and if leucocytosis and pyrexia are present, the former is the more probable diagnosis. A tender tumour in the left iliac fossa, associated with muscular rigidity, is much more frequently due to diverticulitis than to cancer. An X-ray examination after an opaque meal and an opaque enema generally settles the diagnosis. It is necessary to add that cancer occasionally develops in a colon affected with diverticulosis

or diverticulitis. The only sign which might suggest such a possibility would be the appearance of red blood and obvious pus in the stools in a patient in whom an X-ray examination has shown diverticula to be present.

Treatment.—The accidental discovery of diverticulosis in the course of a routine X-ray examination indicates the necessity for permanently keeping the stools soft by means of large doses of paraffin and the avoidance of pips and skins of fruit and of pickles, salads, and cooked green vegetables except as purées. No other aperient should be used. In very mild cases of diverticulitis the same treatment is effective. In more severe cases with pyrexia and abdominal rigidity the patient should be kept in bed till all signs of active inflammation have disappeared. The diet already mentioned should be given together with an ounce of paraffin three times a day. Belladonna may be required to control the secondary spasm. Six ounces of paraffin should be injected into the rectum every evening and retained during the night. If the bowels do not act satisfactorily in the morning, water should be injected into the rectum very slowly and under very low pressure, in quantity insufficient to cause pain. By this means the accumulation of fæces generally present is gradually evacuated, and the pain and inflammation subside. Contrary to what was formerly thought, very few cases require operation. Only if the condition is complicated by the development of an abscess, signs of spreading peritonitis, definite obstruction, or increasing cystitis suggesting that a vesico-colic fistula is about to form is an immediate operation indicated. In addition to this, if the treatment described does not lead to the subsidence of inflammation and obstructive symptoms, an operation is required. It is sometimes possible to excise or short-circuit the whole of the affected portion of the bowel, but more often a colostomy has to be performed.

INTUSSUSCEPTION

ACUTE INTUSSUSCEPTION: see Acute Intestinal Obstruction (p. 602)

CHRONIC INTUSSUSCEPTION

Ætiology.—Chronic intussusception is a rare disease occurring only in adults. Twenty per cent. are secondary to innocent tumours, most of which project as polypi into the lumen of the bowel, 15 per cent. are secondary to malignant tumours, and 6 per cent. to dysenteric, tuberculous and other ulcers. A case of mine was associated with chronic uræmia in a man suffering from nephritis due to lead poisoning.

Symptoms.—A chronic intussusception may last for a month, a year or longer before it terminates in an attack of acute obstruction or of general peritonitis from perforation. It may finally reach the anus, from which it may project for some inches without preventing the passage of fæces. The onset is generally insidious; occasionally it is acute, but the severity of the symptoms generally diminishes and the subsequent progress of the case is chronic. Only about one-half of the cases are accompanied by constipation, diarrhœa being present in the majority of the others. The most

prominent symptom is colic, occurring in attacks which steadily increase in frequency and severity, and which may be brought on by taking food or by aperients; constipation is present during the attack, and blood and mucus may be passed at frequent intervals in entero-colic and colic, but not in enteric, intussusceptions. A palpable tumour is present in half the cases; it becomes harder and longer during an attack of colic, and appears to recede in the intervals. Severe attacks are accompanied by vomiting, especially in the enteric form. Visible peristalsis and dilatation often occur in the intestines above the intussusception. An opaque enema, given for suspected chronic obstruction, may reveal the presence of an intussusception by the typical appearance it produces.

Treatment.—The treatment is always surgical.

ACHALASIA OF THE PELVI-RECTAL AND ANAL SPHINCTERS (HIRSCHSPRUNG'S DISEASE IN CHILDREN AND MEGACOLON IN ADULTS)

Ætiology and Pathology.—Hirschsprung's disease is a rare condition occurring in young children, in which the colon becomes greatly dilated and hypertrophied although no organic obstruction is present. The disease is better named after the Danish physician who in 1886 first satisfactorily described it, or, in view of its pathogenesis, achalasia of the pelvi-rectal and anal sphincters, than by the alternative designation of "congenital idiopathic dilatation of the colon."

Megacolon is a similar condition occurring in adults; it is either the sequel of Hirschsprung's disease which has remained latent, or it may develop only in later life.

Both Hirschsprung's disease and megacolon in adults occur about eight times more frequently in males than in females.

In children the lower limit of the dilatation is situated with equal frequency at the junction of the pelvic colon with the rectum—the pelvi-rectal sphincter—and at the anal sphincter, but in adults it is always at the latter. From these points upwards there is a rapid enlargement, the maximum diameter being generally 3 or 4 inches higher. In about half of the cases, the enlargement is confined to the pelvic colon or rectum and pelvic colon, which may be so dilated that it reaches the left dome of the diaphragm or even finds its way above the liver under the right dome. In other cases, varying lengths of intestine are dilated, but the dilatation is always greatest in the pelvic colon, and diminishes as it is traced towards the cæcum, the small intestine being always spared. The muscular coat of the dilated intestine is greatly hypertrophied. The mucous membrane is thickened from chronic inflammation and is often ulcerated. The hypertrophy can only be a result of the increased work which the intestine has to do in order to overcome some obstruction, and peristalsis occurring in the hypertrophied colon could not fail to evacuate it, if there were no obstruction to the passage of its contents into the undilated rectum in the pelvi-rectal cases or through the anal canal in the anal cases. The obstruction in the two varieties is probably due to absence of the relaxation of the circular muscle fibres respectively at the pelvi-rectal sphincter and anal sphincter,

which should occur during defæcation; it is analogous to achalasia of the cardia, which is the cause of so-called idiopathic dilatation and hypertrophy of the œsophagus. It probably depends, like the latter, upon organic changes in Auerbach's plexus in the region of the sphincter; these are probably secondary to inflammation of the mucous membrane, which disappears completely but leaves behind permanent degeneration of the nerve tissue Such degenerative changes have been observed in a case of Hirschsprung's disease by Munro Cameron. In the pelvi-rectal variety the primary cause of obstruction must be aggravated at an early stage by obstruction of a different sort: the pelvic colon, when once dilated, produces a kink by overhanging the undilated rectum below.

Symptoms.—In Hirschsprung's disease there is almost always a history of constipation dating either from birth or from the first few months of life. At an early stage the bowels cease to act spontaneously, and drugs gradually lose their effect, until an evacuation can only be procured by means of enemata. The stools are generally soft or even semi-fluid, but in early cases scybala may be passed. Soon after the onset of the constipation, the abdomen, which is generally normal at birth, begins to increase in size owing to distension of the colon with gas and fæces, the size varying from time to time according to the frequency with which the bowels are opened. By examining the patient with the X-rays after a barium meal it is possible to recognise where the stasis begins, and if a barium enema is also given the exact extent of the dilatation can be discovered. In pelvi-rectal achalasia the rectum is empty but sometimes ballooned. In anal achalasia it is greatly dilated and filled with fæces, which are generally quite soft.

Sooner or later, an attack of complete obstruction may occur, no fæces being passed for even two or three months, though momentary relief sometimes follows the evacuation of small quantities of gas. The abdomen becomes enormously distended and tense; it is often painful, and the pressure on the diaphragm may cause severe dyspnœa, cyanosis and palpitation. The outline of the distended colon is seen, and peristalsis is generally visible. Albuminuria and œdema of the legs, penis and scrotum are sometimes observed. Vomiting may now occur, and the patient becomes exceedingly emaciated; death finally results from exhaustion, from general peritonitis secondary to perforation of a stercoral ulcer, or from some intercurrent disease, especially of the lungs. An attack of complete obstruction is sometimes relieved by enemata or by the passage of a rectal tube beyond the pelvi-rectal flexure; this permits the escape of gas and fæces under high pressure, but similar attacks are very apt to recur.

Death may occur in the first year of life, but more frequently between the ages of 3 and 8. In a few cases adult life is reached. When a megacolon is discovered in adults it is generally impossible to decide whether it dates from early childhood or whether it is a result of anal achalasia developing at a later date. It may give rise to no symptoms beyond more or less severe constipation. The abdomen is often not obviously distended, though the diaphragm is pushed up by the dilated bowel. Acute attacks of violent pain due to temporary obstruction may occur, but they generally end spontaneously after a few hours. An opaque meal shows the large intestine as far as the descending or iliac colon; it is then lost in the enormous pelvic colon. In order to define the position of the latter an opaque enema of six

or eight pints is required. A large gas-containing loop is often visible under the right dome of the diaphragm. The sigmoidoscope can be passed its full length without meeting the slightest resistance, and the walls of the enormous cavity formed by the pelvic colon can then be seen.

Treatment.—(*a*) *Anal achalasia.*—All cases of anal achalasia can be kept in a satisfactory state of health by non-surgical means. If the constipation is severe, a rectal tube should be inserted into the dilated rectum every day and the colon washed out. It may be necessary as a preliminary measure to empty the bowel digitally under an anæsthetic. Obviously neither a short-circuit operation nor colectomy could help, as the obstruction is at the anus. Even the results of colostomy are very unsatisfactory. On the other hand, daily lavage, if carried out with sufficient thoroughness, gives excellent results, and it is often possible after a time to wash the bowel out once a week or even less frequently instead of every day.

(*b*) *Pelvi-rectal achalasia.*—An attempt should be made to pass a rubber tube beyond the kink at the pelvi-rectal flexure, so that flatus can escape and the dilated bowel can be washed out. It is occasionally possible to do this by simply putting the patient into the knee-elbow position. As a rule, however, it is necessary to manipulate a sigmoidoscope beyond the kink into the pelvic colon, the patient being in the knee-elbow position; a tube is then passed through the sigmoidoscope, which is withdrawn, leaving the tube in position. In some cases recovery has followed dilating the pelvi-rectal sphincter with a distensible rubber bag. Very rarely operative treatment is required. It may be possible to make an anastomosis between the undistended rectum and the lower end of the dilated part of the colon. More frequently, however, the whole of the dilated colon has to be excised, but colectomy has a very high mortality in these cases.

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ACUTE INTESTINAL OBSTRUCTION

Acute intestinal obstruction is a condition in which the passage of the contents along the intestinal canal is more or less suddenly obstructed either completely or in greater part. Only mechanical causes of intestinal obstruction will be dealt with in this place, conditions of paralysis or spasm causing obstruction being considered elsewhere.

Ætiology.—The causes of acute intestinal obstruction are numerous, and may best be considered under (1) causes within the lumen of the bowel, (2) causes in the wall of the bowel, and (3) causes outside the bowel, while there are two additional conditions—intussusception and volvulus—which do not come under any of these categories.

1. Causes within the lumen of the bowel giving rise to acute obstruction are gall-stones, fæcal accumulations, and, very rarely, true foreign bodies.

Large gall-stones enter the intestine through a fistula between the gall-bladder and duodenum or, more rarely, some other part of the intestinal canal. Gall-stones are generally passed spontaneously; when this does not occur the site of impaction is nearly always the lower part of the ileum near the ileo-cæcal sphincter.

Fæcal accumulation is a common cause of an acute termination to a case

of chronic obstruction, but even without any previous narrowing it may cause obstruction. In such case the fæcal mass may be enormous in size and of a stony hardness; it leads more frequently to the pseudo-diarrhœa of partial obstruction than to complete obstruction.

2. Causes in the wall of the bowel give rise in most cases to chronic rather than acute obstruction; the commonest of such narrowings are those due to cancer. These conditions are discussed elsewhere, and it is only their liability to an acute termination which needs consideration here. Such a final catastrophe may result from the impaction of fæces, a distended coil of bowel may become twisted, or acute paralysis of the intestinal wall with or without peritonitis may develop. Congenital stricture is a rare cause of acute intestinal obstruction in early infancy; apart from stricture of the rectum, the commonest site is in the duodenum, just above the entrance of the bile-duct and in connection with Meckel's diverticulum.

3. The most common cause outside the intestine is strangulation of a portion of intestine by congenital or adventitious bands, diverticula or peritoneal adhesions. Such bands may result from old tuberculous or inflammatory disease, or may be a sequel to a laparotomy, if blood is left in the peritoneum or the peritoneum is much damaged. They may be produced by the adherence of normal structures, such as the omentum, Fallopian tube or appendix to other abdominal organs, or may result from the presence of a persistent Meckel's diverticulum. The latter may remain attached to the umbilicus, or its free end may become adherent. Such bands may obstruct by bridging across a portion of bowel, or a knuckle of bowel may become twisted round or under them, or, if the band is not long, mere kinking at its point of attachment may be sufficient to obstruct the lumen. Internal hernias may give rise to strangulation and intestinal obstruction; their commonest sites are congenital or acquired slits or tears in the mesentery or omentum, one or other of the normal peritoneal fossæ, or, more rarely, the foramen of Winslow or congenital or acquired apertures in the diaphragm. The peritoneal fossæ into which such internal hernias may pass are situated in the neighbourhood of the duodeno-jejunal flexure, in the peri-cæcal region, and in the root of the pelvic mesocolon.

4. *Intussusception.*—By intussusception is meant the passage of one segment of intestine into another immediately below. When this occurs a tumour is formed consisting of three layers, the outermost or intussuscipiens being the portion of bowel into which invagination is occurring, and the inner two constituting the intussusceptum, which therefore consists of an entering layer and a returning layer. Between these latter is the strangled mesentery, interference with the vessels of which speedily occurs and induces changes in the intussusceptum. The apex is the distal part of the intussusception, and the neck the narrow part where the returning layer turns to become the sheath or intussuscipiens.

The chief cause of intussusception is undue enlargement of the intestinal lymphatic tissue producing irregular muscular action, aided no doubt by an unusually long mesentery, and by an atonic condition of the ileo-cæcal sphincter. All these three factors, particularly the first, are most common in early childhood, and intussusception is consequently rare at other ages; 70 per cent. of cases occur in infants under a year old. In adults an intestinal polypus or carcinoma is often the starting-point of the invagination, which

generally differs from that occurring in infants by being chronic instead of acute.

Various forms of intussusception occur, of which the ileo-cæcal variety, with the ileo-cæcal valve as its apex, constitutes about 70 per cent. Enteric, colic, ileo-colic and multiple intussusceptions are less frequent. An intussusception always increases at the expense of the ensheathing layer, its apex remaining constant.

5. *Volvulus* is a condition in which a coil of intestine becomes twisted on itself around its mesenteric axis, leading to interference with its circulation and with the passage of its contents. It occurs most frequently in the pelvic colon and the ileum, but may affect the cæcum or any part of the intestine with a mesentery. It usually occurs late in life, is commonest in males, and depends partly upon an abnormally shaped mesentery and partly upon loading of the loop from chronic constipation. The dilated coils above a chronic obstruction are especially liable to become twisted and so bring about an acute termination to the case.

Pathology.—In acute intestinal obstructions the conditions found fall mainly into two groups depending on (1) the occurrence of obstruction of intestine with a previously normal lumen, and (2) acute obstruction terminating a case of gradually increasing chronic obstruction.

1. In most cases in this group a portion of intestine is strangulated in addition to the obstruction to the lumen of the bowel, and consequently the condition of the intestine must be considered in three regions—namely, above the obstruction, below it, and in the strangulated coil itself. An exception occurs in the acute obstruction produced by an impacted foreign body, where, of course, there is no strangulation.

(*a*) The intestine above an acute obstruction is usually greatly distended, its walls are at first pale and thin, and later œdematous and purple in colour, and the extent of these changes rapidly increases upwards as the obstruction persists. The distended coils are full of fluid (partly the normal dammed-back secretion, partly an exudation of serum), and as the case progresses bacteria escape through the distended and paralytic coils, and lead to peritonitis. These changes are far more marked in small intestine obstruction than when the colon is affected.

(*b*) Below the obstruction the coils are, as a rule, empty, contracted and pale.

(*c*) As a result of circulatory interference, the strangulated coil itself becomes distended with effused blood and gas, the latter mainly CO_2, which cannot be absorbed. It is purple in colour, tense, œdematous and paralysed, and it exudes bloodstained fluid both into its lumen and into the surrounding peritoneum. If the strangulation is sufficiently severe to obstruct arteries as well as veins the coil becomes gangrenous in less than an hour. Such a coil is grey and loses its peritoneal sheen; it is flaccid and exudes free gas and stinking fluid into the peritoneum. This condition is, of course, irrecoverable, but in less complete strangulation the intestinal wall quickly returns to normal when the strangulation is released. A strangulated coil soon loses power to prevent the passage of bacteria, and if left alone its vessels inevitably become thrombosed, and its walls become gangrenous and ultimately perforate. The contents of an obstructed loop are profoundly toxic, the toxicity being greater the higher in the course of the alimentary canal the obstruction is situated.

2. When acute supervenes on chronic obstruction, the bowel has already had time to accommodate itself in some degree to the presence of narrowing of its lumen. The final blockage of the passage is most frequently due to impaction of fæces in the narrowed part, or kinking, adhesion, volvulus or acute paralysis of the intestine above it. In such cases the already existing hypertrophy above the obstruction gives place to rapidly increasing distension, and as a result the intestinal circulation is interfered with, and gas, being no longer efficiently absorbed, collects within the bowel. The enteritis and ulceration usually present in some degree above a chronic obstruction rapidly increase, and perforation and consequent peritonitis speedily follow.

Symptoms.—The symptoms of acute intestinal obstruction vary to a certain extent with the particular cause of the condition, but some of them are present in all cases. Of the general symptoms, pain, vomiting, constipation and collapse are the most important.

Pain is an early symptom and is very severe, in many cases a patient in perfect health being suddenly seized with an acute abdominal pain which doubles him up and never remits. At first the pain is stabbing in nature, but later he complains of exacerbations which are colicky in character, and which occasionally serve to localise the obstruction. If the case is allowed to progress until peritonitis supervenes, the continuous pain and tenderness associated with that condition are present in addition.

Vomiting, preceded by nausea and severe retching, usually comes on about an hour after the pain, but it may be delayed for 8 or 10 hours. Once it has begun it continues with increasing frequency, and from the second to the fourth day it becomes fæcal in character. The higher the site of the obstruction is situated in the bowel, the greater the vomiting and the sooner it becomes fæcal. Fæcal vomiting is not due to antiperistalsis, but is caused by the stagnant and excessive secretions of the portions of bowel above the obstruction, gradually extending upward until they overflow into the stomach and cause vomiting. The fæcal character is accounted for by the remarkable speed with which *Bacillus coli* and other organisms multiply in the stagnant contents.

Collapse is early and severe. The patient is prostrated, anxious, and restless, the pulse is rapid, small and thready, the temperature subnormal, and the extremities cold and clammy. The collapse is partly reflex from stimulation of the vagal and splanchnic nerve endings in the abdomen, and is partly due to loss of fluid from sweating and excessive intestinal secretion. A very important part is also played by the toxic intestinal contents; the higher in the bowel the obstruction is situated the greater is the toxicity of the stagnating contents.

Constipation is as a rule absolute, although the bowel below the obstruction may empty itself shortly after the onset of the pain and vomiting. Neither fæces nor flatus are passed, and enemata after washing away any fæcal material present in the bowel below are either retained or return slowly without force.

In addition to these cardinal symptoms the patient presents certain other important signs. The tongue is dry and the teeth are covered with sordes. The abdomen at first is not tender to touch, and sometimes pressure may relieve the pain. It is often not distended, though in some conditions,

such as volvulus, the distension may be extreme. If acute obstruction supervenes on chronic obstruction visible peristalsis may be present, and the coils can be felt to harden under the hand. Occasionally a tumour is felt in the abdomen, especially in intussusception, where a sausage-shaped mass can frequently be felt. On auscultation intestinal sounds are present in increased intensity. If the case goes on until peritonitis supervenes the symptoms of that condition develop and consequently the abdominal picture changes. In acute intestinal obstruction the urine is scanty and highly coloured, and when the obstruction is low in the bowel it contains a great excess of indican. The viscosity of the blood is increased from loss of fluid; this probably accounts for the frequent cramp-like pains in the limbs.

Diagnosis.—The diagnosis of acute intestinal obstruction is usually easy, but the further differentiation of the site and nature of the obstruction, though sometimes fairly simple, is often impossible before operation. The history is of importance in deciding whether the acute symptoms have supervened on those of chronic obstruction, in which case similar but less severe attacks which were relieved by enemata or purgatives may have occurred. A previous history pointing to gall-bladder trouble, particularly if the onset of obstruction is somewhat less acute than usual, suggests gall-stone impaction.

Inquiry should be made for evidence of abdominal attacks suggesting appendicitis, salpingitis, or other conditions, which might produce bands.

The presence in an infant of a sausage-shaped tumour, which can be felt to harden and is situated usually in the upper abdomen, with tenesmus and the passage of blood and slime, acute attacks of colic causing the child to scream and to draw up its legs, with occasional vomiting, forms a characteristic picture of intussusception, and enables a confident diagnosis to be made in many cases. In doubtful cases, examination under anæsthesia may be required, and rectal examination may enable the intussusception to be felt.

In volvulus the onset is acute, but collapse may be absent. Vomiting is not frequent at first, but the characteristic feature is the rapid onset and extreme degree of distension. This distension may at first be localised and indicate the seat of the volvulus, but it soon involves the whole abdomen and may cause severe cardiac and respiratory embarrassment.

Distension implies interference with the blood supply and consequent deficient absorption of gas from the bowel; it is thus a valuable indication as to whether strangulation has taken place as well as intestinal obstruction.

The conditions from which acute intestinal obstruction has to be differentiated are numerous. The most important is hernia, and a careful examination of the hernial apertures should always be made. In some cases of small femoral hernias in fat persons it is very easy to overlook the condition, and in the rare obturator hernia diagnosis is frequently only possible on opening the abdomen. Fæcal impaction is another important condition to be considered, particularly in view of the grave results of laparotomy mistakenly undertaken for its relief. The history of chronic constipation and the presence of hard or putty-like masses in the rectum or pelvic colon should prevent errors.

Peritonitis is often a source of difficulty. The extreme tenderness and rigidity, the absence of fæcal vomiting, the partial nature of the constipation at first, as well as the temperature, history, and silence of the abdomen on

auscultation are distinguishing features. Difficulty may arise from conditions causing acute stimulation of the sympathetic nerve, such as torsion of the testicle, ovary, or omentum, or the passage of a renal or biliary calculus. Careful inquiry of the history, the characteristic distribution of pain in the colics, examination of the scrotum and vagina and of the urine will usually lead to a correct diagnosis. Further, in these conditions enemata generally result in passing of flatus, and the course of the disease does not follow the usual sequence of cases of acute intestinal obstruction. In acute pancreatitis the pain is localised in the epigastrium, while the constipation is usually not absolute.

Lead colic can be distinguished by the blue line on the gums, the history, the blood picture, the absence of fæculent vomiting, and the result of enemata ; while a routine neurological examination will distinguish tabetic crises.

Rare conditions which may lead to mistakes are embolus or thrombosis of the superior mesenteric vessels. In embolus some cardiac lesion is usually present, and in thrombosis there may be evidence of cirrhosis, gall-bladder disease or thrombosis of other veins, while hæmatemesis and melæna are common in both conditions.

Prognosis.—Spontaneous cure is remotely possible in all cases of intestinal obstruction, but in the majority of cases, if operation is not undertaken, death occurs at varying intervals, the average being after 6 days. Once the obstruction has been relieved by operation recurrence is uncommon, excepting perhaps in cases due to adhesions following operation. Even when operation is undertaken acute intestinal obstruction has a grave outlook, depending partly on the length of time elapsing before operation and partly on the nature of the lesion present. Volvulus is the most fatal form of obstruction, closely followed by gall-stone impaction. Other conditions materially affecting the prognosis are the age and general condition of the patient, and the presence of toxæmia, septicæmia, peritonitis, or complicating conditions elsewhere.

Treatment.—Excluding cases of fæcal impaction the treatment of all cases of acute intestinal obstruction is immediate operation. The object of the surgeon is to locate the seat of the obstruction, and to relieve it as quickly as possible with the minimum of handling and exposure of the abdominal contents. When the abdomen is opened a collapsed portion of gut is sought, as it helps to localise the seat of obstruction. When found, the obstruction must be relieved in the simplest possible manner, by reducing a hernia, dividing a band, reduction of an intussusception by manipulation, removing a gall-stone, etc. If, however, the obstruction cannot be relieved, or if the bowel is too severely damaged to return to the abdomen, it is wise simply to establish drainage above the obstruction and to wait till the acute period is passed before undertaking further measures. In cases with much distension, where the obstruction is obviously in the colon, and where an exploration would entail considerable handling, the proper treatment is undoubtedly to perform a blind cæcostomy and to delay further procedures until the distension has been relieved. Apart from operation, saline solution should be given intravenously, or subcutaneously to combat the fluid loss, and opium may be given to relieve pain once the diagnosis is established and operation agreed to.

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APPENDICITIS

Ætiology.—The two sexes are affected equally. No age is exempt, but whereas acute appendicitis is more common in children, chronic appendicitis is more common in adults.

The appendix may become infected either by organisms spreading from the lumen of the cæcum or conveyed by the blood. In the former case, the original infection may presumably come from infected food, but septic foci in connection with the teeth, tonsils and naso-pharynx are undoubtedly of more importance. The latter are also the chief sources of hæmatogenous infection.

The commonest organism is the *Bacillus coli communis*; next in order of frequency come streptococci and staphylococci. The proteus, tubercle and actinomycosis organisms are rare. Congenital or acquired abnormalities are present in a considerable proportion of cases. In the former the appendix is not fully descended, is of the infantile variety, or is twisted on itself. In the latter, there are adhesions or kinks caused by previous inflammation either of the appendix itself or of neighbouring organs; and in many cases the bands resulting from chronic intestinal stasis lead to kinking of the appendix. Obstruction to its lumen from any of these causes produces stagnation of its contents, and provides the necessary conditions for bacterial invasion. Foreign bodies are another cause, but they occur less frequently than might be expected. Intestinal worms, pins, and fruit pips and stones have all been met with, but by far the commonest foreign body is the so-called "appendicular concretion," formed of inspissated fæcal material moulded into shape by the appendix itself.

Acute Appendicitis

Pathology.—In catarrhal appendicitis the mucosa only is affected, but in the commoner diffuse type all the coats are involved, the organ being hyperæmic, rigid, tense, and swollen, and the mucous membrane being frequently ulcerated. Later the lumen of the appendix becomes filled with pus, and if there is obstruction, empyema of the organ results. Later still, local or general gangrene occurs, the most frequent sites being the tip or the base. Perforation is very liable to take place at any of these stages, leading either to a localised appendicular abscess or to generalised peritonitis. The chief factor in determining which of these two complications will occur is the virulence of the organism, since it requires time for the reaction of the peritoneum to come into play sufficiently to localise the results of perforation to the immediate neighbourhood. In milder cases the inflammation tends to resolve, and the appendix may return to an apparently normal condition, but if the attack has been at all acute, either adhesions or narrowing of the lumen generally remain, leaving it far more liable to further attacks of inflammation. If perforation and abscess formation occur and operation is not undertaken, spreading peritonitis results. Suppurative pylephlebitis may result from spread of infection along the mesenteric veins either with or without perforation of the appendix.

Symptoms.—In nearly all cases the following symptoms are present,

though they may vary in degree—(1) sudden abdominal pain, (2) pyrexia, (3) increased pulse rate, (4) gastro-intestinal symptoms, (5) local signs.

1. *Sudden abdominal pain.*—The onset is usually sudden, the patient being seized with severe abdominal pain, often severe enough to produce collapse and vomiting, and often referred at first to the region of the umbilicus, particularly in children. Later the pain becomes more or less localised to the right iliac fossa, and may be of considerable intensity. In very severe cases, especially in children, and where early gangrene occurs, the pain may be comparatively slight after the initial onset, and in other cases the affection may progress to abscess formation with relatively little pain. Such cases, are, however, the exception, and the pain is usually a prominent symptom.

2. *Pyrexia* is almost always present at some time during the attack, though its height is no measure of the severity of the lesion in the appendix. There is sometimes a rigor at the onset, and the temperature in an average case varies from 100° to 102°, rarely higher. A rise only to 99° or 100° is not uncommon, but is important, as very few cases occur in which there has not been some pyrexia at some period of the attack. When a localised abscess has formed, and in very severe cases with perforation and generalised peritonitis, the temperature may be normal or subnormal throughout.

3. The *pulse rate* is usually increased and tends to continue to increase as the disease progresses.

4. *Gastro-intestinal disturbances* are almost invariably present. The tongue is furred and rapidly becomes dry. Vomiting is frequent. There is usually vomiting at the onset of the attack, and though this persists in the severe cases with peritonitis, it may pass off, but nausea usually continues. Constipation is the rule, and in the majority of cases is absolute. Diarrhœa is, however, by no means uncommon, indicating usually a pelvic position of the appendix, in which the inflammation spreads to and irritates the rectum. If the process is allowed to progress, complete constipation resulting from peritonitis and consequent paralysis of intestinal movements ensues. Even before this stage has been reached, auscultation over the region of the cæcum often reveals a complete absence of the usual intestinal sounds, which may be of considerable help in diagnosis.

5. *Local signs.*—There is usually no distension of the abdomen at the onset of the attack, but on inspection it will be seen that the lower abdomen moves less freely than the upper on respiration, and the right side less than the left. There is frequently hyperæsthesia of the skin in the right iliac fossa, and occasionally some œdema can be discovered by loosely picking up the skin and subcutaneous tissues between the fingers and comparing with the other side. There is great rigidity of the right rectus muscle, and this is probably the most important single sign; the rigidity is often too great to allow of any proper deep palpation. In addition to the rigidity there is great tenderness and pain on palpation, which has its maximum at MacBurney's point, situated at the junction of the outer and middle thirds of a line drawn from the anterior superior iliac spine to the umbilicus. In children the maximum pain and tenderness are often in the region of the umbilicus. In some cases an ill-defined mass can be felt in the right iliac fossa, and the longer the history, the more likely is such a mass to be present. It is constituted mainly of adherent coils of intestine and omentum surround-

ing the inflamed or perforated appendix. Rectal examination is often of value, and in many cases a tender mass can be felt on the right side of the rectum, when none can be made out from above. Considerable irritability of the bladder may be present, especially with a pelvic appendix, and the urine, which is scanty, frequently contains albumin.

A blood count is occasionally of value for purposes of differential diagnosis, and usually shows a leucocytosis of from 15,000 to 20,000.

In many of the worst cases, some or all of these signs and symptoms may be absent, but with a careful examination and a clear history it is usually possible to reach a correct diagnosis.

In some cases an abnormally situated appendix gives rise to characteristic symptoms. With a retro-cæcal appendix, local signs in the right iliac fossa may be absent, there being instead great pain and tenderness in the loin, and rigidity without great tenderness of the right rectus. These cases are specially apt to develop subdiaphragmatic abscess, and later empyema. An appendix running down into the pelvis is apt to give diarrhœa and bladder irritability, local rigidity may be slight and a mass can usually be felt per rectum. An appendix running directly inwards may occasionally give rise to left-sided symptoms.

Course.—Where a correct diagnosis is made, early operation should be undertaken at once, for reasons to be discussed later, but if for any reason operation is delayed the case may take one of three possible courses.

(*a*) Gradual recovery may ensue, and in first attacks this will occur in a large number of cases. Improvement begins about the second or third day and the acute symptoms generally subside in a week. In such cases the patient is extremely liable to have further attacks, a liability which is increased in proportion to the degree of change which has occurred in the appendix.

(*b*) In many cases, as the result of ulceration or perforation of the appendix, the local symptoms not only do not disappear at the end of the first week, but persist and become aggravated. The temperature usually rises and there may be rigors, while at the same time a tumour becomes palpable in the iliac fossa. In some cases the abdominal wall may become œdematous and indurated, and the patient frequently begins to lose weight rapidly, to sweat profusely and to show all the signs of closed suppuration. If an operation be now performed, an abscess is found in connection with the appendix, having definite walls composed of adherent and matted intestine, omentum and parietal peritoneum Such abscesses often contain large quantities of very foul-smelling pus, and if left alone may burst into the rectum or general peritoneum, or more rarely on to the surface, usually in the neighbourhood of the umbilicus. Spontaneous recovery may follow rupture into the rectum or on to the surface, but in the other cases death is almost certain to ensue.

(*c*) The third result of an unoperated attack of acute appendicitis, and by far the commonest cause of death in this disease, is generalised peritonitis. This may occur either from perforation of the appendix before limiting adhesions have had time to form, or it may occur without any perforation at all. In the latter case bacteria pass through the wall of the inflamed appendix and set up suppuration in the neighbourhood; if the resistance is poor, this involves the neighbouring peritoneum and ultimately leads to a

generalised infection. In other cases a localised abscess may form and later burst into the peritoneum, a result often precipitated by sudden exertion on the part of the patient, injudicious palpation, or the administration of aperients. The great danger of appendicitis, and one that can only be met by immediate operation in all definite cases, is that general peritonitis may occur from the very beginning, and its symptoms may be indistinguishable from those of the acute appendicitis itself. In the hands of competent abdominal surgeons, operation in the early stages is one of almost absolute safety, and in these circumstances any delay, with the shadow of possible peritonitis menacing the patient at any time, is quite unjustifiable.

Diagnosis.—As appendicitis is by far the commonest acute inflammatory condition occurring in the abdomen in people under middle age, it must always be thought of in the presence of acute abdominal disease. In a typical case, with acute onset of abdominal pain, generalised at first and later settling into the right iliac fossa, with vomiting, constipation and local rigidity and tenderness, the diagnosis is easy, but one or more of these signs may be absent, and in such cases it is well to remember that a single positive sign is worth several negative ones. The most constant single sign is tenderness on deep pressure in the iliac fossa, and if this is present even in moderate degree, the case must be carefully watched before a diagnosis of acute appendicitis can be safely discarded.

Rectal examination may reveal bulging of the rectal wall by an abscess, particularly with a pelvic appendix, which, if palpable, is extremely tender.

A general examination of the patient is essential in order to eliminate certain other conditions which sometimes lead to mistakes. Right-sided pneumonia may cause difficulty, as the onset is sometimes associated with considerable pain and rigidity in the right side of the abdomen, but as a rule the accompanying respiratory symptoms and signs, especially the rapid respiration, will prevent error. In children contraction of the right psoas muscle with flexion of the hip may suggest an acute arthritis or even a psoas abscess, whilst a psoas abscess is occasionally mistaken for appendicitis. Of the abdominal lesions most likely to cause confusion the most difficult to differentiate is acute tubo-ovarian disease in women. In some of these cases, appendicitis coexists from spread of infection, and where doubt remains after a thorough pelvic examination it is safer to operate than to risk leaving a possible acute appendicular lesion.

In perforation of gastric or duodenal ulcers, the general shock is more profound, the rigidity is more general and board-like, and the pain is diffuse and not localised; in biliary, renal, and intestinal colic, the nature and distribution of the pain usually suffice to prevent mistakes. Twisting of a small ovarian cyst may be impossible to differentiate, but operation is called for in either case. In certain cases of typhoid fever the clinical picture may simulate appendicitis very closely. The relatively slower pulse and higher temperature, the constant headache, and the absence of any definitely acute onset, are of the greatest help in distinguishing, and a leucocyte count may be of considerable assistance, as leucopenia is present in typhoid fever in contrast with the leucocytosis of appendicitis.

Prognosis.—If left alone a considerable proportion of cases of acute appendicitis tend to recovery, but it is at present impossible to give an accurate prognosis of the course of any particular case within the first 48 hours. The

chief cause of death is peritonitis, and less often pylephlebitis, septicæmia, or pulmonary embolism. Even if recovery from a first attack does occur, the patient is left with a far greater liability to subsequent attacks, and is in some danger of acute or chronic obstruction from the adhesions which so frequently develop. Successive attacks of appendicitis tend to be more severe, and a patient who has had two is almost certain to have further trouble.

With early operation the prognosis is extremely good, death being rare after operation within 36 hours. Even when operation is undertaken later in the attack, the prognosis is still good, unless general peritonitis has ensued, in which case the prognosis without operation is uniformly bad. A further great advantage of early operation is that drainage of the abdomen can be avoided in these cases, whereas in later operations drainage is frequently necessary with a consequent increased risk of post-operative hernia.

Treatment.—In acute appendicitis operated on within 36 hours of the onset, the mortality in the hands of most surgeons is negligible, and since it is quite impossible to determine the course which any particular attack is going to take, there can be no doubt that when the diagnosis is definitely established, operation should be undertaken at once. Some surgeons are of opinion that when the case is seen later than 48 hours from the onset and is tending to improve, medical treatment should be undertaken until the attack has subsided, and the appendix should be removed during the quiescent period. Since operation in these cases is, with modern technique, very little more difficult or dangerous than in early cases, such a view has little to recommend it, since it condemns the patient to two tedious periods of sickness instead of one, and there is, in addition, the risk of the patient's natural objection to an operation, when he feels perfectly well, overcoming the advice he has been given and leaving him exposed to all the risks of a further attack. When peritonitis or localised abscess formation has occurred, there are no two opinions as to the necessity of operation. If, for any reason, operation is impossible or refused, the patient should be kept in the Fowler position, should have nothing but water by mouth, and may be given morphine to diminish both pain and intestinal movement, provided always that the question of operation has been finally and definitely decided.

Where an appendicular abscess has developed, it was formerly held that the abscess should be drained and the appendix removed subsequently. Modern surgical opinion is in favour of doing both at one operation, and in the hands of an experienced operator this procedure is undoubtedly best, but where skilled surgical aid is not available, simple incision and drainage of the abscess meet the immediate emergency.

E. G. Slesinger.

Chronic Appendicitis and Appendicular Dyspepsia

Symptoms.—Chronic appendicitis may give rise to gastric symptoms, which may either be the sole manifestation of the disease, or may be accompanied by constant discomfort or short attacks of pain in the right iliac fossa. Epigastric pain, which may radiate downwards to the umbilicus or below, and occasionally towards the right iliac fossa, occurs after meals. The time

of its onset is very irregular. Most commonly it occurs immediately after meals, but occasionally it may be delayed for 2 or 3 hours. It is at the most only slightly relieved by alkalis, and food very rarely gives even momentary relief. It is aggravated by fatigue to a greater extent than is the case with the indigestion of gastric and duodenal ulcer and gall-bladder disease. The degree of discomfort varies from time to time; it is rarely completely absent, and may sometimes be sufficiently severe for the patient to go to bed. Nausea is common and is often present in the absence of vomiting. Vomiting may occur, especially after food and when the pain is severe, but it gives much less relief than in gastric ulcer. Heartburn and acid regurgitation are uncommon. Hæmatemesis may occur from an acute gastric or duodenal ulcer secondary to the appendicular infection.

A fractional test-meal shows that in only 12 per cent. of cases gastric secretion is unaffected; in 55 per cent. of a series of 65 cases, in most of which the symptoms were mainly epigastric, there was hyperchlorhydria, and in 33 per cent. of cases, in most of which the pain was situated chiefly in the right iliac fossa, achlorhydria was present. It is probable that hyperchlorhydria is a reflex effect of the appendicitis, whereas achlorhydria dates from a period preceding the appendicitis and predisposes to its development owing to the loss of the antiseptic properties of the normal gastric juice.

Tenderness is generally more marked in the right iliac fossa than in the epigastrium, even when there is no spontaneous pain in the former situation. Occasionally the localised tenderness can only be discovered when pressure is exerted directly over the appendix after it has become visualised with the X-rays. In many cases pressure in the right iliac fossa leads to no local pain, but to discomfort in the epigastrium with nausea, exactly simulating the spontaneous symptoms. Constipation is commonly present. In rare cases there may be chronic diarrhœa, but more frequently a form of pseudo-diarrhœa, in which frequent small stools are passed, is present owing to irritation of the rectum caused by a chronically inflamed appendix situated in the pelvis. Pelvic appendicitis may also lead to irritability of the bladder with frequent micturition, and in women to dysmenorrhœa.

Diagnosis.—The diagnosis of chronic appendicitis may be exceedingly difficult, and it is consequently not uncommon for an appendix to be removed without benefit. The operation is not justifiable for chronic appendicitis, unless the diagnosis has been confirmed by means of the X-rays and, if possible, by means of Bastedo's inflation sign. The X-rays show where the appendix is in almost all normal individuals and about 80 per cent. of cases of appendicitis, and its discovery in the pelvis or immediately under the liver may explain anomalous symptoms. In chronic appendicitis, the appendix itself is always found to be the point of maximum tenderness, definitely more tender than the end of the ileum or the cæcum. By manipulating the cæcum so that the position of the appendix in the abdomen is altered, the tender point moves with it. In some cases, pressure on the appendix produces epigastric discomfort, either with or without local tenderness. Indirect evidence of appendicitis is occasionally afforded by the presence of ileal stasis, and by the recognition of adhesions in the right iliac fossa, which are most commonly due to chronic appendicitis.

On inflating the colon with air through a tube introduced into the rectum,

normal individuals feel a generalised discomfort in the abdomen. Bastedo's sign of chronic appendicitis is the production under these conditions of localised pain in the right iliac fossa with increased tenderness, sometimes associated with or even entirely replaced by epigastric discomfort. This is present in a large proportion of cases, but never in salpingitis, ureteral calculus, gall-bladder disease or other conditions, which might simulate chronic appendicitis. Inflation should be carried out during the X-ray examination, as it raises a pelvic cæcum and brings the appendix within reach of the palpating fingers. It also unravels confusing pelvic shadows and makes it possible to decide to what extent adhesions are present in connection with the terminal ileum, cæcum and appendix.

If repeated attempts fail to visualise the appendix it is probable that its mouth is obstructed ; in the presence of suspicious symptoms and tenderness in the ileo-cæcal angle the absence of an appendicular shadow favours the diagnosis of appendicitis. In such cases Bastedo's sign is also negative, as it depends upon distension of the appendix itself, which is only possible when barium can also mark its lumen.

Treatment.—Medical treatment gives little or no relief ; this is an important point in diagnosis, as in any case of chronic dyspepsia, which does not yield to ordinary treatment, the possibility of chronic appendicitis should be considered. In mild and doubtful cases the effect of removal of any source of infection in the teeth and tonsils should first be tried, and in cases associated with complete achlorhydria dilute hydrochloric acid should be taken with meals for some time, as this occasionally results in complete disappearance of the symptoms.

Recovery should follow the removal of the appendix, but it is not infrequent for the symptoms to persist for a time after the operation, especially if the disease is associated with some functional nervous disorder or with chronic typhlitis or cholecystitis. Such associated conditions require attention both before and after the operation, and if the gall-bladder is infected it should be removed at the same time.

ARTHUR F. HURST.

DISEASES OF THE LIVER

TESTS FOR HEPATIC FUNCTION

In our experience the lævulose test for hepatic efficiency is the only one of sufficient value to deserve description. In considering the diagnosis of jaundice, van den Bergh's reaction for excess of bile pigment in the blood will be described, and the direct investigation of the bile obtained by means of a duodenal tube will be considered in connection with cholecystitis.

Lævulose tolerance test.—In normal individuals the blood sugar does not rise more than about 20 mgr. per 100 c.c. 1 hour after 50 grm. of lævulose have been taken in 100 c.c. of water on an empty stomach, and in 2 hours it falls again to the fasting level. If, however, the liver is diseased, the rise at the end of 1 hour is greater, and it is still considerably above the fasting level at the end of 2 hours.

JAUNDICE

Synonym.—Icterus.

Definition.—Jaundice is the condition caused by the presence of excess of bile-pigment in the blood, which manifests itself clinically by yellow coloration of the conjunctivæ and skin.

Ætiology and Pathology.—All cases of jaundice may be divided into three groups—hæmolytic jaundice, toxic and infective hepatic jaundice, and obstructive hepatic jaundice (McNee).

(*a*) HÆMOLYTIC JAUNDICE.—In hæmolytic jaundice bilirubin is produced from hæmoglobin set free in the general circulation by the destruction of red cells as a result of abnormal fragility, as in acholuric jaundice, or of the presence of hæmolytic toxins in the blood, as in Addison's (pernicious) anæmia. The hæmoglobin set free is broken down, and bilirubin is formed by the action of the endothelial cells of the spleen and to a less extent the similar endothelial cells of Kupffer, which lie along the portal capillaries adjacent to the bile capillaries of the liver, and the endothelial cells of other organs. The excess of bile pigment in the blood is thus formed quite independently of the glandular cells of the liver.

(*b*) TOXIC AND INFECTIVE HEPATIC JAUNDICE.—This includes the jaundice caused by infection with *Spirochæta* (*Leptospira*) *ictero-hæmorrhagica* (p. 183) as well as that occurring in yellow fever, malaria, typhoid fever, pneumonia and septicæmia. This form of jaundice is one of the characteristic symptoms of acute yellow atrophy. It may occur in snake and mushroom poisoning, and in rare cases after large doses of salvarsan and allied preparations, chloroform, chloral, acetanilide, atophan, santonin, filix-mas, and in poisoning with phosphorus, arseniuretted hydrogen and aniline. Poisoning with trinitrotoluene and tetrachlorethane was the cause of the epidemic of jaundice in aeroplane and munition workers during the Great War (p. 381). Severe cases of toxæmic jaundice are sometimes grouped under the name of *icterus gravis* or *malignant jaundice*.

Toxic and infective jaundice is due in part to damage to the hepatic cells, which may vary from cloudy swelling in pneumonia, fatty degeneration in chloroform poisoning and partial necrosis in spirochætal jaundice to almost complete necrosis in acute yellow atrophy. The damaged hepatic cells are unable to convey the bile pigment from Kupffer's endothelial cells lining the portal capillaries into the bile capillaries; the pigment consequently passes to the hepatic vein and thence into the general circulation. At the same time any bile pigment which is excreted by still active liver cells is obstructed by inflammatory swelling of the walls of the small bile-ducts caused by toxins excreted in the bile; it is consequently reabsorbed. The jaundice is thus in part due to insufficiency of the hepatic cells and in part obstructive, the proportion of the two factors varying in different cases. The degree of hepatic insufficiency can be judged by the lævulose test, which is unaffected in pure obstructive jaundice.

(*c*) OBSTRUCTIVE HEPATIC JAUNDICE.—In obstructive jaundice bile excreted by the hepatic cells is reabsorbed by the hepatic blood capillaries together perhaps with the lymphatics, owing to the rise in pressure caused by obstruction of the bile-ducts. The obstruction may occur (1) within the ducts, or it may be due to (2) changes in their walls or (3) pressure from without.

1. *Obstruction within the ducts.*—This is almost always due to gall-stones. In very rare cases a hydatid cyst has ruptured into a duct, which became obstructed by a piece of membrane or a daughter cyst, or a round worm has entered the common bile-duct from the duodenum.

2. *Obstruction due to changes in the walls of the ducts.*—Primary carcinoma of the bile-ducts and biliary papilla quickly leads to jaundice. Simple stricture is almost always congenital (p. 620), as an acquired stricture from cicatrisation of an ulcer produced by a gall-stone is excessively rare except in the cystic duct, where it does not lead to jaundice. Catarrhal jaundice is generally due to the obstruction produced by inflammatory swelling of the mucous membrane in the biliary papilla; infective and suppurative cholangitis also lead to jaundice, but in some cases, at any rate, the obstruction to the ducts is associated with changes in the liver cells which are in part responsible for the production of the jaundice.

3. *Pressure on the ducts from without.*—Malignant tumours of the liver, and much less frequently gummata and hydatid cysts, give rise to jaundice by pressing on the intrahepatic branches of the bile-ducts; if some of the latter escape, bile still passes into the duodenum from other parts of the liver, and the fæces remain coloured. The tumour may project into the portal fissure and give rise to jaundice with colourless stools by pressing upon the hepatic ducts or common bile-duct.

Enlarged glands in the portal fissure may cause jaundice by pressure upon the ducts. The most common cause is primary or secondary cancer of the liver, as these glands drain the liver, but not the other abdominal viscera or peritoneum; for the same reason they rarely become tuberculous. They may be enlarged in Hodgkin's disease, but never in syphilis.

Jaundice may occur in cancer of the stomach, even when no secondary deposits are present in the liver or in the glands in the portal fissure; this is due to the pressure of glands in the neighbourhood of the head of the pancreas, or to direct spread of the growth into the lesser omentum, where it compresses the common bile-duct and may invade its walls.

A movable kidney may give rise to typical attacks of biliary colic associated with jaundice, owing to the traction it exerts on the common bile-duct itself or indirectly by drawing down the duodenum. The diagnosis of a movable kidney from cholelithiasis is suggested by the fact that the attacks never begin in the night and are rapidly relieved by lying down, and is confirmed if a movable kidney is found and relief follows its successful treatment.

Jaundice is produced by obstruction of the common bile-duct when chronic pancreatitis occurs in an individual in whom the duct is embedded in the head of the gland. Jaundice is generally present in cancer of the head of the pancreas, and very rarely with a pancreatic cyst or calculus.

Symptoms.—Jaundice appears first in the conjunctivæ and then successively on the face, neck, body and limbs. The mucous membrane of the lips and palate becomes yellow very soon after the conjunctivæ. In chronic jaundice the pigment in the skin becomes dark green. In a small proportion of cases which have lasted for a very long period, multiple xanthoma (or xanthelasma) develops, but this condition also occurs without jaundice. The patches are generally flat and are sometimes very painful; they consist of cholesterol, which the blood in jaundice

contains in excess. They are most frequent in the eyelids, but in rare cases they are found in the hands and feet and even over the whole body. In chronic jaundice there is a tendency for telangiectases to develop over the body and face and occasionally on the mucous membrane of the tongue and lips; they may disappear at the same time as the jaundice. Purpura and hæmorrhage from mucous membranes, especially the nose and gums, may occur.

The urine becomes bile-stained before the conjunctivæ and skin, the interval being sometimes as long as 24 hours, but it generally returns to normal before the yellow colour of the skin has disappeared. The urine may be yellow, olive, dark brown or even black. The colour can be distinguished from that in urobilinuria, hæmaturia and melanuria, and that produced by rhubarb, senna, santonin and chrysophanic acid by Gmelin's test for bile-pigment.

When obstruction to the bile-ducts is complete, no bile reaches the intestines and urobilin is absent from the urine; when the obstruction is incomplete, decomposition of the bile which reaches the intestines may occur and urobilinuria results. Bile-salts are only present in the urine for the first few days, the disappearance being probably due to inhibition of their production in jaundice. In chronic obstructive jaundice bile-stained casts are almost always present in the urine, and less frequently albuminuria occurs. The urine often reduces Fehling's solution owing to the presence of glycuronic acid.

The fæces are bulky and often extremely offensive; when the obstruction is complete they are clay-coloured, partly owing to the absence of bile-pigment and partly to the presence of excess of fat.

The sweat may contain bile, which is also sometimes present in the tears and in the milk; but the saliva, cerebro-spinal fluid and mucus of the alimentary canal are free from bile, although the salivary glands and other organs are deeply bile-stained. The sputum in pneumonia and the effusion in pleurisy and peritonitis contain bile-pigments. The blood plasma is tinged with bile. Coagulation is considerably delayed, perhaps owing to the fixation of the lime salts of the blood by the bile-pigment. There is very little anæmia except in severe cases, when granular degeneration of the red corpuscles may occur, and leucocytosis is common.

In catarrhal and recent jaundice the pulse is slow, but in other cases it is generally normal; there may be an abnormal tendency to acceleration on assuming the erect position. The slowing is probably due to the bile-salts, which cease to be formed after the jaundice has persisted for a few days. The blood-pressure tends to be low, and mitral incompetence may occur owing to myocardial weakness. The liver is often enlarged owing to retention of bile.

Pruritus occurs in about 20 per cent. of cases, especially when the jaundice is well marked; it may be very severe and interfere with sleep. It is not directly due to the jaundice, as it may occur before the jaundice appears and continue after its disappearance; when present before the jaundice, it may subside with the onset of the latter, and it has also been observed in association with gall-stones, when no jaundice was present. Like bradycardia, it is probably due to retention of bile-salts.

The yellow vision or xanthopsia of jaundiced patients is less marked than

that caused by santonin, and is rarely sufficiently obvious for the patient to mention it unless directly asked.

The absence of bile and sometimes also of pancreatic juice from the intestines leads to deficient digestion in the small intestine, especially of fat. Loss in weight results, and the excess of undigested food which reaches the colon is likely to cause excessive bacterial decomposition. This may lead to intestinal intoxication, especially if the hepatic cells are damaged and their antitoxic action impaired in addition to the bile channels being obstructed. Intestinal intoxication and the other effects of the primary disease which causes the jaundice account for the various symptoms which may be associated with jaundice.

Diagnosis.—(*a*) RECOGNITION OF JAUNDICE; VAN DEN BERGH'S REACTION.—Bilirubin is normally present in the blood. Just as the kidneys in diabetes do not excrete sugar until the concentration in the blood has reached the leakage point, which is considerably higher than the normal concentration, so no bilirubin passes into the urine until the concentration in the blood has risen from the normal of 1 in 250,000 to the leakage point of 1 in 50,000. About the same concentration is required to cause jaundice, but the appearance of a trace of bile pigment in the urine is easier to recognise with certainty than the first trace of pigmentation of the skin or conjunctiva. Moreover, the pigmentation is somewhat slower to develop, and it remains for a time after all pigment has disappeared from the urine.

Van den Bergh has shown that excess of bilirubin in the blood can be recognised by a colour reaction, now commonly known as van den Bergh's test, which is given by Ehrlich's diazo reagent. The *direct reaction* may be "prompt," the maximum being reached within 30 seconds; it may be "delayed" for 1 to 15 minutes or entirely negative; or it may be "biphasic," giving a slight prompt reaction followed after a delay by gradual deepening of the colour. The *indirect reaction*, obtained after precipitation with alcohol so as to bring the bile into alcoholic solution, is always prompt.

With van den Bergh's test it is possible to distinguish two different forms of bilirubin. In all cases of hyperbilirubinæmia the indirect reaction is obtained. The direct reaction is prompt with the bilirubin reabsorbed into the blood after it has been excreted by the hepatic cells in cases of obstructive jaundice, but is negative or delayed when the excess of bilirubin is a result of over-production, as in hæmolytic jaundice; it is negative, delayed or biphasic when the jaundice is due to inability of the hepatic cells to excrete it, as in toxic and infective hepatic jaundice.

By means of van den Bergh's test it is also possible to recognise latent jaundice. Thus the hyperbilirubinæmia present in Addison's anæmia gives a positive indirect reaction, although there is no jaundice except in occasional acute hæmolytic crises, which may result in the concentration of bilirubin in the blood being sufficient to colour the conjunctivæ and skin the yellow colour of ordinary jaundice. Excess of bilirubin in the blood at a concentration below the leakage point may also result from a very slight degree of biliary obstruction, such as occurs in cirrhosis of the liver, some cases of secondary growth and rarely of gall-stones; it is recognised by giving a positive direct van den Bergh's reaction in spite of the absence of jaundice and of bile from the urine. In other cases of obstructive jaundice a positive direct reaction is

given at a stage before jaundice develops and bile appears in the urine, and still longer before any change is noticed in the stools.

(*b*) FACTORS HELPING IN THE DIFFERENTIAL DIAGNOSIS OF THE CAUSE OF JAUNDICE:

1. *Age, sex and history.*—The differential diagnosis of jaundice present at birth or developing a few days later is considered elsewhere (p. 620). Jaundice occurring in childhood or before the age of thirty is most commonly catarrhal; after thirty, gall-stones are frequent, especially in women; and after forty, cancer of the liver is common in both sexes, and cirrhosis is common in men. Jaundice developing in pregnancy should raise a suspicion of acute yellow atrophy. When more than one member of a family are affected, an infection, such as spirochætal jaundice, or a toxæmia is probably the cause in acute cases; in chronic cases acholuric jaundice should be considered.

2. *Course.*—Jaundice of short duration is generally catarrhal or due to gall-stones. Jaundice, which progresses until it becomes extremely deep, suggests cancer, whilst chronic jaundice, which varies from time to time, is generally due to gall-stones.

3. *Condition of the gall-bladder.*—Enlargement of the gall-bladder indicates obstruction of the cystic or common bile-duct, though the former is not likely to be associated with jaundice. The enlargement is present in over 90 per cent. of cases in which obstruction is due to causes other than gall-stones, but only in 20 per cent. of cases of calculous obstruction. This difference is known as Courvoisier's law, and is due to the contraction of the gall-bladder as a result of chronic inflammation in cholelithiasis, in which, moreover, the obstruction is often incomplete.

4. *Condition of the liver.*—Jaundice associated with great enlargement of the liver is generally due to growth if it is irregular, and to chronic pancreatitis if the liver is smooth; the irregular enlargement due to syphilis is less extreme and less often associated with jaundice, and that due to hydatid cysts or an abscess is rarely associated with jaundice. The presence of ascites points to a growth or to cirrhosis; but the jaundice is generally more marked in the former.

5. *Examination of duodenal contents.*—A specimen of the duodenal contents should be obtained by means of Einhorn's tube when the patient is fasting. The presence or absence of bile shows whether the common bile-duct is incompletely or completely obstructed, and the presence or absence of diastase, trypsin and lipase shows whether the pancreatic ducts are free or obstructed. Complete obstruction of both bile and pancreatic ducts indicates obstruction of the common bile-duct by a growth or chronic pancreatitis. Incomplete obstruction of the bile-ducts and a normal quantity of pancreatic ferments point to gall-stones or catarrhal jaundice.

6. *Pain.*—Constant pain suggests growth, attacks of pain gall-stones, and absence of pain catarrhal jaundice, chronic pancreatitis or cirrhosis; but many exceptions to this general statement occur.

7. *Syphilis.*—Vigorous anti-syphilitic treatment should be tried if syphilitic lesions or scars are found in other parts of the body, or if there is a history of syphilis. In all cases in which there is the slightest chance that the disease is syphilitic in origin, the Wassermann reaction should be tested.

Treatment.—The treatment of jaundice is the treatment of the condition which causes it. The subject, therefore, requires no further con-

sideration here, except for the pruritus and tendency to hæmorrhage, which are results of the jaundice itself. A warm alkaline bath may give relief to the pruritus, or moistening the irritable parts of the skin with 1 in 40 carbolic acid, 1 in 50 ichthyol, or 1 in 70 solution of menthol in spirit. The tendency to hæmorrhage is much reduced by the subcutaneous injection of calcium salts, and it is advisable to treat every jaundiced patient in this way for a few days before any operation is performed.

Jaundice in the Newly Born

Jaundice frequently occurs in the newly born. In a large proportion of cases it is only temporary and gives rise to no symptoms; the term *icterus neonatorum* is commonly applied to this condition alone, although strictly speaking the other and more serious forms of jaundice in the newly born should be included under the name.

I. Simple Jaundice in Infants (Icterus Neonatorum).

Ætiology.—Simple jaundice occurs in about 50 per cent. of infants, and especially among the premature.

Pathology.—The number of red corpuscles is high in the newly born, but quickly falls during the first few days of life. The excessive blood destruction is associated with an excess of bile-pigment in the blood, as shown by van den Bergh's reaction, which gives a positive indirect but negative direct reaction in all new-born infants. The jaundice is therefore hæmolytic, and when death occurs from some independent cause, nothing abnormal is found in the liver, bile-ducts or other parts of the body.

Symptoms.—The jaundice generally begins on the second or third day of life; it increases in intensity for 2 or 3 days, and then gradually diminishes until it disappears after 1 or 2 weeks; but occasionally it lasts for a longer period. The jaundice begins on the face and spreads over the whole of the body; unlike other forms of jaundice, the conjunctivæ are only affected after the skin, and in slight cases they are not stained at all.

Diagnosis.—If the jaundice is slight, its presence can only be recognised by pressing the blood out of the cutaneous vessels, when the normal redness of the infant disappears, and the yellow colour remains. Its short duration and the absence of enlargement of the liver and spleen distinguish simple icterus neonatorum from congenital obliteration of the bile-ducts, and the healthy condition of the infant distinguishes it from the infective forms of jaundice.

Prognosis and Treatment.—Rapid recovery always occurs, and no treatment is required.

II. Obstructive Jaundice.

Obstructive jaundice may occur in infants as a result of congenital obliteration of the bile-ducts, or congenital syphilis of the liver.

Congenital Obliteration of the Bile-Ducts

Ætiology.—This rare disease occurs rather more frequently in male than female infants. It is occasionally familial, and is not associated with congenital syphilis.

Pathology.—Some unknown toxin probably passes from the mother by the umbilical vein to the fœtus. Part of the toxin reaches the liver direct and causes multilobular cirrhosis. The rest passes into the general circulation and reaches the liver by the hepatic artery; it is excreted in the bile and gives rise to unilobular cirrhosis, with cholangitis affecting the small and large ducts and gall-bladder, which, being extremely small at birth, become more or less completely obliterated. The disease is thus a combination of portal and biliary cirrhosis with obstruction of the ducts.

Symptoms. Jaundice is generally present at birth, but may not appear for two or more weeks. The meconium is normal, but the stools are free from bile from the first, and the urine is deeply bile-stained. The liver and spleen are large and hard. Hæmorrhages from the mucous membranes and umbilicus and under the skin are common.

Diagnosis.—Deep jaundice, with a large liver and spleen and hæmorrhages without any early evidence of infection, in a new-born infant is generally due to this disease.

Prognosis.—Life may last from a few days to as much as 11 months.

Treatment.—No treatment is of any value.

III. Infective Jaundice.

Infective jaundice is rare in infants, but may occur in various forms.

(*a*) *Mild infective jaundice.*—This condition may occur sporadically or in epidemics, and is identical with the catarrhal jaundice of older children and adults. It is probably due to the invasion of the previously sterile alimentary canal with organisms in the first few days of life, a mild degree of inflammation of the bile-ducts resulting. The jaundice appears a few days after birth, and is accompanied by anorexia, vomiting, diarrhœa, slight pyrexia and drowsiness. The urine contains bile, but the fæces may be normal. Recovery generally occurs, but the infant may be very ill. The treatment is that of the infective entero-colitis of infants.

(*b*) *Severe infective jaundice.*—**Ætiology.**—Epidemics of very fatal jaundice were formerly not uncommon in lying-in hospitals; but they have become rare since the introduction of antiseptics. Sporadic cases also occur. The infection may enter by the umbilicus, causing suppurative phlebitis of the umbilical vein; this leads to jaundice by infecting the liver. In other cases the infection is probably conveyed by the alimentary canal.

Symptoms.—Jaundice appears about the fifth day of life, and is accompanied by high fever and other symptoms of severe septicæmia or pyæmia. When the umbilicus is the channel of infection, it is red and swollen, and severe hæmorrhage may take place from it. Gastro-intestinal hæmorrhage may occur independently (Buhl's disease), or in addition to hæmorrhage from the umbilicus. In some epidemics, hæmaturia has occurred (Winckel's disease). The skin has a bronze colour, owing to the combination of jaundice with cyanosis. The infant finally becomes comatose, and death almost always follows.

Treatment.—The treatment is that of severe epidemic diarrhœa of infants; the bowels should be washed out, fractional doses of calomel administered, and anti-streptococcic serum should be injected subcutaneously.

IV. Hereditary and Familial Jaundice.

Jaundice is hereditary and familial in acholuric jaundice and in "grave familial jaundice of the newly born."

Familial Icterus Gravis Neonatorum

The jaundice, which affects successive members of the same family, though the first-born often escapes, begins within a few hours of birth. The colour rapidly deepens till the skin is deep bronze. The infants are drowsy and take the breast badly. The stools are normal in colour. The urine is dark and contains urobilin and often bilirubin in excess. The liver and spleen are not enlarged.

The bilirubin in the blood at birth is greater than normal; the blood contains no hæmolysin, but the cells show a slightly increased tendency to hæmolysis (Hampson).

Death generally occurs within a few days and almost always within 3 weeks: post mortem nothing abnormal is found. Hampson has shown that complete recovery occurs if 5 to 10 c.c. of the mother's blood serum are injected daily into the infant's muscles.

ACHOLURIC JAUNDICE

Synonym.—Chronic Splenomegalic Hæmolytic Jaundice.

Ætiology.—The disease may be hereditary and familial, when it is either congenital or only appears some years after birth, the two varieties sometimes coexisting in the same family. The disease may occur in as many as four generations and may be transmitted through healthy parents. It may also be acquired in adult life without obvious cause or after some infection.

Pathology.—The red corpuscles are abnormally "fragile," undergoing hæmolysis with remarkable ease. This fragility leads to the liberation of hæmoglobin and the formation of excess of bilirubin in the blood. No hæmolytic toxin is present in the blood, the hæmolysis being apparently due to the fragility of the corpuscles as a result of inheritance or an infection.

There is no evidence that the jaundice is obstructive, as the bile-ducts are free from inflammation or evidence of obstruction, and the bile is not abnormally thick. It appears, therefore, that the jaundice is hæmatogenous and due to the formation of bilirubin from hæmoglobin in the tissues.

Symptoms.—(*a*) *Familial type.*—The jaundice may vary in degree from time to time, and may temporarily almost disappear; it is increased by excitement, over-exertion and exposure to cold. None of the symptoms of chronic jaundice, such as pruritus, xanthoma and a slow pulse, are present. The urine is free from bile, but is dark and generally contains urobilin, and the fæces are normal in colour. In the exacerbations, however, bile may appear temporarily in the urine, and the fæces become pale.

In some cases attacks of colic, which may be accompanied by pyrexia and aggravation of the jaundice, occur; they are caused by pigment calculi, which are generally found in the gall-bladder in cases requiring the operation, though in most cases they do not give rise to symptoms. Except for these attacks the general health is hardly affected.

The red blood corpuscles are abnormally fragile; they begin to undergo hæmolysis in a 0·6 per cent. sodium chloride solution, and the process is complete in a 0·42 per cent. solution, whereas hæmolysis in normal blood begins in a 0·42 per cent. sodium chloride solution, and is complete in 0·3 per cent. solution. The corpuscles are smaller than normal, but as they are also thicker their total volume is not reduced. Stained films show well-marked polychromatophilia and basophil granules. Moderate anæmia is generally present, the colour-index being less than one. The blood plasma contains excess of bilirubin, but no free hæmoglobin. The spleen is enlarged, but the liver is unaffected.

(b) Acquired type.—In the acquired form of the disease the jaundice is less marked, but the anæmia is more severe; it may resemble that of Addison's anæmia with a high colour-index and nucleated corpuscles. Leucocytosis is present and myelocytes with excess of eosinophil cells are found. The fragility of the corpuscles is less marked than in the congenital form. Attacks of febrile colic occur, and symptoms of anæmia are present.

Diagnosis.—The diagnosis depends upon the characteristic fragility of the red blood corpuscles. In the acquired form, in which the fragility is less marked, Addison's anæmia with jaundice may be closely simulated; but in the latter condition the resistance of the corpuscles to hæmolysis is actually greater than normal and the leucocyte count is different. The febrile and painful attacks are indistinguishable from ordinary biliary colic, and are, indeed, commonly due to gall-stones, but the history and the condition of the blood should prevent a mistake in diagnosis. An examination of the blood also helps to distinguish those cases in which jaundice is slight from splenic anæmia.

Prognosis.—The symptoms in the hereditary and familial forms of the disease have no tendency to disappear; but the condition does not interfere with normal growth or shorten life, and the patient cannot really be considered ill. On the other hand, in the acquired form, although the symptoms are much more serious, spontaneous recovery is possible.

Treatment.—The patient should avoid everything, such as exposure to cold and over exertion, which is likely to lead to exacerbations. In severe cases splenectomy should be performed, as it is followed by rapid disappearance of the jaundice and anæmia, and in most cases the fragility of the red corpuscles returns to normal.

CATARRHAL JAUNDICE

Ætiology and Pathology.—Catarrhal jaundice is a condition in which jaundice results from obstruction of the mouth of the common bile-duct by the swollen mucous membrane and thick mucus caused by catarrh of the biliary papilla. This is generally a sequel of gastro-duodenal catarrh, the inflammation spreading through the biliary papilla for a short distance up the common bile-duct. The primary gastro-duodenal catarrh most commonly develops without obvious cause; but it may follow food-poisoning and also occur as a symptom of an acute infection, such as influenza, pneumonia and very rarely typhoid and paratyphoid fevers. The epidemic jaundice which occurred during the Gallipoli campaign in 1915 was indis-

tinguishable from ordinary catarrhal jaundice. It was quite distinct from spirochætal jaundice and appeared to be due to infection with a paratyphoid-like organism. In some cases the cholangitis is associated with hepatitis, the jaundice being then partly "infective hepatic" and partly obstructive. Thus whereas the van den Bergh test sometimes gives a prompt direct action, in other cases, clinically indistinguishable, it gives a biphasic or delayed direct action. In the former cases, which are in my experience the most common, the lævulose test shows no impairment in hepatic efficiency; in the latter it shows more or less impairment.

Symptoms.—Jaundice is almost invariably preceded for 1, 2 or 3 days by symptoms of gastric catarrh. The patient complains of epigastric discomfort most marked immediately after meals, with nausea and often vomiting, which relieves the discomfort. The appetite is lost, headache and general malaise are present, and there may be diarrhœa. Slight pyrexia is common. The stools become pale, and the urine contains bile before jaundice is obvious. As the jaundice develops the gastric and general symptoms abate. The patient becomes deeply yellow, but is by now often quite comfortable so long as he keeps quiet, though activity tends to bring on vomiting. The liver is generally enlarged, and the gall-bladder may be palpable. The liver is slightly tender, but there is no increased tenderness over the gall-bladder. The spleen may also be enlarged.

In slight cases the jaundice begins to disappear in a week, but more commonly it persists without abating for a month or even for as long as 3 or 4 months. The stools become more coloured before the jaundice is obviously less; the quantity of bile in the urine then gradually diminishes, but 3 or 4 weeks may elapse before the last trace of jaundice and the last trace of bile in the urine disappear.

Diagnosis.—When jaundice, unaccompanied by pain and with very slight constitutional symptoms, develops in a patient with mild gastric symptoms of a few days' duration, catarrhal jaundice is the probable diagnosis. When the initial gastric symptoms are absent and the jaundice persists for more than 6 weeks, especially in elderly patients, or when the colour changes from yellow to green, the possibility of chronic pancreatitis or of a growth must be considered. When pain of any severity occurs, especially after the onset of jaundice, and when the gall-bladder is tender, fever persists, or the jaundice recurs, gall-stones are probably present.

Treatment.—The patient should be kept in bed on a plain diet containing as little fat as possible. The bowels should be opened daily with Epsom salts, which at the same time promote biliary drainage. The patient should not be allowed to get up until the jaundice is beginning to disappear.

CONGESTION OF THE LIVER

Congestion of the liver may result from increased inflow of blood—active congestion, and from obstructed outflow—passive congestion.

Active Congestion

Ætiology.—The most common cause of active congestion of the liver is habitual indulgence in rich and highly seasoned food and alcoholic drinks—

the latter being the more important. As congestion and catarrh of the stomach and intestines are likely to result from the same causes, it is probable that the congestion of the liver is due in part directly to the excess of irritating food, and in part to the congestion and catarrh of the alimentary canal. Middle-aged stout individuals, who lead a sedentary life, are most frequently affected.

Acute congestion of the liver is much more common in Europeans living in tropical countries than in England, where well-marked cases are rarely seen, but it is comparatively uncommon among natives. This is partly due to the richness of the diet and the frequency of alcoholic excess among Europeans in the tropics; but malaria, dysentery and other tropical disorders may themselves cause acute congestion of the liver. Patients who have suffered from congestion of the liver whilst living in the tropics are liable to recurrences after their return to England, especially in cold and damp weather. Exposure to cold whilst in the tropics is also likely to bring on an acute attack.

Symptoms. In addition to the symptoms of gastro-intestinal catarrh, a feeling of discomfort, rarely amounting to actual pain, is felt in the liver; the patient's complexion is sallow, and there is often a slight degree of jaundice. The liver is enlarged and tender, and the spleen is often increased in size. The patient is generally drowsy, irritable and depressed, and often complains of headache. The urine is concentrated and loaded with urates.

Prognosis.—An attack of acute congestion of the liver generally subsides with suitable treatment in about a week. If the attack is neglected, or if the patient is not in the future careful to avoid the causes which gave rise to it, the condition may become chronic, and may finally develop into cirrhosis.

Treatment.—The patient should be dieted on the same lines as in cirrhosis of the liver (p. 633). The bowels should be well opened by means of Epsom salts during an acute attack, and the patient should be careful to keep his bowels regular afterwards. Regular exercise, especially riding, and residence in a cool but dry climate help to prevent a recurrence. The patient should avoid getting chilled, and should wear a cholera-belt. An occasional visit to a spa, such as Harrogate, Llandrindod Wells or Vichy is often very useful.

Passive Congestion

Ætiology.—When the outflow of blood from the hepatic vein is impeded as a result of right-sided heart failure, due to primary disease of the heart or to obstructive pulmonary disease, passive congestion of the liver may result. It is also produced by thrombosis of the hepatic veins, which is a rare condition, generally secondary to some neighbouring malignant, syphilitic or inflammatory disease.

Pathology.—The sublobular and intralobular veins are dilated. The centre of each lobule thus appears as a dark spot, whilst the outer part is pale, owing to fatty infiltration; the mottled appearance resembles the section of a nutmeg, and has led to the name "nutmeg liver."

Symptoms.—In addition to the symptoms of the cardiac or pulmonary disease which has led to the right-sided heart failure, special symptoms result from the passive congestion of the liver. The capsule of the liver is

stretched and pain results, especially if the enlargement of the organ is rapid. When the increase in size is more gradual, there is a feeling of fullness and weight in the right hypochondrium. The liver can be felt to extend considerably lower than normal, its size varying from time to time according to the condition of the heart. It is firm and tender, especially if the congestion is recent and acute. Distinct expansile pulsation can sometimes be felt by placing one hand in the loin and the other just below the right costal margin; this corresponds with ventricular systole if tricuspid regurgitation exist, and with auricular systole if there is tricuspid stenosis. It must be distinguished from the non-expansile pulsation transmitted through the diaphragm from the hypertrophied and labouring right ventricle.

The congestion of the liver leads in turn to congestion of the organs which are drained by the portal vein. Anorexia, discomfort immediately after food, flatulent distension of both stomach and intestines from deficient absorption of the gas swallowed with the food or produced by fermentation, and constipation are commonly present. The combination of slight jaundice with cyanosis produces a characteristic dusky green colour of the face.

Ascites is common, but is rare in the absence of general œdema, being mainly due to the same causes; it is also in part a direct result of portal congestion and sometimes of chronic peritonitis. The spleen is very rarely enlarged, in spite of the interference with the outflow of blood in the splenic vein caused by the hepatic congestion.

Diagnosis.—When the heart disease is obvious the diagnosis is easy. Sometimes, however, the most prominent symptoms are due to the congestion of the liver, and the diagnosis from cirrhosis may be difficult. In congestion of the liver the spleen is not enlarged, and the symptoms rapidly improve and the liver diminishes in size with rest and cardiac tonics; moreover, hæmatemesis, though common in cirrhosis, very rarely occurs in passive congestion in spite of the congestion of the gastric mucous membrane.

A history of alcoholism does not necessarily point to cirrhosis. If the heart is failing and there is no valvular disease, the enlargement of the liver is probably due to congestion, and the heart failure to alcoholic poisoning. The diagnosis would be confirmed if the ankle-jerks are lost, as latent alcoholic neuritis is frequently associated with an alcoholic heart and congested liver, but very rarely with cirrhosis.

Treatment.—Apart from the treatment of the primary condition, the local pain and discomfort are rapidly relieved by the application of 6 leeches over the hepatic region. Mild purgation by means of calomel and saline aperients also helps to relieve portal congestion.

ACUTE YELLOW ATROPHY

Definition.—Acute yellow atrophy is a rare and very fatal disease, in which jaundice, diminution in the size of the liver, fever and nervous symptoms are caused by acute necrosis of the liver cells.

Ætiology.—Most cases occur between the ages of 20 and 30. Adult females are affected twice as often as adult males, owing to the fact that pregnancy is one of the chief exciting causes, but the proportion is reversed in childhood. The disease has followed influenza and typhoid fever. In

rare cases, especially in females, the jaundice, which may occur in the secondary stage of syphilis, develops into acute yellow atrophy, instead of yielding rapidly to treatment. Very rarely acute yellow atrophy has been an immediate sequel of excessive indulgence in alcohol, and delayed chloroform poisoning has manifested itself as acute yellow atrophy. In many cases, however, no cause is found for the disease.

Pathology.—Acute yellow atrophy is due to a very acute toxic necrosis of the liver cells, the intracellular ferments of which are set free and cause autolysis.

Acute yellow atrophy is closely allied both pathologically and clinically with the icterus gravis which results from phosphorus poisoning, but in the latter the liver is generally enlarged and contains only 5 per cent. of fat, its yellow colour being due to bile. These differences may be due to death occurring earlier in phosphorus poisoning, as in exceptional cases, in which life is more prolonged, absorption of fat and necrotic liver cells occur, the condition being then indistinguishable from acute yellow atrophy.

The necrosis of the liver cells results in diminution in the size of the liver, which may weigh only half or a third of the normal. Its surface is smooth and the capsule loose and wrinkled. Externally the liver is greenish-yellow or normal in colour, and on section bright yellow with red areas, which represent a late stage of the yellow atrophy, the fat and necrotic tissue having been absorbed, so that the vascular fibrous tissue is alone left.

Symptoms.—In the first stage jaundice is present with fever, malaise, vomiting, constipation and muscular pains, the condition closely resembling catarrhal jaundice. In about a third of the cases the patient suffers from general malaise for some time before the jaundice appears, and in rare instances jaundice is absent throughout. This first stage generally lasts for 5 or 6 days, but it occasionally persists for several weeks.

The second stage begins suddenly with drowsiness, headache, photophobia, restlessness and delirium. Muscular twitching and occasionally general convulsions follow, and the patient may become violent. Transient squint is sometimes present, the pupils are generally dilated, and an extensor plantar reflex has been observed. The symptoms may closely resemble those of meningitis. Severe vomiting occurs, and the vomited material may contain altered blood. The tongue is dry and tremulous. The pulse becomes rapid and feeble, but the temperature is generally subnormal, though it often rises just before death. An erythematous rash is sometimes present. Purpura is common, and hæmorrhage may also occur from the nose, kidneys, uterus and alimentary canal, and in the retina. Coma finally develops, with stertorous breathing and incontinence of urine and fæces, the whole of the second stage lasting less than a week and often only 3 or 4 days.

The liver is often enlarged and tender in the first stage, but at the onset of severe symptoms it rapidly diminishes in size, until the hepatic dullness disappears, owing to the atrophied and flabby liver falling back and allowing the intestines to pass between it and the abdominal wall. The spleen is sometimes enlarged. Ascites is rarely detected during life, though it may be found after death.

There is no anæmia, but moderate leucocytosis.

The urine contains bile and albumin, and casts are often present. There

is no glycosuria. The percentage of nitrogen excreted as ammonia increases from the normal of about 5 to 20 owing to the acidosis, which causes ammonia to be fixed by organic acids before there is time for it to be converted into urea. Rounded discs of leucin and needle-shaped crystals of tyrosin, derived from autolysis of the liver cells, may be deposited in the urine when it cools, but they are sometimes only found after concentration, and may be absent altogether, though they are subsequently discovered in the liver. They are also occasionally found in the urine in typhoid fever, erysipelas, small-pox and leukæmia, so that their presence is not pathognomonic of yellow atrophy.

Diagnosis.—The diagnosis depends upon the occurrence of severe general symptoms and diminution in the liver dullness in association with jaundice. In phosphorus poisoning the diagnosis may be obvious from the history; the symptoms differ from those of acute yellow atrophy in the absence of progressive diminution in the hepatic dullness, and in the slighter severity of cerebral symptoms. In phosphorus poisoning an interval elapses between the severe gastric symptoms and the onset of jaundice, but in acute yellow atrophy the second stage is continuous with the first.

It is sometimes impossible to distinguish between subacute yellow atrophy and acute cirrhosis, as clinically and pathologically they merge into each other.

Prognosis.—More than half the cases are fatal within a fortnight, but the first stage of the disease may be prolonged over many weeks or months, or even as long as 2 years. Prolonged and subacute cases occur most frequently in children; they are difficult to differentiate from subacute cirrhosis with jaundice. As nodular hyperplasia of the liver has been found in cases surviving six months, a year and a half, and two years, there is a possibility of permanent recovery, but it is probable that most of the recorded cases of recovery were really examples of spirochæal jaundice. As children more often show the changes of subacute atrophy, the prognosis is rather less hopeless in them than in adults.

Treatment.—When jaundice occurs in pregnancy or in secondary syphilis, or when a patient with supposed catarrhal jaundice becomes drowsy or shows other toxic symptoms, the possibility of acute yellow atrophy developing should be remembered, as treatment is much more likely to be successful if begun at this stage than when the second stage has fully developed. The diet should consist of milk and carbohydrate food only, and large quantities of fluid should be drunk; if there is much vomiting saline solution should be given by the rectum and in severe cases under the skin. The bowels should be kept freely opened. An attempt may be made to disinfect the bile with very large doses of hexamine. Large quantities of sodium bicarbonate may be required to counteract the acid intoxication. Intravenous injection of dextrose, with small doses of insulin, with the object of "fixing" the glycogen in the liver has recently been tried with success.

HEPATITIS

The only form of non-suppurative hepatitis which is of any clinical importance is that due to the *Amœba histolytica*, although acute yellow atrophy, icterus gravis and some forms of infective jaundice might perhaps be included under the heading of hepatitis.

Amœbic Hepatitis and Hepatic Abscess

Ætiology.—Amœbic hepatitis is very rare before the age of 20 and is most common in the third and fourth decades. Like amœbic dysentery, it is uncommon in women. Amœbic hepatitis and amœbic abscess of the liver are invariably secondary to amœbic dysentery. In 98 per cent. of fatal cases Rogers either obtained a history of dysentery or found amœbic ulcers or scars of ulcers in the large intestine. The patient has had dysentery in the past or is still suffering from it in about 75 per cent. of cases, and in an additional 15 per cent. there is a history of diarrhœa, which was doubtless a mild form of amœbic dysentery: in the remaining cases amœbic ulcers had probably been present in the cæcum or ascending colon, situations in which they do not necessarily give rise to any symptoms. Dysentery may precede the development of an abscess by months or even years, and when hepatitis develops during an attack of dysentery, the latter generally becomes less severe as the inflammation in the liver progresses.

The geographical distribution of the disease is identical with that of amœbic dysentery, but as it may develop in chronic cases and long after the onset of dysentery, it is not uncommon among individuals who have returned to Europe from the tropics. Chronic alcoholism is an important, but not an essential, predisposing cause.

Amœbic dysentery was very common during the Great War in Gallipoli, Egypt, Mesopotamia and India. Treatment with emetine was not always continued for a sufficient period, especially at the beginning of the Gallipoli epidemic, and as a considerable number of slight cases must have escaped treatment altogether, hepatitis, especially the chronic non-suppurative form, is still seen in England in 1928 among men who had served in the East between 1915 and 1919.

Pathology.—The amœbæ, which collect in the thrombosed veins at the base of dysenteric ulcers, pass to the liver by the portal vein. Nothing more is known as to the pathology of non-suppurative amœbic hepatitis, as death does not occur unless an abscess forms, but the infection appears to be widespread and uniform through the liver. An abscess forms if a local accumulation of amœbæ gives rise to thrombosis in a portal radicle. The circulation is obstructed and necrosis of the surrounding tissue occurs; at the same time pus is secreted as a result of the irritant action of the amœbæ on the liver tissue. The wall of the abscess is at first formed by necrotic liver tissue, but the cavity gradually becomes limited by a fibrous capsule produced by the inflammatory reaction.

In 70 per cent. of cases a single abscess is present; in nearly half of the others there are 2 abscesses, in a quarter there are 3, and in the remainder there are 4 or more. A single abscess is found five times as often in the right as in the left lobe of the liver.

The pus generally contains amœbæ, but no bacteria; in chronic cases all the amœbæ may have died, but they can still be found in the material obtained by scraping the wall of the abscess. In rare cases an amœbic abscess becomes spontaneously sterile, and its dried remains have been found at a post-mortem examination years afterwards. When an hepatic abscess reaches the surface, adhesions form between the liver and the adjoining

structures, so that the contents of the abscess may burst into the lung, stomach or bowel, or open externally without infecting the serous cavities.

Symptoms.—The symptoms vary so greatly in different cases that it is convenient to describe separately the fulminating variety—in which the whole liver is riddled with small collections of pus, with no fibrous tissue separating them from the surrounding liver substance, the common subacute form, and the chronic form; but every gradation occurs between these three types. As most cases of the subacute type, including some with severe symptoms, subside completely with emetine injections, it is clear that in the early stages acute hepatitis without actual suppuration is present. The symptoms of subacute amœbic hepatitis and those of hepatic abscess can therefore be described together.

1. *Fulminating multiple abscesses of the liver.*—About one-tenth of the cases are of this type in India, but it rarely, if ever, occurs outside the endemic areas. There is always a definite history of dysentery, which is often still present when the hepatitis develops. The liver rapidly increases in size; it is very painful and extremely tender. Slight jaundice may be present. The temperature is high with rapid remissions, the rise being often accompanied by rigors and the fall by copious sweating. Leucocytosis is well marked. Death generally occurs between 6 and 18 days from the onset of symptoms.

2. *Subacute hepatitis and subacute abscess of the liver.*—Discomfort and a sense of weight are felt in the right hypochondrium in the slighter cases, but in the more severe ones the pain may be so great that the patient is hardly able to move, and often he is unable to lie on his left side owing to the dragging pain caused by the change of position. Pain may also be referred to the right shoulder and occasionally to the right arm, especially when the upper part of the liver is involved. The liver is enlarged and tender, but the rigidity of the abdominal muscles may be so great that it is impossible to feel its edge. Slight jaundice is occasionally present in the severer cases. The appetite is impaired or lost, and the patient rapidly becomes weak and emaciated.

The temperature is generally remittent, varying between 100° in the morning and 103° or 104° in the evening. In severe cases it remains high with only small remissions, but in more chronic cases, especially when the abscess bulges through the capsule of the liver and the tension within its cavity consequently falls, the fever is less marked; it may then be low, continued or relapsing, and may finally disappear. Copious sweating is common in the more severe cases. Moderate leucocytosis is always present, and the proportion of polymorphonuclear cells is considerably increased, especially when actual suppuration has occurred; if the percentage is less than 70, simple hepatitis and not an abscess is probably present.

The upper part of the liver is most frequently involved, and the main increase in dullness is then in the upward direction, but the lower border is also abnormally low. The lower ribs bulge and the intercostal spaces become wider; the skin may become œdematous even in acute hepatitis without suppuration. At an early stage the breath sounds become feeble and the percussion note impaired at the right base; the X-rays show that the right side of the diaphragm is abnormally high, and when suppuration occurs its movements are diminished and finally cease completely. If the diaphragm

is perforated by an abscess of the liver a pulmonary abscess or less frequently an empyema develops. In the former case large quantities of thick reddish pus are expectorated, and if emetine is given, rapid recovery generally results.

An abscess in the anterior and lower part of the right lobe produces a tender tumour in the right side of the epigastrium; the lower ribs often become prominent and the lower border of the liver can either be felt or is found by percussion to be displaced downwards. A rub may be heard when an abscess reaches the surface of the liver, but it disappears on the formation of adhesions with the anterior abdominal wall. In advanced cases the skin becomes œdematous, fluctuation is present, and the abscess may open externally just below the costal margin. Less frequently the abscess reaches the under surface of the liver, when it may rupture into the duodenum or hepatic flexure of the colon; pus is then passed per rectum and the tumour suddenly diminishes in size. The general condition of the patient immediately improves, the temperature falls, and spontaneous recovery may follow.

An abscess in the left lobe of the liver generally gives rise to a tender tumour in the epigastrium; if it becomes adherent to the anterior abdominal wall, definite fluctuation is obtained. An abscess bulging from the lower or upper surface of the left lobe is less easily diagnosed; it may escape recognition till it ruptures respectively into the stomach, when the characteristic thick reddish pus is vomited, or into the left lung or pericardium.

In some cases the X-rays show a localised increased density in the hepatic shadow, especially if the abscess is in the left lobe or if it is large and surrounded by a thick fibrous capsule. Localised subdiaphragmatic, subhepatic and retroperitoneal abscesses are uncommon complications, and general peritonitis rarely develops.

3. *Chronic hepatitis.*—The symptoms of chronic hepatitis are sometimes, but not always, preceded by a period of alternating diarrhœa and constipation, and there may be a definite history of dysentery. The patient sometimes feels ill, his appetite is poor, he loses weight and strength, and his temperature may rise to about 100° every night, but in the more chronic cases his general health is only slightly impaired and there is no pyrexia. The area of hepatic dullness is increased, especially upwards, and the lower border is felt below the costal margin. There is often a dull dragging ache in the right hypochondrium. In chronic hepatitis without any localised abscess, the whole of the liver below the costal margin is uniformly tender on palpation in contrast with the local tenderness over the gall-gladder in cholecystitis. The abdominal wall is often slightly rigid over the tender liver. The blood changes and the X-ray appearances may be similar to those of a subacute abscess, but are less marked and are often entirely absent.

Diagnosis.—The possibility of amœbic hepatitis or hepatic abscess should be considered whenever an individual, who has been in the East, is suffering from progressive deterioration in health with more or less pyrexia, especially if the latter is remittent and accompanied by chills and sweats, and if obscure abdominal symptoms are present. The possibility of amœbic hepatitis should also be considered when chronic pain is felt in the region of the liver even in the absence of other symptoms. A history of dysentery or simple diarrhœa, occurring in India, Egypt or Mesopotamia, or during the summer and early autumn of 1915 in Gallipoli, would strengthen the suspicion, which would be further increased if no emetine or only 1 or 2 injections had been

given, but the diagnosis would not be excluded in the absence of such a history. The most characteristic local symptoms are progressive enlargement of the liver, pain in the region of the right hypochondrium and in the right shoulder, and tenderness over the liver. In all cases the lævulose test shows some impairment of hepatic efficiency.

Subacute hepatitis is most commonly confused with malaria; but the rise of temperature in hepatitis is generally in the evening instead of during the day, and the liver is enlarged out of proportion to the spleen instead of vice versa, leucocytosis is present with a relative increase of polymorphonuclear cells and only 2 to 4 per cent. large mononuclear cells, in contrast with the normal or subnormal count with 15 to 20 per cent. large mononuclear cells found in malaria; the malarial parasite cannot be found in the blood, and emetine gives good results, whilst quinine fails to influence the pyrexia.

A localised tumour in the liver in a man who has been exposed to amœbic infection is generally an amœbic abscess; it is elastic or fluctuating, unlike the hard solid tumour formed by a gumma and a growth, which are unaccompanied by leucocytosis or marked pyrexia. A suppurating hydatid cyst is a much less probable diagnosis in such an individual, and in most cases eosinophilia is present, while it is absent in amœbic cases.

Prognosis.—Until 1907 hepatic abscess was the second commonest cause of death in the British Army in India, but the incidence of the disease has become much smaller since amœbic dysentery has been treated by emetine injections, and the mortality has been greatly reduced since the necessity for operation has become comparatively rare, owing to the frequency with which treatment is instituted in the pre-suppurative stage. The prognosis is best if the abscess is single, as multiple abscesses are difficult to locate and their evacuation may be impossible, especially in the rare fulminating cases.

Treatment.—In acute and chronic hepatitis without suppuration very rapid improvement follows the subcutaneous injection of 1 grain emetine hydrochloride on 12 or more consecutive days; the hepatic tenderness diminishes within 8 hours of the first injection, and the temperature may fall to normal in 24 hours. As there are no definite signs which distinguish hepatitis without suppuration from hepatic abscess, unless a definite tumour is present, no local treatment should be adopted until emetine injections have been given daily for a week without producing any improvement. Even a small abscess may be completely absorbed without aspiration after the amœbæ in its walls have been killed by subcutaneous injections of emetine.

The most satisfactory treatment of an abscess is evacuation by aspiration, emetine being injected subcutaneously in order to kill the amœbæ in the abscess wall and in any ulcers which are still present in the colon. If the pus reaccumulates, a grain of emetine hydrochloride dissolved in an ounce of water should be injected into the abscess cavity after it has been aspirated. The results with this treatment are so successful, that the open operation, which is frequently followed by prolonged convalescence or death owing to secondary infection, is now only required in the comparatively rare cases, in which the situation of the abscess cannot be determined or bacteriological examination of the pus obtained by aspiration shows that the abscess already contains pyogenic bacteria.

When an abscess has ruptured into the lung, stomach or bowel, subcutaneous emetine injections should be continued until the temperature has

remained normal for a week. Recovery generally takes place without aspiration or drainage becoming necessary.

CIRRHOSIS OF THE LIVER

Synonyms.—Portal or Multilobular Cirrhosis.

Definition.—The portal or multilobular form of cirrhosis of the liver is so much the most common that it is generally described shortly as cirrhosis of the liver. It is a disease in which degeneration of the hepatic cells occurs in association with fibrosis spreading from the portal spaces to enclose various numbers of lobules.

Ætiology.—Cirrhosis of the liver is generally fatal about the age of fifty; but a distinct group of cases occurs in childhood. It is three times more common in men than in women, but only slightly more so in boys than in girls. It is more common in individuals who follow a sedentary occupation than in those who lead an active life, and among the poor than the well-to-do, though since the Great War it has become less common among the former and more common among the latter.

A large majority of patients with cirrhosis of the liver have indulged excessively in alcohol; it is three times more common among people connected with the liquor trade than among the general public. Cases occur, however, especially in Indians and Egyptians and in children, in whom alcoholic excess can be excluded with certainty. Thus, cirrhosis is not infrequent among Brahmins, the majority of whom indulge in large quantities of ginger, cardamoms, red pepper and other spices, but never touch alcohol. It is probable, therefore, that excessive indulgence in highly seasoned food may lead to cirrhosis. I have seen a typical case with severe ascites in a lady of 30, who was teetotal and had always taken an ordinary diet.

Pathology.—Cirrhosis very rarely develops experimentally in animals as a result of chronic alcoholic poisoning, although fatty changes and occasionally necrosis with a slight degree of small-celled infiltration may be produced. It occurs in less than 3 per cent. of drunkards dying from the effect of alcoholism, and its geographical distribution does not correspond with that of chronic alcoholism, cirrhosis being rare, for example, in Scotland and Ireland; and when excessive indulgence in alcohol leads to nervous or cardiac symptoms the liver is rarely involved. It is probable, therefore, that alcohol produces cirrhosis of the liver indirectly by leading to gastro-enteritis; the poisons produced in the stomach and intestines are absorbed and pass to the liver. As ordinary gastro-enteritis does not lead to cirrhosis, an additional factor must be present. This is probably the direct poisonous action of alcohol and occasionally of other toxins, such as those of amœbic dysentery, typhoid fever, malaria and congenital syphilis, on the liver cells, which are thus made more liable to injury by gastro-intestinal toxæmia.

Cirrhosis of the liver may result from the action of other poisons which reach it from the spleen. This is the cause of Banti's disease, in which a terminal cirrhosis of the liver develops in a patient with splenic anæmia, as the liver does not become affected if the spleen is removed at a sufficiently early stage.

It is probable that the poisons which cause cirrhosis of the liver lead both

to degeneration of the hepatic cells and to irritative hyperplasia of the connective tissue; the degeneration of the hepatic cells is increased by the connective-tissue hyperplasia, which in turn is exaggerated by replacement fibrosis due to the atrophy of the hepatic cells.

The size of the liver varies greatly; it may be much smaller or much larger than normal. The large liver is due to compensatory hyperplasia of the liver cells, and to a less extent to fatty change in them.

The surface of the liver is irregular. The projections may be as small as those of a granular kidney, but more frequently they give rise to a hob-nailed appearance.

The obstruction to the intrahepatic branches of the portal vein produces a rise in pressure in its tributaries; this results in dilatation of the collateral circulation which normally exists between the portal and general venous symptoms. This compensatory circulation is carried out by the following groups of vessels:

1. An anastomosis may develop within the liver between the branches of the portal vein and the intralobular veins. Large branches pass from the liver and its capsule to the phrenic and intercostal veins, where the liver and diaphragm are uncovered by peritoneum. Occasionally a single large vein passes from the liver in the falciform ligament by the side of the obliterated umbilical vein to join the veins of the abdominal wall at the umbilicus; the subcutaneous veins around and above the umbilicus are consequently dilated, and a large bunch of dilated veins—the caput Medusæ—may form at the umbilicus.

2. The gastric veins anastomose with the œsophageal veins, which open into the azygos veins; the veins in the lower end of the œsophagus may become greatly dilated.

3. The inferior mesenteric vein communicates through the superior and middle hæmorrhoidal veins with the inferior hæmorrhoidal vein, which is a branch of the internal iliac vein; this might be expected to give rise to hæmorrhoids, but they are hardly more common among patients with cirrhosis than in individuals with healthy livers.

4. The veins of Retzius unite the radicles of the portal veins in the intestines and peritoneum with the inferior vena cava and its branches. These include the retro-peritoneal veins, which are often greatly enlarged, especially in the neighbourhood of the kidneys.

Symptoms.—About 50 per cent. of patients with cirrhosis of the liver die from some intercurrent disease or accident. Such cases are generally described as latent; but in the majority symptoms due to the condition were probably present before death, and the fatal result of the intercurrent disease or accident was often due to the diminished power of resistance which results from cirrhosis. In some cases, however, the disease may be genuinely latent, owing to compensatory hyperplasia of the liver cells and to the development of an efficient collateral circulation between branches of the portal vein and systemic veins.

In a large majority of cases symptoms of alcoholic gastritis are present for a considerable period, which may amount to years, before any definite evidence of cirrhosis of the liver appears. The patient habitually wakes in the morning with a feeling of nausea and no desire for breakfast; violent retching often occurs, and he then vomits a small quantity of alkaline watery

fluid, after which some bile-stained mucus may appear. A sense of uncomfortable fullness is also felt in the epigastrium after other meals, and the nausea and vomiting may recur. The appetite is poor, and there is a special repugnance for meat. When cirrhosis develops, the symptoms due to catarrh are exaggerated by the congestion of the gastric mucous membrane caused by portal obstruction; this leads to the secretion of still more mucus, and by preventing absorption of gas leads to flatulence, which aggravates the feeling of distension already present.

The complexion is generally sallow and bloated, with dilated capillary or arterial angiomata, especially over the nose and cheeks. In the later stages, the face is drawn, the cheeks and eyes are sunken, and the conjunctivæ are congested and often slightly tinged with bile. The skin of the body is dry and inelastic; numerous spider angiomata appear on the face, neck and back as the disease progresses, and red or purple areas of skin may be produced by the uniform distention of small venules. Purpura and various forms of erythema may occur.

The tongue is flabby and furred, the gums readily bleed, and pharyngitis is common owing to chronic irritation by alcohol. The breath is often offensive as a result of oral sepsis.

The patient is generally constipated, owing to weakness of the intestinal musculature, and to dryness of the fæces if ascites is present; but there may be attacks of diarrhœa, especially during the last few weeks of life.

In a large proportion of cases the liver is enlarged. Its lower border can generally be felt below the costal margin in the right nipple line; but ascites and occasionally flatulent distension of the intestines or obesity may render it impalpable. It is always abnormally firm; its edge can consequently sometimes be felt, even when it is not enlarged, by the fingers dipping under the costal margin. In rare cases, an enlarged liver can be observed to shrink as the disease progresses, until it ceases to be palpable, and after death it may be found to be considerably smaller than normal. In the early stages the enlargement may be partly due to congestion; a drinking bout may thus cause a rapid increase in size, which disappears with treatment. The irregular surface of the liver can occasionally be recognised by palpation.

Discomfort is often felt in the right hypochondrium; but pain only occurs if the disease is complicated by an attack of perihepatitis. The discomfort is increased, and tenderness is present, if the capsule is rapidly stretched as a result of acute congestion.

In about 35 per cent. of cases jaundice occurs. It is generally slight and is often transient. Well-marked jaundice is generally due to gastro-duodenal catarrh; but in subacute cases it is probably a result of inflammation of the small intrahepatic bile-ducts. Even in the absence of jaundice van den Bergh's test may give a positive direct reaction, indicating that some bile pigment has been re-absorbed owing to incomplete obstruction of the ducts.

In 80 per cent. of cases the spleen is enlarged; owing to its hardness it is easily felt, unless it is obscured by ascites or intestinal flatulence, when its enlargement can be recognised with the X-rays. Discomfort or actual pain may result from stretching of the capsule if rapid enlargement occurs; more frequently it is due to perisplenitis. When both the liver and spleen are much enlarged, the left lobe of the former may overlap the latter.

Hæmatemesis occurs in about 25 per cent. of all cases of cirrhosis. It is

generally an early symptom, and is often the first indication of the presence of serious disease, though it is most frequently preceded by symptoms of gastritis. It is uncommon after ascites has developed. Occasionally it is directly preceded by a period of increased indigestion, which may be associated with fever and enlargement of the spleen; in such cases the patient often feels more comfortable and the spleen diminishes in size after the hæmorrhage. The hæmatemesis generally takes the form of a single large hæmorrhage; but sometimes a smaller quantity is vomited during the next few days. It is generally only repeated after a considerable interval.

The blood collects slowly in the stomach, and often passes into the intestine, causing melæna without hæmatemesis. When a considerable quantity has collected in the stomach, the distension causes it to be vomited; small quantities are not brought up unless vomiting occurs from some independent cause. The blood collects more slowly than in gastric ulcer, and is therefore generally more clotted and darker, as there is more time for digestion to occur; for the same reason fainting occurs less frequently. Death from hæmatemesis is very unusual in cirrhosis, and accounts for less than 5 per cent. of the mortality.

In the majority of cases hæmorrhage results from the rupture of varicose œsophageal veins, which form in the development of the collateral circulation. Occasionally superficial ulceration occurs over a vein. The dilated veins occur in the lower 3 inches of the œsophagus; the blood consequently runs into the stomach, though in severe cases it may well up directly from the œsophagus. In rare cases the hæmorrhage comes from a varicose vein of the stomach, or from the congested pharynx; in the latter case the blood is swallowed and then vomited. The hæmatemesis may be due to minute erosions associated with acute gastritis: they are often very difficult to discover post mortem, and there may perhaps be no actual loss of surface, the hæmorrhage corresponding with the bleeding which occurs from other mucous membranes and under the skin as a result of the toxæmia.

Epistaxis is common. The hæmorrhage generally comes from a point on the anterior part of the septum. In the late stages oozing from the nose may occur, as well as from the gums, lungs, kidneys and uterus, as a result of the toxæmia caused by hepatic insufficiency, and small hæmorrhages often occur under the skin. Hæmoptysis, however, is generally due to the cirrhosis being associated with pulmonary tuberculosis.

Ascites is present in most cases of cirrhosis which run their full course; it is a late symptom in uncomplicated cases, and is often absent if the patient dies from some independent cause or from hæmatemesis at a comparatively early stage. The onset is generally gradual, but it occasionally develops suddenly after a blow on the abdomen, a chill, or an acute infection, such as influenza; it is also acute if portal thrombosis occurs. It sometimes disappears spontaneously shortly before death.

Ascites is due in part to portal congestion, as the intrahepatic branches of the portal vein are compressed, some being completely obliterated; occasionally others are thrombosed, and in rare cases thrombosis of the portal vein itself occurs. This is not the sole cause of ascites, as the fluid may collect with extreme rapidity instead of *pari passu* with the changes in the liver, and it is often absent when the portal pressure is high, as shown by the occurrence of hæmatemesis; moreover, it is often present when the

collateral circulation is well developed, although this should prevent it. In uncomplicated cases the ascites is probably always in part due to the lymphagogue action of toxins normally destroyed by the liver, which increase the flow of fluid into the peritoneal cavity by injuring the vessel walls.

In many cases ascites is a result of chronic perihepatitis, or of more generalised chronic peritonitis, which may be due to irritation of the peritoneum by toxic substances present in the ascitic fluid or to chronic alcoholism.

The ascitic fluid is clear and sometimes slightly bile-stained. Its reaction is alkaline, its specific gravity between 1008 and 1015, and a large proportion of the cells it contains are endothelial. When the ascites is due to chronic peritonitis the specific gravity is greater than 1015, more albumin is present, flakes of fibrin may form on standing, and polymorphonuclear cells are found. When 50 per cent. or more of the cells are lymphocytes, tuberculous peritonitis is probably present. In rare cases the ascites is chylous or chyliform; still more rarely it is hæmorrhagic.

Œdema of the ankles is frequent, but it is rarely very marked, though occasionally it spreads up the legs to the abdomen and back. It may develop before or at the same time as the ascites, in which case it must be toxic in origin, but most frequently it follows it and is caused by pressure of the ascitic fluid on the inferior vena cava and the abdominal lymphatics; it rapidly diminishes when the abdomen is tapped.

Muscular weakness and loss of energy may be the earliest symptoms; they are constant in the late stages. The muscles are flabby and atrophied, and marked wasting of the whole body occurs.

The urine is diminished in quantity and the specific gravity is high. It is very acid and high-coloured, and a large deposit of urates generally forms on standing. It contains excess of urobilin, but even when slight jaundice is present bile-pigment is often absent. In the late stages the percentage of nitrogen excreted as ammonia increases at the expense of urea; this is due to ammonia being required to unite with the excess of organic acids present, and not to inability of the liver to form urea, as ammonia given by the mouth is still excreted as urea. In the last days of life leucin and tyrosin are sometimes found.

Albuminuria is occasionally present as a result of intestinal toxæmia, granular kidney, or, much more rarely, chronic parenchymatous nephritis, or congestion of the kidneys from heart failure. Glycosuria is rare, as the glycogenic function of the liver is maintained to a certain extent even in advanced cases, but the lævulose test for hepatic efficiency shows some impairment throughout the course of the disease.

The blood pressure is generally low, and in the later stages the heart may be dilated and the pulse rapid. The blood is generally normal, except when severe hæmorrhages have led to secondary anæmia. I have seen two cases in which the secondary achlorhydria caused by the associated alcoholic gastritis led to the development of typical Addison's anæmia.

The temperature is often raised in rapidly progressing cases, apart from complications, such as tuberculosis, pleurisy, infective endocarditis or gastro-enteritis.

In the late stages of cirrhosis, the toxæmia which results from hepatic insufficiency gives rise to restlessness, irritability and low, muttering delirium, and finally to coma.

Nervous symptoms may also be present as a result of chronic alcoholism. Delirium tremens may follow a drinking bout and occasionally hæmatemesis; slight mental disturbance and muscular tremor are not uncommon, but alcoholic neuritis is a rare complication.

Active tuberculous disease is found more frequently in patients dying with cirrhosis of the liver than with other diseases. This is probably due to the diminished resistance to tuberculous infection caused by chronic alcoholism. The lungs are most often affected, phthisis being the cause of death of 15 per cent. of cases of cirrhosis, and tuberculous pleurisy is not uncommon. Either the cirrhosis or the phthisis may give rise to no characteristic symptoms, being only discovered at the autopsy.

Tuberculous peritonitis is found in 10 per cent. of cases; the ascites which it produces is often thought during life to be due to the cirrhosis. The lungs are generally also involved. The majority of cases of tuberculous peritonitis in adult males are associated with cirrhosis.

Diagnosis.—A regularly enlarged, hard liver in an alcoholic individual, especially if symptoms of gastritis are present, is generally due to cirrhosis. The occurrence of hæmatemesis, enlargement of the spleen, slight jaundice, or simply a positive direct van den Bergh reaction, makes the diagnosis still more probable, especially if the lævulose test shows the presence of hepatic insufficiency. The enlarged hard liver, which is produced by the chronic venous congestion in heart failure, may be difficult to distinguish from cirrhosis, if the patient is seen when the heart is no longer failing. A history of heart failure with pain in the hepatic region and any evidence of existing heart disease point to congestion. The difficulty is greatest when the patient is alcoholic and the heart failure is the result of alcoholism. In such cases I have always found the ankle-jerks are absent when congestion is the cause, the heart failure being apparently due in part to vagal neuritis, whereas the ankle-jerks are almost always present and there is rarely any other evidence of latent alcoholic neuritis when the enlargement of the liver is caused by cirrhosis.

The diagnosis from syphilis and from malignant disease of the liver is discussed elsewhere (p. 615 and p. 648).

Splenic anæmia with hæmatemesis can be distinguished from cirrhosis by the much greater enlargement of the spleen and the presence of leucopenia. It must, however, be remembered that splenic anæmia is liable to give rise to cirrhosis of the liver.

The symptoms in the last stages are often indistinguishable from those of uræmia, and the diagnosis may be very difficult in the absence of a full history; but a high blood-pressure, increased blood-urea, albuminuric retinitis or the presence of a large quantity of albumin with casts in the urine would prove that uræmia was present.

Prognosis.—If an individual with cirrhosis permanently gives up alcohol in the pre-ascitic stage, there is a good chance that the disease will not progress and that his symptoms will disappear. Even the damage done to the liver can be repaired to some extent by hyperplasia of its cells, and the danger of hæmatemesis, together with the other ill-effects of portal congestion, may be overcome by a sufficient development of the anastomoses between the portal and general venous systems.

Much, therefore, depends upon the patient's character, as, if he is unable

to control his desire for alcohol, the disease is certain to advance to a fatal issue. The younger the patient the more chance there is for functional compensation to occur, but the prognosis is always bad in children. However completely latent the disease may become, much of the damage to the liver is of course permanent, and the patient's power of resisting acute infections and all other diseases is materially reduced.

Hæmatemesis in itself is not a serious symptom, as it is very rarely fatal.

When ascites is present, if it is due to the cirrhosis, the prognosis is very bad, and the patient rarely survives the performance of paracentesis on more than two or three occasions. If, however, it is due to chronic peritonitis, it is much less serious, and the accumulation of fluid may eventually cease.

Fever is a serious symptom, as it indicates rapid advance of the disease, or the presence of some complication. The development of the typical cirrhotic facies, together with a loss of subcutaneous fat and atrophy of the skeletal muscles, is a very serious symptom. When the patient becomes drowsy, death is certain to follow rapidly, only very temporary improvement being possible as a result of treatment. Multiple hæmorrhages under the skin or from the mucous membrane are of equally serious import.

The prognosis is much aggravated if the kidneys are diseased and unable to excrete the excess of poisons present in the blood as a result of hepatic insufficiency.

In rare cases the disease runs a subacute course, death occurring within 6 months or even in 2 months from the onset of symptoms. Such cases are most frequent in comparatively young adults who are heavy drinkers. The liver is painful and tender, fever is present, emaciation is rapid, and multiple hæmorrhages are likely to occur. Pathologically the subacute cases can be regarded as examples of subacute hepatitis.

Treatment.—Alcohol must be absolutely prohibited for the rest of the patient's life, and no medicine containing alcohol should be allowed. Curries, pickles, ginger, all highly seasoned food, vinegar, mustard, pepper, high game and ripe cheese must be permanently avoided.

Apart from these restrictions, the diet in the early stages should be that required for the treatment of the associated chronic gastritis. In the later stages, when symptoms of hepatic insufficiency are present, the diet should consist entirely of milk, milk foods, vegetable purées and fruit, and even when improvement occurs very little animal food should be allowed.

Gastric lavage is often useful for the gastritis; as this improves, free hydrochloric acid generally returns, but if permanent achylia has developed, dilute hydrochloric acid should be taken with water as a beverage during meals (p. 528). The bowels should be kept regular by means of Epsom salts. No other drugs are required in uncomplicated cases. The treatment of the gastritis, ascites and hæmatemesis is considered elsewhere.

The regular life led at a spa, such as Harrogate or Vichy, combined with the use of a mild aperient water, is often very beneficial.

The drowsy toxæmic condition of the late stage should be treated by means of normal saline solution given by the rectum, or, if it is not retained, subcutaneously. If the urine contains diacetic acid, sufficient sodium bicarbonate should be administered to keep the urine neutral.

HÆMOCHROMATOSIS

Synonyms.—Pigmentary Cirrhosis; Bronzed Diabetes.

Definition.—Pigmentary cirrhosis is a condition in which cirrhosis of the liver is associated with hæmochromatosis or pigmentation of the organs and in most cases of the skin. In the late stages diabetes generally develops as a result of cirrhosis of the pancreas; the condition is then known as bronzed diabetes.

Ætiology.—Bronzed diabetes is a very rare disease, which is almost confined to the male sex.

Pathology.—The cells and connective tissue of the liver, pancreas and the secreting and lymphatic glands contain a ferruginous pigment—hæmosiderin; the muscle-fibres of the heart and intestines contain an iron-free pigment—hæmofuscin. The pigmentation of the skin is due to excess of its normal iron-free pigment. It is doubtful whether cirrhosis of the liver is the primary condition, or whether it is secondary and due to irritation by the pigment. The cause of the pigmentation is unknown, as there is no evidence of hæmolysis.

Symptoms.—The symptoms are those of cirrhosis and diabetes, associated with pigmentation. The liver and spleen become progressively larger; ascites may occur and the subcutaneous veins are sometimes enlarged. The skin is generally pigmented a slaty colour, especially in the exposed parts of the body. In the rare cases in which no pigmentation is present, the nature of the disease is only discovered after death. Occasionally purpura develops. In most cases severe diabetes with acidosis appears within a year of death, sometimes acutely, but it may be absent to the end.

Diagnosis.—The disease can only be diagnosed with certainty when pigmentation, diabetes and cirrhosis are associated together. When two of these conditions are present alone, a definite diagnosis cannot be made. It can, however, be made with a considerable degree of probability if well-marked bronzing is associated with cirrhosis even in the absence of diabetes.

Prognosis.—So long as no diabetes is present the prognosis is not necessarily worse than that of uncomplicated cirrhosis, but the onset of diabetes is always a very grave event.

Treatment.—The treatment is that of cirrhosis and diabetes.

BILIARY CIRRHOSIS

A condition has been described under the name of Hanot's biliary cirrhosis, which is said to affect children and young adults, often several in a family, and to be characterised by enlargement of the liver and spleen, with chronic jaundice and febrile attacks, but rarely ascites. Though I gave the usual description of the disease in the earlier editions of this book, I have never seen a case which could be accurately described as biliary cirrhosis, and I am exceedingly doubtful whether such a clinical entity exists. The term has probably been used to include cases of splenic anæmia with cirrhosis (Banti's disease), acholuric jaundice, or ordinary cirrhosis associated with infective cholangitis, and very chronic cases of infective cholangitis. I do not therefore propose to help to perpetuate what I believe to be a clinical myth.

SYPHILIS OF THE LIVER

Congenital Syphilis

Ætiology and Pathology.—The liver is affected in quite 50 per cent. of infants with congenital syphilis. This great frequency is probably due to the *Spirochæta pallida* passing through the placenta and the umbilical vein direct to the fœtal liver, which is the first organ it reaches, and which is consequently found to contain it in larger numbers than any other organ.

Congenital syphilis produces diffuse changes in the liver very different from the focal lesions of acquired syphilis, except in rare cases occurring in later childhood, in which caseous gummata are found. The liver is smooth and uniformly enlarged, and is firmer and paler than normal. The changes are due to interacellular (unicellular or pericellular) cirrhosis, the result of diffuse infiltration with embryonic connective-tissue cells between the individual liver cells. These may be associated with small collections of round cells or miliary gummata, which resemble tubercles when seen by the naked eye.

The spleen is generally enlarged and hard. Diffuse small-celled infiltration or fibrosis may be found in the kidneys, pancreas, testes, suprarenal glands and lungs.

Symptoms.—Symptoms pointing to disease of the liver are not often present in infants with congenital syphilis; but on examination the liver and spleen are found to be enlarged and abnormally firm. The liver normally extends further down in young children than in adults, owing to its relatively larger size and the more horizontal position of the ribs. Only a very definite enlargement of the liver can, therefore, be regarded as important in the absence of other evidence of congenital syphilis. The liver may be tender, and in very rare cases a localised gumma is felt.

Jaundice is only rarely present at birth; still less frequently it develops some weeks later. It is probably caused by pressure on the small intrahepatic ducts, and corresponds with the jaundice sometimes seen in acquired secondary syphilis.

Diagnosis.—The diagnosis is generally easy owing to the well-marked signs of congenital syphilis present in other parts of the body. In the absence of such evidence the diagnosis must be made from rickets, tuberculosis and gastro-intestinal infection, and when jaundice is present at birth the possibility of simple jaundice and of congenital obliteration of the bile-ducts must be remembered. In doubtful cases the Wassermann reaction settles the diagnosis.

Prognosis.—The prognosis depends upon the general condition of the infant. The disease is less amenable to anti-syphilitic treatment if the liver and spleen are greatly enlarged, and if hæmorrhages occur or jaundice is present. The prognosis in delayed congenital syphilis is less favourable than in acquired syphilis, owing to the changes being generally more widespread.

Treatment.—The treatment is that of congenital syphilis.

Acquired Syphilis

1. *Secondary syphilis.*—Jaundice occurs in about ¼ per cent. of cases of syphilis at the same time as the roseola and enlargement of glands. It is probably due to obstruction of the small intrahepatic bile-ducts, caused by hepatitis, the result of poisoning with the syphilitic virus. The onset is sudden, and the jaundice is not accompanied by any gastro-intestinal or general symptoms. The liver is slightly enlarged. It is very important to distinguish true secondary syphilis of the liver from the toxic jaundice, which occasionally results from the treatment of syphilis with organic arsenic preparations (pp. 210, 382).

Recovery is generally rapid with anti-syphilitic treatment; but in very rare cases acute yellow atrophy develops.

2. *Tertiary syphilis.*—**Ætiology.**—Gummata are found in only 0·3 per cent. of autopsies; but in more than half of the cases in which other active syphilitic lesions are found the liver is affected.

Syphilis affects the liver three times as frequently in men as in women. The disease is generally discovered between 10 and 20 years after infection; but in rare instances it has occurred within a year.

Pathology.—In the early stages a mass of pink syphilitic granulation-tissue, sharply separated from the healthy liver, is found; necrosis soon occurs in the centre, which becomes yellowish-white. The caseous mass is later surrounded by a fibrous capsule; as this contracts the liver becomes more and more deformed. The capsule of the liver in the neighbourhood of a gumma is thickened, and adhesions often develop between it and the adjacent organs, the diaphragm and anterior abdominal wall. Unless they are very large, gummata are slowly absorbed till they may finally be represented by nothing more than scars, from which fibrous tissue radiates into the capsule.

Gummata are generally multiple; much less often a large part of the liver is diffusely infiltrated. The right lobe and anterior surface are most commonly affected.

Symptoms.—Gummata and cicatrices are sometimes found after death without having led to any symptoms. The nature of the symptoms they produce depends upon the size, extent and position of the lesions. Before any localising symptoms appear the patient often complains of general ill-health, which is often associated with gastro-intestinal symptoms.

The first symptom pointing to disease of the liver is generally pain in the right hypochondrium, the result of perihepatitis over a gumma. The pain may radiate to the right shoulder, and is sometimes associated with local tenderness.

Cases of syphilis of the liver may be divided into six clinical groups, according to the disease they simulate.

1. Cirrhosis of the Liver.—Ascites may occur owing to pressure of gummata or cicatrices on the intrahepatic branches of the portal vein, or less frequently on the vein itself in the portal fissure, in which cases thrombosis is likely to occur; it may also result from constriction of the hepatic veins, or from perihepatitis over gummata and much less frequently from universal perihepatitis or widespread chronic peritonitis. In rare cases the fluid is chyliform or hæmorrhagic.

The diagnosis from cirrhosis of the liver is suggested by the greater irregularity in the enlargement of the liver. When there is any reason for doubt the Wassermann reaction should be tried. Hæmatemesis, dilated veins on the abdominal wall, jaundice and symptoms of gastritis are much more common in cirrhosis, and the nutrition suffers at an earlier stage than in syphilis of the liver.

2. Lardaceous Disease.—When a gummatous liver is associated with lardaceous disease, the clinical aspects of the latter may be so prominent that the presence of a gumma is overlooked. The liver and the spleen are enlarged, ascites and œdema are present, and the urine contains albumin and casts. It must be remembered that similar evidence of renal disease occurs in syphilitic nephritis apart from lardaceous disease; the former, unlike the latter, may rapidly improve with specific treatment.

3. Hepatic Tumours.—Irregularities on the anterior surface of the liver produced by gummata and by the contraction of cicatrices are easily palpable. The diagnosis from malignant disease can be made by the presence of a positive Wassermann reaction and the rapid disappearance of a gumma with anti-syphilitic treatment; jaundice and ascites are much more common in malignant disease, in which the constitutional symptoms are generally more severe, and there may be evidence of a primary growth in some other situation. In hydatid disease the liver is smooth apart from the tumour itself, but in syphilis it is often irregular, owing to the contraction of cicatrices. The presence of eosinophilia points to hydatid disease. A gumma near the gall-bladder or in the left lobe of the liver may simulate a growth of the gall-bladder or of the stomach respectively.

4. General Infections; Hepatic Abscess.—Irregular fever sometimes occurs in syphilis of the liver. The general symptoms may simulate pylephlebitis, tuberculosis, typhoid fever or malaria, but they generally disappear under anti-syphilitic treatment. In rare cases an infected gumma may break down, when the symptoms and sequelæ do not differ from those of other forms of hepatic abscess.

5. Cholelithiasis.—Jaundice is infrequent in syphilis of the liver, but it is occasionally produced by the pressure of a gumma or of a syphilitic cicatrix; in very rare cases this is associated with attacks of pain, indistinguishable from biliary colic due to gall-stones.

6. Splenic Anæmia.—The spleen is sometimes greatly enlarged as a result of lardaceous disease when the liver is affected with syphilis. Apart from this a condition indistinguishable from splenic anæmia with secondary cirrhosis of the liver may be associated with syphilis; but it does not respond to specific treatment, though recovery generally follows splenectomy.

Diagnosis.—The possibility of syphilis should always be remembered in obscure hepatic disorders. Apart from a history of infection, and the presence of other syphilitic lesions, the Wassermann reaction should always be tested in doubtful cases. As, however, infection with syphilis does not prove that every lesion present is syphilitic, the final proof of the nature of the disease is only obtained if great improvement or complete recovery results from anti-syphilitic treatment.

Prognosis.—The prognosis of syphilitic lesions of the liver is good, if treatment is actively carried out at an early stage. In rare cases the symptoms

are due to pressure exerted by cicatrices and not by gummata; little or no improvement can then occur.

Treatment.—As soon as the possibility of syphilis is recognised, large doses of iodide should be given. I have very rarely found ill results follow the administration of as much as 60 grains of potassium iodide every 6 hours; a patient is more likely to suffer from iodism if the dose is gradually increased from a small quantity than if full doses are given at once. Mercury may also be given, and full doses of a salvarsan preparation should be injected at weekly intervals until the Wassermann reaction is permanently negative; but neither of these drugs alone leads to such a rapid disappearance of a gumma of the liver as iodides.

HYDATID OF THE LIVER

Ætiology and Pathology.—Hydatid disease is produced by swallowing the ova of the echinococcus or hydatid worm (see p. 335). Food may be contaminated by the fæces of infected dogs, or infection may occur directly if an individual touches the tongue or muzzle of a dog, which has been soiled with eggs from the fæces or anus of another dog. The frequency of the disease thus depends upon the number of infected dogs in a district. It is most common in Iceland and in parts of Australia; it also occurs in England, France and parts of Germany and Russia, but it is almost unknown in North America, except among foreigners.

When the eggs are swallowed, the embryos set free by digestion of the egg-shell pass through the walls of the stomach or small intestine into the radicles of the portal vein, by which they reach the liver, where they are generally arrested. The embryo now forms a small cyst, with an internal, nucleated, protoplasmic layer (the endocyst) and an external "cuticular membrane." The reaction in the surrounding tissues results in the formation of a fibrous capsule. After a time a dozen or more buds project from the endocyst, and develop into daughter cysts, identical in structure with the mother cyst; these soon separate from the endocyst of the mother cyst and become free.

The fluid in the cyst is clear or very slightly opalescent, with a specific gravity of between 1·005 and 1·010. It contains chlorides, phosphates, traces of sulphates and succinates, and some unknown toxic substances, but only occasional traces of albumin and sugar. Hooklets and less often hydatid heads may be found in the fluid.

The liver is involved in 60 per cent. of cases of hydatid disease in man; a single cyst is generally present, but there are occasionally multiple cysts, or single ones may develop in more than one organ.

The hydatid may live for many years. When it dies the cuticular membrane folds on itself and may become calcified; its contents dry up and form a mass containing gritty material.

Symptoms.—The patient remains in good health until the weight of the cyst, its pressure on surrounding parts, or the occurrence of a complication, such as rupture or suppuration, causes symptoms. A hydatid cyst of the liver may remain latent and be only discovered after death, or in the course of a routine examination of the abdomen in a patient without abdominal symptoms.

The increasing size of the liver may give rise to a sensation of weight and fullness in the right hypochondrium, and pain may be felt in the right shoulder. Owing to its slow growth, pressure symptoms are rare; occasionally dyspepsia, vomiting and constipation result from pressure on the stomach and intestines. Upward pressure on the diaphragm may cause dyspnœa. Jaundice caused by pressure on the bile-ducts, ascites by pressure on the portal vein, and œdema by pressure on the inferior vena cava, are extremely rare.

A small cyst may rupture into the biliary passages; intense jaundice results and the patient generally develops suppurative cholangitis. A large cyst may burst into the general peritoneal cavity, the stomach or the intestine, especially after a blow on the abdomen. Rupture may occur through the diaphragm into the pleural or pericardial cavity.

The upper part of the right side of the abdomen and lower part of the thorax become prominent when the cyst is large. If the cyst reaches the front of the liver it becomes palpable in the hypogastrium. When it projects from the under surface, the liver is pushed forward and it may simulate a large gall-bladder or a renal tumour. A cyst near the convexity pushes the diaphragm upwards, and may compress the lung and simulate a pleural effusion. In such cases the irregularity in the upper surface of the liver can be recognised with the X-rays. When deeply embedded in the liver, it produces a more general expansion and no local tumour is palpable. The tumour is generally tense and elastic. In very rare cases, of which I have only seen two, percussion of the middle finger, when the left hand is placed flat over the cyst, produces a peculiar vibration—the hydatid thrill—which is almost pathognomonic, but as it is not due to the presence of daughter cysts, having been obtained in their absence, it can also in very rare instances be observed in other tense cysts.

Bacteria may invade the fibrous capsule and multiply between it and the cuticular membrane, with the result that the nutrition of the hydatid is impaired and the parasite dies. Its death results in a change in the cuticular membrane, which, when healthy, is impervious to bacteria and leucocytes, but now allows them to pass into the fluid, which acts as an excellent culture medium and gradually becomes filled with pus cells. Symptoms of hepatic abscess are now present, and the abscess may finally rupture into the general peritoneal cavity and give rise to general peritonitis.

Diagnosis.—The discovery of a tumour of the liver should lead to a consideration of cancer, syphilis and hydatid cyst. The general health is greatly affected in the first, comparatively little or not at all in the second and third. In cancer and syphilis the tumour is likely to be irregular and multiple; in hydatid it is a uniform rounded swelling, and most frequently only one can be felt. The two former are hard and obviously solid, while the latter is elastic, and in rare cases the characteristic hydatid thrill can be felt in it. The Wassermann reaction is positive with a gumma and generally negative in the other diseases. Eosinophilia is frequent in hydatid, but in no other liver disease; it was known to have been present for eleven years when a patient, who proved to have a hydatid of the liver, first consulted me. The proportion of eosinophil cells may be enormous. In the case of a boy of 18, in whom the cyst had grown very rapidly and the legs and scrotum had become œdematous, they amounted to 65 per cent. of 16,000 leucocytes

per cubic millimetre ; the total and differential counts fell to normal within 3 weeks of the removal of the cyst. I have seen two cases of very large tumours of the right suprarenal, which produced a rounded protuberance in the front of the displaced liver, closely simulating a hydatid cyst ; the diagnosis was made more difficult by the presence of eosinophilia of 15 to 20 per cent. A doubtful diagnosis can sometimes be confirmed by a precipitin serum reaction. Some of the patient's serum is mixed with an equal quantity of stock hydatid fluid ; a precipitate forms at 37° C. in 30 per cent. of cases of hydatid, but only very rarely in the serum of individuals with no hydatid.

Prognosis.—A cyst may continue to grow for as long as 20 years. It may, however, die, shrivel up and cause no further trouble. But suppuration may occur without obvious cause at any time ; this makes the prognosis much more serious. A rapidly growing cyst is always liable to rupture. The prognosis is worst with deeply-seated cysts and cysts situated near the upper and posterior part of the liver, owing to their inaccessibility to operation, and if multiple one or more of the cysts may escape observation at the time of the operation. Rupture into the stomach or intestine may lead to spontaneous recovery, but rupture elsewhere is very serious, unless early operation can relieve the condition.

Treatment.—*Prophylactic.*—In places where hydatid disease is common, the drinking water should be boiled, fruit and vegetables should be cooked or washed with boiled water, and care should be taken not to convey infection from dogs to food by the hands.

Surgical.—Hydatid cysts were formerly treated by tapping, with or without subsequent injection of antiseptic fluids. Apart from other dangers, the escape of some of the fluid into the peritoneal cavity not infrequently led to severe urticaria, and in rare instances to epileptiform convulsions, collapse and cardiac failure. This, however, only occurred if the cyst had died, as the fluid of living cysts is generally non-toxic. Such methods have now been completely superseded by an open operation, in which the fluid is run off and as much of the cyst wall as possible is removed. This operation should be performed whenever a hydatid cyst is diagnosed, even if it causes no symptoms, as there is always a danger of serious complications arising.

MALIGNANT DISEASE OF THE LIVER

Ætiology and Pathology.—(*a*) *Primary growths.*—Primary carcinoma of the liver is only found about once in each thousand autopsies, and primary sarcoma is considerably rarer. Primary carcinoma may occur as a single large mass, which is sometimes associated with smaller secondary deposits in the liver. More frequently several nodules of about the same size are present, and it is then impossible to say which is primary, the condition closely resembling a liver invaded by secondary carcinoma. In comparatively rare cases the growth is diffuse, when it may infiltrate the whole of a lobe. Secondary deposits occur in other situations in more than half the cases : the disease spreads by the lymphatics to the glands in the portal fissure, which may then press upon the portal vein and bile-ducts, and other

glands in the abdomen and thorax are frequently involved; malignant emboli may pass by the hepatic veins to the lungs.

Primary carcinoma of the liver occurs most frequently as an independent disease, but in about 25 per cent. of cases it is associated with cirrhosis of the liver (*cirrhosis carcinomatosa*), although a cirrhotic liver is rarely attacked by secondary growths. The carcinoma is secondary, and due to the excessive and atypical development of the compensatory hyperplasia of the liver-cells which may occur in cirrhosis. The symptoms are those of cirrhosis, and after death the cirrhosis is found to be universal and of long standing, whereas the carcinoma appears to be of recent origin. The liver contains numerous nodules of carcinoma, which often reach the surface, but are never umbilicated. They tend to grow into the portal and hepatic veins; they thus spread through the liver and produce secondary deposits in the lungs, pleura and elsewhere, but the glands in the portal fissure are not involved. The symptoms may be indistinguishable from those of cirrhosis, the liver being normal in size or slightly enlarged. In the latter case, however, nodules can sometimes be felt on the surface. The spleen is often enlarged, and ascites is always present owing to portal obstruction. Pain in the right hypochondrium and jaundice are more common than in uncomplicated cirrhosis.

(*b*) *Secondary growths.*—Secondary carcinoma of the liver is about thirty times as common as primary carcinoma; it is ten times as common as secondary sarcoma.

Secondary malignant disease occurs most frequently after the age of 50; it is rather more common in women than men, because carcinoma is more common in women, and also because secondary deposits frequently occur in the liver with carcinoma of the breast and female genital organs, but rarely with carcinoma of the lip, mouth or tongue, which are much more common in men than in women.

The most common seat of the primary disease in cancer of the liver is the stomach, and then in order the colon, œsophagus, pancreas and gall-bladder; it is a common sequel of primary disease of the breast and uterus, and may also occur when the primary disease is situated in any other organ. Cancer of the gall-bladder, extrahepatic bile-ducts and the stomach may invade the liver by direct continuity.

Symptoms.—The liver is almost always palpable, as it is enlarged and abnormally hard. It becomes progressively larger until it may be so enormous that it appears to fill the whole abdomen, the right lobe being generally most affected. The liver is irregular in shape and individual nodules of growth are often felt to be umbilicated or depressed in the centre. Deposits of growth may be felt at the umbilicus and in the falciform ligament near the linea alba. A rub is sometimes heard over part of the liver as a result of perihepatitis.

Persistent pain is generally felt in the right hypochondrium and in the back; it may pass to the right shoulder and occasionally down the arm. It is in part due to stretching of the capsule of the liver, especially when it grows rapidly, but the most severe pain is due to perihepatitis. Occasionally deep-seated growths, especially if primary, give rise to no pain throughout the illness.

Jaundice is present in 50 per cent. of cases, owing to pressure on the

main bile-ducts within the liver by the growth or on those in the portal fissure by glands. Jaundice is more frequent and more often severe in secondary than in primary growths, especially when the primary source of the former is in the pylorus or gall-bladder, from which it has spread directly to the portal fissure. The fæces sometimes retain their colour, as the jaundice may be due to pressure on the intrahepatic bile-ducts, one or more of which escapes. The jaundice is progressive and persistent, but it occasionally develops acutely with vomiting and pain, the symptoms being indistinguishable from those of biliary colic due to gall-stones. Long-standing jaundice in elderly people is rarely due to anything but cancer of the liver.

Ascites is also present in 50 per cent. of cases. It is most commonly due to malignant peritonitis or to perihepatitis; it may also be caused by pressure on the capillaries when the liver is extensively infiltrated with growth and by portal thrombosis caused by invasion of the portal vein. The fluid is generally serous, and when jaundice is present it is bile-stained; extravasation of blood into a superficial nodule may cause it to be hæmorrhagic; in rare cases it is chylous owing to obstruction of a main lymphatic, but more frequently it is chyliform. Perforation of the organ primarily involved or infection without perforation may cause it to become purulent. Œdema of the ankles is present in the late stages, as a result of the toxæmia and cardiac weakness; more widespread dropsy may be caused by obstruction, or thrombosis of the inferior vena cava or some other large vein.

Cachectic symptoms develop as a result of the cancerous toxæmia, and also from intestinal toxæmia, which is no longer kept in check by the antitoxic action of the liver. The patient becomes weaker and weaker; the appetite is lost, and there is often a special distaste for meat. The body weight falls progressively, but occasionally the loss of weight due to the general emaciation is more than counterbalanced by the increase in weight of the liver and the accumulation of fluid in the abdomen. The skin is inelastic and sallow, and secondary anæmia develops. It is often possible to see the liver moving slowly up and down with respiration through the wasted abdominal wall.

Fever is often present, especially in rapidly advancing cases, quite apart from the fever which may be caused by infection of the primary growth or of a necrotic secondary deposit. Suppurative cholangitis may be caused by the infection of ducts which have become dilated as a result of obstruction.

Subcutaneous and submucous hæmorrhages may result from the intestinal toxæmia; it is often associated with jaundice, though it is not directly due to the bile in the blood.

The large liver and the ascites may push the diaphragm up and compress the bases of the lungs, which are then likely to become congested, but the main enlargement is always downwards. The growth may spread through the diaphragm and cause hiccough and cough; pleurisy generally develops and often gives rise to a bloodstained effusion, but empyema is rare.

In the late stages the patient becomes somnolent and he may be delirious Coma is generally present during the last day or two of life; respiration becomes shallower and shallower, and death comes imperceptibly.

Diagnosis.—A painful and irregular enlargement of the liver is most frequently due to a growth, and the probability is increased if general symp-

toms of malignant disease are present; if there is evidence of a primary growth elsewhere, the diagnosis can be made with certainty.

The tumour produced by cancer of the liver must be distinguished from that due to syphilis and hydatid of the liver. The shape of the liver often helps in the diagnosis, and umbilication of a tumour is conclusive evidence of cancer. The general health is much more impaired, and the patient is generally older in cancer than in syphilis or hydatid disease. A history of syphilis or evidence of its effects in other parts of the body points to a gumma, and unless a primary growth is discovered the Wassermann reaction should always be tested. Whenever hydatid disease is possible, a differential blood count should be made, as eosinophilia is frequently present, but not in the other conditions. When there is much ascites it may be impossible to diagnose between cirrhosis and cancer, especially if the patient is slightly jaundiced. The abdomen should be tapped so that the liver can be palpated; the irregularities of the cirrhotic liver are so much less marked than those in cancer that they are rarely recognisable through the abdominal wall. The spleen is generally large in cirrhosis, but normal in size in cancer, and the liver is rarely very large in cirrhosis. Pain is generally more marked in cancer, and jaundice, when present, is more profound.

The diagnosis of a growth of the liver from a displaced, but otherwise normal liver, from an enlarged liver caused by chronic venous enlargement, chronic malaria, lardaceous disease, or the impaction of a gall-stone in the common bile-duct without a previous attack of colic, and from a tumour of the right kidney, or an accumulation of fæces in the transverse colon, ought to cause no great difficulty.

Diagnosis between primary and secondary malignant disease.—In secondary cancer of the liver the primary disease is often latent, especially when it is situated in the stomach or colon. But when a thorough investigation fails to reveal a primary growth elsewhere in the body, if jaundice and ascites are absent and emaciation is slight, a single, rapidly growing tumour of the liver is more likely to be primary than secondary.

Prognosis.—Cancer of the liver is always fatal. The course of primary cancer is very rapid, as it rarely lasts more than four months, and death may even occur within four weeks of the onset of the symptoms. The duration of the illness in secondary carcinoma of the liver depends upon the primary disease, death being often due to the latter. If the primary disease has been removed by operation, or is latent, death may not occur for a year or even longer after the disease of the liver is discovered; but most cases prove fatal within six months. The disease generally advances steadily; but occasionally it may remain almost stationary for a time, and then rapidly progress to a fatal issue.

Treatment.—In very rare cases a primary growth of the liver or a growth invading it from the gall-bladder or stomach has been removed, but the disease has generally recurred, as it is impossible to tell at the time of the operation whether secondary deposits are not present in the deeper parts of the liver. It is never justifiable to operate when it is known that a growth of the liver is present; but if, during an operation for cancer of the stomach or gall-bladder, the liver is found to be involved in the immediate neighbourhood alone, an attempt should be made to remove the affected part.

The medical treatment of cancer of the liver is purely palliative,

but by means of morphine the patient should be spared pain throughout the illness. An injection of morphine should be given whenever pain is felt, and the dose should be increased as the disease progresses and the patient becomes accustomed to the drug. There is no reason to fear giving very large doses several times in the day, as with their aid patients often feel perfectly happy and comfortable up to the end. Acetyl-salicylic acid is also useful, especially in the early stages. The bowels should be kept regular by drugs, such as infusion of senna pods, the dose of which generally requires to be increased as more morphine is given. The patient should be allowed to eat and drink exactly what he likes, and no restrictions should be made on account of the supposed indigestibility of certain articles of food, nor should large quantities of food be forced upon a patient who has no appetite. When the diagnosis has once been made with complete certainty, frequent examinations of the abdomen distress the patient without doing any good. If the distension produced by ascites gives rise to pain, the fluid should be removed.

ARTHUR F. HURST.

DISEASES OF THE PORTAL VEIN

NON-SUPPURATIVE PYLEPHLEBITIS AND PORTAL THROMBOSIS

Ætiology and Pathology.—Cirrhosis of the liver accounts for about 30 per cent. of cases of portal thrombosis, but the latter is so rare that it only occurs in about 1½ per cent. of cases of cirrhosis. Its occurrence in cirrhosis is due to stagnation of blood in the portal vein, associated with sclerosis of the walls caused by the local rise in blood-pressure, together with infection secondary to intestinal catarrh. Malignant disease of the liver, stomach and pancreas is the next most common cause; invasion of the veins of the affected organ leads to thrombosis, which spreads to the portal vein. Syphilitic changes in the walls of the portal vein, and non-suppurative pylephlebitis caused by spread of infection from neighbouring parts, may cause thrombosis.

Portal thrombosis may extend throughout the vein and its branches, but more frequently it is localised to the main trunk and one or more intra-hepatic branches or extrahepatic tributaries.

Symptoms.—In the presence of cirrhosis of the liver or intra-abdominal growth, especially if ascites is present, there may be no indication that portal thrombosis has occurred. If, however, the patient is in comparatively good health, sudden occlusion of the portal vein may lead to the rapid development of ascites, hæmatemesis and melæna, and the spleen becomes enlarged; when the splenic vein is occluded, the splenic enlargement is rapid and considerable. When mesenteric veins are suddenly involved, hæmorrhagic infarction results, which leads to intestinal paralysis, with severe melæna.

Diagnosis.—The sudden onset of ascites and hæmatemesis with splenic enlargement, with or without evidence of cirrhosis or intra-abdominal growth, is suggestive but far from conclusive evidence of portal thrombosis.

SUPPURATIVE PYLEPHLEBITIS

Synonym.—Portal Pyæmia.

Ætiology.—Suppurative pylephlebitis is almost always secondary to some intra-abdominal inflammatory disease, generally associated with the presence of pus under pressure. Acute appendicitis accounts for nearly half of the cases.

Pathology.—The veins leading from the source of infection to the liver, together with the trunk and intrahepatic branches of the hepatic vein, may all be involved, but the disease is generally less extensive and may be confined by firm clots to a part of the portal vein or one of its branches. The affected veins contain pus and broken-down blood clots; their walls are acutely inflamed and may give way, leading to the formation of abscesses; thus a large abscess may develop in the mesentery or behind the pancreas. The liver is almost always involved by extension to the intrahepatic portal branches, or by secondary abscesses formed from infective emboli from the part of the vein primarily affected. Innumerable minute abscesses are present, many of which may coalesce to form a honey-combed appearance or large abscesses. Superficial abscesses may rupture and lead to general or local peritonitis, which may also result from the primary disease. The infection is generally caused by streptococci, staphylococci or *B. coli*, and very rarely *B. typhosus* or *B. dysenteriæ*.

Symptoms.—The onset is generally sudden, the symptoms due to the primary disease being complicated by the occurrence of a rigor or pain and tenderness over the liver. The clinical picture is eventually made up by symptoms of the primary disease, sepsis, and liver disease, with the frequent addition before death of pneumonia, pulmonary abscesses, or empyema, generally on the right side; evidence of portal obstruction is rarely present. The patient looks anxious and ill; he is sallow, and in about half the cases is jaundiced; the jaundice is generally slight, but may be severe from associated cholangitis. Fever is continuous, intermittent or remittent, and the pulse and respiration are rapid. Rigors, with profuse sweating, are common, especially in the early stages. Uniform enlargement of the liver occurs in about 60 per cent. of cases; it is often considerable. Pain and tenderness are generally present, and a rub may be heard over the liver. The spleen is only occasionally enlarged. Vomiting is common and diarrhœa may occur. Leucocytosis is common. Blood cultures are generally sterile.

Diagnosis.—The development of a septicæmic state, with rigors and enlargement and tenderness of the liver, in a patient with appendicitis or other intra-abdominal disease, is suggestive of suppurative pylephlebitis, but a correct diagnosis is rarely made. In amœbic abscess of the liver there is generally a history of dysentery, the progress of the disease is less rapid, and there may be signs of a single abscess, instead of a uniform enlargement of the liver. A history of gall-stones is much more common in suppurative cholangitis than in pylephlebitis, and jaundice appears earlier and is deeper. The diagnosis from a subdiaphragmatic abscess secondary to appendicitis may be impossible, and the two may be present together. Infective endocarditis, with enlargement of the liver and spleen without cardiac murmurs,

closely simulates suppurative pylephlebitis. Chronic malaria may also give rise to similar symptoms, but can be recognised by examination of the blood and by the improvement which occurs with quinine.

Prognosis and Treatment.—The disease is always fatal, and no treatment is of any avail.

ARTHUR F. HURST.

DISEASES OF THE GALL-BLADDER AND BILE-DUCTS

CHOLECYSTITIS

Ætiology and Pathology.—Chronic cholecystitis is an extremely common condition, though until recent years only the much less frequent acute and subacute forms were recognised.

Cholecystitis results from infection of the gall-bladder, which may be brought about in three ways. (1) Streptococci from foci of infection, such as the teeth, tonsils or appendix, may pass into the blood and be carried to the wall of the gall-bladder by the cystic artery. Thus streptococci isolated from infected teeth and tonsils in cases of cholecystitis often have a specifically selective action on the gall-bladder when inoculated into animals. (2) Bacteria present in the alimentary tract may pass into the portal circulation, from which they may be excreted in the bile and thus reach the gall-bladder. Thus *B. coli* is present in pure culture in the bile in a large proportion of cases of cholecystitis. The *B. typhosus* and *paratyphosus* also reach the gall-bladder in this way, but the mere presence of bacteria in the bile does not necessarily lead to cholecystitis, and although subacute cholecystitis is a not uncommon complication of the enteric fevers, chronic cholecystitis is a rare sequel. (3) Achlorhydria is present in over 40 per cent. of cases of gall-stones and probably with equal frequency in cholecystitis. This is due to the fact that the absence of the normal antiseptic action of the gastric juice permits the duodenum to become infected with the *B. coli* and less often with other organisms; infection then spreads up the common bile-duct and cystic duct to the gall-bladder and cholecystitis results.

Infection of the gall-bladder first leads to congestion and infiltration of the mucous membrane with lymphocytes. Necrosis of the mucous membrane of the apices of the villi may then occur; the latter become bile-stained and appear as yellow specks on a normal or congested mucous membrane, giving it a strawberry-like appearance ("strawberry gall-bladder"). The villi are gradually replaced by connective tissue, the velvety appearance of the normal mucous membrane being replaced by a smooth, grey or pigmented surface. The outside of the gall-bladder, which may look quite normal in the earlier stages, becomes grey and the walls thick and firm. Adhesions may form with neighbouring organs.

Cholecystitis may be acute, subacute or chronic from the onset, and acute and subacute cases may become chronic. Purulent or gangrenous changes may occur rapidly in the course of an acute infection, but very rarely in a chronically infected gall-bladder.

At any stage in a case of chronic cholecystitis gall-stones may develop,

but the condition may last for years and finally disappear spontaneously or as the result of treatment without the formation of any stones.

Symptoms.—The patient complains of intractable indigestion of an extremely irregular character, in striking contrast with the clock-like regularity of the pain in gastric and duodenal ulcer. As in appendicular dyspepsia, the time of onset and the severity of the pain vary greatly from meal to meal and from day to day; it sometimes begins immediately after food, and at other times it may not come until 2 or 3 hours after a meal, or it may only occur in the early part of the night. It is unaffected or only incompletely relieved by taking food and by alkalis. In most cases the patient complains of what he calls flatulence, but this is really only a sensation of fullness, which is not associated with increased fermentation, and only with eructation when it gives rise to aerophagy by causing the patient to make repeated but futile efforts to belch in the hope of relieving his discomfort.

Nausea is very common. It may occur on waking, when it is sometimes associated with vertigo, cold sweats or headaches, in which case migraine may be simulated, though the headache is not unilateral. It may be relieved by breakfast, unless eggs are eaten, when it is often aggravated. It is sometimes followed by vomiting, which gives much less complete relief than in ulcer.

Patients with ulcer generally lose all their pain in 2 or 3 days if put to bed on a strict diet, but improvement is less likely to follow in cholecystitis; the dyspepsia may, however, rapidly improve if yolk of egg and other fatty foods are excluded from the diet. Constipation is generally present, but in some cases intermittent or continuous diarrhœa of a mild grade occurs, and in rare instances profuse, watery diarrhœa heralds the onset of an acute exacerbation.

If attacks of biliary colic, whether of the abortive or acute variety, occur in association with symptoms of cholecystitis, gall-stones have probably developed.

The discomfort after meals is generally in the mid-epigastrium, but it often extends to the right and may be confined from its onset to the right hypochondrium. It is frequently associated with pain at the angle of the right scapula.

Tenderness of the gall-bladder is the most characteristic sign of cholecystitis. It is best elicited with the patient lying relaxed on his back; the fingers are then pressed beneath the right costal margin in the region of the gall-bladder. The pain is much increased when the fingers are brought into still more intimate contact with the gall-bladder by deep inspiration; at the same moment the latter is brought to a sudden end. The pain produced in this way is in striking contrast with the absence of tenderness when deep pressure is exerted under the left costal margin or a very short distance to the inner or outer side of the gall-bladder under the right costal margin. Pressure on the gall-bladder often causes nausea, which may even occur in the absence of pain.

Graham has shown that when pills of sodium tetra-iodo-phenolphthalein are taken in the evening the salt is absorbed and excreted in the bile, in which it reaches the gall-bladder the following morning. Owing to absorption of water in the mucous membrane the salt becomes sufficiently con-

centrated to throw a shadow of the gall-bladder which can be seen with the X-ray screen and a cholecystogram can be taken. A normal gall-bladder forms a uniform shadow with a uniform outline; it is not tender when directly palpated and it is freely movable, being quite independent of the shadow of the duodenal bulb, which can be seen simultaneously by giving a small opaque meal. The normal gall-bladder contracts and gets rid of the greater part of its contents an hour after a fatty meal consisting of scrambled eggs has been taken.

In simple cholecystitis the gall-bladder shadow is normal, but the visualised organ is found to be the seat of the tenderness previously discovered in the supposed position of the gall-bladder. Not infrequently the gall-bladder is found in an unusual position, and tenderness which would not otherwise have been found can then be elicited. In severe cases the outline may be deformed, or the gall-bladder is found to be adherent to the duodenal bulb. In some cases it throws a poor shadow or fills and empties too slowly.

Tenderness is also frequently present over the third to the tenth dorsal spines (Ryle), the muscles to their immediate right and the end of the eleventh rib. The upper part of the right rectus abdominis muscle is often tender and rigid; tenderness and rigidity of the lowest intercostal muscles may cause impeded respiration and a stitch in the right side of the chest.

In chronic cases there is generally no pyrexia, but occasionally the temperature rises to between 99° and 100° F. each evening, or during exacerbations of the inflammation accompanied by more marked symptoms. In acute cases the temperature is always raised, and jaundice, which is absent in chronic cases, is not uncommon owing to the participation of the common bile-duct in the inflammation.

Whenever cholecystitis is suspected an attempt should be made to obtain some of the contents of the gall-bladder for pathological examination. A sterilised Einhorn tube is swallowed up to the 23-inch mark first thing in the morning before the patient has had anything to eat or drink. The stomach is emptied and then washed out with sterile water. The tube is then slowly paid out up to 28½-inch mark, which allows sufficient length for the duodenum to be reached. Samples are aspirated every quarter of an hour until the comparatively abundant, acid, turbid and colourless fluid present in the stomach is replaced by the very small quantity of neutral or alkaline, clear, and generally bile-stained fluid present in the duodenum. The pylorus is generally passed in less than half an hour. The duodenum is washed out with sterile water, and from 2 to 4 drachms of magnesium sulphate in 25 per cent. solution are injected through the tube. This causes the gall-bladder and the bile-ducts to contract and the sphincter of the common bile-duct to relax. An abundant flow of pure bile rapidly appears; this is aspirated, and the tube is withdrawn. In the absence of gall-bladder disease the bile rarely contains any pus cells or epithelial cells and never any cholesterol crystals, but often a little mucus; it is generally sterile, but a few bacteria may be present if the duodenum has not been sufficiently washed out, especially in cases of achlorhydria, in which the duodenal contents generally swarm with bacteria. In cholecystitis the quantity of mucus is greater than normal, and columnar epithelial pus cells are often present; the bile contains bacteria, most commonly *B. coli* in pure culture, and rarely streptococci or staphylo-

cocci. In two cases of mine *B. typhosus* was isolated,—23 and 10 years respectively after typhoid fever. The presence of a yellow lipoid material in the gall-bladder contents suggests the presence of a strawberry gall-bladder. Cholesterol crystals and pigment granules are rarely found in the absence of cholesterol and pigment stones respectively.

Treatment.—The majority of early cases of cholecystitis can be cured by medical treatment, and great improvement often occurs in very chronic cases. Hexamine is excreted by the bile; whereas it only acts as an antiseptic in acid urine which sets free formalin from it, the presence of bile salts makes it active in bile in spite of its alkalinity (Knott). As a maximal concentration of the drug is required, alkalis should be given simultaneously in sufficient quantity to make the urine alkaline; by this means the production of formalin in the urine is prevented and large doses can be given without irritating the bladder. A solution containing 100 to 150 gr. of hexamine in 1 oz. of water is made up, and another with 60 gr. each of sodium bicarbonate and potassium citrate in 1 oz. of water. The patient takes 4 dr. of the first solution with 1 oz. of the second three times a day, the first dose after breakfast, the second after tea and the third after a glass of water or milk on going to bed. Each day 1 dr. of the hexamine mixture is added to each dose till the full 1 oz. (100 to 150 gr.) is taken three times a day, and he continues with this quantity until all symptoms have disappeared. It is sometimes necessary to reduce the dose or to omit it altogether for a few days if the bladder shows signs of being irritated. An autogenous vaccine prepared from the *B. coli* or other organism isolated from the bile should be given.

Stasis of bile in the gall-bladder must aggravate the infection. It is fortunate therefore that thorough drainage can be assured by the oral administration of magnesium sulphate (1 to 4 dr.) in concentrated solution when fasting an hour before breakfast. This causes the gall-bladder and bile-ducts to empty their contents into the duodenum through the relaxed sphincter of the common bile-duct. Olive oil in ½ oz. doses should be taken three times a day before meals, as it has the same effect as magnesium sulphate on the gall-bladder.

If cholesterol crystals were found in the bile from the gall-bladder, a cholesterol-free diet should be given. No eggs and nothing made from the yolk of eggs should be allowed. Butter must be used sparingly; cream, kidney, liver, sweetbread and brain are not allowed, and as little animal fat as possible should be taken.

If achlorhydria is present, hydrochloric acid should be given before breakfast and with lunch and dinner (p. 528). If hyperchlorhydria is present, belladonna should be given in addition to the olive oil before meals.

Foci of infection in the teeth and tonsils should be looked for and thoroughly treated. If the appendix is diseased, it should be removed and cholecystectomy should be performed at the same time. Apart from this, the indication for surgery in chronic cholecystitis is the failure of medical treatment after it has been thoroughly carried out for an adequate time. If it is likely that gall-stones are present, it is generally useless to delay. In all cases, cholecystectomy should be performed in preference to cholecystostomy.

GALL-STONES

Synonym.—Cholelithiasis.

Ætiology.—Clinically, gall-stones occur about twice as frequently in women as in men, but they are found post mortem about five times more often in women than men. They are very rare before the age of 15; 75 per cent. of clinical cases occur between 30 and 60, between 40 and 45 being the most common age. The most common age at which gall-stones are found post mortem is about 20 years later; they occur in about 25 per cent. of all women and 7 per cent. of all men dying after the age of 25.

Pathology.—(*a*) *Infection.*—Infection of the gall-bladder leads to cholecystitis. The agglutinated bacteria, precipitated mucus and cellular débris may form the nucleus of gall-stones if excess of cholesterol or bile-pigment is present in the bile, especially if the flow from the gall-bladder is less free than it should be. The nature and the path of infection have been discussed in the description of cholecystitis (p. 652). When gall-stones have once formed, the infection frequently dies out, and the bile, stones and wall of the gall-bladder may be sterile, though the latter always shows signs of old inflammation. In other cases the organisms commonly found in cholecystitis are still present.

(*b*) *Cholesterolæmia.*—The majority of gall-stones contain a considerable proportion of cholesterol. Normal blood contains cholesterol, which comes from endogenous and exogenous sources. The endogenous cholesterol is produced by the constant activity of the cortex of the suprarenal glands, and by the periodic activity of the corpus luteum at each menstrual period. During pregnancy the corpus luteum produces a very large quantity of cholesterol, so that the percentage in the blood gradually increases to nearly double and that in the bile to four times the normal. The exogenous cholesterol comes from certain articles of diet; it is abundantly present in eggs, and to a less extent in cream, and in liver, kidney, sweetbread and brain.

(*c*) *Biliary stasis.*—A stone is especially likely to form in the presence of infection and cholesterolæmia if biliary stasis is also present. This is particularly likely to occur in cholecystitis owing to partial obstruction caused by the swelling of the mucous membrane at the mouth of the cystic duct. Intermittent obstruction of the bile-ducts explains the occasional association of gall-stones with hepatoptosis, nephroptosis and general visceroptosis. Deficient exercise may also perhaps lead to biliary stasis, and in some cases there appears to be a congenital abnormality of the anatomy or neuro-muscular mechanism of the bile channels which impedes the evacuation of the bile.

By examining sections of gall-stones it is generally possible to get some idea of the history of their formation. Thus the centre of most stones is white and consists of pure cholesterol; only after the stone has reached a certain size is there as a rule any deposit of pigment or lime salts corresponding to a period of infection. Then there may be a further layer of cholesterol due to a return of cholesterolæmia owing to a second pregnancy; then another stratum of pigment and lime salts may form, and so on. A pure cholesterol stone corresponds to a pure oxalic acid or uric acid stone in the kidney, and the presence of pigment and of lime salts corresponds to that of phosphates in a urinary stone.

Symptoms.—It is rare for gall-stones to be present in the absence of symptoms. Most frequently their development is preceded and accompanied by continuous or intermittent dyspepsia. These "inaugural symptoms" are sometimes referred to as gall-stone dyspepsia: they are really due to cholecystitis (p. 652) and not to the presence of stones. Abortive attacks of biliary colic may occur independently or associated with gall-bladder dyspepsia. Typical attacks of acute colic are less frequent. They are commonly preceded by more chronic symptoms and rarely occur without any previous warning.

Many patients who suffer from gall-bladder dyspepsia, and a few who have no such symptoms, complain of short attacks of severe pain, which may occur at any time of the day or night without any obvious cause, such as an indiscretion in diet, although occasionally an attack is the direct sequel of a long railway journey, a drive in a motor-car on a bad road, or violent exercise. Attacks may occur daily or at long intervals, or there may be a series close together followed by a long spell of freedom. The patient may shiver during an attack, although his temperature never rises greatly and often does not rise at all. The shivering is occasionally accompanied by a sensation of "goose-skin," particularly in the epigastrium and right side of the upper part of the abdomen. When the pain is acute it is impossible to take a deep breath, the attempt producing a "catch" in the right side of the chest, which is very similar to what is felt in pleurisy.

Attacks of biliary colic most frequently result from impaction of the stone in the pelvis of the gall-bladder, close to or at the orifice of the cystic duct. They often occur in the night. The attack begins with extremely sudden acute pain in the epigastrium or in the region of the gall-bladder or both; it may pass through to the angle of the scapula or towards the tip of the right shoulder. The violent pain is accompanied by great restlessness, in marked contrast with the motionless state of a patient with a perforated ulcer or acute appendicitis. Some relief may be obtained by pressing upon the abdomen. The patient feels cold, but sweats profusely. Breathing is generally difficult. Nausea and vomiting almost always occur; the vomiting may give some relief. Aerophagy is generally present. The pain commonly disappears with absolute suddenness. The sudden onset and sudden cessation are especially characteristic of gall-stone obstruction in the cystic duct. There is often slight albuminuria during an attack, and constipation is complete.

Gall-stones are only passed in a very small proportion of cases. It is important to distinguish gall-stones or biliary sand from intestinal sand and concretions produced by drugs or by the administration of large quantities of olive oil. The majority of gall-stones consist of cholesterol and can, therefore, be recognised by being very light and inflammable. The rarest form of stone to be passed is a very small rounded one, which has probably traversed the normal passages during an attack of colic: as it may be the only one, a cure may result. More frequently faceted stones are passed; even if large numbers are found, it is very unlikely that all have left the gall-bladder. Lastly one, or less frequently two or three large stones, which may be formed by the agglomeration of several smaller ones, may be passed after traversing a fistulous communication between the gall-bladder and duodenum or colon. The fistula may develop very slowly without symptoms after chronic cholecystitis has led to the production of adhesions. More

frequently, the perforation appears to be sudden, and takes place during or after an attack of colic. In other cases, the fistula may be caused by the perforation of an empyema of the gall-bladder into the bowel. When a large stone traverses the whole bowel, pain is generally produced at one time near the right iliac fossa owing to obstruction in the terminal ileum. If it passes further, pain is later felt below the umbilicus and finally in the rectum, from which it may have to be dislodged by the finger. The passage may take from one to eight days.

It is generally impossible to palpate the gall-bladder during an attack of acute pain owing to the rigidity of the abdominal muscles, but when the attack passes off the tenderness generally becomes localised to the gall-bladder itself. In some early cases the gall-bladder is found to be enlarged owing to distension with clear fluid, especially if the stone is impacted in the cyst duct. Very commonly it gradually contracts on the stone or stones within it, probably after temporary dilatation, so that in long-standing cases it is rarely palpable. Even if a gall-stone passes into the common bile-duct, the gall-bladder does not become enlarged; thus a large gall-bladder in a case of chronic jaundice indicates chronic pancreatitis or a growth of the head of the pancreas or of the common bile-duct, whilst an impalpable gall-bladder suggests the presence of an impacted gall-stone.

Jaundice occurs only when a stone reaches the common bile-duct. But in 30 per cent. of cases no jaundice is present at the time of examination, though there is almost always a history of jaundice following an attack of colic, in contrast with the repeated attacks of colic without jaundice in stones in the neck of the gall-bladder or the cystic duct. The slightest yellow tinge of the conjunctivæ or a trace of bile in the urine is very valuable evidence that an attack of pain of doubtful origin is due to gall-stones. Sometimes the obstruction caused by a stone is sufficient to give rise to a positive direct van den Bergh reaction, though there is no obvious jaundice and no bile in the urine.

Pure cholesterol gall-stones are never visible with the X-rays, but when much lime salts are present, especially in thin patients, they often throw a characteristic shadow. The shadow must be distinguished from that produced by a renal calculus, a calcified tuberculous focus in a kidney, a calcified tuberculous gland or a calcareous deposit in a costal cartilage. This can now be easily done by means of cholecystography. This method also makes it possible to photograph transparent stones, as they are seen as pale areas surrounded by the dark shadow formed by the pigment filling the rest of the gall-bladder. Failure to produce a cholecystogram on two successive occasions indicates that the cystic duct is obstructed, probably by an impacted stone, or that the lumen of the gall-bladder is entirely occupied by stones.

In many cases of gall-stones there is never any pyrexia, but in a doubtful case it is advisable to have the temperature taken every half-hour during the attacks of severe pain, as the temperature often rises slightly.

Complications.—Cholecystitis is always present before gall-stones develop. Chronic inflammation often causes the gall-bladder to become adherent to the duodenum and pylorus or to the hepatic flexure. A fistulous communication between the gall-bladder and duodenum or colon may subsequently develop. In some cases inflammation may spread up the hepatic ducts or down the common bile-ducts; in the latter case the pancreatic

ducts may become infected, and chronic pancreatitis develops. In rare cases glycosuria or actual diabetes follows. Cancer of the gall-bladder is an occasional sequel of gall-stones. Acute suppuration or gangrenous cholecystitis may develop in connection with gall-stones and call for immediate operation.

Treatment.—During an attack of biliary colic the patient must remain in bed until it has terminated, and the pain should be controlled by the injection of morphine with atropine.

The early recognition and thorough treatment of cholecystitis can be regarded as a true method of prophylaxis of gall-stones.

Treatment of cholecystitis may also result in the solution or washing away of cholesterol deposited on the walls of the gall-bladder and of minute agglomerations of crystals—the basis of what might later become gall-stones. Moreover, even when definite stones are present it may cause the accompanying indigestion, the so-called gall-bladder dyspepsia, which is really due to the cholecystitis, to disappear. However, if the symptoms point definitely to the presence of gall-stones, an operation should be advised, unless on account of obesity or renal or cardiac complications the patient is a bad subject for operation. Under such conditions the accompanying cholecystitis should be treated medically, and an attempt should be made to improve the patient's condition in case an operation has eventually to be performed. Unless the case is urgent a short preliminary course of antiseptic treatment is always advisable before operating, and the liability to complications or the recurrence of symptoms is greatly reduced by the regular use of magnesium sulphate to prevent stagnation of bile after the operation. Wherever feasible cholecystectomy should be performed in preference to cholecystostomy.

BILIARY COLIC WITHOUT GALL-STONES

It occasionally happens, especially in otherwise healthy young adults of both sexes, that typical attacks of slight or severe biliary colic, generally unaccompanied by jaundice, occur in the absence of gall-stones. During an attack and for a short time afterwards the gall-bladder is found to be tender. The bile obtained through a duodenal tube from the gall-bladder is normal in every way, and cholecystography shows no abnormality, with the exception that pressure upon the visualised gall-bladder, especially in a direction from its vertex towards its neck, causes pain, and the gall-bladder is sometimes unusually large.

On abdominal exploration the gall-bladder looks healthy, but it may be tightly distended. Careful examination may show some abnormality in the anatomy of the cystic duct, which results in kinking when the gall-bladder is in certain positions, so that it may be difficult to empty it by direct pressure. The condition is analogous to Dietl's renal crises. Cholecystectomy is generally followed by permanent cure, though neither macroscopical nor microscopical examination shows any abnormality in its walls or contents.

When no anatomical abnormality is discovered, the condition is probably identical with that which gives rise to attacks of biliary colic after cholecystectomy for gall-stones or cholecystitis, and which leads to the assumption that a stone has been left in the common bile-duct, though at operation

no stone or other cause of organic obstruction is discovered. They are, I believe, caused by a disturbance of the neuro-muscular mechanism of the biliary ducts and the sphincter of the common bile-duct (Oddi's sphincter). When the gall-bladder has been removed, the common bile-duct often dilates to form a reservoir which to some extent takes its place; this can only be due to the resistance offered by the unrelaxed Oddi's sphincter to the flow of bile, corresponding with the dilatation of the œsophagus following achalasia of the cardia. It may take a long time for the neuro-muscular mechanism of the common duct and its sphincter to adapt itself to the conditions present after cholecystectomy, and during this period attacks of pain may result from temporary obstruction by the closed sphincter when the dilated common duct is attempting to empty itself.

Diagnosis.—Biliary crises can be diagnosed if, with typical attacks of colic, cholecystography shows that no stone is present and the bile obtained from the gall-bladder is normal. The tenderness of the gall-bladder present during the attack generally disappears, whereas in cholecystitis it rarely goes completely. When several attacks of colic occur after cholecystectomy has been performed for gall-stones by a competent surgeon crises of this kind are the most probable cause.

Treatment.—Regular contraction of the gall-bladder and ducts and relaxation of Oddi's sphincter can be promoted by giving Epsom salts when fasting in the morning and olive oil half an hour before meals. When this fails, the gall-bladder may have to be removed, as the obstruction is then probably due to an anatomical and not a neuro-muscular derangement. Post-operative cases can generally be relieved by Epsom salts and olive oil. They would probably occur much less frequently if this treatment was given to all patients for some months after cholecystectomy.

CARCINOMA OF THE GALL-BLADDER

Ætiology.—Carcinoma of the gall-bladder is more common among women than men. The relative frequency among women is due to the common association of gall-stones with carcinoma of the gall-bladder. Calculi are present in at least 80 per cent. of cases, and stones may have been present earlier and passed in some of the remainder.

Pathology.—Primary carcinoma of the gall-bladder may be columnar or spheroidal-celled. Columnar-celled carcinoma generally forms a papilloma projecting into the cavity of the gall-bladder; spheroidal-celled carcinoma more often infiltrates its walls and grows more rapidly. Carcinoma starts most frequently in the fundus of the gall-bladder; it may be situated in the centre of the gall-bladder, when it is likely to produce an hour-glass constriction, or at the neck, when the gall-bladder becomes distended with mucous fluid owing to obstruction to its outlet. Clinically, carcinoma of the cystic duct is indistinguishable from carcinoma of the neck of the gall-bladder.

Symptoms.—In 70 per cent. of cases there is a history of dyspepsia, probably due to cholecystitis, and much less frequently a definite history of biliary colic due to gall-stones. The first symptom of the disease itself is generally discomfort or pain in the right hypochondrium, often radiating to the right scapular region, with indigestion, anorexia and loss of weight. The

pain is generally worst after meals and aggravated by jolting. Flatulence, nausea and vomiting are common. A tumour can generally be felt; it may at first be smooth, but later becomes hard and irregular. It is generally not very tender, and there is less muscular rigidity over it than is commonly the case with an inflamed gall-bladder.

After a time secondary deposits lead to symptoms, and in some cases these are most prominent throughout, the primary disease remaining latent. Thus the liver is often large, hard and irregular from the presence of secondary deposits. Jaundice often occurs as a result of extension to the bile-ducts or compression by enlarged glands; it is occasionally remittent or intermittent, when it is generally due to catarrh or a gall-stone in the common bile-duct.

Ascites is present in about a quarter of the cases as a result of malignant peritonitis or pressure of glands on the portal vein. Extension of the growth to the pylorus or duodenum, or to the colon may lead respectively to symptoms of pyloric and intestinal obstruction. The constipation, which is generally present, tends to be replaced by distressing nocturnal diarrhœa if the pancreas becomes involved. In other cases septic complications, such as suppurative cholecystitis or cholangitis, or local or general peritonitis may occur. Death generally supervenes within 6 months of the development of definite symptoms apart from those due to the preceding cholecystitis or gall-stones.

Diagnosis.—The diagnosis is often exceedingly difficult, but the presence of a hard irregular tumour in the region of the gall-bladder with pain, anorexia and loss of weight in a middle-aged or elderly individual especially if he has had symptoms pointing to cholecystitis or gall-stones, is suggestive of a growth of the gall-bladder.

Treatment.—It is not often possible to remove a growth of the gall-bladder owing to the difficulty in making an early diagnosis. The operative mortality is high, and a very large proportion of cases recur within 6 months. Now that cholecystectomy is generally performed for gall-stones instead of cholecystostomy, very early carcinoma of the gall-bladder is sometimes discovered, and permanent recovery may follow.

CARCINOMA OF THE BILE-DUCTS

Ætiology.—In this rare disease males are affected slightly more often than females in contrast with primary carcinoma of the gall-bladder in which females are much more frequently affected.

Pathology.—The growth arises most frequently in the common bile-duct at its origin, its lower end, or in the ampulla of Vater, when a papillomatous projection into the duodenum develops. The common hepatic duct and the middle part of the common duct are next most affected, but a growth of either of the two hepatic ducts is very rare. Primary growths of the cystic duct can rarely be recognised, as at the time of death they are likely to have spread either to the gall-bladder or to the junction with the hepatic duct.

Symptoms.—The first symptom is jaundice, which develops gradually, and steadily progresses; but though the faeces are clay-coloured, they generally contain a little stercobilin. Apart from loss of weight and strength, the symptoms are simply those of obstructive jaundice, but sometimes pain is felt in the epigastrium or right hypochondrium, and attacks of colic may occur.

The gall-bladder and less frequently the liver is enlarged. The primary tumour is never palpable. Ascites may occur as a result of secondary malignant peritonitis, or of pressure of glands on the portal vein. Death generally occurs within 6 months of the onset of jaundice from exhaustion or coma, but with a primary growth of the ampulla of Vater the course of the disease is generally much more prolonged and the jaundice is likely to be intermittent.

Diagnosis.—Progressive jaundice in a middle-aged or elderly man in the absence of pain, especially if the gall-bladder is enlarged, suggests the presence of chronic pancreatitis or much less frequently a growth of the head of the pancreas or of the bile-ducts; in a growth of the bile-ducts, but not in the other conditions, the fæces generally contain a trace of stercobilin. A growth arising from the duodenal mucous membrane over the biliary papilla may produce identical symptoms, but the jaundice is more often intermittent, and the disease is more frequently complicated by infective cholangitis than with a growth of the bile-duct, except when it arises in the ampulla of Vater. If a gall-stone is impacted in the common bile-duct, there is often a history of biliary colic before the onset of the jaundice, which is remittent instead of progressive, and symptoms of infective cholangitis are much more frequently present. Enlargement of the gall-bladder makes a diagnosis of gall-stones improbable, but it is also absent when the growth involves the hepatic duct. The presence of occult blood in the stools is in favour of a growth.

Treatment.—Life may be rendered more bearable as well as considerably prolonged by cholecystenterostomy if the obstruction is in the common bile-duct, or by external drainage of a dilated duct if it is at or above the junction of the cystic and hepatic ducts. In very rare cases, the growth has been excised.

ARTHUR F. HURST.

DISEASES OF THE PANCREAS

THE INVESTIGATION OF DISEASES OF THE PANCREAS

The pancreas normally produces an external secretion—pancreatic juice, and an internal secretion—insulin. The two functions are entirely independent, and in the diseases affecting the former, which are alone considered in this section, glycosuria due to deficient insulin is rarely present and never severe.

The pancreatic juice reaches the duodenum by the large duct of Wirsung and the small duct of Santorini. The duct of Wirsung runs by the side of the common bile-duct for a short distance, and then joins it to form the ampulla of Vater, a small cavity in the wall of the descending part of the duodenum, which opens in the biliary papilla. The duct of Santorini discharges through a small papilla a short distance nearer the pylorus, but in 30 per cent. of normal individuals it is not patent or is too small to perform the functions of the duct of Wirsung if the latter is obstructed. The common bile-duct is completely surrounded by the head of the pancreas in 62 per cent. of bodies; in the remainder it lies in a more or less deep groove in the gland.

It is clear from these anatomical facts that the pancreatic juice may fail to reach the intestine and deficient pancreatic digestion follow either as a result of disease of the pancreas, which inhibits the activity or actually destroys the secreting cells, or, in the 30 per cent. of people with an incompetent duct of Santorini, as a result of obstruction caused by a gall-stone in the ampulla of Vater or a growth of the ampulla or biliary papilla. The effect on digestion will obviously be the same in each case. It is further clear that in 62 per cent. of cases of chronic inflammation or cancer of the head of the pancreas jaundice will result; but, if the duct of Santorini is incompetent, jaundice accompanied by deficient pancreatic digestion may be equally well due to obstruction of the ampulla of Vater without disease of the pancreas.

The Stools in Deficient Pancreatic Digestion.—The stools are bulky and pale owing to excess of fat, the normal proportion of which in the dried fæces may be increased to 60 to 80 per cent. from the normal of 15 to 25 per cent. The pallor is still more marked in the presence of jaundice, as stercobilin is then absent or reduced in quantity. The fat is present chiefly in its neutral form, whereas normally only about 10 per cent. is unsplit; in rare cases it separates as oil, which solidifies on cooling. Microscopically oil droplets are seen, together with crystals of fatty acids and soaps, which are formed by bacterial decomposition of the undigested fat, but the proportion of neutral fat to fatty acids and soaps remains high, in contrast with the excess of the latter and small proportion of the former in chylous diarrhœa due to obstruction of the lacteals (p. 662). Meat fibres and vegetable food can sometimes be recognised with the naked eye, especially if the presence of excess of fat is prevented by giving a fat-free diet; they are always recognisable with the microscope, when the striation of the muscle fibres can also be seen. In severe diarrhœa with rapid passage through the small intestines meat may escape digestion in the absence of pancreatic disease.

The irritating products of bacterial decomposition of undigested food may give rise to diarrhœa; in such cases excess of mucus is often present.

Pancreatic Ferments in the Duodenal Contents, Fæces and Urine.—The duodenum normally contains trypsinogen, which is converted into active trypsin by the enterokinase of the intestinal juice, amylopsin (diastase) and steapsin (lipase). Under the conditions already described in which no pancreatic juice reaches the intestine, the ferments cannot be isolated from the duodenal contents obtained through an Einhorn tube; but it is impossible to recognise with certainty a simple reduction in the quantity present, owing to the great variations which normally occur, and the technical difficulties in the quantitative estimation of the ferments. The same is true with regard to their presence in the stools, but a rough estimation of the quantity of pancreatic juice secreted can be made by estimating the tryptic activity of the fæces. On the other hand, the quantity of diastase present in the urine is fairly constant and not difficult to estimate. In destructive disease of the pancreas it is not reduced, as the ferment is apparently formed in the liver and simply excreted by the pancreatic juice. Consequently in acute pancreatitis the diastase index is increased from the normal of between 6 and 30 units to 200 or more, and in many cases of chronic pancreatitis and growth of the pancreas, especially during exacerbations which manifest themselves by increase in pain, and also in obstruction of the ducts, it is

increased to a less extent, a unit being the number of cubic centimetres of 0·1 per cent. starch solution digested by 1 c.c. of urine. The index is low in renal disease owing to deficiency in the excreting power of the kidney.

The Urine.—Although the secretion of insulin is rarely much affected in the diseases of the pancreas considered in this section, slight glycosuria or a rise in the blood sugar without glycosuria is sometimes observed; in doubtful cases this would be a strong point in favour of pancreatic disease. The diastase index has already been discussed. Cammidge's so-called pancreatic reaction is now generally recognised to be quite untrustworthy.

ACUTE PANCREATITIS

Ætiology.—Acute pancreatitis occurs most frequently in fat middle-aged individuals.

The infection generally reaches the pancreas by its ducts. Gall-stones are present or have previously been passed in about 50 per cent. of cases, and in a few additional cases pancreatic calculi have been found. In the absence of gall-stones the infection probably spreads from the duodenum, as a gastro-duodenal catarrh is often present, many of the patients being alcoholic, and occasionally a duodenal ulcer has been found. Acute pancreatitis has also been known to result from an injury, which has in most cases produced hæmorrhage into the gland, and to follow parturition.

Very rarely infection reaches the pancreas by way of the blood-stream in pyæmia and infective endocarditis, and abscesses may result from retrograde thrombosis in suppurative pylephlebitis. Acute pancreatitis has been observed in influenza, typhoid fever and small-pox. It is also a rare complication of mumps, but suppuration and necrosis never occur in this variety.

Pathology.—Acute pancreatitis is always due to infection; obstruction of the ducts with stagnation of the pancreatic juice and reflux of bile into the pancreatic ducts being important but not essential factors. Hæmorrhages, suppuration and necrosis are found in varying proportions in the pancreas and in the neighbouring fat. Opaque white areas of fat necrosis are found in the fat of the pancreas, the retroperitoneal tissue, omentum and mesentery, and also occasionally in that of more distant parts, such as the pericardium. Bacteria, especially the *B. coli* and streptococci, can always be isolated from the inflamed gland and often from the gall-bladder. These organisms can activate the zymogens of the pancreatic juice and thus set free trypsin and steapsin, which are the active agents in the production of the characteristic necrotic and hæmorrhagic changes in the pancreas and of the fat necrosis. The peritoneal cavity often contains blood-stained fluid, especially in the lesser sac; in the later stages this fluid is infected and suppurative peritonitis may be present.

Symptoms.—Without any warning a sudden very violent pain is felt in the epigastrium. It continues without intermission, but paroxysms of still more severe pain occur from time to time. Severe pain across the back is also often present. After a short time vomiting begins and is repeated at frequent intervals; the gastric contents are first ejected, and after a time the vomit contains bile. Flatus may be passed, but the bowels are

not opened, and no sounds indicating gastro-intestinal activity can be heard on auscultation. The abdomen soon becomes distended; it is very tender on palpation, but the muscles are often not correspondingly rigid. The tenderness and rigidity begin in the epigastrium, but before long become general. In rare cases the enlarged pancreas can be felt, but the rigidity of the abdomen generally makes this impossible. Slight jaundice is occasionally present as a result of pressure of the swollen pancreas on the common bile-duct. The patient soon becomes collapsed, with a weak and rapid pulse and slight cyanosis; he appears more severely ill in the first few hours than is generally the case in acute peritonitis. The temperature is not greatly raised and may be subnormal, and leucocytosis is generally absent. Dyspnœa is occasionally observed. Glycosuria is rare, probably because death occurs too rapidly, as the diabetes produced in animals by the removal of the pancreas often does not develop until some days have elapsed. The diastase index of the urine is always raised above 100 and generally above 200.

Diagnosis.—The possibility of acute pancreatitis should be considered in all cases of acute symptoms in the upper part of the abdomen in adults, especially if the patient is an elderly, obese, alcoholic individual, who has previously suffered from symptoms which might have been due to gall-stones or gastro-duodenal catarrh. The symptoms may closely resemble those due to perforation of a gastric or duodenal ulcer, but in the latter there is generally a history pointing to the presence of an ulcer before the onset of acute symptoms; vomiting is continuous in pancreatitis, but occurs only at the onset or not at all in perforation, and the hepatic dullness does not alter in pancreatitis, but often disappears owing to the escape of gas through a perforated ulcer; and the abdominal muscles are generally less rigid in pancreatitis than in perforation. In other cases acute intestinal obstruction is simulated, but flatus generally continues to be passed, the abdomen is less distended and intestinal sounds disappear at once instead of being unusually loud at first. A rise in the diastase index to 200 or more is conclusive evidence in favour of acute pancreatitis. At the operation the discovery of fat necrosis at once makes the diagnosis clear.

The occurrence of sudden severe epigastric pain, incessant vomiting, with epigastric tenderness, and occasionally an elongated tumour in the situation of the pancreas on the third or fourth day in a case of mumps, is probably due to acute pancreatitis. Glycosuria and jaundice are extremely rare.

Prognosis.—The most acute cases are always rapidly fatal, unless an operation is performed. Some cases run a subacute course, especially if one or more localised abscesses form; the illness may then continue for a week or more with rigors and leucocytosis. Milder cases may perhaps recover or lead to chronic pancreatitis. Only one fatal case of pancreatitis due to mumps has been recorded, complete recovery generally occurring within a week without any operation being required.

Treatment.—An operation should at once be performed in all cases of acute pancreatitis, except in those complicating mumps, the pancreas being drained at the site of greatest damage. The gall-bladder also should be drained. The best results are obtained when a localised abscess is present, gangrenous pancreatitis being almost invariably fatal. The earlier the operation is performed, the greater is the prospect of recovery.

CHRONIC PANCREATITIS

Ætiology and Pathology.—Chronic pancreatitis is generally due to infection spreading up Wirsung's duct. This is most likely to occur if the pancreatic secretion stagnates owing to obstruction of the duct, especially in an individual in whom the duct of Santorini is insufficiently developed to drain the gland. A small gall-stone impacted in the ampulla of Vater obstructs the mouth of Wirsung's duct, and is therefore generally complicated by chronic pancreatitis; if it be impacted in the terminal part of the common bile-duct, this complication may also occur, especially in an individual in whom the duct is completely surrounded by the head of the pancreas.

In rare cases the duct is obstructed by a pancreatic calculus, but this is probably itself a result of catarrh of the pancreatic ducts. Cancer of the head of the pancreas and obstruction of the mouth of the common bile-duct by cancer of the ampulla of Vater or of the duodenum are generally complicated by chronic pancreatitis, as the flow of pancreatic juice is obstructed.

When no obvious obstruction is found to account for chronic pancreatitis, the disease may be due to a gall-stone which has been passed, but the infection can also ascend from the duodenum, or descend from the upper biliary passages, as non-calculous cholecystitis is sometimes present. The cases which occur in alcoholic individuals and those which follow influenza are probably secondary to gastro-duodenal catarrh, and a typhoidal infection of the bile passages probably accounts for the occurrence of chronic pancreatitis as a sequel of typhoid fever. When a chronic gastric or duodenal ulcer erodes the pancreas the neighbouring part of the gland becomes chronically inflamed.

In chronic pancreatitis the inflammation and the fibrosis to which it gives rise are mainly interlobular, coarse bands of connective tissue, often visible to the naked eye, separating the lobules of the gland from each other. The head of the pancreas is generally most affected: it is hard and somewhat enlarged.

Symptoms.—In chronic pancreatitis the normal functions of the pancreas must be more or less disturbed, but in the majority of cases no distinctive symptoms are observed, the condition being accidentally found during an operation performed for the relief of the primary disease, or at autopsy if the primary disease has proved fatal. When the secretion of pancreatic juice is deficient or absent owing to the inhibition of secretion which results from inflammation, and to the obstruction of the pancreatic ducts by the primary disease or the swollen gland itself, the stools are pale and fatty (p. 663) and diarrhœa may result. The deficient digestion causes gradual emaciation with increasing weakness, but this is generally very slow. Anorexia is sometimes present and may be extreme.

Diabetes rarely results from chronic pancreatitis, but it may occur in very chronic cases if the inflammation spreads into the lobules and invades the islands of Langerhans.

When the common bile-duct passes through the head of the pancreas, the swelling of the gland is likely to obstruct the duct and cause jaundice, the presence of which does not therefore indicate that the pancreatitis is due

to obstruction of the common bile-duct. The obstruction of the common bile-duct causes the gall-bladder to be dilated unless gall-stones are or have been present; the liver is often enlarged and abnormally hard.

Pancreatitis itself does not often give rise to pain, but severe attacks of colic are occasionally observed even in the absence of gall-stones; when present, the pain tends to radiate, as in other diseases of the pancreas, along the left costal margin, and to bore through to the muscles immediately to the left of the lower dorsal spine and to the angle of the scapula. Left-sided pain of this kind in gall-bladder disease and chronic ulcer should suggest the possibility that chronic pancreatitis is present as a complication. In rare cases the enlarged head of the pancreas can be felt just above and to the right of the umbilicus; more frequently some tenderness is present in this situation.

Diagnosis.—It is rarely possible to determine with certainty whether chronic pancreatitis is present as a complication of gall-stones or of the other conditions with which it may be associated. If glycosuria develops in such a case, it is extremely probable that the pancreas is becoming affected. The changes in the fæces, which result from the absence of pancreatic digestion, do not prove that the pancreas is affected in a case of chronic jaundice, as obstruction of the ampulla of Vater may prevent the pancreatic juice as well as the bile from reaching the duodenum, although the pancreas may be healthy. The rise in the diastase index of the urine, which may occur in chronic pancreatitis, is also only of importance in the absence of obstructive jaundice.

The possibility of chronic pancreatitis should be considered in all cases of chronic jaundice of which the cause is doubtful. Even in the absence of a characteristic history, the occurrence of attacks of pain makes it probable that gall-stones are present, especially if the gall-bladder be impalpable. In the absence of such attacks, especially if the gall-bladder be enlarged, either chronic pancreatitis or a growth is probably present. A growth is much more commonly associated with chronic pain, and emaciation and weakness develop more rapidly. It is often impossible, however, even at an operation, to distinguish between a growth of the head of the pancreas and chronic pancreatitis; only when a patient recovers completely and permanently is it possible to be certain that the condition was inflammatory.

Prognosis.—The prognosis depends upon that of the primary condition in secondary cases, and the presence of chronic pancreatitis does not alter the prognosis in operations for gall-stones. When the disease has appeared to be primary, recovery has taken place after an exploratory operation in which nothing was done. The disease is, however, likely to progress, and death to result from asthenia, unless some drainage operation is performed.

Treatment.—It is only necessary to consider the treatment of those cases which appear to be primary, as when the pancreatitis is secondary it requires no treatment beyond what is necessary for the primary disease. If jaundice does not abate within 3 months, or a shorter period if the patient rapidly loses weight and strength, an operation should be performed. If any obstruction is found, its cause should be removed when possible, and the gall-bladder should be drained if necessary, otherwise a cholecystenterostomy should be performed in order to cure the jaundice and to remove one source

of irritation of the pancreas by draining the infected bile. The operation has no ill-effects, and should therefore be performed in spite of the fact that some cases have recovered when nothing was done at the operation.

SYPHILIS OF THE PANCREAS

The pancreas is affected in 20 per cent. of cases of congenital syphilis in the new-born; in most cases the liver is simultaneously affected, and somewhat less frequently the spleen, bones, lungs and other organs. The gland is enlarged and hard owing to proliferation of the interlobular connective tissue; the gland-cells atrophy, but the islands of Langerhans escape.

Syphilis in adults occasionally gives rise to chronic pancreatitis, and much less frequently to gummata of the pancreas.

Symptoms.—The symptoms are those of chronic pancreatitis. The occurrence of diabetes in a syphilitic patient should suggest that the pancreas may be affected.

PANCREATIC CALCULI

Ætiology.—Pancreatic calculi are extremely rare. The majority of cases have occurred in middle-aged men.

Pathology.—Between five and ten calculi are generally found, but in rare cases one only, or as many as 300, may be present. They are white, yellow or brown, and vary in size from mere sand to smooth or irregularly-shaped masses, an inch or more in length. Although pancreatic juice contains no calcium carbonate, this is the chief constituent of the calculi. If they reach the ampulla of Vater, a deposit of cholesterol and bile-pigment may form over them, causing them to become externally indistinguishable from gall-stones. Calculi probably never form in a healthy pancreas, but are the result of infection of the ducts with stagnation of the secretion; thus the ducts behind the calculi are dilated and show catarrh of their walls; chronic pancreatitis is often present, but suppuration is very rare. The condition is often associated with gall-stones.

Symptoms.—In most cases the calculi have only been discovered after death. They may cause attacks of epigastric pain very similar to biliary colic, but the pain radiates along the left costal margin and may extend to the angle of the left scapula, and vomiting is generally absent; fragments of calculi may be passed after an attack. In chronic cases dyspepsia, malnutrition and the passage of fatty stools result from obstruction to the flow of pancreatic juice, and amylopsin disappears from the duodenal contents and stools, but is found in excess in the urine. Glycosuria sometimes develops. A stone may cause jaundice by pressing on the common bile-duct or by passing into the ampulla of Vater.

Diagnosis.—The colic caused by pancreatic calculi differs from that due to gall-stones in the pain being generally on the left instead of the right side; jaundice is less frequently present, and, owing to the large proportion of calcium they contain, pancreatic calculi form a much more definite shadow than gall-stones with the X-rays.

Treatment.—If the condition is diagnosed the calculi should be removed by operation.

PANCREATIC CYSTS

Ætiology.—The majority of true pancreatic cysts are produced by the retention of pancreatic juice owing to obstruction of the ducts by gall-stones, and much less frequently by pancreatic calculi or a tumour; as obstruction also leads to chronic pancreatitis, this is almost invariably present.

A large proportion of so-called pancreatic cysts are really pseudo-pancreatic cysts, being collections of fluid in the lesser sac of the peritoneum, the foramen of Winslow having been occluded by peritonitis. About a quarter of these cases result from an injury to the pancreas, which causes the escape of blood and pancreatic juice into the lesser sac with secondary peritonitis. In the remaining cases serous fluid collects slowly owing to local peritonitis secondary to pancreatitis, the condition being analogous to a pleural effusion following pneumonia.

Pathology.—A single large pancreatic cyst may contain as much as 14 pints of fluid; in other cases there are multiple cysts of various sizes, which are often quite small. Fragments of gland substance may be found in their walls; they are sometimes in direct communication with the pancreatic duct, but in other cases the latter is obliterated. The cyst is often adherent to the surrounding parts. It may rupture into the lesser sac of the peritoneum, the general peritoneal cavity or the stomach.

The contents of true pancreatic cysts are generally turbid and dark reddish-brown or yellow in colour. The fluid is alkaline, slightly viscid and albuminous, and may contain altered blood; microscopically degenerated epithelial cells, leucocytes, and occasionally crystals of cholesterol and rarely of leucin and tyrosin are found. The pancreatic ferments are often absent, especially in old cysts.

Symptoms.—There are often no symptoms when the tumour is accidentally discovered. In other cases symptoms due to the disease which gave rise to the cyst may precede its discovery. When the cyst has reached a considerable size there may still be no symptoms, but sometimes attacks of epigastric pain, which may radiate to the left shoulder, occur; they are sometimes accompanied by vomiting, wasting and jaundice. Glycosuria is very rare.

The tumour is generally in the centre of the upper part of the abdomen, but it often extends farther to the left than the right. It does not move on deep respiration, and is only very slightly movable in each direction. As it grows it extends farther down and may finally appear to fill the entire abdomen. It is smooth, rounded and elastic; a thrill is often produced on striking it. A large cyst may push the diaphragm upwards and impede respiration. It may compress the stomach and intestines and cause indigestion and constipation; very rarely it obstructs the common bile-duct and causes jaundice, or obstructs the inferior vena cava and causes œdema of the legs.

Its relation to the stomach and colon can be readily determined by means of the X-rays after a barium meal and enema. It is first behind the stomach, but as it enlarges it generally reaches the anterior abdominal wall between the stomach above and the transverse colon below. Less frequently it comes forward above the stomach or below the transverse colon between

the leaves of the mesocolon. It generally grows very slowly, but sudden enlargement may result from hæmorrhage into it.

Diagnosis.—There ought to be no difficulty in diagnosing a pancreatic cyst from ascites, or from a hydronephrosis, enlarged gall-bladder, ovarian cyst or distended bladder. It is generally impossible to distinguish a true pancreatic cyst from a pseudo-pancreatic cyst; even at an operation the distinction may be impossible. Mesenteric cysts, however, are generally more movable than pancreatic cysts.

Treatment.—The cyst should be emptied and drained by operation. It is never wise to attempt to remove it owing to the dense adhesions which often fix it to its surroundings. The immediate results of operation are very satisfactory, but a recurrence is not uncommon.

MALIGNANT DISEASE OF THE PANCREAS

Ætiology.—Primary carcinoma of the pancreas occurs about three times as frequently as primary carcinoma of the liver, but whereas secondary carcinoma of the liver is very common, secondary carcinoma of the pancreas is three times as rare as the primary disease. In secondary carcinoma the pancreas is generally invaded by direct spread of the growth from the stomach; less frequently a small secondary deposit is found when the primary disease is situated in some distant situation. Both primary and secondary sarcoma are extremely rare.

Cancer of the pancreas occurs three times as frequently in males as in females.

Pathology.—The head of the pancreas is involved in 75 per cent. of cases, in some of which the disease probably originates in the pancreatic or biliary ducts. Cancer of the head of the pancreas obstructs the duct, which becomes dilated and occasionally forms retention cysts. The stasis of the pancreatic secretion frequently leads to chronic pancreatitis, but a pancreatic calculus is rarely present. Secondary deposits are often found in the neighbouring lymphatic glands, the liver and peritoneum, and less often in more distant organs.

Symptoms.—When the head of the pancreas is involved jaundice is generally present owing to pressure on the common bile-duct, but the latter may escape if it is not embedded in the gland. When the growth is confined to the body or tail of the pancreas there is no jaundice unless the duct is compressed by a secondary deposit. The jaundice increases until it is very intense, bile being then completely absent from the fæces. The gall-bladder is almost always distended and is generally palpable; the liver is also generally large and hard. Apart from jaundice, the symptoms are not distinctive, and in its absence a correct diagnosis is rarely made before death. Severe pain is present in most cases. It is generally left-sided and often radiates through to the back. Occasionally attacks of colic occur in the same region, especially at the onset of jaundice. Wasting is rapid in almost all cases, and the patient becomes progressively weaker. Diarrhœa may occur and the stools may have the characteristics described on p. 663.

The tumour is not often palpable, as it is deep-seated and likely to be hidden by the enlarged liver and the ascites, which is present in a third of

the cases as a result of malignant peritonitis or pressure on the portal vein. In thin patients it is, however, sometimes felt just above the umbilicus; it is hard, fixed, and sometimes slightly tender.

Diagnosis.—Unless a tumour can be felt, the diagnosis from chronic jaundice due to primary carcinoma of the common bile-duct is impossible, chronic jaundice with an enlarged gall-bladder being present in both; in primary carcinoma of the ampulla of Vater and of the duodenal surface of the biliary papilla, however, the jaundice may be intermittent, and suppurative cholangitis is a frequent complication. A calculus in the common duct may simulate growth of the pancreas; thus pain is not always present in cases of gall-stones, and colic may occur as an early symptom of a growth. It is generally possible to diagnose gall-stones from the history, and the jaundice is often intermittent instead of steadily progressive. Progressive jaundice with enlargement of the liver and gall-bladder, but with no pain or other symptoms, is generally due to chronic pancreatitis and not to a growth.

Prognosis.—Death generally occurs within 6 months of the onset of symptoms, and is rarely delayed beyond 12 months.

Treatment.—If there is the smallest doubt about the diagnosis in a case of chronic jaundice, an exploratory laparotomy should be advised. If a growth of the pancreas is found, a cholecystenterostomy should be performed in order to relieve the jaundice and thus save the patient from one of the most distressing of his symptoms. Moreover, in numerous instances, permanent recovery has followed this operation when performed for a supposed growth of the pancreas, the surgeon having mistaken chronic pancreatitis for a growth. No operation can be of any use in the absence of jaundice, even in the rare cases in which a correct diagnosis is made.

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VISCEROPTOSIS

Synonym.—Splanchnoptosis, Glénard's Disease, Enteroptosis.

Ætiology and Pathology.—Visceroptosis is most frequently due to a fall in intra-abdominal pressure, caused by weakness of the abdominal and pelvic muscles, the normal tone of which maintains the viscera in position. The tone of the abdominal muscles is often impaired by the stretching which they undergo during pregnancy and as a result of the accumulation of abnormal quantities of subperitoneal and omental fat. After parturition the sudden diminution in the volume of the abdominal contents is so great that a considerable fall in intra-abdominal pressure occurs, as the stretched muscles are at first very lax. If the patient remains in bed for a sufficient period, they gradually regain their tone, and the separated recti come together again, but otherwise they become permanently weakened. Weakness of the abdominal muscles is common among people who take too little exercise. Atrophy and degeneration of the abdominal muscles are also produced by malnutrition in rickets, anæmia and prolonged fevers.

The pelvic floor consists of a muscular diaphragm, which is formed by the levator ani together with other less important muscles. These may be damaged in difficult labour, and a slighter degree of weakness is frequently

present in addition to that of the abdominal muscles in individuals who lead a sedentary life.

When the intra-abdominal pressure is abnormally low, the viscera drop directly gravity comes into play, but at first they regain their normal position as soon as the individual lies down. At a later stage, when the daily descent of the viscera has continued for a considerable time, the displacement persists in the horizontal position.

The degree of ptosis of the different organs depends upon their weight and upon the length and elasticity of their peritoneal attachments, which, in the absence of their natural support, act as true ligaments.

True visceroptosis must be distinguished from the "hyposthenic habitus," a constitutional condition common in women, but comparatively rare in men, which is characterised by a long narrow chest and a small epigastric angle. In this the viscera are congenitally lower than in the average individual owing to the relatively small capacity of the upper part of the abdominal cavity.

Symptoms.—Most of the symptoms of visceroptosis occur only when the erect position is assumed; they consequently disappear on lying down and are absent at night; they are temporarily relieved when the lower part of the abdomen is compressed by means of the hand, and in women they frequently show a steady improvement as pregnancy advances, owing to the rise in intra-abdominal pressure and the support given to the viscera by the growing uterus. They are often worse in the latter part of the day than in the morning owing to the progressive relaxation of the abdominal muscles resulting from fatigue.

The symptoms have been ascribed in turn to the kidney, stomach, intestines or uterus, according to which happened to be the special object of study. It is certain, however, that the general effects are commonly of much more importance than those due to ptosis of individual organs.

Gastroptosis.—Gastroptosis is uncommon, and even when present it is rarely the cause of symptoms. The normal stomach varies greatly in length. In the erect position it swings between the œsophagus, where it passes through the diaphragm, and the junction between the movable duodenal bulb and the descending retro-peritoneal portion of the duodenum. In a stomach of average length the umbilicus (or inter-iliac line) passes about half-way between the lesser and greater curvatures. The greater curvature of the short stomach of the hypersthenic gastric diathesis does not reach the umbilicus. On the other hand, in the long stomach, which is particularly common in individuals with a hyposthenic habitus, the lesser as well as the greater curvature is below the umbilicus, and the latter may reach the true pelvis. This condition has generally been called gastroptosis, but as it is congenital and the stomach has never occupied a higher position the name is quite inappropriate. Moreover, the long stomach is just as competent as a short one or one of average length.

When the abdominal muscles become weak, a long stomach is likely to be more affected than one of ordinary length, and a short one does not drop at all. But the gastroptosis caused in this way does not lead to kinking of the pylorus, as the pyloric end of the stomach together with the first part of the duodenum is surrounded by peritoneum and is freely movable. It may, however, give rise to a kink where the first part of the duodenum joins

the second or descending part, as the latter is situated behind the peritoneum and is normally fixed. Discomfort may then occur, which begins during the meal and reaches its greatest intensity as soon as all the food has been taken. It depends more upon the quantity than the quality of the food, milk producing just as much disturbance as an equal weight of solid food. In most cases, however, the duodenum drops with the stomach, and a considerable degree of gastroptosis may be present with little or no gastric disturbance. It is thus always necessary to note the position of the duodenum as well as that of the stomach during an X-ray examination: if the upper extremity of the duodenum is not at least an inch above the umbilicus duodenal ptosis is present.

After having determined the position of the stomach and duodenum in the erect and horizontal positions, it must next be determined whether the stomach is able to evacuate its contents in a normal manner. If the duodenum drops with the stomach, the passage of food out of the stomach and through the duodenum is generally normal in rate. This is also sometimes the case even if the duodenum has not dropped, but in the majority of cases, especially if the ptosis is well marked, it can be seen with the X-rays that although the food may pass without difficulty from the stomach into the first part of the duodenum, there is delay in the passage beyond this point.

A second examination should be made 6 hours after the opaque meal, no food having been taken in the interval. The patient should not lie down, but should follow his ordinary occupation until the second examination is made. Gastric stasis is present if the stomach still contains food at this second examination. In order to decide whether this is due to the ptosis or to some complication, such as organic obstruction of the pylorus, a second opaque meal should be given on another day, and the patient should lie on his right side in the interval between the two examinations. If the ptosis is the sole cause of the stasis, the stomach will be empty in 6 hours, and if an intermediate examination is made it will probably be found to be already empty in 3 or 4 hours. If there is no delay in the evacuation of the stomach in the erect position, indigestion is not likely to be due to the gastroptosis.

It is important to observe whether voluntary contraction of the abdominal muscles in the erect posture is sufficient to raise the stomach to its normal position, as if this is the case the prognosis is good, and abdominal exercises and massage together with the temporary use of an abdominal support will probably result in a cure. If the stomach cannot be raised to the normal position in this way, the back should be supported by the left hand whilst the lower part of the abdomen is pressed inwards and upwards with the right. In most cases this results in raising the stomach to the normal position, which indicates that an abdominal support is likely to give relief to symptoms, though it will not by itself cure the condition.

ENTEROPTOSIS (COLOPTOSIS).—Ever since Glénard drew attention to the condition he called "enteroptosis," it has generally been supposed to produce kinks of the intestines, especially at the flexures of the colon, which give rise to obstruction to the onward passage of fæces, and a pelvic cæcum and a dropped transverse colon are often referred to as if they were invariably associated with constipation. But I have seen a pelvic cæcum in almost

as large a proportion of strong healthy individuals, especially females, with perfect digestion and no constipation as of constipated patients. If visceroptosis caused obstruction at the intestinal flexures, the constipation would be associated with colic. But although much discomfort is often present in such cases, colic is rare and strong contractions of the intestines are never either visible or palpable. Moreover, chronic organic obstruction leads to hypertrophy of the intestinal musculature above the obstruction, but in operations and autopsies on cases of visceroptosis no hypertrophy is ever found.

The constipation, which is so often associated with visceroptosis, is generally due to the weakness of the abdominal and pelvic muscles and the ptosis of the diaphragm, which render the act of defæcation inefficient, so that the rectum and pelvic colon are never properly emptied. Ptosis of the transverse colon never leads to kinking at the hepatic flexure, as the cæcum and ascending colon drop with it. A definite sharp kink is occasionally produced at the splenic flexure, as the phreno-colic ligament is stronger than any other of the intestinal attachments. A dragging pain together with a sense of distension is then often felt in the left hypochondrium.

It is sometimes possible to recognise the presence of coloptosis by palpation, but accurate knowledge concerning the position of the colon and the passage of fæces through it can only be obtained by the X-rays; they are essential for the recognition of the numerous cases in which coloptosis is only present in the vertical position. It is important to remember that in the vertical position the lowest part of the transverse colon of normal individuals is almost invariably situated well below the umbilicus, even when the stomach is empty, and that in normal individuals examined with the X-rays the hepatic and splenic flexures often appear to be acutely kinked. This is the result of the shadow being cast in a single plane, as the limbs of the flexures belonging to the transverse colon are in front of those of the ascending and descending colon respectively, and the flexures appear to be acute, although they form a wide angle when looked at from the side.

The characteristic bulging of the lower part of the abdomen and retraction of the epigastrium seen on standing is due mainly to ptosis of the small intestine and is of no clinical importance.

Chronic Duodenal Ileus.—The drag of the small intestines in enteroptosis may lead to obstruction of the duodenum where it is crossed by the mesentery with the mesenteric vessels (Fig. 22). In many cases no other evidence of visceroptosis is present. The proximal part of the duodenum becomes dilated, and the violent peristalsis, which can be seen with the X-rays to give rise to backward and forward movement of its contents in its effort to pass the obstruction, results eventually in hypertrophy of its muscular coat. The condition often gives rise to no symptoms and is discovered accidentally during a routine X-ray examination, but it may cause right-sided discomfort, which sometimes simulates duodenal ulcer or gall-bladder disease; occasionally paroxysmal vomiting is the only symptom, especially in neurotic women. The duodenal stasis is probably a factor in the development of duodenal ulcer and of cholecystitis when chronic ileus is present in an individual who is already predisposed to these conditions.

Hepatoptosis.—When the liver drops it rotates towards the right, or less frequently it falls forward so that its upper surface bulges in the

epigastrium. The condition can be recognised by palpation and percussion, the upper border of the hepatic dullness being abnormally low. A palpable liver is not necessarily an enlarged one, but may simply be displaced. It gives rise to no special symptoms beyond a vague pain in the right hypochondrium, which may radiate towards the shoulder; it is increased by jumping, walking and coughing and disappears on lying down. Very rarely the common bile-duct is kinked so that jaundice occurs, and gall-stones may result from the consequent stagnation of bile.

A *dropped spleen* can be easily recognised by palpation; it generally gives rise to no symptoms, but in very rare instances great pain is produced by twisting of its pedicle.

For *nephroptosis*, see p. 1236.

When the pelvic floor is weak, it allows the *pelvic viscera* to drop, and retroflexion of the uterus generally occurs simultaneously; it may also result in actual prolapse of the uterus and rectum.

Downward displacement of the *diaphragm* results in dyspnœa, as, being constantly in the position of extreme inspiration, it is no longer possible for its normal respiratory excursions to occur. This is particularly noticeable in patients with weak hearts, whose abdominal muscles have been stretched by an accumulation of ascitic fluid which has since been absorbed. The downward displacement of the diaphragm is accompanied by a similar displacement of the heart, which gives rise to no special symptoms.

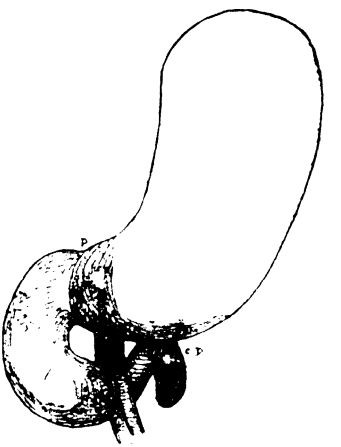


FIG. 22. — Chronic duodenal ileus. DD, dilated duodenum secondary to obstruction by MV, mesenteric vessels; P, pylorus; CD, undilated duodenum beyond obstruction merging into jejunum.

Under normal conditions the abdominal wall and pelvic floor are the only support of the viscera; the peritoneal folds help to maintain them in position, but they do not support their weight. If as a result of weakness of the muscles of the abdominal wall and of the pelvic floor the viscera drop when the individual is erect, a pull is exerted on the peritoneal folds, which become true suspensory ligaments. Their sensory nerves are constantly stimulated, the patient often complaining of vague abdominal discomfort, which is generally described as a weight or pressure or as being of a dragging nature; it is relieved by lying down and by pressure upon the lower part of the abdomen. The discomfort is most marked in neurasthenic individuals owing to the irritability of their nervous system; if the nervous system is healthy it may be completely absent. It is increased by exercise and physical fatigue and to a less extent by mental fatigue. The chronic pain aggravates the nervous depression, a vicious circle being thus produced, but neurasthenia is never a result of visceroptosis alone.

Visceroptosis leads to an alteration in the centre of gravity of the body. In order to maintain the upright position, certain muscles of the spine which

are ordinarily little used are brought into action; this is a frequent cause of chronic backache.

The maintenance of the circulation when the erect position is assumed depends to a considerable extent upon the tonic contraction of the abdominal muscles; when this is deficient, as it is in visceroptosis, the abdominal veins dilate and the pulse becomes abnormally accelerated on standing; giddiness and syncope may also occur.

Treatment.—Much can be done to prevent visceroptosis and the associated constipation in women by proper management of the puerperium. The patient should remain in bed for the first 12 or 14 days after parturition, or, when much bruising has occurred, especially in the case of primiparæ, for as long as 3 or 4 weeks. Most of the time during the first few days after getting up should be spent on a couch, and a return to full physical activity should only be permitted after 6 weeks.

The first indication is to raise the intra-abdominal pressure. In order to do this the condition of the abdominal and pelvic muscles must be improved. Exercise and Swedish gymnastics are of great value. It is essential to prevent the over-stretching of the muscles, which occurs whenever the erect position is assumed, as it is impossible for them to regain their normal postural tone so long as they have to bear the weight of the viscera for the greater part of every day. In many cases, therefore, a support is required until the abdominal muscles have had time to recover.

An abdominal support should fit closely to the symphysis pubis and Poupart's ligaments below; above it should not extend higher than the umbilicus. It should be so made that it presses the abdominal contents upwards, backwards and inwards. In mild cases of visceroptosis in women all that is necessary is a special straight-fronted corset, which does not constrict the waist, but supports the lower part of the abdomen. In most cases, however, a light support, hinged in the middle line and fixed in position by steel springs, which pass over the hips to end in pads applied to the sacrum, is required.

The abdominal support should always be put on when the patient is lying down with the pelvis raised, so that the organs are held in proper position, and it should be worn all day. Not infrequently, however, the X-rays show that the stomach and colon drop on standing almost or quite as far when the support is worn as without it. This is particularly likely to occur in cases in which an organ falls into the true pelvis, as the support does not then reach low enough, and in thin patients upon whom it is impossible to exert sufficient pressure. Such a patient, however, often derives great benefit from wearing a support, although it does not hold the colon or stomach up at all. This shows that it acts chiefly by increasing the intra-abdominal pressure and that many of the symptoms ascribed to kinks are really the result of the low intra-abdominal pressure interfering with the circulation and with the proper performance of defæcation.

When visceroptosis is due in part to weakness of the pelvic floor, this may require treatment by pessaries and local operations, which have the object of restoring the injured parts to a more normal condition, but an exercise for the levator ani muscles is often of great value in such cases. The patient is instructed to perform the movement she would make were she attempting to overcome an urgent desire to defæcate. The exercise should

be repeated about thirty times twice a day while in the recumbent position. I have often seen a tendency to prolapse of the rectum and of the uterus overcome in this way, the associated dyschezia being cured at the same time.

In slight cases of gastroptosis the patient should lie down after meals, but in severe cases, in which there is much emaciation or the abdominal muscles are greatly atrophied, it is best for him to remain in bed for some weeks, as by this means the intra-abdominal pressure is reduced to a minimum, and all tension is removed from the abdominal and pelvic muscles. The foot of the bed should be raised as high as possible, as this helps the organs to return to their proper position, which is often maintained after the patient gets up again, especially if he gains weight during the rest.

He should lie on his right side during and for an hour after meals. He should only sit up to open his bowels and to wash when his stomach is empty before breakfast, and even then a pad should be bandaged over the lower part of the abdomen so that the stomach should not drop. After the complete rest is over he should continue to wear an abdominal support and should at first lie for an hour on his right side after meals.

Small meals should be given at frequent intervals, and food should be chosen which contains a maximum of nourishment in a minimum of bulk. Upward massage is useful, especially if the stomach or colon is low in the horizontal as well as in the vertical position: it is most effective if the masseuse gives her first treatment under the X-ray screen, so that she can see what manipulations are required to bring the stomach and colon back to their normal position.

In no circumstances should any operation be performed for raising dropped viscera. As it is unusual for one organ to drop alone, the effect of such operations is rarely permanent, and the neurasthenic condition of many of the patients makes surgical interference of any kind most undesirable. Short circuiting operations are very rarely required for the purpose of overcoming kinks in the alimentary canal. Gastro-jejunostomy is never followed by any improvement in cases of gastroptosis; in rare cases of severe kinking at the splenic flexure a short-circuiting operation, such as an anastomosis between its limbs, may be required, and the results obtained are generally satisfactory. When chronic duodenal ileus gives rise to definite symptoms, which do not disappear with postural treatment, abdominal exercises and a support, it may be necessary to perform a duodeno-jejunostomy. The results obtained, however, especially in neurotic patients, have not been satisfactory in my experience.

ARTHUR F. HURST.

DISEASES OF THE PERITONEUM

ACUTE PERITONITIS

Definition.—Peritonitis is the disease which results from infection of the peritoneum with bacteria. Owing to the large area of the peritoneum and its great powers of absorption the results are very severe, and because of its intimate relationship to the alimentary canal the risk of such an infection occurring is considerable.

Ætiology.—Infection may reach the peritoneum (1) from without; (2) by the blood stream; and (3) from the contained organs.

1. Infection from without is possible in the case of wounds, but is of infrequent occurrence. In most instances severe abdominal wounds injure the contained viscera also, and the consequent peritonitis is usually the result of this.

2. Infection by the blood stream is an occasional though uncommon mode of infection. In streptococcal and staphylococcal septicæmia peritonitis may occur as a terminal event; it frequently gives rise to such few symptoms, however, that its existence is unrecognised during life. When pneumococcal peritonitis complicates pneumococcal lesions elsewhere the infection is undoubtedly blood borne.

3. Infection from contained or neighbouring organs is by far the commonest cause of peritonitis. The majority of cases depend more or less directly on the passage of bacteria from within the alimentary canal owing to changes in its walls. The appendix is the most frequent seat of the primary condition. When there is no actual breach of continuity in the organ, bacteria escaping through its damaged walls generally lead to the formation of peritoneal adhesions and possibly to a local abscess. When, however, the infection is particularly virulent or the patient's resistance unusually poor, a sufficient local reaction does not take place, and spreading diffuse peritonitis results. This is commoner in children than adults, and may occasionally occur, even when the local reaction has been good, through manipulation or ill-judged surgery separating the adhesions and allowing the infection to spread. Diverticulitis and acute cholecystitis are occasional causes of this type of acute peritonitis, but more usually result in local adhesive changes. Peritonitis complicating typhoid fever in the absence of perforation, and pneumococcal peritonitis when associated with pneumococcal enteritis, have a similar origin.

In intestinal obstruction and strangulated hernia the changes which occur in the bowel wall speedily permit the passage of organisms through it to the peritoneum. This takes place first in the neighbourhood of the obstruction, but as paralysis and distension spread along the bowel, organisms can make their way through, and consequently most cases of this type are widely generalised. The infection, however, is gradual, and the reactive forces of the peritoneum have time to respond. By far the commonest organism in these cases is the *B. coli communis*, usually preceded by or accompanied by the *Staphylococcus epidermidis albus*.

Perforation of a hollow viscus into the peritoneal cavity is responsible for some of the most virulent and widespread cases of peritonitis; the lower the perforation in the bowel, the more virulent the resulting infection will be. The appendix is the commonest source, gangrene or a perforating ulcer leading to a sudden peritoneal infection before any gradual passage of organisms has had time to produce a local peritoneal reaction. Perforating ulcers of the stomach and duodenum come next in order of frequency; less common causes are perforating ulcers of the ileum, the most important of which is the typhoid ulcer, rupture of the gall-bladder, bile-ducts or ureters, and perforating wounds of any of the hollow organs, or leakage from surgical anastomoses. Abscesses of the liver, appendix, gall-bladder or Fallopian tubes occasionally burst into the general peritoneal cavity. Infection of the

peritoneum may also result by direct spread from neighbouring parts. This type of case is particularly common in women, spread taking place either directly through the Fallopian tubes, or by lymphatic permeation of the uterine walls. Peritonitis is a very rare sequel to infections of the lung and pleura, although the reverse is far from unusual. In the infant an infection of the thrombosed umbilical vein may lead to peritonitis by direct spread.

Symptoms.—As acute peritonitis is almost invariably a secondary condition, its symptoms and course are subject to very considerable variations, depending not only on the nature of the primary lesion from which it arises and on the nature and virulence of the infecting organism, but also on the general condition of the patient.

1. *Acute generalised peritonitis.*—This is usually associated with the perforation of a hollow organ or the sudden bursting of an abscess into the peritoneum, and owes its chief characters to the fact that in such cases the peritoneum is suddenly flooded with infection without any preliminary preparation. The patient may have been free from any symptoms of ill-health, and is suddenly seized with very acute abdominal pain, accompanied sometimes by a sensation of something having given way. The pain may at first be localised in position, and thus help in the diagnosis of the actual lesion; but it speedily spreads to the whole abdomen, and is followed almost at once by a feeling of syncope or collapse. Within a few minutes the patient becomes cold and pale; his features are pinched and betray the most intense anxiety; beads of sweat stand out upon the skin, and the pulse may be almost imperceptible. He complains of nausea, but does not often vomit, and his respirations are shallow and quickened. In a short time a certain amount of improvement takes place; the pulse, though rapid, is of better volume, and the pain may take on an intermittent colicky character. The abdomen is absolutely rigid, and is usually retracted, though it may be distended; it is very tender on pressure. The liver dullness is usually absent; but this is only important if an abdominal examination made at the onset of the attack revealed a normal area of dullness. These symptoms are caused by the perforation or other primary cause and the resultant flooding of the peritoneum with infective material. Occasionally they may be sufficiently severe to lead to death by themselves; but more usually they gradually merge into the symptoms of the consequent acute peritonitis itself. The latter are reactive in nature, and are due to Nature's attempts to limit the process.

The patient becomes extremely restless, this being one of the most characteristic and distressing features of nearly all forms of peritonitis. Owing to the loss of fluid by sweating, vomiting and exudation, the subcutaneous tissues become shrunken and give the patient the so-called "facies Hippocratica." The tongue is dry and furred, and the teeth become covered with sordes. The pulse increases in rate and becomes thready and later running in character, and the temperature, which at first may be subnormal, rises. The abdomen is of a uniformly board-like rigidity and extremely tender. It is held immovable, respiration being entirely thoracic, and the patient lies with his knees drawn up to relieve the abdominal tension. There is usually absolute constipation, and the intestinal sounds are absent. Gradually the paralytic intestine becomes dilated and the abdomen distended. Vomiting is early and frequent. The vomited matter is usually only small

in quantity; it speedily becomes exceedingly foul, though it is rarely fæcal, and the breath is extremely offensive. The urine is scanty and may contain traces of albumin, and its passage may produce a paroxysm of pain. It usually contains a large amount of indican.

Throughout the whole course of the disease the outstanding feature is the pain. This may at first be intermittent and colicky; but as the peritonitis develops it becomes constant and agonising, being increased by the smallest movement. In spite of this the restlessness persists, the patient being unable to resist the desire to move his limbs. The pain and restlessness, with the persistent vomiting, the intense thirst, which is hardly relieved by drinking, combine to make the patient's misery extreme. The pulse increases in rapidity until it can scarcely be counted, the extremities become cold, the eyes grow more sunken, and the features more pinched. As death approaches, the skin takes on a cyanotic hue; the persistent restlessness, the increasing voicelessness, and the remorselessly unimpaired consciousness bring death as a merciful release, even though the pain may be somewhat relieved towards the end.

The foregoing description applies to an acute fulminant case of peritonitis, running its course to death in from 24 to 48 hours; its outstanding features are a condition of profound shock and toxæmia, giving a measure of the high grade of peritoneal absorption. In the aged, and in patients with tabes or Bright's disease, the symptoms may be very atypical; pain may be but little marked, and vomiting and tenderness may be absent, while the bowels may act freely throughout. The striking restlessness, the condition of the tongue, the pulse and the ultimate meteorism will, however, usually indicate the true nature of the condition.

2. *Acute spreading peritonitis.*—This variety differs from the preceding in that the peritoneum is not suddenly flooded with infective material, but is prepared for infection by the more or less gradual spread of the condition. It accompanies many cases of appendicitis, and is a sequel of intestinal obstruction if unrelieved for a sufficiently long period. The peritoneal reaction is intense, and the coils of intestine become glued together with a sticky exudate, while pockets of pus form between them. If surgical interference is not undertaken these cases may progress for weeks. The pain is at first localised to the region of origin; but as the infection spreads it extends until it may become generalised over the whole abdomen. It is, however, never so intense as in the preceding variety, and may be distinctly spasmodic in character. The general abdominal symptoms are also less severe, the tenderness, rigidity, meteorism and constipation being of varying grade. The aspect of the patient betokens a profound septic infection, the tongue is furred and dry, the pulse rapid, and the temperature of the hectic type. Rigors and sweats are not uncommon, and if left alone the case may terminate with fatal septicæmia, suppurative pylephlebitis, or in rare cases the pus may accumulate and burst either externally in the region of the umbilicus or into one of the hollow viscera.

3. *Pneumococcal peritonitis.*—This presents certain fairly characteristic features, which in many cases enable the nature of the infection to be correctly diagnosed from the clinical picture alone. It is far more frequent in children than in adults, and in girls than boys in the proportion of nearly 7 to 3. It occurs in a diffuse and an encysted form, depending probably on

the resistance of the patient. In many cases there exists a definite pneumococcal enteritis, the organisms penetrating the wall of the bowel and so infecting the peritoneum. The predominance of the disease in girls is probably due to the female genitals being a source of infection, as the pneumococcus has been cultivated from the vagina in some instances. In the majority of cases, however, the peritonitis is part of a pneumococcal septicæmia; thus, when it is secondary to pneumococcal disease of the middle ear, local pneumococcal abscesses or pneumococcal arthritis, the blood stream appears to be the source of infection, and it probably is so also in those cases which follow pneumonia or empyema, since the physics of the upper abdomen renders a direct spread through the diaphragm unlikely.

There is a striking resemblance between the symptoms of most forms of pneumococcal infection, a resemblance which strongly supports the view of their origin in a septicæmia. The onset is usually sudden, often accompanied by a chill and a high temperature, the pain is violent and persistent, and the prostration severe. The patient has the characteristic flush, the respiratory rate is raised, and the accessory muscles of respiration are called into play. Vomiting is frequent, and tenderness and rigidity are marked; but in place of the usual absolute constipation there is frequently profuse diarrhœa, which, associated with the other symptoms of acute peritonitis, is often almost diagnostic. In the diffuse form, unless operation is undertaken, death takes place early; but if the patient lives long enough there may be a sudden fall of temperature about the seventh day, as in pneumococcal pneumonia.

The encysted and more common variety of pneumococcal peritonitis is less severe, and shows a remarkable tendency for pus to collect in the lower abdomen. There is the same acute onset as in the diffuse variety; but the patient then appears to improve for a few days. Later, however, he gets gradually worse, the abdomen becomes distended, the diarrhœa changes to obstinate constipation, and an abscess forms in the lower abdomen and finally bursts at the umbilicus. The exudate in these cases is a greenish, odourless pus, which is sufficiently characteristic to enable the infection to be diagnosed when it is discovered at operation.

4. *Gonococcal peritonitis.*—Gonococcal peritonitis is rare; it occurs both as an acute diffuse affection of the peritoneum and as a localised pelvic inflammation. It is commoner in females than in males, owing to the ready channel for infection through the Fallopian tubes, and when it occurs in males it is usually secondary to epididymitis. The infection is generally a mixed one, the more fragile gonococcus being readily overgrown, and some cases of unexplained peritonitis, which on culture show only *B. coli*, are possibly gonococcal in origin. The symptoms do not differ in the diffuse cases from those of other forms of acute peritonitis, although the primary focus usually gives rise to symptoms. The prognosis is, however, good, and the majority of cases, even those presenting severe symptoms, recover without operation.

5 *Streptococcal peritonitis.*—Peritonitis due to the *Streptococcus pyogenes longus* is occasionally secondary to lesions of the alimentary canal; but much more frequently it is a sequel of puerperal infections. It occurs commonly after a first delivery, and is frequently associated with retained products.

Infection takes place along the lymphatics of the damaged uterus or through the Fallopian tubes, and may be localised in the pelvis; but it often gives rise to generalised peritonitis. The symptoms are characteristic, and are associated with evidence of a marked septicæmia. The abdominal walls, being already greatly stretched, do not show the usual rigidity, and extreme distension occurs rapidly. Diarrhœa is commoner than constipation, and a high temperature with rigors is usual. The uterine discharges are offensive, the milk secretion is suppressed, and the cases frequently progress to death within the first week. This type of infection is more fulminant than any other, except certain cases of perforative peritonitis.

Diagnosis.—The diagnosis of acute peritonitis is not usually difficult, except in cases where the severity of the causal condition is so great that it masks the peritoneal response, or where the peritonitis occurs in a patient already so severely ill that no response is possible. It is often extremely difficult to make a correct diagnosis of the lesion to which the peritonitis is secondary, and in many cases this is only possible after laparotomy. The most valuable signs of acute peritonitis are the severe pain and tenderness, the rigid abdomen, the small, rapid, and thready pulse, the dry tongue, the restlessness, vomiting, and constipation, and the absence of sounds of gurgling on auscultation. Any of these symptoms may, however, be absent, and a diagnosis must be based on their occurrence in combination. In post-operative cases there is sometimes a remarkable absence of both pain and rigidity, and the all-important early recognition of the condition in these patients is often one of much difficulty.

Peritonitis is most likely to be mistaken for lead colic or acute intestinal obstruction. From the former it can be distinguished by the fact that the abdomen in peritonitis is usually extremely tender, while in colic pressure often, though not invariably, relieves the pain; in colic a blue line is present, and the red corpuscles show punctate basophilia, the pain is intermittent, and there is usually no vomiting and less extreme rigidity. From acute intestinal obstruction the diagnosis is often far more difficult, particularly since the two conditions frequently coexist. In the early stages of obstruction, before peritonitis has developed, the intermittent nature of the pain, the absence of great tenderness or rigidity, the copious nature of the vomit, and the evidence of increased peristalsis from inspection or auscultation should help to distinguish the two conditions.

In acute pancreatitis the pain is more definitely hypogastric, the patient is usually over middle age, and collapse is extreme. The menstrual history, the typical pallor, and the results of vaginal examination usually serve to indicate a ruptured tubal pregnancy, and in other acutely painful abdominal conditions the localised nature of the pain and the absence of any extreme general tenderness help to distinguish the condition from peritonitis.

The gastric crises of tabes are seldom likely to be a source of error; but the comparative absence of severe symptoms in tabetics, the subjects of peritonitis, is very apt to lead to a mistaken diagnosis.

Basal pneumonia and diaphragmatic pleurisy may lead to acute abdominal symptoms. The temperature and pulse, the raised respiration rate, and a routine examination of the thorax in all cases should prevent a mistake being made.

Prognosis.—The prognosis of acute peritonitis is always grave, even

with early surgical treatment. Without operation no case of acute perforative peritonitis can be expected to recover; such exceptions as have been recorded must be regarded as medical curiosities. Under these conditions death generally takes place within 48 hours, though it may be delayed a week or even longer when the perforation is high in the bowel and the latter is empty at the time.

In diffuse spreading peritonitis and streptococcal puerperal infections death is almost as invariable, unless operation is undertaken; but the process is less rapid, and a small proportion of cases undoubtedly recover without surgical aid. These cases occasionally merge into a form of chronic fibropurulent peritonitis, characterised by the progressive formation of collections of pus between neighbouring viscera, and by repeated outbursts of symptoms as other parts of the peritoneum become successively involved. This condition usually terminates in fatal septicæmia, with infections in the pleura, pericardium or endocardium. The prognosis in pneumococcal cases is considerably better, as, even without operation, a fair proportion recover, either with or without the formation of a hypogastric purulent collection, which may discharge at the umbilicus. In the rare gonococcal cases recovery is the rule, and the fatal cases recorded have almost invariably followed operation.

In forming a prognosis the chief importance must be placed on the degree of toxæmia and the severity of the intestinal paralysis, and to a less extent on the degree of meteorism and the frequency of the vomiting. Spontaneous bowel actions or their induction by enemata make the peritonitis relatively more favourable.

The rate of rise of the pulse and its ratio to the temperature are also of importance; cases with a subnormal temperature throughout are almost always rapidly fatal.

Treatment.—The principles that must underlie the successful treatment of acute peritonitis are, firstly, the removal or limitation of the process to which the peritonitis is secondary by a thorough and speedy exploration of the abdomen, followed by closure of a perforation, removal of an appendix, or such other measures as the pathology present may indicate; secondly, drainage and relief of tension in the peritoneal cavity; thirdly, the encouragement of the normal peritoneal response and the least possible damage to its protective agencies; and, fourthly, the combating of the shock and toxæmia.

By the adoption of the Fowler position, in which the patient is propped up in bed in a sitting position, not only is infective material removed from the dangerous diaphragmatic area and brought into contact with the much more highly resistant pelvic peritoneum, but at the same time the diaphragm is relieved from the pressure of the dilated stomach and intestines.

A further important adjunct to surgical treatment is the subcutaneous injection of large quantities of saline solution. This raises the blood pressure and redresses the fluid depletion which has taken place, and, being excreted by the peritoneum, it reverses to a certain extent the lymphatic circulation, and consequently largely prevents the absorption of toxic material as well as dilutes that already present.

Until a definite diagnosis has been made and operation advised and agreed to, the administration of opium in any form is definitely contra-indicated. It masks the symptoms, and by bringing to the patient and his

advisers a false sense of security may lead to a fatal delay in undertaking the operation. When, however, a diagnosis has been made, and operation is agreed to, morphine is beneficial in reducing both the mental and physical symptoms, while the necessary preparations are being made. The aperient method of treatment was introduced with the object of preventing the onset of intestinal paralysis and in order to eliminate as far as possible toxic material by the bowel. The great objection to it, however, is the fact that in practically no case is the peritoneal infection absolutely general, at any rate at first, and consequently there is a danger of spreading infection by means of increased peristalsis, while it is doubtful to what extent purgation prevents intestinal paralysis if the toxæmia is considerable. The exact opposite line of treatment has been the one adopted more and more of recent years, morphine being given deliberately and in doses sufficient to affect the respiration rate with the object of diminishing the activity of peristalsis, as well as of combating the shock, pain and restlessness, which help so largely to exhaust the patient's powers of resistance. It is very doubtful whether it ever prevents the response of the bowels to enemata in cases in which they would otherwise respond. If vomiting is a prominent symptom, lavage of the stomach is of value. It should, if possible, always be done before operation, as post-anæsthetic vomiting of fæcal material is a fruitful cause of fatal broncho-pneumonia.

In pneumococcal cases there is not quite the same urgency for operation, and it is sometimes justifiable to wait for a time in the hope of localisation. In gonococcal peritonitis, if a diagnosis can be made, conservative treatment should be followed; but if there is doubt, as there often must be, of the nature of the infection, or if the patient shows any increase of symptoms, laparotomy is the only safe course to follow.

E. G. Slesinger.

CHRONIC PERITONITIS

(*a*) Localised Chronic Peritonitis; Peritoneal Adhesions

Ætiology and Pathology.—Inflammation of the appendix and operations on the appendix, especially if followed by drainage, lead to the formation of adhesions in the neighbourhood. Adhesions near the hepatic flexure are often due to cholecystitis, which may be associated with gall-stones, and somewhat less commonly to a subacute or acute perforation of a duodenal and rarely of a gastric ulcer. Pelvic peritonitis, which is a common sequel of disease of the female genital organs, often involves the pelvic colon, and occasionally the cæcum and appendix; and tuberculous peritonitis is an important cause of local and generalised intestinal adhesions. Inflammation of the mucous membrane of the colon sometimes spreads to the surrounding peritoneum and leads to adhesions. Dense adhesions are also caused by diverticulitis, especially of the iliac and pelvic colon. In many cases, however, bands are found which differ in structure and anatomical relations from these inflammatory adhesions; they are most probably of congenital origin, but perhaps they persist and become thickened and altered as a result of mechanical factors. A membrane, the ileo-pelvic band, may pass from the

under surface of the mesentery of the end of the ileum to the under surface of the ileum itself, round which it passes to the point immediately opposite to the mesenteric attachment; it may involve the whole or part of the appendix. A veil-like membrane, known as Jackson's membrane, may pass from the parietal peritoneum at the outer side of the ascending colon and blend with the peritoneum over its anterior surface or extend to the great omentum. On dividing it, peritoneum is found beneath, but it often adheres to the anterior and lateral aspects of the bowel, so that the outer surface of the cæcum and ascending colon come to be connected with the postero-lateral abdominal wall by membranous bands.

These adhesions are often supposed to form kinks and obstruct the lumen of the bowel. Thus adhesions in connection with the end of the ileum are said to cause kinking ("Lane's ileal kink") and ileal stasis. There is, however, no evidence that any connection exists between Lane's ileal kink and ileal stasis, as structural abnormalities found at operation are no proof that functional abnormalities coexist, and the improvement which follows simple division of bands in connection with the end of the ileum is so inconstant that the operation is now rarely performed. The obstruction offered by an ileal kink is hardly ever as great as that offered by the normal ileo-cæcal sphincter 3 inches farther on. Nothing short of almost complete stenosis could lead to stasis of any importance, as the contents of the ileum are always so fluid that they can pass through a very narrow passage without difficulty.

If the adhesions caused obstruction they would lead to hypertrophy of the colon immediately behind the obstruction, but the bowel is unusually thin and translucent in the majority of cases. There is, however, no doubt that in exceptional cases localised adhesions give rise to partial obstruction, particularly in the more distal parts of the colon, the contents of which are hard, and therefore more easily held back by a slight narrowing in the intestinal lumen. In the more proximal parts, such as the hepatic flexure, adhesions can only cause any considerable degree of stasis if they give rise, as they doubtless not infrequently do, to a local spasm of the circular muscle-fibres of the intestine, except in the very unusual cases in which they produce a narrow stricture. Spasmodic strictures of this sort are intermittent, and the obstruction to which they give rise may be more or less overcome by anti-spasmodic drugs.

Symptoms.—When the symptoms point to the presence of stasis in one particular part of the bowel, especially if there is local tenderness and pain, which is increased when the intestinal movements are active after meals or during defæcation, the possibility of adhesions should be considered Their presence is rendered more likely if there is a history of some inflammatory disease, which could have led to their development; but as adhesions are often present in the absence of such a history, an X-ray examination is essential. It is, however, important to remember that severe local stasis often occurs without any organic cause, so that radiograms alone can give no aid in diagnosis, palpation under the screen being always necessary in order to determine the mobility of the bowel.

The end of the ileum, as it rises from the pelvis to join the cæcum, bends in various directions; as the shadow on the screen is in one plane only, it is natural that it often appears as if it formed one or more acute angles or kinks;

by palpating the abdomen during the examination, especially after inflation of the colon with air in order to raise the terminal ileum out of the pelvis, it is easy to demonstrate that most of these "kinks" are only apparent. By manipulation of the abdomen during the screen examination it should be possible to separate from each other the limbs of the hepatic flexure and of the splenic flexure; if this cannot be done it may be presumed that they are bound together by adhesions.

Adhesions in connection with the pelvic colon can be recognised by palpation after an opaque enema; but a sigmoidoscopic examination should also be made.

Local intestinal adhesions occasionally give rise to so much congestion of the mucous membrane that occult blood may be constantly present in the stools and a growth of the colon may consequently be simulated.

Treatment.—In many cases considerable relief follows the administration of paraffin to render the stools soft, and the use of belladonna in small doses to prevent the intestinal spasm, which may increase obstruction and lead to colic. A diet which leaves a minimum of indigestible and irritating material but contains sufficient chemical stimulants of intestinal activity should be given. Abdominal massage is also often of use; and if the abdominal walls are weak, exercises to strengthen them and a suitable support help to prevent dragging upon adhesions.

Operative treatment is very unsatisfactory, as whatever care is taken, there is always a danger of recurrence of the adhesions. Only when they are very localised and lead to definite obstruction at one or more points is it clearly necessary to divide the adhesions and take steps to prevent their recurrence.

(*b*) Diffuse Chronic Peritonitis; Perihepatitis

Diffuse chronic peritonitis is the condition in which chronic progressive inflammation of the peritoneum occurs independently of tuberculous or malignant disease. The peritoneal covering of the liver is often the part most involved, and the condition has therefore been called perihepatitis; but, as the ascites is just as much due to inflammation of other parts of the peritoneum, this name is not very appropriate.

Ætiology.—1. Chronic peritonitis may be associated with chronic inflammatory changes in the thorax. Effusion may occur from all the serous membranes (polyorrhomenitis, polyserositis, or Concato's disease); this condition is probably in most cases tuberculous. In other cases chronic peritonitis is associated with chronic mediastinitis, adherent pericardium and pleural adhesions; the disease may apparently start either above or below the diaphragm. The peritoneum covering the liver and spleen is generally most involved.

2. In many cases of chronic peritonitis the kidneys are granular and the arteries thickened, the renal condition being probably primary.

3. Simple chronic peritonitis may be a widespread process of obscure origin, or it may start from local infection in connection with a gastric or duodenal ulcer or cholecystitis. In the absence of such sources of infection it may be associated with chronic gastro-enteritis caused by alcoholism. Ascites caused by cirrhosis of the liver, heart failure or renal disease may lead

to secondary peritonitis, especially after repeated tapping, probably owing to the irritant action of toxins present in the fluid.

4. *Chronic syphilitic peritonitis.* Very rarely a positive Wassermann reaction can be obtained from the blood serum and ascitic fluid of patients with cirrhosis and ascites. In these cases anti-syphilitic treatment may lead to considerable improvement and disappearance of the ascites.

Pathology.—The liver may be covered with a thick, hard and white coating of fibrous tissue, which can be peeled off to expose the smooth peritoneal surface. Perihepatitis is almost always associated with a similar thickening of the capsule of the spleen and with thickening of other parts of the peritoneum. The great omentum may be rolled into a hard cord, and the mesentery may be thick and short so that the intestines are tethered to the posterior wall of the abdominal cavity.

Symptoms.—The only important symptom is ascites. Its onset is generally gradual, but it may be acute. Frequent tapping is required, and the intervals between the performance of paracentesis tend to diminish and may finally be as short as a fortnight, when as much as a pint of fluid may be poured into the peritoneal cavity in a day. In exceptional cases paracentesis has been performed over a hundred times.

The liver is generally normal in size, but it may be enlarged at first and become smaller later. If the liver is palpable, its thick edge is felt just under the costal margin. It may be recognised as being bent either outwards or inwards. The spleen is not often enlarged, except in young patients.

Jaundice is almost invariably absent. Œdema, especially of the feet, is frequent in the late stages; it is generally cardiac or renal in origin, but may also be due to pressure on the inferior vena cava. The urine is diminished in quantity, and there may be evidence of granular kidney.

Course.—The course of the disease is very slow, death occurring between 2 and 16 years from the onset of the symptoms, generally from some intercurrent disease. The general health may remain good for a long time. The patient becomes weak and emaciated, but no symptoms of hepatic insufficiency occur. In cases associated with granular kidney, death is due to heart failure.

For the diagnosis and treatment, see Ascites (p. 693).

TUBERCULOUS PERITONITIS

Ætiology.—The peritoneum is involved in 15 per cent. of fatal cases of tuberculosis. Tuberculous peritonitis is rare in infants, and uncommon after 30; the majority of cases occur between the ages of 3 and 20. Boys and girls are equally liable to the disease; it is found much more frequently in women than men at operations, but more frequently in men than in women after death.

Primary tuberculous peritonitis is uncommon in children and rare in adults. It is probably due to infection conveyed by the intestines, which do not themselves become infected, primary tuberculosis of the intestines being rare at all ages. More often, especially in children, the mesenteric glands become tuberculous, generally without any lesion developing in the intestines, and the peritoneum is infected from the glands. In males the

primary focus may be the prostate, vesiculæ seminales or testes, and in females the disease frequently begins in the Fallopian tubes; but the latter may also be infected from the peritoneum. Although tuberculous ulcers are found in 75 per cent. of fatal cases of pulmonary tuberculosis, the peritoneum is only involved in 4 per cent. of cases. The peritoneum, the pleura, and occasionally the pericardium, may be involved together in the absence of any other tuberculous focus. Tuberculous peritonitis is found in 9 per cent. of fatal cases of cirrhosis of the liver; this is partly due to the liability to tuberculosis of individuals whose resistance has been lowered by chronic alcoholic poisoning, the localisation in the peritoneum being due to the portal obstruction and chronic intestinal catarrh.

Pathology.—Tuberculous peritonitis may occur in three forms—the ascitic, loculated and obliterative.

1. In the ascitic form, which may be acute, subacute or chronic, miliary tubercles are scattered over the whole peritoneum, which is free or nearly free from adhesions. In chronic cases the tubercles are larger and more fibrotic than in the acute; the peritoneum is thickened; the mesentery is shortened so that the intestines are tethered to the posterior abdominal wall. This form may closely resemble malignant peritonitis.

2. In loculated tuberculous peritonitis the fluid may be clear, the condition being then intermediate between the ascitic and obliterative forms, or it may be turbid or purulent. In the latter case masses of tuberculous material, separated from each other by adherent coils of intestine, have broken down to form suppurating foci, which may erode the intestine or open at the umbilicus or even into the vagina.

3. Chronic obliterative, adhesive, or fibrous tuberculous peritonitis may result after absorption of fluid in the ascitic form or may develop primarily. No effusion is present, but universal adhesions obliterate the lumen of the peritoneum, all the viscera being inextricably bound together and to the parietal peritoneum.

In each form of tuberculous peritonitis the mesenteric glands are generally caseous and may break down in the centre; the mediastinal glands may also become tuberculous. The omentum is often rolled into a solid mass, which sometimes contains caseous nodules.

Symptoms.—Tuberculous peritonitis is sometimes completely latent, and may be discovered accidentally during an operation for some independent disease or for a hernia, when the sac may be the only part involved.

The onset of abdominal symptoms is generally preceded by a period of ill-health; the patient loses weight and strength, his appetite is poor, and his temperature may rise slightly at night. After a time he complains of general abdominal discomfort. Nausea and vomiting are rare. Constipation is common, especially in the obliterative form. In other cases diarrhœa may occur, owing to tuberculous ulceration of the intestines, fistulous communications between adjacent coils of intestines or simple entero-colitis. The stools are sometimes bulky owing to deficient absorption of fat caused by obstruction of the lacteals by caseous mesenteric glands (*vide* p. 572). The spleen and less often the liver may be enlarged. The skin, especially over the abdomen, is dry, inelastic and sometimes so pigmented that Addison's disease is simulated. In chronic cases there is sometimes no pyrexia; more often the temperature is intermittently slightly raised. In acute and sup-

purative cases the temperature is generally high and irregular, and the pulse is rapid. The urine is often concentrated, especially in ascitic cases, and traces of albumin may be found, owing to the pressure on the renal veins caused by a large accumulation of fluid in the abdomen or to the effect of the toxæmia on the renal cells. A moderate degree of anæmia is often present, and leucocytosis develops if suppuration occurs.

In the ascitic form the abdomen gradually becomes distended; at first it is tympanitic, but after a time evidence of the presence of free fluid is obtained, but the quantity is not often very great. Less frequently a large amount of fluid collects with great rapidity; the sudden stretching of the abdominal muscles is likely to cause a considerable amount of pain. Moderate tenderness of the whole abdomen is generally present. A large accumulation of fluid may compress the inferior vena cava and give rise to œdema of the legs; the diaphragm is pushed upwards and respiration becomes shallow and thoracic. The skin over the abdomen is shiny and the veins are enlarged. The ascitic fluid is generally clear; it contains a large proportion of lymphocytes and often coagulates on standing; less frequently it is turbid or blood-stained. Tubercle bacilli are rarely found in the effusion, although they must be present, as the fluid produces tuberculosis when injected into guinea-pigs.

In the loculated form with suppuration the abdominal pain is generally greater; attacks of colic are common, especially after exercise. The abdomen is distended and doughy; on percussion, irregular tympanitic and dull areas are found. Large caseous glands and collections of pus between adherent coils of intestines may form palpable masses, which are immobile, tender and dull on percussion. The omentum can often be recognised as a thick cord stretching across the upper part of the abdomen; the transverse colon generally forms a resonant band immediately above it, which helps to distinguish it from the lower edge of an irregularly enlarged liver. The ease with which the masses are felt varies from time to time with the amount of flatulent distension of the intestines. When an abscess is about to point at the umbilicus, the latter becomes indurated, red and tender; a similar condition is occasionally observed in pneumococcal peritonitis and in pelvic peritonitis in women. On rectal and vaginal examination thickened Fallopian tubes, enlarged glands or collections of pus may be felt.

The signs of obliterative tuberculous peritonitis are ill-defined; the abdomen gives a characteristic rubbery resistance on palpation and is generally somewhat distended. Irregular masses may be felt in it, and the peristaltic waves of the small intestines are often visible, especially in children. This does not necessarily indicate that partial obstruction is present, as it may be simply due to the adhesion of the intestines to the abnormally thin abdominal wall.

Symptoms of tuberculous disease of other organs, especially of the lungs, pleura, intestines and Fallopian tubes are often present. Generalised tuberculosis may develop at any time, especially in children; vomiting and constipation, which suggest intestinal obstruction, may be the first symptoms of tuberculous meningitis.

In very rare cases acute peritonitis may develop as a result of rupture of a softened caseous gland or perforation of a tuberculous ulcer.

When a patient recovers from tuberculous peritonitis, the tubercles and

adhesions may completely disappear. More frequently localised adhesions remain, and calcified tuberculous mesenteric glands are often found at operations and after death. They may give rise to confusion when the abdomen is X-rayed on account of suspected renal calculi. In a very small proportion of cases the bands, which sometimes form from localised adhesions, may cause acute intestinal obstruction, even years after the active disease has disappeared.

Diagnosis.—In the presence of tuberculous disease of the lungs or other organs, abdominal distension, especially if associated with ascites or irregular abdominal masses, generally indicates that tuberculous peritonitis is present. The discovery of tubercle bacilli in the sputum, and their much less common discovery in the fæces or vaginal discharge, is very strong confirmatory evidence. Ascites in children, and in females with symptoms pointing to tuberculous salpingitis, is generally due to tuberculous peritonitis.

Acute cases may at first closely simulate pneumococcal peritonitis or even appendicitis; but in non-tuberculous inflammatory exudates of the peritoneum most of the cells are polymorphonuclear leucocytes instead of lymphocytes. Ascites due to cirrhosis of the liver in children is almost always mistaken for tuberculous peritonitis; on the other hand, the ascitic form of tuberculous peritonitis in middle-aged alcoholic individuals is likely to be mistaken for ascites due to cirrhosis. When cirrhosis is undoubtedly present, ascites may still be due in part to tuberculous peritonitis; a large proportion of lymphocytes in the fluid is very strong evidence in favour of this, as the ascitic fluid in uncomplicated cirrhosis contains few except endothelial cells. In simple chronic peritonitis there is no fever and little or no pain, and the ascitic fluid contains few if any lymphocytes. The presence of irregular masses, together with fluid in the abdomen, generally indicates tuberculous peritonitis in children; but it is more frequently due to malignant disease in adults, especially in males. The history of the case and any evidence of tuberculous or of malignant disease in other parts of the body help to settle the diagnosis.

Fever, inflammation of the umbilicus, and the presence of lymphocytes in the ascitic fluid point to tuberculosis, whilst nodular infiltration without inflammation of the umbilicus, hard and enlarged glands in the groin or neck, and the presence of large, multinuclear cells or groups of cells in the effusion point to cancer.

A localised collection of fluid may be mistaken for an ovarian cyst, or, if it is in the pelvis, for a hydro- or pyosalpinx, especially if it is associated with tuberculosis of a Fallopian tube; but it forms a less defined tumour than in these conditions.

Prognosis.—Recovery takes place in a large proportion of cases of the ascitic form of tuberculous peritonitis. When localised abscesses develop complete recovery is rare, and when a fæcal fistula forms death almost always follows. Prolonged fever, rapid emaciation and intractable diarrhœa are the most serious symptoms. The prognosis also depends on the severity of any tuberculous disease of the lungs or other organs which may be present. Apparent recovery is sometimes followed by a relapse, generally owing to reinfection from an unhealed primary focus, such as a tuberculous gland, appendix or Fallopian tube.

Treatment.—The patient should be kept in bed so long as the temperature

is raised. He should be in the open air all day and night when the weather permits, and if indoors an abundant supply of fresh air is essential. Heliotherapy or artificial sunlight should be employed, but care must be taken to avoid over-exposure. The mercurial ointment, which is often applied on a binder to the abdomen, is probably quite valueless. Diarrhœa should be treated by a non-irritating diet, and in intractable cases by opium preparations. If chylous diarrhœa is present, fat must be excluded from the diet. With this exception, the food should be as abundant and nourishing as possible. Tuberculin has been much employed, but I am not convinced that it is of any use.

The improvement, which often results from allowing the fluid to escape in ascitic cases, is probably caused by flushing the peritoneum with a new exudation of fluid richer in anti-tuberculous substances than that which was allowed to escape. This result can be obtained by simple paracentesis; but an operation has the advantage of making it possible to remove the primary focus, such as a tuberculous gland, a tuberculous appendix with the infected ileo-cæcal glands, or a tuberculous Fallopian tube. All ascitic cases, which do not improve in 3 months with general treatment, or which get worse instead of better, should therefore be subjected to operation, particularly if there is any evidence pointing to the presence of localised tuberculous disease which might be removed.

Operation should never be performed in obliterative peritonitis, in infants less than a year old, or in the presence of extensive tuberculous disease elsewhere. The occurrence of intestinal obstruction is an indication for operation, though it is rarely possible to do anything useful owing to the extensive adhesions present and the danger of tearing the intestines.

PERITONEAL CYSTS

(*a*) *Hydatids.*—The peritoneum is involved in 1·4 per cent. of cases of hydatid disease. Nearly all cases are secondary, enormous numbers of cysts developing as a result of rupture or leakage of a hydatid of the liver. The cysts grow slowly, and are rarely of sufficient size to give rise to symptoms until two years have elapsed since the primary cysts ruptured.

Hydatid cysts cause a gradual enlargement of the abdomen, which may be diffuse, or separate cysts may be recognised by inspection and by palpation. They are movable, and do not appear to be connected with any definite organ. Symptoms may result from pressure on the stomach, intestines, diaphragm, inferior vena cava, and—in the case of pelvic hydatids—the ureters, bladder and rectum. Single hydatids are generally mistaken for ovarian cysts; but the presence of multiple cystic tumours should suggest the possibility of hydatid disease, which would be confirmed by the presence of eosinophilia, or by the history of a primary cyst in the liver.

(*b*) *Dermoid cysts* may originate in the mesentery or omentum, especially in women. Ovarian dermoids may also become detached and adhere to any part of the peritoneum, or they may rupture and multiple cysts result from implantation.

(*c*) *Mesenteric cysts.*—Apart from dermoids and hydatids, cysts may develop in the mesentery or omentum. They may be derived from the dila-

tation of lymph spaces, and be filled with clear, chylous or hæmorrhagic fluid. Mesenteric cysts, lined with endothelium, arise from the distension of shut-in peritoneal pouches with serous fluid. Cysts may project from the free border of the intestine, or grow from its attached border between the layers of the mesentery.

Mesenteric cysts form definite, round, tense tumours, which are generally situated to the right of the middle line and a little below the umbilicus. They are dull on percussion; but, if attached to the intestines, the latter may form a resonant band around them. They may give rise to colic and vomiting, and in rare cases to acute intestinal obstruction.

CANCER OF THE PERITONEUM; MALIGNANT PERITONITIS

Ætiology.—Cancer of the peritoneum is almost always secondary. The primary disease is generally in the abdomen, especially the stomach and the ovary, the peritoneum becoming involved by spread along lymphatics or blood vessels, by direct contact, or most commonly by malignant cells being set free and scattered widely over the peritoneum. The disease may also spread from cancer of the breast by the deep lymphatics of the chest and abdominal wall, and by lymphatics from malignant disease of the testis.

Pathology.—Malignant deposits may be minute tubercles, or they may form larger white non-caseating nodules or even very large masses. The parts most generally involved are the omentum, mesentery and pelvis. Chronic fibrotic changes frequently occur, and result in the omentum being rolled up and the mesentery shortened as in tuberculous peritonitis. The diaphragm is often invaded with growth, which spreads to one or both pleuræ. Acute or subacute peritonitis may occur.

Symptoms.—The symptoms are due in part to the primary disease and in part to the secondary malignant peritonitis. As the former is generally situated in the abdomen, it is impossible to distinguish between the symptoms due to the two causes. Malignant peritonitis generally results in ascites; the fluid is clear or turbid, hæmorrhagic, chyliform, or less frequently chylous owing to obstruction and subsequent rupture of lacteals. The umbilicus is often infiltrated with growth, and nodules may be felt along the falciform ligament. Tumours are often felt in the abdomen or on rectal examination; they are sometimes too small to be palpable, and in other cases they can only be felt after the fluid has been removed. The rolled-up omentum can often be recognised as a thick transverse cord above the umbilicus. The malignant masses or peritoneal adhesions may give rise to obstructive symptoms.

Diagnosis.—The development of new abdominal tumours or ascites in a patient who is known to have cancer of the stomach or other organ is conclusive evidence that the peritoneum is involved. When there is no clear evidence pointing to the presence of a primary malignant or tuberculous focus, it may be difficult to distinguish between tuberculous and malignant peritonitis (see p. 690). When ascites is present and no tumour is palpable, cirrhosis, simple chronic peritonitis or portal thrombosis may be simulated; the abdomen should be tapped, when a tumour often becomes palpable if malignant disease is present.

Prognosis and Treatment.—It is rare for the patient to survive for

more than 6 months after the peritoneum becomes involved. Treatment is purely palliative. Considerable relief may follow paracentesis.

ASCITES

Definition.—Ascites is the accumulation of free fluid in the peritoneal cavity.

Ætiology.—Ascites is a constant symptom of simple, tuberculous and malignant chronic peritonitis. It occurs when there is a rise of pressure in the portal circulation; it is always present in portal thrombosis and when the portal vein is obstructed by a growth or an aneurysm, and portal obstruction is in part responsible for its presence in cirrhosis of the liver. Ascites is very common in heart failure, in which it is almost always associated with œdema of the feet. It is in part due to the same causes as the œdema, but it is also in part caused by portal congestion, and by obstruction to the lymph flow from the thoracic duct owing to the rise of venous pressure. Lastly, ascites accompanies the dropsy of Bright's disease and severe anæmias.

Symptoms.—The abdomen becomes gradually enlarged, at first in an antero-posterior direction, the costal margin being pushed forward, but at a later stage the bulging occurs in the flanks also. The stretching of the abdominal wall gives rises to a tight sensation, which may amount to actual pain if the fluid collects rapidly. It causes the muscles to atrophy and lineæ atrophicæ develop in the skin. The umbilicus becomes everted and may form a thin-walled bladder.

The rise in intra-abdominal pressure, caused by the accumulation of ascitic fluid, obstructs the inferior vena cava; œdema of the legs may occur, and the obstruction to the renal circulation may cause albumin to appear in the urine, the quantity of which is reduced owing to the loss of water in the ascitic fluid. Compensatory dilatation of other venous channels results: the dilatation of the veins passing between the abdominal wall and those in the falciform ligament is manifested by the development of large and prominent subcutaneous veins around and above the umbilicus; others pass from the superficial and deep epigastric veins in the middle of the groin towards the costal arch, where they join the superficial epigastric and long thoracic veins. When paracentesis is performed, the dilated veins disappear if they have developed as a result of pressure on the inferior vena cava, but not if obstruction of portal veins is the primary condition.

The diaphragm is pushed up; its excursions on respiration are reduced, and dyspnœa may result. The impulse of the heart may be felt in the third intercostal space; the twisting of the heart may temporarily produce a pulmonary systolic murmur. Cardiac irregularity, palpitation, and attacks of faintness may result. The upper border of hepatic dullness may reach the fourth, third or even second intercostal space in front: the right base is dull behind, owing to the liver being pushed up and the lung compressed. Bronchitis tends to develop, and the engorgement of the lung may in rare cases give rise to hæmoptysis. A pleural effusion may be suspected, but the upper limit of dullness is altered on taking a deep breath if it is due to the liver being pushed up, and the increased dullness diminishes or disappears when the patient lies on his face; in pleural effusion the dullness is higher

in the axilla than behind, but this is not the case if it is due to an abnormally high position of the liver.

The pelvis and renal regions hold a considerable amount of fluid, so that no accumulation occurs in the flanks until at least a litre is present in the abdomen. An area of dullness is, however, found in the most dependent part of the abdomen if the knee-elbow position is assumed. As more fluid collects the resonant note in the flanks is replaced by dullness, but the change may be delayed if there is much gas in the colon. The level of dullness now gradually rises and spreads over the pubes towards the umbilicus. On turning from one side to the other the most dependent part remains dull. This is not, however, pathognomonic of ascites, as similar movable dullness occurs in chronic obstruction of the small intestines.

In chronic peritonitis the mesentery may be so shortened that the intestines are unable to float up on the fluid; the fluid then accumulates in front of the intestines, and the highest part of the abdomen is dull.

A characteristic fluid thrill is felt when one side of the abdomen is sharply flicked by the fingers of one hand, whilst the other hand is placed flat upon the opposite side of the abdomen. When the patient is very fat, or the abdominal wall is œdematous, a similar but less marked sensation may be produced; in doubtful cases the hand of an assistant should, therefore, be pressed perpendicularly over the middle line of the abdomen, as this prevents the transmission of the impulse through the abdominal wall, but not through the fluid contents of the abdomen.

When the liver or spleen is enlarged and hard, or when an abdominal tumour is present, the sensation produced by dipping the tips of the fingers suddenly through the fluid on to the solid organ, which may jump away from them, is most characteristic.

Diagnosis of Ascites.—Confusion has often occurred between ascites and a large ovarian tumour. The history of the development of the abdominal swelling may help the diagnosis. In many cases the outline of an ovarian tumour can be definitely felt, and its pelvic attachments can be recognised by vaginal examination. The antero-posterior enlargement is greater than the lateral bulging, whereas the reverse is the case in ascites; the maximal girth is below the umbilicus instead of at the umbilicus or above; the umbilicus, which is normally and in ascites an inch nearer the pubes than the ensiform cartilage, is proportionately farther from the pubes; and the distension on one side is often greater than the other instead of being uniform

Diagnosis of Cause of Ascites.—Chronic peritonitis and perihepatitis are generally associated with adherent pericardium or granular kidney and atheroma. The presence of these conditions would point against cirrhosis as the cause of ascites. On the other hand, an enlarged spleen or the occurrence of hæmatemesis would be in favour of cirrhosis. A patient with ascites due to cirrhosis alone rarely survives the performance of paracentesis more than two or three times, as his general health has already greatly deteriorated; if tapping is frequently performed, chronic peritonitis is therefore probably present, even if other evidence indicates that the patient is also suffering from cirrhosis. In cirrhosis the fluid collects rapidly, and the patient is obviously ill; in chronic peritonitis the accumulation on the first occasion is generally very gradual, and the patient may be otherwise well. Tuberculous peritonitis is rare in adults, except as a complication of cirrhosis of

the liver and when secondary to tuberculous Fallopian tubes. In children, ascites due to cirrhosis is very likely to be mistaken for tuberculous peritonitis. Evidence of tuberculous disease in other parts of the body, solid masses palpable in the abdomen or on rectal examination, pain and tenderness in the abdomen, except over the liver, and induration and redness of the umbilicus point to tuberculous peritonitis. The fluid is generally turbid, the specific gravity is above instead of below 1015, and lymphocytes are present. No tubercle bacilli are found by ordinary methods; but injection of the fluid into a guinea-pig causes it to become tuberculous.

In malignant peritonitis there is generally evidence of the primary disease in some other organ, and nodules may be felt in the abdomen, in the neighbourhood of the umbilicus, or in the middle line above it, and enlarged glands may be present. The spleen is not enlarged, emaciation is generally greater than in cirrhosis, and, except when the primary disease is in the stomach, there is no hæmatemesis. A rectal and vaginal examination are particularly important, as ascites, which may recur very frequently, sometimes results from ovarian tumours. In a doubtful case the diagnosis may become clear after paracentesis, when the large hard liver and spleen may be felt in cirrhosis and an irregular enlargement of the liver, but no splenomegaly, in cancer of the liver. In malignant disease the fluid may contain cancer cells; it is more often hæmorrhagic than in tuberculous peritonitis or cirrhosis.

Rapid development of ascites, with enlargement of the spleen and sometimes hæmatemesis, suggests portal thrombosis; if symptoms pointing to cirrhosis are already present, it is probably secondary to this, and even when none are present, it may be secondary to latent cirrhosis, as the majority of cases are due to cirrhosis.

An examination of the circulatory system and the urine should prevent confusion between ascites due to cirrhosis and that due to heart failure or kidney disease; but these conditions may be associated together.

Treatment.—A salt-free diet should be given, as ascitic fluid never contains less than 8 grammes of sodium chloride in each litre; if the quantity of salt taken in the day is reduced to 0·8 gramme, less than 100 c.c. of ascitic fluid can collect during the same period, as the urine always contains some salt, and the percentage in the body fluids never falls greatly below the normal. The quantity of salt and water retained can be still further reduced by giving 2 drachms of calcium chloride 3 times a day for 10 to 12 days, and then injecting 1 c.c. neptal or other similar mercurial preparation in order to stimulate the kidneys to excrete salt. With this treatment, which can be repeated periodically, the ascites generally disappears.

The bowels should be kept well open; but severe purging weakens the patient and is likely to aggravate the catarrh of the alimentary canal, which is often already present. Repeated small doses of calomel, which also acts as a diuretic, and saline aperients or compound jalap powder are the most suitable drugs.

Diuretics are much more valuable as preventatives, when the fluid first appears, or after it has been removed, than as curatives when a large quantity is present, as the pressure on the renal veins makes the kidneys less active, and an enormous quantity of fluid has to be excreted by them before the accumulation can disappear, whereas comparatively little urine need be

passed to prevent its re-accumulation after tapping. Addison's pill of 1 grain each of powdered digitalis leaves, powdered squill root and blue pill, may be given for 2 days before paracentesis is performed, so that its action can come into play at once, and not be delayed until the fluid has already begun to collect again, as the accumulation of fluid is most rapid immediately after paracentesis. This treatment is, however, now rarely required since the introduction of the combined salt-free diet, calcium chloride and mercurial injection treatment of Blum described above.

Attempts have been made to increase the collateral circulation between the portal and the general venous systems by operative means on the assumption that ascites is a result of portal obstruction. The peritoneum over the liver and diaphragm is scraped and the omentum introduced between them, the abdomen being drained and the patient kept in the sitting position so that no fluid can intervene between the roughened peritoneum and prevent adhesions from forming. Great improvement occurs in a small proportion of cases, but in the majority little or no benefit results, and death shortly after the operation is not infrequent. The unsatisfactory results of operation are hardly surprising, as portal obstruction is rarely the sole cause of ascites. Moreover, there is a distinct danger of increasing toxæmia by allowing an increased proportion of intestinal poisons to enter the general circulation without passing through the liver, which retains some of its antitoxic powers to the end.

Paracentesis should be performed at an early stage, as soon as the accumulation of fluid causes discomfort or seriously interferes with the digestion, circulation or respiration. When dullness or râles appear over the bases of the lungs owing to their compression, or the secretion of urine is diminished, the abdomen should be tapped. Hæmatemesis is a further indication, as paracentesis reduces venous engorgement.

The trocar should be inserted in the middle line between the umbilicus and pubes, or in the flank. Care must be taken to avoid the liver and spleen. A trocar and tube of moderate bore should be used, as the very fine Southey's tube formerly employed tends to become blocked, and the discomfort caused by the paracentesis is needlessly prolonged.

ARTHUR F. HURST.

SECTION IX

DISEASES OF THE LYMPHATIC SYSTEM

AFFECTIONS OF THE LYMPHATIC VESSELS AND GLANDS

AFFECTIONS of these structures are as a rule secondary to disease in the other tissues of the body.

1. AFFECTIONS OF THE THORACIC DUCT.—The chief sign of a lesion of the thoracic duct is the occurrence of a milky effusion into the peritoneal or pleural cavity, or more rarely of chyluria. Such effusions are not all of the same chemical constitution. They are divided into chylous and pseudo-chylous effusions; the causes determining the difference being quite unknown. The lesions associated with these effusions are varied, but the chief place is held by carcinomatous or sarcomatous growths pressing upon or infiltrating the duct. Thrombosis of the left subclavian vein, trauma, lymphadenoma, tuberculosis and cirrhosis of the liver are also recorded.

2. AFFECTIONS OF THE SMALLER LYMPHATIC VESSELS.—(*a*) *Lymphangitis.*—Acute inflammation of the lymphatic vessels is the result of infective processes in the area drained. It is evidenced by the appearance of red lines in the skin leading from the focus to the adjacent lymphatic glands. In the more chronic inflammations such as tuberculosis, and in malignant disease, the lymphatic vessels which drain the affected area become infiltrated and can often be felt as hard cords, *e.g.* the enlargement of the spermatic cord in tuberculosis of the testicle.

(*b*) *Lymphangiectasis* is the name given to a diffuse dilatation of lymphatic vessels; circumscribed dilatations forming tumours chiefly composed of dilated lymph-spaces are called lymphangiomata. These may be either congenital or acquired. Instances of the congenital variety are met with about the lips and tongue and floor of the mouth; macrocheilia; macroglossia; lymphangioma of the neck. The acquired condition is due to obstruction injury, *e.g.* severe scarring after burns; and blocking of the channels by the parasite *Filaria bancrofti* producing elephantiasis of the scrotum and chyluria.

3. AFFECTIONS OF THE LYMPHATIC GLANDS.—(*a*) Acute lymphadenitis resembles lymphangitis in being the result of an acute infection in the area drained. The glands in relation to the fauces are those most often affected. The lymphatic glands are also enlarged in many of the acute infectious fevers.

(*b*) Chronic lymphadenitis is, similarly, most often due to infection. Pyogenic infections are common, but both from its frequency and its results tuberculous infection of the glands is the most serious. Any gland in the

body may be implicated, but involvement of the cervical group is certainly the commonest. The axillary, inguinal, mesenteric and thoracic groups are also often infected. Tuberculosis of the superficial glands usually comes under the notice of the surgeon and is dealt with in surgical text-books. Tuberculosis of the mesenteric and thoracic groups will be found treated of in the sections on diseases of the peritoneum and the lungs respectively.

In rare instances there occur cases of a generalized tuberculosis of the glands of the whole body. It is an acute infection seen in children and much more rarely in adults, and has to be diagnosed from an acute lymphadenoma, leukæmia or sarcomatosis. This can only be accurately done by the excision and microscopic examination of a gland. The disease is not invariably fatal.

(c) Malignant disease of the lymphatic glands is generally secondary to carcinoma. When the growth is primary in the glands the character of the new tissue is sarcomatous or more rarely endotheliomatous. The last is as a rule slowly progressive, and only locally malignant.

Diagnosis.—Where there is a glandular tumour the physician is usually obliged to take into consideration the distinctions between tuberculosis, new growth, leukæmia, lymphadenoma and syphilis; and in some cases the distinction can hardly be made on clinical grounds. It is then necessary to excise the tissue and examine it microscopically. It is often in cases of obscure illness an aid in diagnosis to be fully aware of the position of the groups of glands which are in relation to affected organs, *e.g.* in carcinoma of the stomach it is not uncommon to find an early involvement of the group which lies above the left clavicle.

LYMPHATISM

Synonym.—Status Lymphaticus.

Definition.—In the absence of any knowledge of what constitutes this condition, the definition is of necessity based upon the appearance found in the bodies of those who have died with a peculiar train of symptoms. There are three classes of cases which must be considered under this heading:

1. The sudden deaths of infants for no apparent reason.
2. The deaths under anæsthetics of older children and occasionally of adults without obvious cause.
3. The occurrence in infants of attacks of dyspnœa and cyanosis due to the presence, it is alleged, of an enlarged thymus gland (Kopp's or Millar's asthma).

In all three cases, the thymus gland is found enlarged, sometimes of an enormous size, and, in addition, the lymphatic structures of the body generally, spleen, tonsils, Peyer's patches and solitary follicles of the intestines, and the glands everywhere, are hypertrophied.

Symptoms.—In the first two classes the condition is usually unsuspected during life. Anæmia, enlargement of the tonsils and of the superficial lymphatic glands are common from other causes, and it is often the sudden failure of vitality either under an anæsthetic or in a child apparently in good health, which first indicates the existence of the condition. The cause of death is not as a rule respiratory, but cardiac, failure; death takes place

abruptly without a struggle or a cry, from sudden cessation of the heart-beat. At the autopsy, the thymus gland is found to be enlarged, and the other lymphatic structures hypertrophied. The thymus gland is thick and fleshy, and weighs two, three or four times its normal weight in children, of 10 to 12 grammes.

In the third class, there is more to attract the attention. An infant in the first weeks of life develops respiratory stridor with attacks of cyanosis and dyspnœa, due apparently to compression of the trachea. By some authorities this compression is held to be caused by the mere enlargement of the thymus gland; but in many instances it is certain that the underlying cause both of the increase of the gland and of the dyspnœa is the existence of an inflammatory lesion in the cervical tissues. Thus, in some typical instances suppuration in the lymphatic glands has been found, and in others, the existence of an unsuspected retro-pharyngeal abscess, and the writer has yet to see an uncomplicated case of "thymic asthma."

Diagnosis.—The diagnosis of enlargement of the thymus gland during life is not easy. The discovery of an abnormal dullness to percussion over the manubrium sterni, extending a little to either side, should lead to an examination by means of the X-ray, when the shadow of the gland or of an abscess may be obvious, and lead to the discovery of an unsuspected lesion in the tissues of the neck or pharynx. In children rather older, who are unduly pale and flabby, whose complexion is muddy, or in whom there is a history of attacks of dyspnœa, the condition may be suspected, and in a few of these careful examination will reveal abnormal dullness and an X-ray shadow apparently representing an enlarged thymus gland. X-ray appearances, however, are apt to be misleading, and a diagnosis based principally on the presence of such a shadow has often proved erroneous.

Treatment.—When the condition is suspected the first consideration should be to avoid the administration of an anæsthetic, and when this is inevitable Buxton recommends a low-strength chloroform vapour with oxygen. Generally, treatment must be directed to the improvement of anæmia by means of iron, dieting, open air, and of muscular tone by massage. In cases of "thymic asthma" operation with removal of a great part of the thymus gland has been practised, occasionally with good result. In some cases the surgeon has found unsuspected suppuration.

LYMPHADENOMA

Synonyms.—Pseudo-leukæmia; Hodgkin's Disease; Malignant Lymphoma; Lympho-granulomatosis.

Definition.—A disease characterized by swelling of the lymph glands in various parts of the body, associated with hyperplasia of the lymphadenoid tissue in the liver, spleen and other organs. It is progressive, and in its later stages accompanied by a severe type of anæmia.

Ætiology.—In many instances the disease seems to follow one or other of the acute infective diseases, but often there does not appear to be any predisposing cause: it is not hereditary, nor is there any evidence of a family character; it is met with in all civilized countries; and is probably more often found in the town-dweller than in the countryman. It occurs at all

ages, but more frequently in the first three decades than later, though no age is immune.

The exciting cause is unknown. Bacteriology has so far failed to discover an organism which can be incriminated, though Fraenkel and Much claim to have demonstrated an acid-fast bacillus which they believe to be causal.

Relation to tuberculosis and the "lymphomata."— It has been maintained that lymphadenoma is a specialized form of tuberculous infection, but the bulk of evidence, alike clinical, bacteriological and pathological, is against this assumption. A patient may suffer at the same time from both diseases, and it is certain that association is fairly common, but the lesions of the two are easily distinguishable from one another under the microscope, and no experimental work has yet succeeded in producing the typical lesions of lymphadenoma.

The exact relation of Hodgkin's disease to the "lymphomata" is still uncertain, and must wait for definition on greater knowledge of the histology of such tumours. But with our present knowledge it is already doubtful whether there are any other diseases than lymphadenoma, tuberculosis, leukæmia, new growths and chronic inflammatory conditions, which can give rise to a large and persistent tumour of the lymphatic glands.

Pathology.—The disease affects the lymphatic glands, the spleen, the liver and the lungs in the order named, and, in addition, the lymph tissue in the other organs, notably in the intestines and in the stomach, is frequently hyperplastic. The glands are smooth, white on section, or pinkish-grey and homogeneous; in cases of long standing they are often more fibrous than normal. Suppuration or caseation is uncommon, and when found should suggest the likelihood of simultaneous tuberculous infection. Microscopically, the gland structure is obscured by the overgrowth of endothelial elements and fibrous tissue. Many of the endothelial cells are multinucleate. Eosinophil cells are said to be present in great abundance, but this is not a constant feature. The same remark applies to the presence of plasma cells. The chief microscopic characters of the spleen are similar; in the liver the accumulations of the morbid cells are found mostly in the lymph structures of the portal canals and the same perivascular concentration is true of the other affected organs. Occasionally hyaline degeneration of the glands occurs, an uncommon feature in any other disease.

The chief features of the affection are the large smooth masses of the glands in the neck, in the axillæ, in the groins, mesentery, and in the retroperitoneal region. On section these are found to retain the divisions between the individual glands, and seldom to invade the limiting tissues. The spleen is characteristic; it is studded with firm white nodules of different shapes and sizes, giving the organ the appearance of the almond-studded cake, known by the name of "hardbake." These nodules are sometimes yellowish in colour, and occasionally occur as a single large tumour occupying a considerable portion of the organ. The spleen is always of considerable size, and may weigh several pounds. The liver is enlarged, and in a typical case marked by small white nodules which represent the lymphadenomatous infiltration of the portal canals. The lymphatic tissue of the stomach and the intestines is hyperplastic, and in the case of the first-named organ the

overgrowth occasionally presents a striking resemblance to carcinoma. There is, however, no ulceration. In the intestine the overgrowth is confined to the Peyer's patches and the solitary glands.

Symptoms.—The first symptom to attract attention is nearly always an enlargement of the cervical, though in rare cases the glands of the other groups may be first affected. In a few cases, the first complaint is of swelling of the abdomen, jaundice, shortness of breath or general weakness; but never of anæmia, which is a later symptom. In this early stage there is as a rule nothing else to discover. The patients are not anæmic or seriously ill. The swollen glands are soft, discrete, not attached to the skin or the deeper tissues, painless and of slow growth. Most often the swelling appears in the superficial cervical group, and the submaxillary glands are involved later. Even at this stage, however, the spleen is often palpable, and careful examination may find some enlargement of other glandular groups. This swelling may be present for some considerable time before any further trouble is apparent, but sooner or later other enlargements make their appearance, and the general health begins to suffer; the patients complain of weakness and of shortness of breath on exertion, and become anæmic. By the time the disease is fully established anæmia is often marked, with masses of glands on both sides of the neck and beneath the chin; with enlargement of the axillary and inguinal groups; with swelling of the abdomen, due partially to the size of the liver and spleen and partially to the presence of free fluid in the cavity. There may be great respiratory distress as a result of pressure of the mediastinal glands on the trachea, and in some cases tracheotomy becomes necessary. At this stage the spleen is always enlarged to a marked degree, though seldom reaching the size which is attained in leucocythæmia. It is firm, not tender, and occasionally the nodules of the lymphadenomatous hyperplasia give the surface a rough feeling to the palpating fingers.

The red corpuscles are diminished, the hæmoglobin much reduced and there is often a moderate leucocytosis, due to increase in the number of the polymorphonuclear cells. The eosinophil cells are sometimes increased in number, though this is not a frequent occurrence. In rare instances the lymphocytes show a marked increase before death, and the disease takes on the clinical features of an acute leukæmia.

Besides the symptoms of pressure on the trachea, paraplegia from pressure on the spinal cord has been known to occur.

Fever is often a marked feature of the affection. It assumes three types: (1) Continuous: considered in association with the large spleen and the swollen abdomen such a fever produces a strong resemblance to typhoid fever; (2) Intermittent; (3) Remittent. The intermittent is often periodic, the fever lasting a week or 10 days, followed by an apyrexial interval of variable length, again succeeded by a wave of pyrexia. Such a chart is extremely characteristic of the disease ("Pel-Ebstein type"). This type of fever is said to be more common in cases in which the mesenteric and retroperitoneal glands are the chief seat of the disease.

Other symptoms of more or less frequent occurrence are a moderate degree of albuminuria; œdema of the legs, scrotum and back, pleural or less commonly peritoneal effusions, and rarely the deposition of lymphadenomatous nodules in the skin. These nodules are seldom of large size and tend to

appear and disappear, and at times to become purple in colour owing to extravasation of blood. Pigmentation of the skin is most commonly due to the employment of arsenic as a therapeutic measure, but there are cases on record in which true bronzing has been observed.

Course.—The first manifestation of the disease is usually the appearance of a mass of glands in the cervical region. Should these be excised there is sometimes an interval during which there is no further manifestation; but sooner or later the glands again swell either in the same region or in some other group. At the same time the general condition becomes worse, and on examination the spleen and liver are found to be enlarged. From this period of general dissemination of the disease there may be from time to time remissions, but as a rule there is no further period at which any hope of permanent relief is permissible. The disease makes slow and steady progress, and death occurs either from the pressure symptoms or from gradual exhaustion.

Diagnosis.—In the early stages, the most usual mistake is to confuse the enlargement of the glands with that of tuberculous disease. This mistake is the more easy because there are not seldom caseous deposits in these glands in addition to the lymphadenomatous disease. Even in the later stages when there is fever with generalized enlargement of the lymph glands and the spleen, the diagnosis of general tuberculosis has been made. Microscopical examination of an excised gland will as a rule establish the diagnosis. Sarcoma, endothelioma and leukæmia may also be confused with Hodgkin's disease, and in rare instances the diagnosis of typhoid fever has been made in error.

Prognosis.—From time to time there are records of cases of lymphadenoma which recover. These, however, are so rare that it is permissible to doubt the accuracy of the diagnosis. The more acute cases usually terminate in 3 to 4 months; but where progress is slower the patients may survive for 2 to 3 years, with occasional remissions in which they appear to recover a considerable measure of health. In rare instances the fatal termination may be delayed for a longer period, up to 7 years; in such instances the condition is usually that of living death.

Treatment.—No form of treatment has hitherto proved able to cure the disease. Surgery can deal with the accessible masses; and X-ray can certainly arrest the growth both of the accessible and of the inaccessible intrathoracic masses, and thus spare the patient the sufferings formerly entailed by the pressure on the trachea and bronchi. But neither surgery nor X-rays can reach the hidden foci of the disease embedded in the viscera. Lately, the use of "Radon seeds" has proved successful in causing the disappearance of inoperable gland masses, but it is too early to speak as yet of "cure." Our knowledge of the wide spread of the lesions renders it unlikely that any local treatment will prove efficacious. The localized manifestations of the disease can be held in check by these means, and the physician can second these methods by the free employment of arsenic. There is no doubt that large and continuous doses of this drug tend to delay the spread of the disease, but there is no evidence that it will cure it. It may be given by the mouth or intravenously. Care must be taken to intermit the dosage in order to avoid the danger of arsenical poisoning; but lymphadenomatous patients appear to tolerate the drug extremely well.

Vaccines made from some of the more abnormal organisms of the intestinal tract have been stated to produce remarkable improvement.

MIKULICZ'S SYNDROME

In the year 1888 Mikulicz published the description of an affection the peculiar characters of which constituted, in his judgment, a clinical type of disease till then unknown. The chief features of the affection were the chronic symmetrical enlargement of the lachrymal and salivary glands, without disturbance of the general health. Since that date a considerable literature has accumulated, dealing with the type originally described by Mikulicz and with allied conditions, differing in various points from the classical type. From this material it is possible to arrange a classification of the varying conditions in which the chief feature of Mikulicz's original description, the symmetrical enlargement of the lachrymal and salivary glands, still stands out, though associated with symptoms which were not present in the original case.

(1) Mikulicz's disease in the strict sense is characterized by a chronic symmetrical enlargement of the lachrymal and salivary glands, without other disturbance of the health. The only disability arising from such an affection is the disfigurement, and the restriction of the fields of vision by the steady encroachment of the lachrymal glands at the outer side of either orbit. Removal of the glands is not followed by recurrence, and in some instances has resulted in the slow disappearance of the salivary enlargement. Examination of the tissues shows only evidence of chronic inflammation, without indication of the cause. The lachrymal are usually involved before the salivary glands; in some instances the enlargement affects the lachrymal, in others the salivary glands alone, though always symmetrical. (2) In the second group the symmetrical enlargement of the lachrymal and salivary glands is associated with swelling of the lymphatic glands in various parts of the body, especially the neck, and occasionally with enlargement of the spleen. This type undoubtedly exists, though it is difficult to separate it from such diseases as leukæmia and lymphadenoma (Hodgkin's disease) in which the syndrome appears as a complication. When these can be excluded, there emerges a type of disease, sometimes slowly fatal, at other times merely disfiguring. The cause of the enlargement remains obscure. (3) The third type is that in which the swellings are caused by infiltration with malignant growth, usually of the lympho-sarcoma character. Sometimes there is reason to suppose that the growth is primary in the lymphatic glands of the neck: at others it seems that the enlargement is secondary to disease elsewhere, *e.g.* in the bones or in the retro-peritoneal glands. In one such case the swelling was intermittent, recurring at intervals, while the original growth in the pelvis steadily increased. (4) A type in which the symmetrical painless swellings are undoubtedly the result of tuberculous infiltration. In more than one such case tubercles and bacilli have been demonstrated. (5) A type in which the inflammation is due to syphilitic infection; a rare, but established, phenomenon.

There are met with occasionally cases which, while not agreeing with any of the above types in particular signs, yet probably belong to the same

general type; for example, instances of symmetrical swelling of the salivary glands alone in young children, which persists for months, with some deterioration of the general health, but without any indication of cause. There is also stated to be an hereditary affection which disfigures individuals of the same family through several generations.

Pathology.—Apart from the ascertained causes, leukæmia, malignant growth, tuberculosis and syphilis, we may agree with Mikulicz that the affection is the expression of an unknown infection. This opinion is reinforced by the fact that chronic infection of the naso-pharyngeal tract is often a precursor of the swellings.

Diagnosis and Treatment.—When it is recognized that the syndrome may be the earliest evidence of a serious condition, malignant disease, leukæmia, lymphadenoma or a manifestation of tubercle or syphilis, the residue of cases presenting the peculiar symmetrical enlargements is small. Such patients will more often consult the doctor because of the disfigurement than for any failure of health. Thus, it has happened that a considerable number of the recorded cases have received benefit from the skill of an ophthalmic surgeon; the removal of the lachyrmal glands being followed by the disappearance of the salivary tumours. Besides operative treatment, or, in appropriate instances, specific treatment, attention should be paid to the condition of the tonsils, ears, and sinuses. The use of potassium iodide, to promote a free flow of saliva, appears to be beneficial in some instances.

HUGH THURSFIELD.

SECTION X

DISEASES OF THE BLOOD

CONSTITUENT ELEMENTS OF THE BLOOD

THE blood consists of—(1) Red blood corpuscles; (2) white blood corpuscles: (3) blood platelets; (4) blood plasma.

1. The red blood corpuscles or erythrocytes number 5,000,000 per c.mm. in the male adult and rather less in the female. The actual counts vary somewhat according to the source from which the blood is obtained, whether from artery, vein or capillary. The figures given are those found by the ordinary methods of examination of the capillary blood. Residence at high altitudes above sea-level increases the average count. The red blood corpuscles are examined for their size (anisocytosis), shape (poikilocytosis) and staining reactions (polychromatophilia); and the amount of colouring matter (hæmoglobin) which they contain is estimated by various methods in percentages of the normal. The ratio of the percentage of hæmoglobin to the percentage of the corpuscles is termed the *colour index*. Nucleated red blood corpuscles are only found in normal conditions in the infant—and then usually only for a short time after birth; they occur frequently in disease, especially in the more severe types of anæmia, and are called *microblasts*, *normoblasts* and *megaloblasts* according to their shape and size.

The red blood corpuscles are also examined from the point of view of their *fragility* in solutions of sodium chloride. Normally they retain their hæmoglobin in solutions stronger than 0·47 per cent., but in certain diseases their fragility is more or less pronounced.

2. The white blood corpuscles are usually from 8000 to 10,000 per c.mm.; but their number bears no relation to, and varies independently of, the red corpuscles. The precise nature and characters of the different forms of leucocyte are a matter of dispute, but five varieties are usually recognized—(1) The polymorphonuclear cell; (2) the lymphocyte; (3) the large mononuclear or hyaline cell; (4) the eosinophil cell; (5) the basophil cell.

In addition to these five varieties another type of cell described as "transitional" is often present; and in disease "myelocytes," which are normally found only in the red bone-marrow, appear in the peripheral blood and organs.

An increase of the numbers of the white cells in the capillary blood constitutes a *leucocytosis*; a decrease a *leucopenia*. In strict usage a leucocytosis may be due to an increase in any one or in all of the five varieties mentioned—in common practice a leucocytosis means an increase of the polymorphonuclear variety; when otherwise used the proper qualification is added,

e.g. eosinophil-leucocytosis. A physiological leucocytosis occurs during digestion, after exercise, and during pregnancy. It is seldom likely to cause confusion with that due to disease.

3. The blood platelets number from 200,000 to 300,000 per c.mm. They are much reduced in number in certain diseases—especially idiopathic purpura, and increased after hæmorrhage and in some of the severer forms of anæmia.

4. The blood plasma is obviously of the greatest importance both in health and disease; it has been principally studied in connection with agglutinins, precipitins and opsonins; and is known to carry in solution many other bodies of vital significance.

Clinical methods have been devised for the estimation of the coagulability of the blood, the bleeding-time, the viscosity, specific gravity, and total volume of the blood. These methods have as yet entered but little into general use, but the coagulation-time and the bleeding-time have assumed considerable importance both in the diagnosis and in the pathogeny of the diseases of the "hæmorrhagic diathesis."

CLASSIFICATION OF DISEASES OF THE BLOOD

Knowledge of the essential causes of these diseases is still scanty, so that any classification must be tentative, and that here employed is no less arbitrary than another. It is based partly upon clinical facts, partly upon the results of microscopic methods.

1. Those diseases in which anæmia is secondary to disease elsewhere in the body: Secondary anæmia.

2. Those diseases in which the alteration in the blood appears to be the essential factor in the illness: Primary anæmia.

3. Those diseases in which the alteration in the blood appears to be an essential, but not the dominating factor: Leukæmia, splenic anæmia and similar conditions.

4. Those diseases characterized by an increase in the number of the corpuscular elements of the blood: Polycythæmia,

5. Those diseases characterized by the occurrence of hæmorrhages in the skin and from the mucous membranes, which are due to deep-seated abnormalities of the hæmopoietic system; the diseases of the "hæmorrhagic diathesis."

POLYCYTHÆMIA

Synonyms.—Splenomegalic Polycythæmia; Myelopathic Polycythæmia; Vaquez' Disease; Osler's Disease.

Definition.—A condition characterized by the presence of more than 5,000,000 red corpuscles in the c.mm. of blood.

Ætiology.—Polycythæmia may be (1) relative, or (2) absolute.

1. Relative polycythæmia is due to the concentration of the blood, as in severe diarrhœa or excessive loss of fluid from the body. It can occur locally in a congested or cyanotic area.

2. Absolute polycythæmia is (*a*) secondary, or (*b*) primary. The former

is due to the effort of the hæmopoietic system to compensate for the defective oxygenation of the blood. Such a condition is observed in congenital stenosis of the pulmonary orifice, where counts as high as 11,000,000 erythrocytes have been made; in the cyanosis of acute and chronic bronchitis, and of a failing circulation; and in persons who live for some time at high altitudes. It has also been recorded in some cases of chronic tuberculosis and syphilis, and in cases of thrombosis of the portal vein or its main tributaries. Secondary absolute polycythæmia is termed *erythrocytosis*. (*b*) Primary absolute polycythæmia or *erythræmia* is a disease in which it is believed the cause of the polycythæmia is a primary hyperplastic activity of the hæmopoietic system. It is almost invariably associated with splenomegaly.

The disease affects persons of both sexes, usually in the middle period of life, 35 to 55 years of age; but it has been described in younger and in older individuals. Of the exciting cause nothing is known. It does not appear to be related to any of the known infective organisms.

Symptoms.—The earliest complaint is usually of headache, migraine or giddiness, a sensation of "bursting" in the head, pains in the splenic region, epistaxis or bleeding from the mucous membrane of the nose or mouth. At this stage the cyanosis is often not marked, or only becomes evident on exertion; it is most obvious in the lips, ears and finger-tips. The general appearance is bluish-red rather than the dark blue of pulmonary cyanosis. The vascular engorgement can be best observed in the tongue, fauces, conjunctivæ and retina.

The spleen is usually enlarged and hard, but does not often reach any great size, seldom being palpable below the level of the umbilicus. It is not tender to palpation, though there is often some pain in this region.

The urine often contains a moderate amount of albumin, and a few hyaline or granular casts, and has several times been observed highly coloured with urobilin.

The blood-pressure is usually, but not always, above the normal; though in some cases it has been found very high, above 200 mm. of Hg. Hence some authors have used the name polycythæmia hypertonica.

Examination of the blood shows from 7,000,000 to 12,000,000 red corpuscles, which are stated to be often slightly below the normal in diameter. They are well formed and stain well. There is nearly always a leucocytosis even as high as 40,000, due to the increase in the polymorphonuclear cells. Once or twice a leucopenia has been recorded. Normoblasts are nearly always present, and megaloblasts and myelocytes very frequently. The hæmoglobin is usually above 100 per cent., and may reach as high as 200 per cent., but the colour index is seldom above 1. Other changes, *e.g.* in viscosity, coagulability, specific gravity and total volume have been noted, but at present in too few instances to justify a definite statement. Enlargement of the liver is common, and muscular and mental weakness constant.

Course.—In many instances the disease is apparently non-progressive, in others there appear to be intermissions alternating with exacerbations.

Complications.—Jaundice, hæmorrhage from the mucous membranes, erythromelalgia, pigmentation of the skin, and gradual failure of the heart are the complications most frequently observed. Death occurs from cerebral or meningeal hæmorrhage, with a sudden increase in the cyanosis, or from intercurrent disease.

Treatment is entirely symptomatic. The cyanosis and high blood-pressure may be relieved, temporarily at least, by venesection. Splenectomy has failed. X-ray applications have occasionally appeared to do good. Light diet, abstinence from alcohol, freedom from mental worry, avoidance of sudden exertion, and careful regulation of the bowels appear to be the best means of keeping the patient in comfort. More recently the administration of phenyl-hydrazine, in doses of 2 to 3 grs., has been recommended.

ANÆMIA

(A) SECONDARY ANÆMIA

Definition.—A secondary anæmia is a condition which can be traced to an ascertainable cause, the removal of which leads to restoration of the normal state.

The above definition is obviously defective, but it will be made more intelligible by what follows.

Ætiology.—(*a*) The most obvious cause of a secondary anæmia is the occurrence of hæmorrhage. From whatever source this may arise the effect upon the circulation is immediate and proportionate to the amount of the loss. Apart from trauma, the most common causes of severe loss of blood are hæmorrhages from the stomach and intestinal tract. Profound anæmia may also occur from hæmorrhage from the urinary organs.

(*b*) Anæmia due to the action of poisons, either mineral, chemical or bacteriological. Among the mineral poisons lead takes the first place; other metals are not prominent. Of purely chemical poisons the members of the nitro-benzene group have in the past given rise to some severe cases, even before the Great War; but the poisons of the infective diseases are the most frequent cause of anæmia of this type. All the infectious fevers, the poisons of syphilis and malaria, and probably the toxins of various intestinal infections produce a greater or lesser degree of anæmia. A chronic infective process in the dental alveoli, in the tonsils, and other lymphatic structures of the naso-pharynx is a frequent cause of anæmia. It is of course difficult to separate the different factors in this connection. For example, the anæmia of congenital syphilis is often striking, but the fact that many cases of the disease do not show any anæmia at all, renders it doubtful whether in any given case there are not other factors at work. This is almost certainly the case in chronic tuberculosis, which does not appear, in the absence of complications, to be the cause of any alteration in the blood.

In the case of the parasitic worms there is a twofold possibility. The anæmia may be due to the actual loss of blood as, for example, in the case of infection with the *Ankylostoma duodenale*, or the worms may produce a toxæmia which leads to the destruction of the hæmoglobin and the corpuscles.

(*c*) Anæmias due to defective nutrition are a large and varied group. They include not only the anæmias directly to be traced to an insufficiency of food, or to the absence of some essential element, such as a vitamin, but also those which may be broadly called the anæmias of cachexia. Malignant disease, chronic nephritis, chronic suppuration and chronic indigestion may any of them produce a marked anæmia, which may no doubt often be partially

toxic; but it is also probably partly the result of defective assimilation of food. The extreme instance is a carcinoma of the œsophagus or of the stomach which absolutely prevents the ingestion of sufficient nourishment.

Symptoms.—The recognition of an anæmia due to hæmorrhage is as a rule easy. The patient is restless, thirsty, with a small pulse, and obviously blanched. In severe hæmorrhage the red blood corpuscles may be reduced to a half or even a quarter of the normal; the hæmoglobin suffers to a greater degree. It is possible to lose several pints of blood without a fatal issue. If the hæmorrhage be arrested, regeneration begins with great rapidity; and this is especially true of the corpuscular elements, while the hæmoglobin is reconstituted more slowly. Thus, after a severe hæmatemesis, the number of erythrocytes may be normal in 3 to 4 weeks, but the hæmoglobin will not recover its standard for some weeks later. In the stage of recovery the greatest attention should be paid to the condition of the heart-muscle; dilatation and the consequent breathlessness frequently persist for some weeks or even months after the onset.

In all these secondary anæmias the alteration in the blood is approximately the same. There is a diminution in the number of erythrocytes, with a still greater diminution in the amount of hæmoglobin, so that the colour index is below the normal, and does not usually rise above 0·6 or 0·7. The number of leucocytes is, on the other hand, not as a rule markedly abnormal; in special cases, as, *e.g.*, after hæmorrhage, polymorphonuclear leucocytosis is frequent for a few days and nucleated red corpuscles are noticeable; and as is well known in typhoid fever there is a leucopenia, but generally the secondary anæmias are not characterized by abnormalities in this direction.

Diagnosis.—In many instances the origin of a secondary anæmia is easily discerned, and with the removal of the cause the anæmia usually quickly disappears. In other instances, though the blood-picture constantly presents the above features characteristic of a secondary anæmia, the cause eludes the acumen of the physician. It was, for example, many years after the clinical recognition of "miners' anæmia" that the infection with ankylostoma was recognized as the cause.

Treatment.—With the detection of the cause, and its appropriate treatment, the anæmia does not as a rule persist. Tonics such as iron and arsenic help recovery, and convalescence is often made more rapid by removal to a bracing and invigorating climate. It is only rarely that any more strenuous treatment is required. Good hygiene and careful feeding are necessary.

(B) PRIMARY ANÆMIA

PERNICIOUS ANÆMIA

Synonyms.—Addison's Anæmia; Idiopathic Anæmia.

Definition.—A severe progressive anæmia of unknown causation, characterized by destruction of the red corpuscles, a high colour index, and a leucopenia. It is of course not a primary anæmia in the strict sense of the word, since it is obviously a disease of much besides the blood, but until further knowledge of its essential nature is obtained it is convenient to keep the conventional term of classification.

Ætiology.—Addison was the first to describe an idiopathic anæmia of severe type progressing to a fatal termination. Since his time the existence of such an entity has been called in question, and some types of severe anæmia have been successfully differentiated; but there remains a group which has certain well-defined characteristics, for which it has been found impossible to assign a cause, and which as a rule progresses steadily, through with remissions, to a fatal issue. The disease is found in all civilized countries. There is reason to believe in a family predisposition, manifested in several members of one or more generations. The disease is met with in all classes. It is chiefly one of middle life; indeed, it is doubtful whether the grave anæmias of children belong to the same category. Males are much more commonly affected than females, in the proportion of two to one. It is found alike in those who have suffered a variety of illnesses and in those who have enjoyed robust health. There is no known cause of the disease. Hunter has emphasized that oral sepsis is the cause of the anæmia, but in our opinion the latter is too frequent a phenomenon to permit us to regard the former as more than a contributory cause. Achlorhydria is a constant phenomenon. It is maintained by some authorities that it is the essential underlying cause both of the anæmia and of the combined degeneration of the cord, and that the family predisposition to these diseases, noted above, is due to the existence of a familial achylia gastrica. The recent work of Minot and Murphy on the therapeutic benefits of non-protein, iron-free extracts of mammalian liver suggests that these have a specific action on the production and maturation of erythroblasts in the bone-marrow, and would appear to indicate that the disordered hæmopoiesis is of the nature of a "deficiency disease."

Pathology.—The morbid anatomy is for the most part unilluminating. The body is not as a rule wasted to a marked degree; all the internal organs are bloodless, but in other respects are normal to the naked eye. There are often a few petechial hæmorrhages in the serous membranes, and there is a marked degree of fatty degeneration of the heart muscle ("tabby cat" striation). The striking feature of all cases of idiopathic anæmia is the deposit of free iron in the tissues of the body; the liver and kidneys show this phenomenon best, but it is often present in the heart-muscle, in the suprarenal bodies, in the mucosa of the intestine, in the spleen, and in the bone-marrow. This "Prussian-blue" reaction is so characteristic of the true pernicious anæmia that where it fails the diagnosis must be held doubtful. The bone-marrow is usually of a deep red colour, due to erythroblastic activity. The cells present are for the most part large nucleated red cells, which are greatly in excess of those formed in normal marrow; but general activity of all varieties of cell is marked. Besides these changes there is generally little or nothing to attract attention. The lymphatic glands are seldom enlarged.

Symptoms.—The onset of the disease is slow and insidious; the patient can rarely assign an exact date to the first beginnings; he has only slowly become conscious of failing strength, or of breathlessness on exertion, or that his friends have commented on his appearance, which at once suggests the nature of the disease. The complexion is waxy, with a faint lemon-yellow tint, sometimes most apparent in the sclerotics. The lips and gums are bloodless, and there are often slight hæmorrhages from the mucous

membrane of the mouth. On examination small petechial hæmorrhages may be found in the skin, and in the majority of cases in the retina, and sometimes in the conjunctiva. Epistaxis is not uncommon; but other hæmorrhages are rare. Œdema of the feet and ankles is often present. The muscular weakness is extreme, and the mental condition dull. Physical examination does not add much to these signs. A relatively good state of nutrition, combined with pallor, is very characteristic. Cardiac murmurs are often present, and the heart may show some slight degree of dilatation. The spleen is palpable in about a third of all cases, but rarely reaches any considerable size. Fever is generally present at some time during the course of the illness, but is seldom high; it is often of an intermittent type. Sore tongue is common. Diarrhœa is a frequent feature, and is sometimes intractable. The urine is of a deep colour due to the presence of urobilin. In about half the cases there is, especially late in the disease, evidence of the existence of a combined lateral and posterior degeneration of the spinal cord, revealed by sensory disturbances of the lower limbs, and by paralysis and ataxia, often associated with spasticity. The nervous phenomena may precede the development of the anæmia.

The blood of such a patient shows striking characters. The number of the red corpuscles is always low, often less than 1,000,000 per c.mm., the shapes and sizes of the cells are varied, but increase of cells above the normal size is very characteristic; the staining reactions abnormal; and there are always present nucleated red corpuscles, both normoblasts and megaloblasts. A certain number of reticulocytes may sometimes be present, especially associated with periods of remission and also after the commencement of liver treatment. The hæmoglobin is diminished but usually in much less proportion than the corpuscles, so that the colour index is high; nearly always above 1, and sometimes reaching as much as 2, or even higher. The white cells are diminished, the diminution being due chiefly to the decrease in the number of the polymorphonuclear cells; a common figure is from 2000 to 4000 per c.mm. The blood-platelets are generally diminished in number, but the coagulability and the bleeding-time are usually normal.

A feature of the disease is that the gravity of the case does not correspond to the severity of the blood disorder. It not infrequently happens that the patient may feel better and even fairly well, less breathless and able to walk, or even to do a little light work, with at the same time a blood-picture characteristic of the disease. Vice versa the condition of the blood may be improving steadily towards a normal state while the patient is obviously going fast downhill.

Another curious phenomenon is the occurrence of blood-crises, in which the peripheral circulation is flooded with nucleated red corpuscles for a few days, and the numbers of the corpuscles and the ratio of the hæmoglobin take an upward bound.

Diagnosis.—The accurate diagnosis of this disease is difficult without the frequent aid of skilled laboratory assistance. There are several anæmias of a severe type which a careful examination of the blood can alone differentiate from idiopathic anæmia. Certain cases of infective endocarditis, of septicæmia, of gastric cancer, or of parasitic intestinal disease show symptoms which offer a close resemblance to those of idiopathic anæmia. On the other hand, from time to time there occur cases in which the blood-picture is that

of idiopathic anæmia, but the general symptoms and the course differ widely. To sum up: any severe anæmia which presents the blood-picture characteristic of pernicious anæmia, without any discoverable reason, should be considered to belong to this category, and the prognosis and treatment adjusted to the diagnosis.

Prognosis.—While the course and duration of a typical pernicious anæmia are on the whole progressive and short, there is no doubt that patients suffering from this disease have remissions, during which they not only are able to resume their ordinary life, but their blood often returns almost to a normal condition. Such remissions are usually brief, and a duration of two years is about the usual limit. Death generally occurs as a result of the increasing exhaustion; and the last stages are frequently those of coma. Recovery is exceptional, but does occur with some frequency. It is, of course, always open to the objection that the patient who recovers was not really suffering from Addisonian anæmia, but in late years the careful diagnosis of these cases has lessened the value of this criticism. In a disease in which remissions and relapses are so common it is difficult to estimate the proportion of true recoveries, but it is certainly as high as 10 per cent. and may be as much as 20 per cent.

The foregoing paragraph, written some three years ago, must now be considerably modified in view of the remarkable results of the treatment with liver and extracts of liver. It can be stated with confidence that a patient suffering from pernicious anæmia, if he is able to assimilate liver or liver extract, can expect a rapid return to a fairly normal life, so long as he continues the treatment. The beneficial effects of the treatment are generally established at once, and within a period of two months the red blood-corpuscle count will have reached from 4 to 5 millions per c.mm., with a cessation of other symptoms and a restoration of muscular and mental power. An exception must apparently be made in the case of patients who at the beginning of the treatment have already shown signs of involvement of the nervous system. Subacute combined degeneration of the cord is probably not influenced by the treatment.

Treatment.—Attention should, of course, be paid to all possible sources of sepsis, such as in the mouth, the tongue and the fauces; but in severe cases it is better to delay any operative procedure until the condition has begun to improve.

The treatment of pernicious anæmia has been revolutionized by the discovery of the remarkable effect of a diet of mammalian liver. The quantity required appears to vary with individuals, but it is best to aim at the absorption of half a pound of liver daily. It may be administered by any method, raw or cooked, palatable to the patient. According to Minot and Murphy, however, it should not be subjected to prolonged boiling. Liver extracts have now been prepared by several of the well-known chemical houses, and have been proved equally efficacious with the raw liver. They are more easily administered, as they are in the form of a deliquescent powder, soluble in hot water. The resulting liquid can be flavoured to the patient's taste. The dose of these extracts is stated in terms of the quantity of raw liver from which they have been prepared, and should be the equivalent of at least half a pound daily. The chief difficulty encountered is to secure that the patients shall take and assimilate the required amounts. In some cases

it is necessary to begin with less than the desired amount and to increase the dosage gradually. The progress can be best estimated by an enumeration of the reticulocytes, which increase in number by leaps and bounds; but in most cases a sufficient indication can be secured by frequent estimations of the numbers of the erythrocytes. The liver treatment should be continued after restoration to apparent health, since it is probable that, though it so favourably affects the anæmia, it does not attack the unknown underlying cause. Patients in the convalescent stage should take the liver extract three days in each week; and in most cases will require to do so permanently. As regards other items of the diet, so soon as the general condition allows, the patient should receive a generous allowance of fresh meat, fresh fruit and vegetables.

The achlorhydria, which is a common feature of the disease, is best treated by dilute hydrochloric acid, 1 to 2 dr., in water three times a day (*vide* p. 527). Some authorities consider this drug as an essential part of the treatment, to be continued indefinitely. Transfusion with whole citrated or defibrinated blood is a valuable method of treatment in most critical cases. It seems to be better to give two or three transfusions of moderate amounts, 150 to 250 c.cm., rather than larger single quantities. Some physicians have found splenectomy to be effective in rescuing patients in the last stages of exhaustion. It is most successful in patients in whom the spleen is definitely enlarged. In view of the results of liver treatment, this method of treatment will, however, probably disappear.

Anæmia Gravis of Children

The type of pernicious anæmia described above occurs in children with extreme rarity; so rarely that a critical examination of the records reveals less than a dozen cases which could be so classified with any degree of confidence. Anæmia, however, of a similarly severe and usually fatal type is not uncommon below the age of puberty, and possibly may be the same disease. It is often recorded under the title of "Aplastic Anæmia," but since this is an appellation which is suitable to, and has been employed for, a variety of widely different conditions, it is preferable to speak of it as "Anæmia Gravis."

Pathology.—Regarding pathogenesis, there is nothing to add to what has been said in the preceding section, except that the phenomena of spinal cord degeneration have not been observed in the child. The *morbid anatomy* of the fatal cases is similar to that of the pernicious anæmia of adults; the striking difference is in the condition of the bone-marrow; instead of the reddish tint there is a complete absence of colour, the usual red marrow being replaced by yellowish fat throughout the length of the bone.

Symptoms.—Like pernicious anæmia, the onset is insidious, with lassitude, breathlessness and steadily increasing pallor; there is the same "lemon-yellow" tint of the skin and sclerotics; the same marked diminution in the number of the red corpuscles; and the same leucopenia. On the other hand, the hæmoglobin is destroyed more rapidly, so that there is a low rather than a high colour index; and the nucleated erythrocytes, which are so striking a feature of the blood-picture of pernicious anæmia, are in the child almost

entirely absent. The tendency to submucous and subcutaneous hæmorrhage is in both pronounced; retinal hæmorrhages are common; but hæmorrhages, other than epistaxis, of any degree of severity, are as uncommon as in the adult disease. As in pernicious anæmia, fever is present at some period in the course of the illness, but it is a less striking feature; rarely there is an intermittent pyrexia, with comparatively high peaks of 103 to 104. The teeth, tongue, gums and fauces do not generally present the inflammatory lesions which are common in the adult; but, as in pernicious anæmia, the spleen usually is moderately enlarged. Diarrhœa is not seen, and the urine does not, as a rule, show the urobilin which is common in the adult.

Course.—The course of the disease is similar to that of pernicious anæmia, the difference being that the remissions which are not uncommon in the adult are rare in the child, in whom steady deterioration to a fatal issue is the rule. But just as there are cases of typical pernicious anæmia which after a period of severe cachexia ultimately recover completely, so in children a condition, which in many respects resembles the severest type of the disease, after some months progresses to health.

Treatment.—This is the same as in adults, but so far liver treatment has not seemed to give the remarkable results obtained in the adult form of the disease.

SICKLE-CELLED ANÆMIA

Definition.—A severe anæmia, characterized by the appearance in the blood of a number of red blood corpuscles of a peculiar sickle shape.

Ætiology and Pathology.—Up to the present time the disease has been observed only in the negro. It is hereditary and familial. In the affected families some members who have sickle cells in their blood do not suffer from anæmia. The disease usually dates from infancy. Of its essential cause, nothing is known. The post-mortem appearances do not throw any light upon the pathology.

Symptoms.—The patients are obviously anæmic, and the sclerotics exhibit a greenish-yellow tinge. The liver is bulky, but the spleen is not enlarged. The disease is characterized by intermittent paroxysms of fever, up to 103 or 104 degrees, with severe stabbing pains in the muscles and joints, which last for two or three weeks. In the intervals, the patients suffer but little, though they are listless and depressed. The red blood corpuscles in the intervals reach to a number of about 3,000,000 per c.mm., but during the paroxysms they rapidly fall to less than half that number. The white cells are usually about 15,000 per c.mm., but may rise to as much as 40,000. The sickle-shaped corpuscles are in varying numbers. They appear to increase in number on a warm slide. The coagulation-time, the bleeding-time, the fragility of the corpuscles, and the numbers of platelets are all within normal limits.

Course and Prognosis.—The course of the disease is slow but progressive, and death usually occurs before the age of thirty.

Treatment.—Up to the present time, no treatment has appeared materially to influence the progress of the disease.

CHLOROSIS

Synonym.—Green Sickness.

Definition.—A disease, peculiar to young women, characterized by an anæmia due essentially to a diminution in the amount of hæmoglobin.

Ætiology.—It is a disorder of girls at or near the age of puberty, and of young women. It is said to occur in boys also, but this is extremely doubtful. It is a disease of civilized races, and is more common in the town than in the country. Heredity and family influences play no part in its production. It is most common in the ill-fed and overworked factory hand, who has to spend long hours in close rooms at a period when her growth and development are making the greatest demands on her strength; but these are not essential conditions, as is evidenced by its occurrence among the girls of wealthy families living under the best conditions. Many other causes have been alleged, such as tight-lacing, neglect of the teeth, improper food, habitual constipation, and emotional disturbances, for instance the pangs of unrequited love; but when all is said, the real cause remains undiscovered. What is certain is that, whatever be the reason, the disorder is much less common in the last ten years than it was previously. The age at which it usually makes its appearance is between the fifteenth and the twentieth year of life.

Pathology.—The hypotheses published on the pathology of chlorosis are as numerous and as ill-supported by good evidence as are the guesses at its causation. About the only remark which can safely be made on this head is that measures directed to the cure of the anæmia usually result quickly in the disappearance of all the symptoms of the disorder; in the present state of knowledge it remains a primary anæmia.

Symptoms.—The chlorotic girl is usually well-developed, even fat. Her pallor is striking both in its degree and in its peculiar greenish tint, from which the disorder derives its name. The mucous membranes have scarcely a tinge of colour; the sclerotics are bluish; and there is often a slight œdema of the skin of the face, giving it a puffy appearance. The patients complain of breathlessness, of swelling of the feet and ankles, of fainting attacks, of irritability of temper, and of low spirits. Headache, pain after food, and constipation are often present; and there is nearly always disturbance of the menstrual functions, either amenorrhœa, or less commonly menorrhagia; there is usually also exaggeration of the symptoms at the menstrual periods. Epistaxis sometimes occurs, but as a rule there is no other tendency to hæmorrhage. The appetite is variable and there is often caprice for unusual forms of food or drink. The patients may take large quantities of acid liquids; or eat indigestible materials such as chalk or earth. Pain in the stomach, eructations and vomiting are common. The hydrochloric acid of the gastric juice is commonly increased.

The blood is pale and watery, its total volume increased by an abnormal amount of plasma; the red corpuscles usually somewhat decreased in number to 4,000,000 or less, the hæmoglobin 50 per cent. or less of the normal; and the leucocytes remain in normal or in slightly increased number, the increase if present being due to the polymorphonuclear cells. Under the microscope, the red corpuscles are of various shapes and sizes, and take

stains capriciously (polychromatophilia). Nucleated red corpuscles are uncommon, and abnormal forms of leucocytes are very rare.

The heart is usually dilated to a moderate degree; and palpitation and præcordial pain are common. Pressure over the apex of the heart is often very painful. On auscultation a systolic murmur is frequently present—often at the apex but nearly always at the base of the heart—the so-called hæmic murmur. Over the jugular vein at the root of the neck a loud, harsh, continuous murmur, the *bruit de diable*, is heard. This murmur, though most often found in chlorotic patients, is not peculiar to this disease, for it is found in other forms of severe anæmia.

Chlorosis is an afebrile disorder, but in exceptional instances there is a slight rise of temperature, easily controlled by rest.

Complications.—The only complication met with in chlorosis is thrombosis of veins, and this is rare. The vein most frequently involved is the femoral; but there are records of thrombosis of the longitudinal sinus and even of the veins of the retina. Whenever a large vein such as the femoral is thrombosed there is a possible risk of pulmonary embolism.

Diagnosis.—Usually the condition can be recognized at a glance, and the only error at all likely is to mistake the early anæmia of tuberculosis or of Bright's disease for the simple anæmia. The failure of treatment quickly corrects this mistake.

Prognosis.—There is no disease which is more amenable to treatment than chlorosis, and though in a few cases recovery may be delayed for some weeks it is usually complete and permanent. Recurrences are not very common.

Treatment.—It is almost permissible to speak of iron as a specific drug in the treatment of chlorosis. It may be given in any easily assimilable form: reduced iron, citrate of iron and ammonium, Blaud's pill, or one of the ferruginous waters. Arsenic is also of value. Apart from iron, the physician must pay attention to the relief of the constipation, and for this there is no better remedy than aloes. To these remedies it is only necessary to add rest in bed for a severe case, and fresh air and moderate exercise for the convalescent. The diet should be simple and such as does not lead to the symptoms of indigestion. It is not necessary to give any cardiac tonics, and in fact it is wise to avoid any mention of dilatation; the chlorotic girl is only too ready to diagnose heart disease for herself.

LEUKÆMIA

Definition.—A disease characterized by increase of one or more of the leucocytic elements of the blood.

Ætiology.—The predisposing and exciting causes of the affection are equally unknown. It is recognized in all civilized countries, and in them affects all races; there is no evidence that it is inherited—indeed, healthy children have been born of mothers suffering from the disease—nor is it a family affection. It occurs at all ages from infancy to old age: at least three-quarters of the lymphocytic type occur in children under 10 years of age, whereas the myelocytic form is found predominantly in adults; the two sexes are affected about equally.

A possible conception is that the hæmopoietic system is liable to attack by a variety of toxins having affinity for different portions of the system, manufactured within the body in morbid conditions whether these are of bacterial origin or not.

As to the exciting cause of the disease we are ignorant. If the acute form be studied alone it is difficult to resist the conception of an acute infection. However, in spite of the occasional discovery of streptococcal infection, it is agreed that there is no positive evidence; and at present no other parasite has found acceptance. Moreover, however plausible such an explanation may be for the acute form, it leaves us without an adequate hypothesis for the more chronic type, and in our view no explanation which would separate the two groups can be satisfactory.

Types of the Disease.—The disease is met with principally in two forms, distinguished from each other by the usual course of the illness as well as by the characteristic alteration of the blood. These two types are called—(*a*) the myelocytic type, and (*b*) the lymphocytic type. These will be described separately, but it is necessary to mention briefly some other varieties about which there has been and there still is considerable diversity of opinion.

Mixed leukæmias.—This term is frequently employed to indicate those cases of the affection in which neither the myelocytic nor the lymphocytic type appears to predominate. It is, however, a mistake to make use of a term which merely serves to confuse further a subject already presenting much difficulty in classification, and it is best to adopt Cabot's rule that where there is a large proportion of granular cells, polymorphonuclear, eosinophil, basophil or myelocytic, the designation should be "myelocytic leukæmia," even though the percentage of non-granular forms is high.

A-leukæmic leukæmia.—This cumbrous and contradictory title is given to cases of the disease which run their course without any increase in the total number of leucocytes circulating in the blood. Such cases are uncommon, and it is more usual to find the initial fall in the numbers is only temporary and there is a steadily increasing preponderance of myelocytes or of lymphocytes. The clue to the right appreciation is given by a close study of the forms of leucocytes which are present. Thus in a boy with only 6300 leucocytes a differential count showed that 85 per cent. of these were lymphocytes. In some few of these cases the diagnosis remains uncertain until death, when the leucocytic infiltration of the organs usually gives the required information. Instead of the title used above it is preferable to speak of leukæmia without leucocytosis.

Aplastic anæmia.—This is another term which has been unfortunately employed to denote the absence of leucocytosis in a disease which otherwise has most of the features of leukæmia. The conception which underlies the name is that the hæmopoietic system has been so paralysed that it has entirely ceased to produce the elements of the blood. This condition, however, is not confined to leukæmia, but occurs in other forms of anæmia. The majority of cases which have been published with this title are probably instances of leukæmia without leucocytosis, but they also include unusual types of pernicious anæmia, and possibly some few cases of the most severe type of purpura hæmorrhagica. It is a disputable point whether there is any form of severe rapidly fatal anæmia other than these three diseases, but

the more closely the records of the cases are scrutinized the less reason there appears for the introduction of a new type.

The term "leukanæmia" has also been employed to describe cases of this type: and "pseudo-leukanæmia," specially on the Continent, denotes the same group.

There is a small group of cases in which the changes in the blood are those of leukæmia, myelocytic or lymphocytic, but the nature and growth of the glandular swellings resemble those of a neoplasm. They fall into two divisions —(*a*) chloroma; (*b*) sarcomata originating in the lymphoid tissues of one or other of the glandular organs of the body. These growths are rare and should in the present state of our knowledge be separated from leukæmia.

Pathology.—The view adopted here is that leukæmia is one disease, affecting the whole hæmopoietic system, marrow, glands, spleen and lymphoid tissues of the viscera, with special incidence on one or other of these structures in different cases. The more closely the different types are studied the more clearly does the essential similarity appear. The older conception of two sharply differentiated types, myelogenous and lymphogenous, arising respectively in the bone marrow and the lymphoid tissues, was urged by Ehrlich and his pupils, but it is now generally agreed that both types are myelogenous, and that the various types of cell probably originate from one primitive marrow-cell.

The hypothesis that leukæmia is of the nature of a malignant new growth of the system does not appear to be tenable, if only because it fails to offer any explanation of the cases of fulminating leukæmia, in which death occurs in a very few days.

The changes which are found in the body are almost confined to the hæmopoietic system, and to the lymphoid tissues of the organs. The bone-marrow is unusually red in colour, and in the myelocytic type verges on a purple tint. Microscopically, there is an abundance of mononuclear non-granular cells in all types, and in the myelocytic variety a large number of fully-differentiated granular cells. There is also a marked increase in the number of nucleated erythrocytes.

The blood is often of a greyish colour, due to the preponderance of leucocytes, and the serum opaquely milky. The spleen is always enlarged and in the myelocytic type is often larger than in any other disease, and not infrequently contains large pale infarcts consisting of agglomerations of leucocytes; or of degenerated tissue, partly caseous, partly hyaline.

The liver is large, firm and of a pale yellow tint, or mottled with small whitish areas. Microscopically, the periportal and capillary spaces are thronged with leucocytes, myelocytes in the one form and lymphocytes in the other. In the more acute cases these deposits are more scattered, and considerable search will be necessary to find them.

The kidneys are large and sometimes mottled with hæmorrhages. Under the microscope the interstitial tissue is so crowded with the myelocytic or lymphocytic cells as occasionally to obscure the structure of the organs.

The lungs also show the same microscopic characters, especially under the pleuræ, and the heart muscle, besides the fatty degeneration which accompanies any form of severe anæmia, shows similar patches of infiltration.

Petechiæ are often found in the pericardial and pleural membranes, and

occasionally in the mucous membranes of the intestine, but extensive hæmorrhages are unusual. A special type of hæmorrhage is occasionally seen in the retina, constituting "leukæmic retinitis."

Onset.—Clinically there are two types of onset—the acute and the chronic. The rule, though with exceptions, is that the more acute the onset the more likely is the disease to assume the lymphocytic form, and the chronic cases are for the most part of the myelocytic variety. There are, however, acute cases of the myelocytic type, and even more frequent, especially in older patients, are the chronic cases of the lymphocytic variety. It is also true, that the classification of the chronic cases usually presents little difficulty, and that the "atypical" cases are of acute onset and course. The terms "acute" and "chronic" are arbitrary, and their use is determined by (*a*) the mode of onset, and (*b*) by the duration of the illness, which in the acute form rarely exceeds 3 months.

A. MYELOCYTIC FORM.—**Symptoms.**—The patient seeks medical advice either for the increasing lassitude and breathlessness, or for the enlargement of the abdomen, due to the increasing size of the spleen. The anæmia at this stage is not marked; indeed, the appearance is not seldom one of good health. Pain is sometimes felt in the left side and would appear to be due to the dragging weight of the enlarged spleen. The only other symptom at all common is some degree of discomfort after meals.

On examination the striking feature is the size of the spleen. It occupies the greater part of the left side of the abdomen, often reaching the iliac crest and the middle line at the umbilicus. It forms a hard, smooth tumour with rounded edges, not tender to palpation, and easily recognized by the characteristic notches in the anterior margin. The size tends to vary in the course of the disease; sudden enlargement is due to hæmorrhage or infarction; and marked diminution nearly always occurs with the approach of death. The liver is always larger than normal, but usually the enlargement is moderate. The lymphatic glands are usually palpable in the neck, axillæ and groins, but rarely form any considerable masses.

Fever is commonly slight and there are often long periods of normal temperature, interrupted now and then by small rises of short duration to 101° to 103° F.

The blood.—The principal characteristics are progressive loss of hæmoglobin and of red corpuscles, and increase, frequently enormous, of the leucocytes. A large part of this increase is due to the presence of myelocytes, though all the other varieties of leucocytes share in it. A typical blood count is the following: Red corpuscles, 3,240,000 per c.mm.; white corpuscles, 452,000 per c.mm.; hæmoglobin, 50 per cent.; colour index, 0·7.

Differential count of leucocytes.—Polymorphonuclear cells, 171,700; lymphocytes, 45,200; large mononuclear leucocytes, 6100; eosinophil leucocytes, 8000; basophil leucocytes, 7000; myelocytes, 214,000.

In this instance there were also present a large number of nucleated red corpuscles, both normoblasts and megaloblasts—a common but not invariable feature. There are numerous minor changes in shape, size and staining reactions of the cells.

Although the above count is typical, there is a wide variation in the actual figures. In the later stages, there is much more anæmia, and often very great and sudden alterations in the number of the leucocytes. These may sink

almost to normal, or may exceed the numbers of red corpuscles, reaching a total figure of 1,500,000, or even more. The characteristic cell, the myelocyte, however, almost always forms a large proportion of the leucocytes present.

In the acute cases there is a greater tendency to hæmorrhage, and the blood count shows a greater degree of anæmia, and a smaller number of leucocytes, but with the characteristic cell predominating. The spleen is often very little enlarged, and until the blood is examined the picture is rather of an acute anæmia of the pernicious type than of a leukæmia.

Course and Prognosis.—It is not unusual for the disease to reach a stage in which there is little or no progress, and for months or even for years the patients suffer little inconvenience from their affection. The writer knows of one instance where the pause was prolonged for nearly 7 years, and the patient earned his living as a tram-driver without hindrance, although the spleen remained large and the blood showed the characteristic changes. In a few cases the improvement goes further, and a complete remission occurs with disappearance of the spleen beneath the ribs, and return of the blood to normal conditions. As a rule, however, these remissions are not of long duration, and the patient becomes weaker and more anæmic, and dies either from exhaustion or from some intercurrent infection. A few instances are on record of death from intestinal or gastric hæmorrhage. The average duration of a large number of cases is 3 to 4 years, but some patients survive for 10, 12 or even 15 years.

The duration of the acute cases is as a rule much shorter; the patients go rapidly downhill and die within a few weeks of the onset. Even in such cases, however, remissions occur, and life may be prolonged for several months.

B. Lymphocytic Form.—**Symptoms.**—In the majority of instances of lymphocytic leukæmia the onset is acute, with bleeding from the gums and the nose, and with petechiæ in the skin. This is accompanied by a rapidly increasing anæmia, and often quick enlargement of the lymphatic glands of the neck, or less frequently of one of the other groups of glands. In the chronic form, more frequent in adults, the onset is more often signalized by enlargement of the glands than by anæmia and hæmorrhages, which with the other symptoms are often late in appearing. The widespread involvement of the lymphatic glands often affords a striking contrast to the comparative absence of enlargement in the myelocytic form of the disease.

The hæmorrhages occur in any of the mucous membranes, but those of the mouth and nose are most common, together with the profuse petechiæ scattered all over the body. Retinal hæmorrhage is common; and hæmorrhage from the urinary tract frequent though seldom severe. Hæmorrhage into the meninges is not rare towards the end. Hæmorrhage into the semicircular canals has been known to produce Ménière's symptoms.

The glands at the angle of the jaw are enlarged, soft, not adherent to the skin, and tend to vary much in size. The axillary and inguinal groups are usually unduly palpable, though seldom forming masses; and during life it is uncommon to be able to detect any enlargement of the abdominal groups though post-mortem these are always of considerable size, and often hæmorrhagic.

The liver is always enlarged, sometimes to a considerable size, but the spleen is often small, though it can always be recognized. In exceptional cases it may even reach the level of the umbilicus.

Fever is always present, and sometimes remains throughout at a high level, but is more often intermittent in type. The patient is restless, breathless, often in a "typhoid" state, unconscious and suffering from a profuse diarrhœa.

An occasional remarkable symptom is the development of lymphoid deposits in the skin, similar to those found in lymphadenoma; and a bi-lateral enlargement of the parotid and lachrymal glands occurs. ("Mikulicz's Syndrome.")

The principal characteristics of the blood are the steady fall in the total number of the red corpuscles and of the hæmoglobin, and the extraordinarily high proportion of lymphocytes in the increased number of white cells. The total numbers of these latter seldom reach the figure common in myelocytic leukæmia. Counts below 50,000 per c.mm. are usual, and those above 200,000 are rare. Often, and especially in children, the total white count is actually below normal, 6000 per c.mm. or less. It is the differential count, however, which marks the distinction; instead of the granular myelocyte, which in the myelocytic form occupies the chief place, the non-granular "lymphocyte" here forms from 70 per cent. to 99 per cent. of the leucocytes present. The precise nature of the "lymphocyte" of acute leukæmia is uncertain; it is not the lymphocyte of the normal blood, and is probably (Cabot) "a marrow rather than a lymph-gland cell," termed by some "myeloblast." Some authorities speak of "large" and "small" lymphocytes, and have attempted to correlate their predominance with special types of the disease; but all that can be said with certainty is that the greater the predominance of the "large" form the more acute is the leukæmia.

Diagnosis.—The recognition of leukæmia is not as a rule difficult. In the commonest type of the disease, the splenic tumour can hardly be mistaken. Both kidney tumours and tumours of the intestines are quite unlike it, both in general shape, outline and in position, and in any case of doubt the most cursory examination of the blood will at once give the proper clue. The only disease which in the least resembles chronic myelocytic leukæmia is anæmia pseudo-leukæmica infantum, and here the age of the patient and the result of a careful examination of the blood are sufficient distinctions. Nor is it easy to mistake acute lymphocytic leukæmia, provided the blood be examined, though here there are certain sources of error. In pertussis there is a marked lymphocytosis, occasionally reaching figures of 100,000 or more. In some few cases of sepsis instead of the expected polymorphonuclear leucocytosis there is a lymphocytosis; and in a few cases of generalized sarcomatosis there is an excess of lymphocytes in the circulating blood. The real difficulty occurs with the atypical forms, and in a few of these it may be impossible during life to make an accurate diagnosis. The characteristic microscopical changes in the organs and the bone-marrow found post mortem are nearly always decisive. The most acute cases of purpura hæmorrhagica are distinguished by the absence of the abnormal types of leucocytes, and by the diminution or absence of the blood platelets. Briefly it may be laid down wherever there is, even in the absence of a leucocytosis, a predominance of abnormal cells, whether these be myelocytes or "lymphocytes," to the extent of 25 per cent., or over, of the total, the disease is leukæmia.

Course and Prognosis. The more acute the onset, the shorter is likely to be the duration. Some cases are fulminating, the passage from health

to death occupying less than a week. The majority of patients die within 3 months, of hæmorrhage, weakness and intercurrent infection.

The total duration of the chronic type is usually under a year, but occasionally life may be prolonged for several years. Remissions of the kind met with in myelocytic leukæmia occur but rarely, and recovery is probably unknown.

Treatment.—The treatment of leukæmia is empirical, and the reported successes to a considerable extent invalidated by the fact of the natural "remissions." In the acute forms as a general rule the end comes swiftly, and no therapeutic measure hitherto employed has seemed to do more than defer the fatal issue. On the hypothesis that the disease is a toxæmia, the most benefit might be expected from the use of remedies of the antiseptic and antimicrobic order. Naphthalene tetrachloride in doses of 30 grains a day appeared to be efficacious in one desperate case, but has failed in others. Arsenic, iodides, iron, extracts of various organs, and various sera all seem to be useless. The use of human blood serum in doses of 10 or 15 c.c. intravenously each day undoubtedly helped, but did not save a patient of the writer's.

In the chronic myelocytic form there is more hope. There is now no doubt by the application of X-rays to the region of the spleen, and also possibly to the long bones, a considerable degree of benefit can be secured. The spleen diminishes in size, the anæmia is relieved, and the numbers of leucocytes in the circulating blood sink rapidly. In one patient, treatment of this kind, prolonged over a period of 9 months, reduced the number of leucocytes to less than 9000 per c.mm. with only an occasional myelocyte, and with marked improvement in strength and general health. The improvement was maintained for more than a year, but then relapse occurred, and the end came quickly. Other patients have derived even greater benefit, and it is certainly possible in the majority of cases to secure by this means a considerable prolongation of life, though there is no good evidence of a permanent cure. As regards drugs, arsenic is certainly useful, and should be used in large doses either intravenously or by the mouth. Excision of the spleen in this disease is a dangerous operation, but of late years has been performed with success in several cases, without, however, benefiting the patient otherwise than by the removal of a cumbrous tumour.

CHLOROMA

Definition.—A sarcomatous growth of marrow-like tissue with a green tint, invading the bones, especially of the skull, accompanied by changes in the blood resembling those of leukæmia.

Pathology.—The tumours show a vivid green tint which rapidly fades. They are found principally in connection with the bones of the orbit, the temporal and frontal bones, the vertebræ, ribs and sternum. Metastases have been found in the viscera and in the glands, and these do not always exhibit the typical green tint.

Symptoms.—It is a rare disease of insidious onset, the early signs being simply pallor and listlessness, and headache. The headache is due to the pressure of the tumours in the skull, which later produce deformity of the

temporal and frontal bones, exophthalmos, papillœdema, and swelling of the veins of the head, neck and face. Hæmorrhages occur from the mucous membranes. The lymphatic glands of the neck and axillæ are enlarged, and the spleen usually is palpable. Fever is usual, and rapid wasting occurs.

The blood shows the changes characteristic of leukæmia, usually of the lymphocytic type; but a few cases have been described where the predominant cell was myelocytic.

Diagnosis.—The only affection which can cause confusion is suprarenal sarcoma, which gives rise to similar tumours of the skull. The distinction is made by a blood examination.

Prognosis and Treatment are hopeless.

ATYPICAL CHLOROMATA.—In addition to the more classical type of chloroma, there sometimes occur cases of multiple tumours of bone which excite in the hæmopoietic tissues a "leukæmia" reaction. The reaction may be lymphocytic, myelocytic, or myeloblastic. The tumours are of the general type of sarcomata, and appear to originate in the bone-marrow. They may or may not show the green tint characteristic of true chloroma. It is remarkable that myelomata in general do not appear to possess the power of exciting this "leukæmic" reaction.

ANÆMIA PSEUDO-LEUKÆMICA INFANTUM (VON JAKSCH)

Synonym.—Splenic Anæmia of Infants.

Definition.—A disease of infants characterized by great enlargement of the spleen, a high degree of anæmia, and the constant presence of myelocytes.

Ætiology.—The affection is confined to the first 3 years of life, and the larger proportion falls within the first 2 years. The average age at which the patients come under observation is 18 months. It affects the sexes equally, and does not distinguish races, though Jews are said by some authors to be more liable. Heredity plays no part in the causation, but there is some evidence of family tendency. No predisposing cause is recognised. Rickets, congenital syphilis and marasmic conditions may be present, but do not appear to be determining factors. It is a disease of the poorer classes of the town population, and never, or rarely, affects the children of the well-to-do.

By some authorities it is held that any anæmia in an infant may pass into the present disease.

Relationship to other diseases.—The constant presence of myelocytes and the size of the spleen suggest an affinity to myelocytic leukæmia; but the whole course of the disease is so unlike that of leukæmia that it is clear it is a different disorder. However, in exceptional instances, the terminal stages have been signalized by an influx of lymphocytes into the circulating blood, producing the picture seen in acute lymphocytic leukæmia. Taken as a whole, the features of the affection seem to present the picture of an independent entity.

Symptoms.—The onset of the disease is always insidious, and by the time that the increasing pallor or enlargement of the abdomen has excited alarm the disease is fully established. Occasionally epistaxis or the appearance

of a petechial eruption is the earliest symptom. The pallor, often of a waxy kind, is always extreme. Emaciation is seldom marked; indeed the patients are not seldom fat. They are always listless and apathetic; the muscles are soft and flabby; and there is often some œdema of the feet and ankles. The trunk and limbs are spotted with petechiæ, which also are sometimes seen in the mucous membrane of the mouth. The abdomen is protuberant owing to the size of the spleen, which often reaches the iliac crest and the middle line of the belly. The organ is hard, smooth and free from tenderness. The liver is seldom much enlarged. The lymphatic glands do not often appear enlarged during life, though the superficial cervical or axillary glands are sometimes palpable; but after death it is usual to find the mesenteric group considerably larger than normal.

Besides the epistaxis and the petechiæ already mentioned, hæmorrhage is rare, but slight hæmaturia, traces of blood in the motions, and slight oozing from the gums have been observed. Fever, rarely above 102° F., of an irregular type, is usual, but is not a constant feature, and is of short duration. A fever which lasts more than two days is due to some complication, usually broncho-pneumonia. Diarrhœa occurs in about half the cases, and is intermittent and not often severe. But of the fatal cases the majority die either of broncho-pneumonia or of uncontrollable diarrhœa.

Blood.—The erythrocytes are diminished to 2,500,000 or 3,000,000 per c.mm., and show some slight alteration in shape and size. Nucleated cells are always present—sometimes in large numbers. The hæmoglobin shows a decrease to 20 per cent. to 40 per cent. of normal, so that the colour index is low, from 0·5 to 0·7. There is nearly always a leucocytosis at some time during the course of the disease, but it is moderate, rarely reaching above 30,000, and sometimes the number may sink as low as 5000. The feature of the blood film is the constant presence of myelocytes, which occur in numbers greatly above those found in any other disease except leukæmia, though seldom in numbers sufficient to suggest that disease.

Course and Prognosis.—The course of the disease is slow, but on the whole tends to recovery in 65 per cent. to 70 per cent. of cases. A fatal issue is usually the result of an acute diarrhœa or broncho-pneumonia, and apart from these complications recovery is the rule and is complete, the children regaining health and strength and rapidly returning to a normal growth and development. The duration is from 6 to 9 months. Recovery is accompanied by so great a diminution in the size of the spleen that it often can no longer be palpated in the middle of the third year of life, though in a few cases it may remain palpable for several years.

Treatment.—During the more severe and chronic stages of the affection all the usual measures to combat anæmia seem to be without result. The patients do best with abundance of fresh air and light, and should be nursed, if possible, in the open air. Careful dieting, with the use of intestinal disinfectants, such as salol in doses of 2 to 6 grains per diem, is indicated. Splenectomy has been performed with good results, but hardly seems necessary, since the majority of patients recover. It is probably a wise procedure in view of the great loss of hæmoglobin to give iron, although no immediate result should be expected. Pulv. ferri redacti grs. i–ij per diem is a suitable preparation.

PURPURA

Definition.—Purpura is the name applied to spontaneous extravasations of blood in and beneath the skin and mucous membranes, of unknown causation, more particularly to denote a disease in which extravasations are the chief symptom.

Classification.—It is convenient to divide the cases into classes :

(1) The secondary purpuras, those in which the purpura is a manifestation of a recognisable disease, and (2) primary or idiopathic purpura, where no other recognisable disease is present.

SECONDARY PURPURA.—In this group it is possible to recognize five subdivisions — (1) Infective, (2) cachectic, (3) toxic, (4) nervous, (5) mechanical.

1. *Infective purpura.*—In this subdivision must be placed, firstly, the hæmorrhagic types of the infectious fevers, hæmorrhagic small-pox, hæmorrhagic measles, and the like ; secondly, those fevers almost always accompanied by purpuric eruptions, for example, epidemic cerebro-spinal fever and typhus ; and thirdly, the symptomatic purpura which accompanies the pyogenic infections, for example, streptococcal endocarditis and other septicæmias ; and the hæmorrhages of severe jaundice.

It is probably correct to place in this section also " peliosis rheumatica " (Schönlein's disease), which is discussed later.

2. *Cachectic purpura.*—Purpuric eruptions are frequently met with in the cachexias of chronic Bright's disease, of carcinoma, and of the later stages of tuberculosis, and in children, in the cachexia of marasmus, and other chronic wasting diseases of nutrition. The purpuric spots found in scurvy, in leukæmia, in lymphadenoma, and the like may also be placed in this category.

3. *Toxic purpura.*—The iodides, bromides, antipyrine, and antitoxic sera occasionally produce purpuric eruptions.

4. *Nervous purpura.*—Purpuric spots and subcutaneous hæmorrhages sometimes appear in the course of certain diseases of the nervous system, for example in syringomyelia, and, it is said, in hysteria ; and perhaps it is correct to place the local asphyxias and gangrene of Raynaud's disease under this heading.

5. *Mechanical purpura.*—In old age slight injuries, in the ordinary way quite incapable of producing extravasation of blood, often produce blotches and spots beneath the skin of the hands and legs, and it is possible to consider the purpura of dropsical tissues and the hæmorrhages which occur in the conjunctivæ in pertussis as examples of mechanical purpura.

It is obvious that these divisions are arbitrary, and there is no hard-and-fast line separating them.

PRIMARY OR IDIOPATHIC PURPURA.—When the symptomatic purpuras have been put on one side there remains a large and important class in which no extraneous disease can be recognized, but which has as its principal symptom the occurrence of hæmorrhages in the skin and from the mucous membranes. The nature and course of the illness also serve to set it apart from the secondary purpuras. Till recent years it has been customary to divide idiopathic purpura into four classes, distinguished from each other by

the symptoms which are most prominent and by the course of the disease: (1) purpura simplex; (2) purpura hæmorrhagica; (3) purpura arthritica or rheumatica; and (4) Henoch's purpura or purpura abdominalis. Admittedly this division is purely arbitrary and it is often difficult to assign with certainty an individual case to any one group.

It has long been known that in purpura hæmorrhagica the blood-platelets are, at any rate in the more hæmorrhagic stages of the illness, notably diminished, and even absent; whereas in the other types here under consideration these bodies, though sometimes diminished in numbers, seldom reach so low an ebb as in purpura hæmorrhagica. Hence there has arisen the conception of an essential thrombocytopenic purpura, corresponding to the morbus maculosus of Werlhof, or purpura hæmorrhagica, distinct from the simple purpura, arthritic purpura and Henoch's purpura, which are grouped together under the name of "anaphylactoid" purpuras. The distinguishing marks of an essential thrombocytopenic purpura are held to be: (1) the marked diminution in the number of the blood-platelets; (2) an absence of the retraction of the clot; (3) an increase in the bleeding-time, with a normal or but slightly prolonged coagulation-time; and (4) a marked tendency to recurrence. These signs are said to be absent in the anaphylactoid purpuras, which on the other hand are closely allied to the urticarias and angio-neurotic œdema, so much so that a single patient may at the same or at different times suffer from urticaria, angio-neurotic œdema, painful effusion into joints, and a definite purpuric eruption.

This conception of the relationship of the different types of purpura is probably too precise, and there are clinical and experimental facts which make it difficult to accept. There are, in the first place, cases which would be accepted by all physicians as examples of hæmorrhagic purpura, which yet have not the alleged characteristic absence of thrombocytes. There are cases in which the thrombocytes are markedly deficient, and yet there is little or no bleeding. Further, there are cases which apparently pass from one group to another at different times; and there is apt to be just as frequent recurrence in the anaphylactoid as in the thrombocytopenic purpuras. In spite of these objections, however, the conception has been of considerable value, for it was the supposed malignant influence of the spleen upon the production or maturation of the platelets which led Kaznelson and others to recommend and practise splenectomy for recurrent purpura—a remedy which, though it has but little permanent influence on the numbers of the platelets, yet has apparently the power to abolish the tendency to bleed.

Pathology.—From what has been said it will be clear that there is as yet no accepted pathology of idiopathic purpura. That the platelets are concerned in the tendency to bleed is certain, not only from clinical but also from experimental observations (Bedson and others). But that their diminution alone is capable of inducing the hæmorrhages is known both clinically and experimentally to be an insufficient explanation. Experimentally they may be completely absent without any appearance of purpura. It would appear that we must still retain the older hypothesis of a lesion of the capillary wall, which allows of the escape, now of serum only (urticaria), now of hæmorrhagic serum, and now of the whole blood.

The following description of the disease as a whole, and of its main manifestations, has accordingly been retained, since it appears to agree more

with the observed facts than the newer conception of widely separated entities.

Symptoms.—The one symptom which all forms of the disease have in common is the occurrence of hæmorrhages in and beneath the skin. They usually occur early in the illness, but are sometimes preceded by general malaise, pains in the limbs and abdomen, and œdema of the feet or legs, and in the milder cases are confined to the lower limbs; but when more widespread there is no portion of the surface which escapes—the trunk, the face, the scalp and the neck are covered with the eruption. The latter usually bears some relation to the severity of the illness, but not always, for in some instances of serious or even fatal issue it is comparatively limited, and in some examples of widespread eruption the illness is short and not accompanied by any symptoms of grave import. The hæmorrhages are usually small, round spots, not elevated above the surface, and change their colour, which does not fade on pressure, from the bright red of their first appearance to purple or brown as they fade. Frequently successive eruptions present all shades of colour from bright red to a dingy brown in the same patient. The absence of elevation above the surface is the rule; but occasionally, as mentioned previously, the hæmorrhages occur in the form of papules or weals. The smaller spots are called "petechiæ"; the lines and streaks "vibices"; and the larger irregular patches "ecchymoses." These larger patches in rare instances become gangrenous and slough. Such gangrene occurs in the type known as "purpura fulminans."

The hæmorrhages occur with great suddenness and recur in crops, often for several days, or even weeks. Many patients are subject to recurrences every year, or the attacks may recur at shorter intervals, with intermediate good health. In the milder cases petechial spots in the mucous membrane of the gums, mouth or palate are not common, but in the more severe attacks they can nearly always be seen.

This cutaneous and subcutaneous eruption is the only sign which is common to all forms of the disease, though even in the mildest forms there is usually some degree of derangement of the general health; constipation, slight fever or complaint of pains fleeting over the body and limbs.

The blood is but little altered, even in the most severe cases. There is, of course, anæmia with severe or repeated hæmorrhage, but recovery is as a rule rapid. In the ordinary case the number of red corpuscles is a little lower than normal, the hæmoglobin likewise proportionately diminished, and the white corpuscles normal or slightly increased in number, as a result of a polymorphonuclear leucocytosis. There are no abnormal cells. The blood platelets are diminished in number, and in the severe types absent.

It is claimed that certain cases of gastrostaxis, of "essential hæmaturia," and of bleeding from the uterus, without further evidence of purpura, belong to this chapter of disease, and are benefited by splenectomy. In the opinion of the writer, however, the claim is not as yet substantiated.

Purpura Simplex.—This is the most common form of the disease.

Ætiology.—It is seen most frequently in children between the ages of 4 and 10 years, but is also found in both sexes and at all ages.

Symptoms.—Besides the eruption there is often very little to observe. Fever may occur at the onset, seldom above 100° F., slight malaise with possibly some indication of intestinal disturbance, constipation or diarrhœa.

The eruption is often confined to the lower limbs, and recurs with slight œdema each time the patient is allowed to rise from his bed. The duration of the attack is from 1 to 3 weeks; but it is this form which is so apt to recur.

Purpura Hæmorrhagica.—**Symptoms.**—In the cases which fall into this category all the above symptoms occur with the addition of hæmorrhages of greater or less severity from the various mucous membranes. The fever is often more prolonged, but seldom above 101° F., and the general signs of illness more marked. There is often vomiting at the onset, with slight hæmatemesis. The eruption is more widespread, covering the trunk and often the face and neck. Any of the mucous membranes may bleed, but the bleeding is not usually severe, rather a continued oozing than a free hæmorrhage. Epistaxis and oozing from the gums and mucous membranes of the mouth and throat are the most common; but the urinary and intestinal tracts may bleed as well. In the most severe cases the patient is in a pitiable condition, blood escaping freely from each orifice of the body, and the skin covered with large purple extravasations. Menorrhagia in the adult is frequent, and a dangerous symptom. Even in such cases, however, the prognosis is not hopeless, for, when improvement begins, recovery is as a rule rapid. There is often effusion, which is not bloodstained, into the joints, though this is not frequent in the severest type; it seems to occur most often in association with intestinal and kidney bleeding. In some instances, without hæmorrhage from the kidneys, there is evidence, in the albuminuria and in the presence of casts, of a nephritis; but this is exceptional, and generally is unaccompanied by œdema or deficiency of urinary excretion, and disappears with the termination of the illness.

Purpura Arthritica.—It is common to assume that there is a purpura intimately associated with rheumatic fever. That there are patients who in the course of rheumatism develop purpura is certain; but that there is a purpuric disease which has as its basis rheumatic infection is much less clear. Schönlein described "peliosis rheumatica": a purpuric disease due, he thought, to rheumatism, with hæmorrhages as a complication. Apart from the occasional case of rheumatic fever which develops a purpuric eruption, usually as a symptom of severe infection, or of cachexia, there is but little evidence that purpura and rheumatism are allied with each other. Few of the cases of purpura show endocarditis, and the general course of the affection is quite unlike that of rheumatism. The similarity is confined to the fact that both diseases are associated with effusion into the joints. Further, this effusion may occur in any of the varieties of purpura, and is by no means confined to those cases which have evidence of rheumatic infection. Lastly, the undoubted relationship of purpura with other exudative lesions, such as urticaria and angio-neurotic œdema, points to the fact that in its essence purpura is an exudative phenomenon, and an effusion into the joint-cavities is not therefore unexpected.

Henoch's Purpura.—**Ætiology.**—This variety of purpura is more common in children and young adults than in older people, and is apt to recur at intervals.

Symptoms.—The form of disease thus called is distinguished from the other varieties merely by the severe crises of abdominal pain, often accompanied by vomiting, diarrhœa with bloody stools, and prostration. Sometimes there is also an effusion into the joints as in the other types. The

eruption and the mucous hæmorrhages are similar to those already described. Clearly the division is artificial, and there must be border-line cases. Yet purpura with severe abdominal pain forms a distinct type of the disease. The crises of pain occur often before the appearance of the purpura, or may come on after the illness is already established. These attacks sometimes cause considerable difficulty in diagnosis, and operation has been performed for the relief of supposed intestinal obstruction, or intussusception.

The duration of the attacks varies from a few days to several weeks. Fatal results are rare; but death has been reported from intestinal bleeding and from cerebral hæmorrhage.

Diagnosis.—The diagnosis of purpura is not as a rule difficult. The secondary forms occur in conditions which as a rule are easily recognized. When these are excluded, the only difficulty likely to arise is that of distinguishing the abdominal pain of Henoch's type from other conditions which cause similar crises. In young children the diagnosis from intussusception may be impossible without an exploratory laparotomy, and in at least one instance purpura has been complicated by intussusception.

Prognosis.—There are three points to consider: the probable issue, duration, and the effect on the future health. With regard to the issue the prognosis, except in the fulminating hæmorrhagic cases, is good. Even severe hæmorrhagic cases get quite well. In any large series of cases the actual mortality is very small. As to duration it is difficult to prophesy, because of the marked tendency towards recurrence. Usually health is completely restored in a few months even after a severe attack. Recurrences may, however, go on for several months, usually in a milder form. The only legacy which idiopathic purpura is likely to leave is nephritis, and as already stated this as a rule passes away with the disappearance of the disease.

Treatment.—In the secondary purpuras, the treatment must be directed to the disease of which the purpura is a symptom; and since in many of these cases the occurrence of purpura is the herald of the later stages of a serious infective process, there is often but little that the physician can hope to accomplish.

In the milder cases of idiopathic purpura, rest in bed, with careful dieting and the administration of iron and arsenic, is usually all that is required, though the frequency of recurrences seems to demand more active interference. In the hope of influencing this tendency to recurrence, innumerable drugs have been employed, but on the whole without any appreciable effect. The newer conception of an "anaphylactoid" purpura has naturally led to attempts at "desensitization," but so far without striking results. The injection beneath the skin, or into the muscles, of normal serum is probably the most efficacious method of controlling these recurrences.

In the more hæmorrhagic types, local measures of checking bleeding may be employed wherever the source of the hæmorrhage can be reached. The older styptics are generally useless, but solutions of adrenalin spraved into the mouth or nose are certainly beneficial. Most of the more modern styptics, hæmoplastin and the like, are disappointing; and calcium salts are apparently useless, either locally or given by the mouth or intravenously. There are three methods whereby the tendency to bleed can be arrested. Normal serum injected either intravenously, or intramuscularly, in a number of instances has stopped the hæmorrhage and is always worth a trial. The

amount to be administered is from 10 to 30 c.cm. diluted with warm salt solution. It should be given on two or three days in succession. The danger of anaphylactic shock is practically negligible, unless when a period of ten days or more is allowed to elapse between the first and subsequent doses. The second method of proved value is blood-transfusion. Here again repeated small doses of 30 to 50 c.cm. appear to be more efficacious than single larger amounts; but in any case the amount must be measured by the condition of the recipient: if he is blanched from loss of blood, it should be from 300 to 600 c.cm.

Kaznelson and others, basing their proposals on the pathological conception of a deleterious action of the spleen on the blood-platelets, have shown that splenectomy exercises a remarkable influence on purpura; and undoubtedly wherever the disease is either severe or shows a marked tendency to disabling recurrences, the spleen should be removed. The effect in stopping the hæmorrhage is probably not due to the quite temporary increase in the number of the platelets which follows the operation, as it is now known that a reduction to a very low count often recurs in a few days without any fresh bleeding. Further, the success of splenectomy in the treatment of purpura is not confined to the thrombocytopenic group, but has been observed in the anaphylactoid group, *e.g.* Henoch's purpura, where the blood-platelets are present in normal or but slightly diminished numbers. At present, therefore, in any case of severe hæmorrhagic purpura, of whatever type, or in face of recurring attacks of a milder type, whether the spleen is or is not clinically enlarged, splenectomy should be considered as the most effective form of treatment.

OTHER HÆMORRHAGIC DISEASES

Besides purpura and hæmophilia there are a few other conditions in which spontaneous hæmorrhage occurs either into the skin or from the mucous membranes. These are chiefly met with in infants.

(*a*) *Hæmorrhage due to congenital syphilis.*—This is a rare occurrence. In the cases described the bleeding began about the third day of life, from the mucous membranes, from the navel, or into the skin. The bleeding was usually fatal, and visceral hæmorrhages were found after death.

(*b*) *Melæna neonatorum.*—Bleeding in this type usually begins about the third day of life, and is, as the name implies, usually from the bowel. Blood also may ooze from the mouth, nose, urinary tract, or may be extravasated into the viscera, or into the cavities of the body. It is not very uncommon; but the origin is quite unknown. In some cases acute gastric and duodenal ulcers have been found at autopsy, but it is more probable that these represent necrosed areas resulting from submucous hæmorrhages than that they are the origin of the hæmorrhage. Recently the subcutaneous injection of normal horse serum has completely altered the prognosis. If from 10 to 15 c.c. of serum be given subcutaneously each day the bleeding stops quickly and the infant makes a good recovery. Until this treatment was adopted the mortality was very high.

(*c*) *Epidemic hæmoglobinuria* (*Winckel's disease*).—A very fatal epidemic disease usually occurring among the new-born babies in lying-in institutions.

The onset about the third or fourth day, the fever, hæmorrhages and post-mortem appearances all make it probable this is a severe type of sepsis, though so far no organism has been incriminated.

(*d*) *Buhl's disease* is similar in its occurrence to the last. It is characterized by œdema, anæmia, hæmorrhages into the skin and from the mucous membranes, and death after an illness of a week or 10 days. Post-mortem examination reveals an advanced state of fatty degeneration of all the organs.

(*e*) *Hæmorrhage into the suprarenal capsules.*—In patients under 1 year of age such a condition is characterized by sudden onset, fever, vomiting and petechiæ in the skin; convulsions rapidly occur, and end fatally. Post-mortem examination shows, as the only prominent feature, bilateral hæmorrhage into the suprarenal bodies, which are dark purple and much enlarged. It is probably an infection though no organism has been demonstrated. The cases are uncommon and tend to occur in groups.

HÆMOPHILIA

Definition.—Hæmophilia is an hereditary disease of males, characterized by a tendency to uncontrollable hæmorrhage, either spontaneous or arising from wounds which in the normal person hardly bleed at all.

Ætiology.—In the majority of cases of hæmophilia the "bleeder" is one of a family in which other males have been affected, though there are on record isolated instances. More usually the family tendency is well known, and the diagnosis is made without the aid of a doctor. The main peculiarity of the disease lies in the mode of inheritance. The males of the family are alone attacked, and the transmission is exclusively by the females. To this rule there are according to some authorities exceptions; but the more closely these are studied the less authentic do they appear. Hence the diagnosis of hæmophilia in a female is not, according to the present view, permissible. Not all the males of a "bleeder" family suffer, nor do all the females transmit. The inheritance can be explained in terms of Mendel's laws, as a recessive characteristic.

The disease is one of the temperate zone, and nearly all the reported cases are of English, American or German origin. The Latin races are, it appears, rarely affected, though the French author Weil holds that it is not uncommon.

The phenomena make their appearance early, and persist throughout life.

The number of hæmophilic patients living is not apparently large at any time, and it is obvious, with the rule of transmission stated above, that there is a tendency for the disease to disappear from a family and to appear in some other hitherto unaffected. Family records are seldom reliable for many generations except in the direct male line, but there is one family in which the affection has been traced back for nearly 200 years. The Appleton family, which was the first adequately recorded, is apparently extinct.

Pathology.—Hæmophilic blood clots with greater difficulty than that of normal individuals, but the bleeding-time is not prolonged, as it is in purpura hæmorrhagica. While these facts are acknowledged, their explanation is unknown. The blood-platelets are present in normal number.

Symptoms.—The greater number of individuals who suffer from hæmophilia manifest the tendency early in life. In 60 per cent. to 70 per cent. of the recorded cases the presence of the disease was recognized before the second year. The hæmorrhage establishing the diagnosis is sometimes spontaneous, but more usually follows upon some slight injury. The newborn infant of a hæmophilic family rarely suffers. Circumcision has, however, often led to a recognition of the disease, and has occasionally proved fatal. In a few instances the onset of puberty has put a term to the tendency to bleed, but as a general rule once manifested it persists throughout life.

The special characteristic of hæmophilic bleeding is not so much its severity as its persistence; hence it is rare for the hæmophilic to die of a sudden profuse hæmorrhage; he rather fades out of life owing to the inability to stop the slow continued loss of blood.

Spontaneous hæmorrhage is not nearly so common as traumatic. Indeed it is doubtful whether genuine spontaneous hæmorrhage ever occurs. In some individuals there are prodromal symptoms of giddiness, palpitation, sweating or dyspnœa before the actual hæmorrhage, and visceral hæmorrhages are occasionally met with in men who are known to be hæmophilics.

The great majority of hæmorrhages occur either from the skin, or from the mucous membrane of the mouth and nose. Those in the skin are chiefly in the form of bruises or ecchymoses, rarely appearing as petechiæ. Oozing of blood from the unbroken skin of the finger-tips has been recorded. Generally the bleeding is preceded by some scratch or slight wound which has broken the skin. Epistaxis is the most frequent form of hæmorrhage from the mucous membranes, and next in order bleeding from the gums. Some patients cannot use a tooth-brush for this reason. Hæmorrhage from the internal organs is uncommon, either from the lungs, intestines, stomach or the urinary tract. Hæmorrhage into the subcutaneous tissue or into the muscles sometimes occurs, and forms a hæmatoma which has been mistaken for an abscess and incised.

The most remarkable form of hæmorrhage, and one which is common, is into the cavities of the joints. The joints which suffer most often are the knees and elbows; but any joint may be affected. The swelling and effusion take place with great rapidity, and with a great deal of pain. The joint is hot, tender, reddened, and the surrounding tissues swollen. The temperature is raised to 101° or 102° F. The effusion is almost pure blood, but as absorption proceeds it becomes a dirty brown colour which stains the synovial membrane and the cartilages of the joint. It is sometimes absorbed rapidly, and the joint restored to complete mobility. When absorption is slow or effusions repeated contraction and ankylosis may cripple the patient permanently. In a joint often affected there is always considerable destruction of the cartilages and of the ligaments, with the result that the bones are exposed and undergo changes resembling those of osteo-arthritis. Osteophyte formation is however rare, and so is bony ankylosis. Fibrous ankylosis is, on the other hand, common.

The other symptoms noted for the most part depend on the hæmorrhages. Wright states that these are often periodic, and more likely to occur by night than by day. It has also been noted that hæmophilics often have depraved appetites, and are ready to eat dirt and grit of all kinds.

Diagnosis.—A diagnosis of hæmophilia must rest in large degree on a

knowledge of the family history. In the absence of a "bleeder" in the family tree the diagnosis is suspect. It must be remembered there are other causes of hæmorrhage than hæmophilia: purpura, for instance, is sometimes accompanied by effusion into a joint. In purpura, however, the effusion is serous, not bloody, as in hæmophilia. The real difficulty occurs in the known hæmophilic family when one of the boys has had an epistaxis, some urinary hæmorrhage, or possibly some effusion into a joint, and the doctor is asked to determine whether the phenomenon is a mere accident or a manifestation of the inherited tendency. Such a question it may be impossible to answer without observation of the individual extending over several years.

Prognosis.—As regards life the outlook is bad. It has been stated that less than 12 per cent. of known "bleeders" survive to puberty. This would seem to be an exaggerated estimate, and is probably based on the figures of the recorded "bleeder" families. It has already been stated that puberty sometimes terminates the manifestations. In those patients who survive there is likely to be serious interference both with education and pursuit of a trade or profession, but with the lapse of years the danger to life seems to become distinctly lessened.

Treatment.—*Prophylaxis.*—The females in a known "bleeder" family should be advised not to marry. If this advice is disregarded and they have sons, the children must be considered as potential "bleeders," and consequently any operation, such as circumcision, the extraction of teeth, or tonsillectomy, should be undertaken only after careful preparation and also with all the means at hand for the control of hæmorrhage. The preparation for operation should include a subcutaneous or intramuscular injection of fresh normal serum (20 to 30 c.cm.).

Treatment of Hæmorrhage.—Local treatment of actual hæmorrhage is comparatively easy when the bleeding point is accessible to pressure. Pressure with tampons soaked in serum or in fresh normal blood, quickly brings the oozing under control. In bleeding from cavities, such as the mouth and nose, where pressure is difficult or impossible, the employment of heat is said to be efficacious. It is applied by the use of sprays of water as hot as the patient can tolerate. The raising of the patient's temperature by radiant heat, or hot baths, or vapour baths, is also of assistance, since it has been shown that the time of coagulation is appreciably shortened with a rise in temperature. In serious cases, or when these simpler methods have not succeeded, no time should be lost in transfusing with the whole blood, defibrinated or citrated, of a normal healthy person. It is said that the blood of the other members of a "bleeder" family, provided they are of an appropriate blood-group, is not contra-indicated. While the preparations for transfusion are being made, the subcutaneous or intramuscular injection of 20 to 30 c.cm. of normal horse serum is advantageous. The joints should be immobilized in the acute phase of the effusion, but passive movements should be begun as soon as possible, in order to avoid the occurrence of ankylosis. Where the effusion is considerable, it is quite safe to puncture the joint and remove as much as possible of the blood. A needle puncture hardly ever bleeds in a hæmophilic patient.

Attempts have been made to find some method of altering *permanently* the time of coagulation. Weil claims that the subcutaneous or intra-

muscular injection of normal serum (20 to 30 c.cm.) every two months has in his hands not only kept hæmophilic patients free from manifestations for several years, but has resulted in a definite lowering of the prolonged coagulation-time to periods within normal limits. No other author, however, has been able to confirm Weil's results. Recently, the induction of protein shock by intravenous injection of a foreign protein (t.a.b. vaccine) has apparently given good results.

HUGH THURSFIELD.

SECTION XI

DISEASES OF THE SPLEEN

ENLARGEMENTS OF THE SPLEEN

THE spleen, more than other organ of the body, is liable to enlargement in disease. It is affected in many, if not all, of the acute specific fevers; in the general pyogenic infections; and in a long list of chronic diseases. On the other hand, it is seldom the seat of carcinoma or sarcoma, whether primary or secondary, and hydatid and other cysts are rather pathological curiosities than clinical phenomena.

Diagnosis.—The diagnosis of a splenic tumour is seldom doubtful. The situation, the extension upwards of the splenic dullness, normally situated at the level of the ninth rib in the mid-axillary line, the recognition of the notches in the anterior border, and the abrupt margin of the tumour in the loin are usually sufficient to prevent a mistake. There is, however, occasionally a difficulty in distinguishing between a splenic and a renal tumour, or between a splenic and an intestinal or mesenteric mass; and a movable spleen may cause some confusion by presenting itself as a tumour in parts of the abdominal cavity remote from its normal site. The relationship of the descending colon to the tumour is important; it lies in front of a renal, but internal to a splenic, tumour.

The conditions in which enlargement of the spleen occurs may be classified as follows: (1) Enlargement due to acute general infections—typhoid fever, other specific fevers, infective endocarditis, pyogenic septicæmia, Mediterranean fever and acute catarrhal jaundice. (2) Enlargement due to chronic infective processes—tuberculosis, syphilis and lymphadenoma. (3) Enlargement due to protozoal infections—malaria, kala-azar and possibly some others, *e.g.* Egyptian splenomegaly. (4) Enlargement due to mechanical obstruction—hepatic portal cirrhosis, thrombosis of the splenic vein, decompensated cardiac disease and movable spleen. (5) Enlargement due to new formations—cysts (parasitic and non-parasitic), malignant growths, and amyloid degeneration. (6) Enlargement associated with disorders of the blood—idiopathic pernicious anæmia, the leukæmias and acholuric jaundice (congenital or acquired). (7) Primary enlargement—splenic anæmia, splenic anæmia with hepatic cirrhosis (Banti's disease) and splenomegalic cirrhosis.

The clinical characters of the splenic enlargement in the greater number of the conditions mentioned are fully considered elsewhere. Here it will be sufficient to point out that the chief difficulties are found in the differential

diagnosis of chronic enlargements due to tuberculosis, syphilis, lymphadenoma and splenic anæmia; and it will often be necessary to employ not only accurate blood examinations and the Wassermann test, but even to resort to splenic puncture, or the histological examination of tissue, *e.g.* from a lymphatic gland, in order to arrive at a correct judgment.

Tuberculosis of the Spleen

In general tuberculosis the spleen is often considerably enlarged, but seldom reaches more than an inch or so below the costal margin. Its enlargement is due to the inflammation which accompanies the development of miliary tubercles in the organ.

A much more pronounced enlargement is occasionally met with as a result of the formation of caseous masses in the organ. It may then be mistaken for the spleen of Banti's disease, or lead to a diagnosis of lymphadenoma. In this condition it is sometimes difficult, even when the organ is seen after death, to be assured of the character of the numerous yellowish deposits, which give it a marked resemblance to the spleen of Hodgkin's disease. During life the diagnosis of these rare cases is dependent on the existence of tuberculous lesions elsewhere in the body. Splenectomy has been practised with success in some such cases.

Syphilis of the Spleen

The spleen is enlarged in the syphilis of infants, especially in the period of the more acute manifestations during the first 3 months of life. Its detection at this period is often of considerable service in diagnosis. At a later period of childhood the spleen is enlarged, together with the development of a syphilitic cirrhosis of the liver. The later manifestations of syphilis cause enlargement of the spleen in two ways, either (1) by the development of gummatous deposits in the organ, when it may occasionally reach a great size; or (2) by the development of lardaceous disease. Syphilitic enlargement of the spleen only gives rise to difficulties in diagnosis when it is accompanied by severe anæmia, and this appears to be rather the exception than the rule in gummatous disease, except after severe hæmatemesis. On the contrary, the existence of large gummatous deposits, or of large tuberculous caseous deposits in the spleen, is often accompanied by an unduly high red blood corpuscle count, and a fairly high percentage of hæmoglobin.

SPLENIC ANÆMIA

Synonyms.—Banti's Disease; Primitive Splenomegaly.

Definition.—A disease characterized by anæmia of a definite type, accompanied by enlargement of the spleen.

The terminology of the group of diseases included under this name is at present in a very confused state. Banti considers that the disease begins as an anæmia with enlargement of the spleen, and steadily progresses through a long period of years to a terminal stage of hepatic cirrhosis with ascites. It is, however, certain there are cases where the stage of cirrhosis is never

reached, and therefore it is better to regard the condition as a single disease of which the termination may be either a fatal anæmia or an equally fatal cirrhosis. There are, in addition, other conditions in which the combination of splenomegaly with anæmia are present, but their other features enable them to be separated from the disease under consideration; for example, syphilitic splenomegaly, Gaucher's type of splenomegaly; and splenomegaly associated with acholuric jaundice, whether congenital or acquired. The disease therefore which is here discussed is characterized by the following features:

1. A primitive, chronic, cryptogenetic (Banti) splenomegaly.
2. Anæmia, with (*a*) diminution in the number of erythrocytes, and absence of erythroblasts; (*b* diminution in the hæmoglobin, proportionate with or greater than that of the erythrocytes, *i.e.* a colour-index below 1; (*c*) diminution in the numb)er of leucocytes with absence of myelocytes; (*d*) diminished or normal fragility of the erythrocytes. The anæmia is a constant feature of the disease, even when there has been no hæmatemesis. Its usual disappearance after splenectomy suggests that it is due to some abnormal influence of the disordered splenic functions.
3. Absence of enlargement of the lymphatic glands.

Ætiology.—The disease is most commonly met with in the third and fourth decades; but occurs at all ages outside infancy. It is slightly more common in males than in females. It is found in all civilised countries and in all races.

Pathology.—Its causation is unknown. Various organisms, including a streptothrix, have been described; but at present no good evidence is extant for their causal connection with the disease. The morbid anatomy likewise gives no characteristic change, beyond the enlargement of the spleen due to the increase of fibrous tissue and the dilatation of the blood sinuses. Infarcts of any size are rare, but perisplenitis is common. Dilatation of the œsophageal veins is often seen, and is the source of the hæmatemesis. In the later stages the liver is always the seat of a periportal cirrhosis.

Symptoms.—The patient complains of increasing weakness, of anæmia, of hæmatemesis, or of the presence of a tumour in the abdomen. Physical examination shows an enlargement of the spleen which is usually already extreme by the time the patient applies for advice. It commonly reaches the umbilicus in the mid-line, and the iliac crest in the flank. It is firm, not tender, and as a rule the splenic notches can be readily felt. Occasionally accessory splenic nodules can be discerned. The lymphatic glands are not enlarged.

The anæmia is obvious at a glance. An examination of the blood shows a diminution, generally not extreme, of the erythrocytes, *e.g.* between three and four millions; a diminution of the hæmoglobin usually to 50 per cent. or under; with consequently a colour-index below 1, *i.e.* 0·6 or 0·7; and a leucopenia due principally to a loss in the number of the polymorphonuclear leucocytes. The fragility of the erythrocytes is normal, or more commonly slightly less than normal. The blood-platelets are not diminished.

In addition to these physical signs there is, as a rule, nothing else remarkable; the heart may be moderately dilated, and there may be a hæmic murmur.

Some of the patients, a large proportion according to Banti, develop an

hepatic cirrhosis with marked ascites, and after being relieved by tapping soon relapse and die of progressive weakness. The degree of emaciation varies, but is seldom extreme. Pigmentation of the skin also occurs on occasion; but the more usual complexion of the patient is sallow, without anything which could be called real pigmentation.

Course.—The duration of the disease is variable; it cannot be called acute in any case, for nearly always it is 2 to 3 years before the more fatal signs make their appearance. The pre-cirrhotic state of the disease may last for 12 years, and there are on record cases in which the disease has been recognized by competent observers 15 or 20 years before death.

Such a patient has reached a condition in which he may remain for a number of years without further progress, at times being able to resume active life to a moderate degree, but always subject to increase in his anæmia, and likely at any time to suffer from a severe hæmatemesis. This accident is in fact a frequent termination of the disease.

Diagnosis.—The recognition of splenic anæmia is by no means easy. There are a number of other conditions accompanied by enlargement of the spleen and anæmia, and even when these are recognized there remain cases which it is very difficult to classify. The conditions which have most frequently led to confusion in the past are the anæmias with splenomegaly of syphilitic origin; the splenomegaly of hepatic cirrhosis; the rare cases of large tuberculous spleens; the congenital and acquired acholuric jaundices; and rarely abnormal cases of pernicious anæmia and of lymphadenoma. Careful examination of the blood, and of the fragility of the erythrocytes, and observation of the course of the disease usually serve to establish a conclusion. If the patient has already reached the stage of cirrhosis of the liver with ascites, it becomes almost impossible, without most careful investigation of the history and of the symptoms, to separate the condition from that of cirrhosis of the liver with secondary enlargement of the spleen. The distinction, however, is of great importance, for in the latter case splenectomy, which is of undoubted value in splenic anæmia, has a high operative mortality. In tropical and semi-tropical countries there are conditions which with our present knowledge cannot be differentiated from the type which we are considering. Such a disease is Egyptian splenomegaly, which differs in the accesses of fever and the seasonal variation from splenic anæmia. Kala-azar also has points of resemblance. The enlarged spleen of chronic malaria, with its attendant severe degree of anæmia, also deserves mention. Lastly, there is the rare condition of Gaucher's type of splenomegaly.

Treatment.—The ultimate outlook in this disease is so uniformly bad that it is probably the duty of the physician, so soon as he has established the diagnosis beyond doubt, to advise splenectomy. The results of such a proceeding have been in some instances remarkable, the patient being enabled to resume a normal life, and even in one case within the writer's knowledge to perform heavy manual labour. The mortality from the operation cannot at present be placed lower than 10 per cent., and in a fair number of cases the results, while leading to improvement, have not cured the condition. A successful splenectomy saves the patient, at least for a time, from the dangers of death from hæmatemesis, and certainly defers, if it does not abolish, the progress of the illness. The anæmia usually disappears completely within a brief period of the operation.

Apart from this remedy the physician is confined to the treatment of the anæmia with ordinary remedies, or to the employment of X-rays. These have now been used in a considerable number of cases, and while there is no doubt the spleen tends to grow smaller with their application there is no improvement in the anæmia, and the progress of the disease is not apparently checked.

Gaucher's Type of Splenomegaly

The distinctive features of this type of disease are: (1) its incidence in childhood; (2) its frequent presence in other members of the family; (3) the progressive enlargement of the spleen to an enormous size without materially interfering with the normal health and comfort of its possessor; (4) the later and equally enormous enlargement of the liver; and lastly and most important, (5) the presence in spleen, liver, lymphatic glands and bone-marrow of large mononuclear cells of an endothelial type.

The disease is being increasingly recognized. Its pathology seems to place it among the inborn errors of metabolism; the error leads to the infiltration of the cells of the reticulo-endothelium throughout the body with a lipoid substance—kerasin (Pick). A similar, but chemically different, infiltration has been described in children by Niemann. None of Niemann's cases, which were all in infants, survived beyond the second year. There is often a definite anæmia, which, however, preserves the characters of a secondary anæmia, without the appearance of abnormal cells. Some patients have shown a tendency to bleed from the gums, and in them there has been found a diminution of the blood-platelets. The infiltration of the bone-marrow has led to spontaneous fractures of the long bones, and in one instance to a spinal curvature simulating spinal caries, and in another patient, under the writer's observation, there were severe attacks of hæmorrhagic periostitis, resembling acute osteo-myelitis.

The diagnosis of the disease can be made with some certainty by the method of splenic puncture, the tissue removed by the needle showing the typical "Gaucher cells." It is now known that the course of the disease is not so benign as was originally supposed.

Treatment is entirely symptomatic. Splenectomy has now been done in some 20 to 30 cases, chiefly where life has been threatened or made miserable by hæmorrhages. It has been completely successful in causing the cessation of the bleeding, but there is at present no evidence that it alters or controls the course of the disease otherwise.

Hugh Thursfield.

SECTION XII

DISEASES OF THE CIRCULATORY SYSTEM

DISEASES OF THE HEART AND PERICARDIUM

It is generally recognised that within recent years there has been a great advance in our knowledge of cardiac disorders, and this advance has been of so practical a character, and of such vital importance in the diagnosis, prognosis and treatment of these diseases that it is the duty of every clinician to make himself acquainted with its nature and scope. This progress has been mainly due to the introduction of what are called graphic methods in the examination of the cardiac mechanism. By means of the electro-cardiograph and the clinical polygraph we are now able to analyse the cardiac action in a manner which was never possible before. The work of elucidation having been accomplished, it is, however, not now necessary to employ either of these instruments in the great majority of cases, the use of a sphygmograph being sufficient, and in a large proportion palpation and auscultation suffice. This is of great practical importance to the general practitioner.

As the electro-cardiograph cannot be regarded as an instrument available to the general practitioner, I have included clinical electro-cardiography at the end of the section.

PHYSIOLOGICAL CONSIDERATIONS

The Apex-beat.—In normal circumstances it is the left ventricle which gives rise to the clinical apex-beat, and the apex-beat is then a definite forward thrust, lasting about $\frac{1}{3}$rd second, and occurring about $\frac{1}{10}$th second before the carotid, and $\frac{1}{5}$th second before the radial, pulse. It consists of three phases, namely: (*a*) a sudden and short shock, representing the pre-sphygmic period; (*b*) bulging of the heart into the intercostal space, the apex pressing against the chest-wall, corresponding with the sphygmic period; and (*c*) a backward movement or falling away from the intercostal space, corresponding with the post-sphygmic interval. When the right ventricle is much enlarged, however, that chamber may displace the left ventricle backwards, so that the apex-beat is formed by the right, instead of the left, ventricle: in this event, there may be a more diffuse systolic recession over the lower part of the præcordium, the out-thrust being diastolic in time.

Sino-auricular Node.—The sino-auricular node is a node of specialised tissue, discovered by Keith and Flack, at the junction of the superior vena cava with the auricle, immediately beneath the epicardium. In it are

nerve-fibres and ganglion cells, which are connected with the vagus and sympathetic nerves.

AURICULO-VENTRICULAR NODE AND BUNDLE.—The auriculo-ventricular node is a small node of specialised tissue which is situated in the septal wall of the right auricle, near to the coronary sinus, immediately above the insertion of the median cusp of the tricuspid valve. The auriculo-ventricular bundle of Stanley Kent and His is a bundle of tissue connecting the auricles and ventricles. It arises from the auriculo-ventricular node, passes forwards in the interauricular septum, then turns downwards, and at the upper margin of the interventricular septum divides into two branches, the right and left septal divisions, one of which goes to the right and the other to the left ventricle, each ending in the ventricular musculature by widespread subendothelial arborizations—the Purkinje fibres. Nerve-fibres and ganglion cells are present in the auriculo-ventricular bundle, and its blood supply is mainly derived from a special branch of the right coronary artery.

In the adult mammalian heart the primitive cardiac tube has become modified, and has ceased to exist as a tube. The sinus venosus, instead of remaining as a separate structure, has become incorporated in the auricle, its area being bounded by the orifices of the two venæ cavæ, the coronary sinus, and the interauricular septum. The sino-auricular node is believed to represent part of the sinus venosus, and there is reason to believe further that the auriculo-ventricular node and bundle are also remains of the primitive cardiac tube. The remains of the primitive cardiac tube are more excitable than the auricular or ventricular tissue, and the remains of the sinus venosus at the orifices of the great veins are the most excitable part. The stimulus for contraction, therefore, arises normally at this point, and there is reason to believe that it begins in the sino-auricular node; for this reason the node has been called by Erlanger the "pace-maker" of the heart; the rhythm of the sinus governs the rhythm of the remaining segments of the heart, the impulse travelling as a wave of contraction which spreads peristaltically over the other portions of the heart at rates of speed which vary in different parts. From the sino-auricular node the stimulus spreads rapidly over the auricles, and auricular systole takes place. It then travels through the auriculo-ventricular node, along the auriculo-ventricular bundle, its two main branches and their subendothelial arborisations, and is so distributed to the ventricles. Normally, therefore, stimulation and contraction of the sinus, the auricles, and the ventricles occur in the order named, the ventricle contracting only in response to stimuli received from the auricle through the auriculo-ventricular bundle. It is scarcely necessary to point out that relaxation proceeds in the same order as contraction. As will be noted later, by means of a specialised function, called conductivity, the cardiac muscle has the power of conveying the stimulus for contraction from fibre to fibre. The stimulus travels so rapidly that the contraction of the ventricle commences almost immediately after the completion of the auricular systole. But while normally the stimulus for contraction arises in the sinus part of the auricle, if any other portion of the remains of the primitive cardiac tube becomes more excitable the stimulus for contraction arises at that point; for this reason the different parts of the heart are capable of starting an independent contraction.

The auriculo-ventricular junctional tissues—either the auriculo-ventricular

node, or the auriculo-ventricular bundle above its division into two branches —and also the ventricle below the division of the auriculo-ventricular bundle, possess the power of originating the stimulus for contraction. In what is termed "nodal rhythm" the stimulus for contraction arises in some part of the auriculo-ventricular junctional tissues, giving rise to a simultaneous contraction of both auricle and ventricle. When the ventricles beat independently of the auricles, the independent rhythm of the ventricles is called "idio-ventricular rhythm." What is known as "reversed rhythm" may occur when, owing to the fact that the ventricle below the division of the auriculo-ventricular bundle is the most excitable part of the heart, the stimulus for contraction arises there, proceeding thence to the auricle, so that each contraction of the auricle follows, instead of precedes, ventricular systole.

FUNDAMENTAL FUNCTIONS OF THE HEART MUSCLE-FIBRES.—Gaskell has described five fundamental functions of the fibres of the heart muscle, namely, stimulus production, excitability, conductivity, contractility and tonicity—contractility being the most important. Mackenzie has defined these functions as follows: By stimulus production is meant the power which the muscle-fibres possess of originating a stimulus which can excite the heart to contract; by excitability is meant the power to receive a stimulus; by contractility is meant the power of contracting when stimulated; by conductivity is meant the power of conveying a stimulus from fibre to fibre; and by tonicity is meant that function of the heart muscle which keeps the heart during diastole in a state of slight tonic contraction.

The functions of stimulus production and excitability are most highly developed at the sinus part of the auricle. The rate of the heart depends upon these functions, an increase of their activity resulting in an increase of the frequency of the cardiac action. The activity of the function of stimulus production varies a good deal, as, for instance, the slight acceleration of the heart-rate during inspiration, and the corresponding slowing which occurs during expiration, in the young. When excitability is increased, the heart has also a greater tendency to respond to abnormal or irregular stimuli; hence extra-systoles are more likely to occur. While diminished excitability may lessen the heart-rate, it should be remembered that slowing of the ventricular rate may be due to other causes, such as depressed conductivity. When stimulus production and excitability are equal, the rhythm of the heart is regular. The pulsus alternans is probably an indication of depressed contractility of the heart. The rate at which the wave of contraction travels from fibre to fibre varies in different parts of the heart. Thus, the impulse spreads in the auricles and ventricles more quickly than it does from auricle to ventricle. In this connection it may be noted that conductivity is observed by estimating the time between the systole of the auricles and ventricles. A lowered state of tonicity results in dilatation of the heart and of the auriculo-ventricular orifices.

Immediately after the muscle-fibres of the heart have contracted, they cannot again be stimulated; in other words, excitability has for the moment disappeared. This is called the refractory stage. Restoration of excitability, however, at once recommences, and steadily increases during diastole. When stimulated, the cardiac muscle either does not contract at all, or it contracts to the fullest possible extent at the time, whether the stimulus

be weak or strong. There is, therefore, no relation between the strength of the stimulus and the strength of the contraction; it is a case of "all or none."

The longer the time that has elapsed since the previous contraction, the weaker is the stimulus required to bring about a further contraction. Further, the greater the degree of excitability of the muscle-fibres, the weaker is the stimulus required, and the earlier in the refractory period will the heart contract. The contractility of the muscle-fibres is measured by the degree of contraction. The amount of contraction does not depend upon the strength of the stimulus employed, but varies according to the time at which the stimuli are applied. When a contraction occurs early in diastole, the contraction in the succeeding cardiac cycle is weaker than that preceding it. Within certain limits, the degree of contractility depends upon the length of the preceding diastole; the greater the period of rest, the more perfect and full is the recovery. It can, therefore, be readily understood that the greater the heart-rate the greater is the possibility of cardiac failure. The circulation is carried on most efficiently when the cardiac rate is exactly that which allows the myocardium to recover its full contractility, a rate over or under this being a disadvantage. Similar laws apply to each of the other special functions of the heart muscle. In the case of conductivity, for example; when conduction occurs, this function has been exercised to the fullest extent possible at the time of stimulation. The refractory period follows immediately after the conduction of a stimulus, and during this brief period the muscle-fibres cannot again conduct a stimulus, conductivity being completely exhausted. Restoration, however, quickly commences, and ultimately the function is restored. The extent of the relaxation between the contractions depends upon the degree of tone present, and upon the rate of the heart-beat. With a slower rate, there is, of course, more time for full relaxation. There should be a sufficient period of rest after each function has been exercised. Within certain limits, the greater the period of rest the more perfect and full is the recovery of each special function. In heart failure one or more of these special functions are at fault, and, if this occur to two or more simultaneously, the different functions are not necessarily equally affected. From what has been said, the value of rest in heart failure can be readily understood.

The heart has the power of rhythmically contracting and dilating, due to an inherent power possessed by the cardiac musculature, independent of any extrinsic nervous influence. Nevertheless, the activity of the various functions of the muscle-fibres is under nervous control. Both the inhibitory fibres of the vagus and the accelerator fibres of the sympathetic are normally in a state of tonic activity, and the cardiac centres are in a state of continuous slight excitation.

There are reasons for believing that, besides decreasing the rate of the heart, the vagus nerve depresses the functions of excitability, contractility, conductivity—either by acting on the auriculo-ventricular bundle, or by diminishing the irritability of the ventricle itself—and tonicity; and that the accelerator nerve, besides increasing the rate of the heart, increases the force of contraction and conductivity. Stimulation of the central part of the divided vagus nerve is followed by a fall of blood-pressure, and simultaneously by a retardation of the beats of the heart. Inhibition of the heart is due

to stimulation of the vagus as a diastolic effect; acceleration is due to stimulation of the sympathetic as a systolic effect.

THE CARDIAC CYCLE.—Stated briefly, in the cardiac cycle there occur in rapid succession auricular systole, ventricular systole, and ventricular diastole. The auricular diastole commences during the ventricular systole, and the ventricular diastole continues during auricular systole. The diastole of the auricles coincides with the commencement of the ventricular systole, the diastole of the ventricles with the commencement of the pause. The two active phases (systole and diastole) are followed by the state of rest.

There are three phases in the systole of the ventricles, namely: (*a*) The period during which all four valves are closed; this is called the pre-sphygmic period. The pressure within the ventricles has caused the auriculo-ventricular valves to close, but it is not yet greater than that in the aorta and pulmonary artery, so that the semilunar valves remain closed. (*b*) The period during which the semilunar valves are open; this is called the sphygmic or pulse-period. The pressure within the ventricle having risen above that in the aorta and pulmonary artery, the semilunar valves are forced open and the blood flows from the ventricles into these vessels. (*c*) The period between the closure of the semilunar valves and the opening of the auriculo-ventricular valves; this is called the post-sphygmic period. It should be noted that the sphygmic or pulse-period in a tracing of the cardiac apex, carotid pulse or radial pulse, does not refer to the actual time of occurrence of ventricular systole, but to a period in the tracing; and, on account of the distance from the heart, the sphygmic or pulse-period will necessarily be later in a radial tracing than the same period in a tracing taken at the cardiac apex or over the carotid. The periods of time which elapse between the apex-beat and the carotid pulse, and between the carotid and radial pulses, have each been found to be $\frac{1}{10}$th of a second; the pulse-period, therefore, in a radial tracing commences about $\frac{1}{10}$th of a second behind the same period in a tracing of the carotid, and about $\frac{1}{5}$th of a second behind that in a cardiogram.

Assuming that in normal health the human heart beats about 72 times per minute, each cardiac cycle, therefore, is completed in about $\frac{5}{10}$ths of a second, this time being divided up in the following manner: Systole of auricle, $\frac{1}{10}$th of a second; systole of ventricle, $\frac{3}{10}$ths of a second; diastole, $\frac{4}{10}$ths of a second. The most stable part of the cardiac cycle is the ventricular systole, and the most variable is the diastole. The rate of the heart-beat mainly depends upon the duration of the diastole. When the heart beats unusually quickly, the duration of the diastole is shortened by a greater degree than that of the systole; in other words, when the period of the cardiac cycle decreases it is the long pause which is particularly shortened.

THE CLINICAL POLYGRAPH: POLYGRAPHIC RECORDS

By means of the clinical polygraph we are able to obtain records of the movements of both the auricles and ventricles, to measure the function of conductivity of the auriculo-ventricular bundle above its division into two branches, and to make out the time-relations of the contraction of the auricles and ventricles. It often affords—directly, or by inference—valuable information regarding the state of the myocardium. It is possible to take a simul-

taneous tracing on the same recording surface of any two of the following: the radial pulse, the apex-beat, the carotid pulse, the jugular pulse, the liver pulse and the respiratory curve; further, a time-marker registers $\frac{1}{5}$th second on the same recording surface. The usual plan is to take simultaneous tracings of the arterial and venous pulses. With regard to the former, the radial artery is usually chosen, although the carotid is sometimes employed. As a rule a tracing of the radial or carotid artery is more reliable than that of the apex-beat, because, in contrast with the latter, it is possible to determine with certainty the systolic and diastolic portions. Sometimes, however, as, for example, when it is difficult or impossible to obtain a satisfactory tracing of the radial artery, it is advisable to take a tracing of the apex-beat instead. With regard to the venous pulse, the jugular vein is almost always employed; very rarely the liver.

A tracing of the arterial pulse is called a sphygmogram, a tracing of the apex-beat is called a cardiogram, and a tracing of the venous pulse is called a

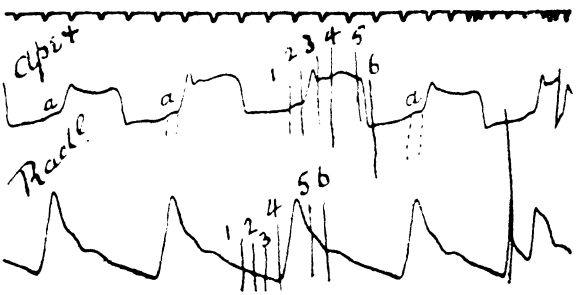


FIG. 23. Simultaneous tracings of the apex-beat and of the radial pulse showing a positive cardiogram. At 1, the commencement of auricular systole; at 2, the commencement of ventricular systole; at 3, the commencement of the carotid pulse; at 4, the commencement of the radial pulse; at 5, closure of the semilunar valves; at 6, opening of the tricuspid valves. The space between 2 and 3 represents the pre-sphygmic period, the space between 3 and 5 the sphygmic period, and the space between 5 and 6 the post-sphygmic period. Note that the radial pulse begins $\frac{1}{5}$th second after the commencement of ventricular systole.

phlebogram. It is not my intention to deal here with the normal sphygmogram, but it may be noted that the sphygmic or pulse-period commences with the beginning of the percussion wave and ends at the bottom of the dicrotic notch.

THE CARDIOGRAM.—If the receiver be placed over the left ventricle the record is called a positive cardiogram, while if the receiver be placed over the right ventricle it is called a negative or inverted cardiogram. It should be remembered that when in enlargement of the right ventricle that chamber displaces the left ventricle, and the clinical apex-beat is formed by the right, instead of the left, ventricle, a cardiogram over the actual apex-beat will be a negative or inverted one; otherwise, the significance of an inverted cardiogram will be misunderstood.

On analysis, a positive cardiogram is found to consist of the following parts (Fig. 23): (*a*) An ascending limb, representing the pre-sphygmic period. Its commencement is indicated by the vertical stroke 2, and exactly

corresponds with the summit of the *a* wave in a tracing of the jugular vein, and is synchronous with the commencement of the first sound; while its termination, which is usually abrupt, is represented by the vertical stroke 3, and corresponds with the commencement of the carotid pulse. (*b*) A fairly level line—the systolic plateau; but, instead of this, the line may continue to rise, or it may sometimes rapidly descend, representing the sphygmic or pulse-period. Its commencement is indicated by the vertical stroke 3, and its termination by the vertical stroke 5, the termination practically corresponding with the dicrotic notch of the carotid pulse. (*c*) A fall, either a slanting or a more vertical descent, representing the post-sphygmic period Its commencement is represented by the vertical stroke 5, and the lowest point by the vertical stroke 6; the latter coincides with the apex of the *v* wave in the phlebogram. (*d*) During the period in which the blood flows from the auricles into the ventricles and slowly fills them, the heart may push against the intercostal space, giving rise to a gradual ascent in the cardiogram; or filling of the ventricles may have no effect upon the interspace, in which event the level of the tracing remains much the same until the next ventricular

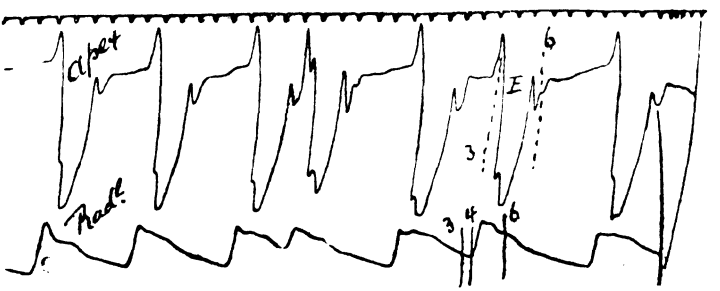


FIG. 24.—Simultaneous tracings of the clinical apex-beat and of the radial artery, from a case of greatly dilated heart, showing a negative cardiogram.

systole. In some cases a slight abrupt rise is found immediately preceding ventricular systole, due to the contraction of the auricle causing a sudden increase in the contents of the ventricle. The positive wave is called *a*, and its commencement is represented by the vertical stroke 1. Normally it precedes the commencement of the wave due to the ventricular systole by about $\frac{1}{10}$th second, an increase of this interval being sometimes indicative of a delay in the passage of the stimulus from auricle to ventricle. The *a* wave may be absent even when other indications of auricular systole are present. There is a period of about $\frac{1}{10}$th of a second each between the vertical strokes 2 and 3, and 3 and 4.

A negative cardiogram is characterised by the following features (Fig. 24): Instead of an ascending limb and a flattened elevation, there is a slight rise, followed by a great depression—the former being due to the shock of the contracting ventricle, and the latter to the ventricles diminishing in size, on account of pouring out their blood as soon as the semilunar valves have opened. The *a* wave may be present.

THE PHLEBOGRAM.—If a tracing of the jugular pulse taken from a normal individual be studied, in each cardiac cycle three main waves are seen

(Fig. 25). They indicate a rise of pressure within the vein. The first wave in point of time is due to the contraction of the auricle, and is called the *a* wave. Its commencement is an indication of the beginning of auricular systole. Following the first wave is a fall, called *x*. The fall *x* is temporarily interrupted by the second wave. It has been already noted that the semilunar valves open at an early stage of ventricular systole. A wave of increased pressure passes along the arterial system, reaching the carotid artery about $\frac{1}{10}$th second before the radial artery. This wave of increased pressure in the carotid artery is represented by the second wave in the tracing of the jugular vein, and is called the *c* wave, being synchronous with the primary or " percussion " wave of the arterial pulse at the same level of the neck. After the *c* wave the fall *x* is continued until towards the termination of ventricular systole, when the third wave occurs ; the onflowing blood experiences an increasing difficulty in entering the auricle, leading to a fullness of the jugular vein, this being indicated by a wave in the venous tracing. The third wave is called the *v* wave. It terminates at about the time of opening of the tricuspid valves, and is then followed by a depression, which is called *y*.

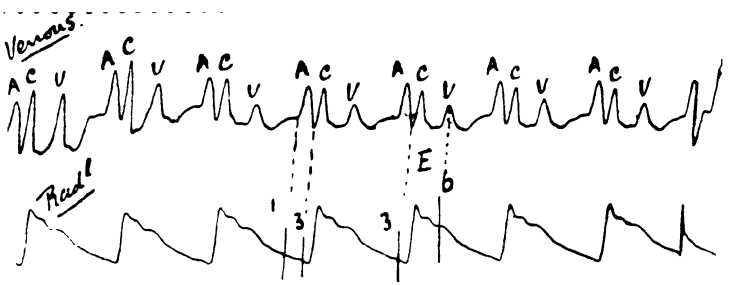


FIG. 25.—Simultaneous tracings of the jugular and radial pulses, showing the auricular form of venous pulse. Note that the *a–c* interval is $\frac{1}{5}$th second, and that the summit of the *v* wave coincides with the dicrotic notch of the radial pulse.

The pressure within the ventricle falls rapidly during diastole, the blood contained in the auricle passes into the ventricle, and as a result the auricular pressure falls. From the point of time corresponding with the bottom of the *v* wave to the beginning of the next auricular systole, the venous tracing shows a line which is either horizontal, or which slopes upwards to the commencement of the following *a* wave. Sometimes the *c* wave is divided into two component parts, and the *a* wave more rarely so.

The time-distance between the beginning of the *a* wave and the commencement of the *c* wave is called the *a–c* interval. It is of great clinical importance ; for it is an index of the *As–Vs* interval, that is, the interval separating the commencement of auricular and ventricular contraction, and is a measure of the function of conductivity of the heart. In normally acting hearts the *a–c* interval is almost constant, and does not measure more than $\frac{1}{5}$th of a second (Fig. 25), being about 0·15 to 0·20 second in duration. In rapidly acting hearts there is a tendency for it to become shortened. If, therefore, in rapidly acting hearts the *a–c* interval measure $\frac{1}{5}$th of a second, or, if in hearts acting at the normal or less than the normal rate

it exceed $\frac{1}{5}$th of a second (Fig. 43)—particularly if there be a change in the *a–c* interval from beat to beat—it may be inferred that there is a prolongation of the *As–Vs* interval, and a delay in the conduction of the stimulus, this indicating that the function of conductivity is depressed; this is called "depressed conductivity," and probably indicates some affection of the auriculo-ventricular node or of the auriculo-ventricular bundle above its division into two branches. The *a–c* interval is longer than the corresponding *As–Vs* interval in a cardiogram by $\frac{1}{10}$th of a second.

The time of commencement of the *v* wave varies, this in all probability depending largely upon the degree of engorgement of the right heart; it may begin during the systolic plateau, or towards its termination. The earlier the *v* wave commences in the negative phase *x*, the greater the degree of engorgement of the right side of the heart; when the engorgement is marked, there may be no fall in the tracing during the period *E*. The termination of the *v* wave, on the other hand, does not vary; it never extends beyond the end of systole; when, therefore, the duration of the *v* wave increases, it does so by commencing earlier in the sphygmic period.

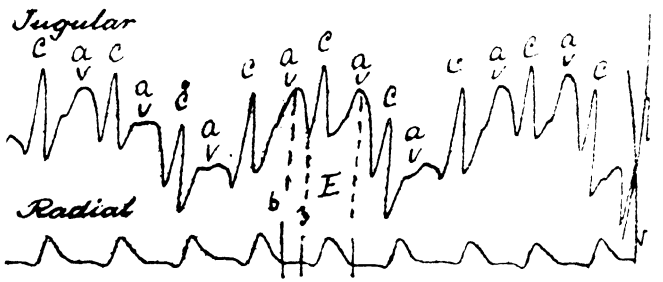


FIG. 26.—Simultaneous tracings of the jugular and radial pulses. The *v* and *a* waves coincide and superimpose.

The summit of the v *wave is of great importance as a time-mark, being synchronous with the opening of the auriculo-ventricular valves. It corresponds approximately with the bottom of the aortic notch in the radial pulse.* Sometimes the *v* wave is divided into two component parts, there being a notch or angle between them, that part which occurs earlier being called v^1, and the other v^2. The angle between the two component parts, in other words the beginning of v^2, coincides in point of time with the closure of the semilunar valves, and is represented in tracings by the vertical stroke 5; while the apex of v^2 coincides in point of time with the opening of the auriculo-ventricular valves, and is represented by the vertical stroke 6.

The negative phase *y* begins with the opening of the auriculo-ventricular valves. This phase tends to diminish more and more as diastole becomes shortened with increasing frequency of the cardiac rate; the *v* wave approaches more and more to the following *a* wave, and when the cardiac rate is unusually frequent *v* and *a* may even coincide and superimpose (Fig. 26).

THE *h* OR *b* WAVE.—Occasionally, more especially in relatively slow-acting hearts, there may be small waves due to stasis. Hirschfelder and

A. G. Gibson described a fourth wave, occurring in the diastolic period of each cycle, shortly after the opening of the tricuspid valves, and between the *v* wave and the succeeding *a* wave; it has been called the *h* or *b* wave (Fig. 27). It disappears when the pulse-rate becomes more rapid.

We are now able to note the relation of the different events in the cardiac cycle as recorded in a sphygmogram, cardiogram, tracing of the carotid pulse, and phlebogram:

At 1, commencement of the *a* wave in the phlebogram, and, if present, in the cardiogram.

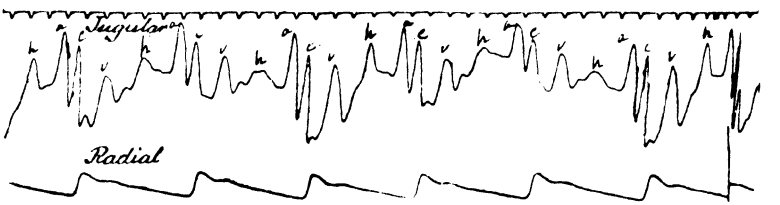


FIG. 27.—Simultaneous tracings of the jugular and radial pulses, showing the auricular form of venous pulse, with the *h* or *b* wave.

At 2, summit of the *a* wave in the phlebogram, and commencement of the ascending limb in the cardiogram.

At 3, commencement of the carotid pulse, of the *c* wave in the phlebogram, and summit of the ascending limb in the cardiogram.

At 4, commencement of the radial pulse, and summit of the *c* wave in the phlebogram.

At 5, commencement of v^2—if the wave be divided into two component

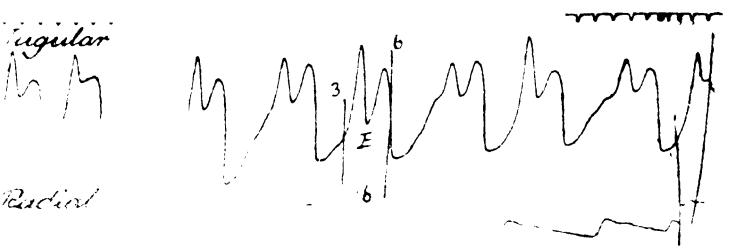


FIG. 28. Simultaneous tracings of the jugular and radial pulse, showing the ventricular form of venous pulse, from a case of auricular fibrillation.

parts—sudden drop in the cardiogram, and dicrotic notch in the carotid pulse.

At 6, lowest point in the cardiogram, summit of the *v* wave—or of v^2 if the *v* wave be divided into two component parts—in the phlebogram, and in the radial curve the bottom of the aortic notch. There is an interval of about $\frac{1}{10}$th second each between the vertical strokes 1 and 2, 2 and 3, and 3 and 4.

THE AURICULAR AND VENTRICULAR FORMS OF VENOUS PULSE.—When in a venous pulse the *a* wave is undoubtedly present, the form of pulse is called the auricular or negative form of venous pulse (Fig. 25). In this form of pulse

the *a* wave is present in each cardiac cycle, and its position is constant from cardiac cycle to cardiac cycle. The presence of the *a* wave informs us that the auricle is contracting normally. In what circumstances does the auricular form of venous pulse occur? It is present in two classes—(1) in all normal individuals; (2) in a large proportion of cases of organic heart disease—a point which should be particularly noted.

When in a venous curve there is no sign of the presence of the *a* wave,

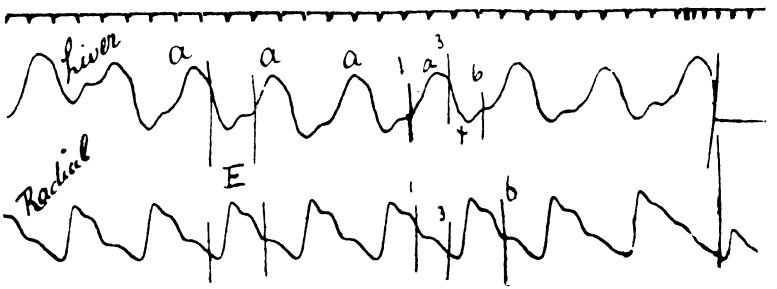


FIG. 29.—Simultaneous tracings of the liver and radial pulses. The liver pulse is of the auricular form.

the type of pulse is called the ventricular or positive form of venous pulse (Fig. 28), in contradistinction to the auricular form of pulse. It signifies that the auricle is not contracting in a normal manner. The vast majority of cases are due to auricular fibrillation; a small proportion are due to a greatly distended right auricle, or to some forms of paroxysmal tachycardia. It will thus be seen that all cases of heart disease, whether valvular

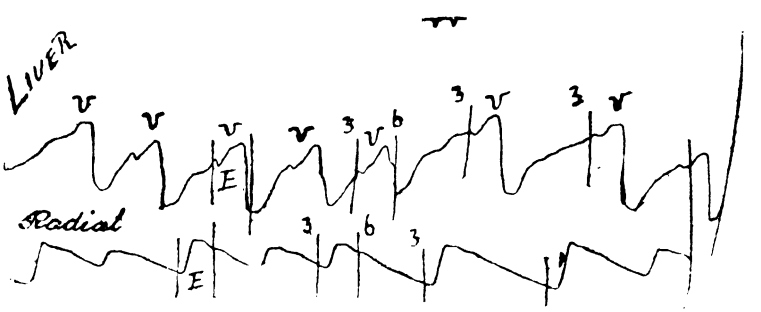


FIG. 30.—Simultaneous tracings of the liver and radial pulses. The liver pulse is of the ventricular form.

or myocardial—and it may be here mentioned whether cardiac failure be present or not —may be divided into two groups—(1) those cases in which the auricular form of venous pulse is present, and (2) those cases in which the ventricular form of venous pulse is present.

LIVER PULSE.—In a tracing obtained from the liver, the *c* wave is, of course, absent. The liver pulse, like the pulse of the jugular vein, may be one of two types—(1) the auricular form, in which the *a* wave is present

(Fig. 29), and (2) the ventricular form, in which the *a* wave is absent (Fig. 30). When the liver pulse is of the auricular type, according to Mackenzie, we may infer that tricuspid stenosis in all probability exists.

FREDERICK W. PRICE.

HEART FAILURE

In considering heart disease it is of fundamental importance that we should have a true conception of the principles which underlie heart failure. It should be understood that the essential cause of cardiac failure lies in the heart muscle, and is due to changes in the heart muscle which render it unable to maintain an efficient circulation, one or more of its five fundamental functions being impaired. Now, if this view of the causation of heart failure be correct, valvular defects, diseased conditions of the blood vessels, and disturbances of the cardiac mechanism—such as auricular fibrillation—should be regarded from the point of view of the relation which they bear to the myocardium, as well as specific affections in themselves. Let us take the case of a valvular lesion: First of all, it can be readily understood that it is a mechanical impediment to the heart muscle in its work. But it should always be remembered that there are as a rule, along with the valvular lesion, coincident changes in the cardiac musculature, the aorta, or coronary arteries. In all cases of valvular disease, therefore, it is of the utmost importance that we should endeavour to ascertain whether the lesion which has invaded the valve has also affected the myocardium, or blood vessels, or both. These morbid changes of the musculature of the heart may not be limited to one chamber, but may affect all the chambers. They may occur as an acute condition, which later on may become chronic; or as a primary chronic affection. As an example of the former, acute infection of the endocardium of the mitral valve by the rheumatic poison may be cited. It is recognised that this is usually followed by organisation, resulting in the formation of fibrous tissue, which tends to contract as life advances, ultimately giving rise to permanent stenosis, or incompetence, or both. It is also known that in every case of acute endocarditis there is probably always present some degree of myocarditis, and that acute myocarditis may occur independently of acute endocarditis. But it is not sufficiently understood that acute myocarditis is often followed by permanent structural changes in the myocardium, which, as in the case of endocarditis, may not fully declare themselves until some years afterwards, and we should always endeavour to try and ascertain the degree of these permanent structural changes. As an example of a primary chronic affection, may be cited many cases of aortic incompetence which come on insidiously in males during or after middle life. As a rule there are coincident or secondary changes in the cardiac musculature, aorta, or coronary arteries, and it is our duty to endeavour to estimate the degree of these changes.

Another point of great importance is whether the lesion (valvular, myocardial, or vascular) is progressive or not. In this connection, it may be mentioned that degenerative processes show a greater tendency to be progressive than those changes which follow an acute inflammation.

Now, with regard to the investigation as to whether the myocardium is involved, and to what extent, and whether the lesion which is present is

progressive, while the results of physical examination—such as evidence of enlargement of the heart—are important, there are other criteria, which are by no means sufficiently appreciated. Of these, *the most important of all is the question of the functional efficiency of the heart.* Is this impaired, and, if so, to what extent, and is the degree of impairment increasing? Mackenzie emphasised that *the best way to answer these questions is to ascertain how the heart responds to effort; in other words, the amount of physical exertion in which the patient can indulge without experiencing symptoms of cardiac distress.*

In conducting this inquiry, it is essential at the outset that three facts should be borne in mind The first is that the natural standard of the heart's strength varies in individuals, each individual knowing the kind and amount of exertion in which he can *normally* indulge without producing symptoms of cardiac distress, and being aware when there is a departure from this, and to what extent. Our inquiry should aim at finding out whether the normal standard of a patient has decreased, and, if so, to what extent, and whether it is still decreasing.

The second fact which should be borne in mind is that symptoms of cardiac distress on exertion may be due to causes other than heart disease. Thirdly, the cardiac muscle may be merely temporarily exhausted, and this may occur whether the heart is diseased or otherwise. But, provided extrinsic and temporary causes—such as anæmia, sleeplessness, temporary physical or mental overstrain, deficient tone due to lack of physical exercise—can be excluded, the fact of a departure from the normal standard of an individual, and its degree, may be taken as fairly indicative of the presence and degree of myocardial disease. Further, if the symptoms of cardiac distress on exertion be increasing—in spite of an adequate period of rest and the employment of other remedial measures—and provided again that we can exclude extrinsic and temporary causes to account for this, we may be satisfied that the lesion is progressing, and its rate of progress may be inferred by the rate of increase in the severity of the symptoms.

Symptoms.—In the great majority of cases, the first indications of heart failure are symptoms of cardiac distress on exertion, and it is only afterwards that objective signs—such as increased pulse-rate, dilatation, or dropsy—appear. These symptoms appear as the result of less and less effort, until ultimately some or all of them are present even during rest, and objective signs also become evident.

Some of the symptoms of cardiac failure are of much greater importance than others. The commonest are breathlessness, palpitation, fatigue, and præcordial pain, on exertion.

The evidences of cardiac failure in chronic valvular disease and myocardial degeneration as a rule appear gradually; in rheumatic carditis, acute myocarditis in diphtheria, and the rapid effusion of fluid into the pericardial sac, they are usually rapid in onset; while in the case of rupture of a valve from over-exertion, and the complete and abrupt closure of the lumen of a coronary artery or one of its main branches, they are usually abrupt.

Breathlessness or dyspnœa is one of the earliest, and a very important, symptom of cardiac failure, the amount of exertion which the patient can undergo without experiencing shortness of breath being of great value in estimating the state of integrity of the heart muscle. It should be borne

in mind, however, that dyspnœa on exertion is a symptom common to many affections besides heart disease, such as anæmia, pulmonary affections, and displacement of the contents of the abdominal cavity. The degree of dyspnœa in heart disease may be so slight that the patient himself may only observe it on over-exertion. Later, it is induced by less and less effort, until ultimately—when cardiac failure is marked—severe dyspnœa is brought on by such slight forms of exertion as a change of position in bed; it may be present, indeed, without any effort of any kind. The degree of dyspnœa may amount to orthopnœa; that is, the patient may be unable to lie down. A peculiar form of breathlessness which may occur in heart disease is what is often termed "cardiac asthma." This condition is characterised by paroxysms of breathlessness, the attack coming on suddenly, with a sense of suffocation—the intensity of which may be extreme—compelling the patient to sit up in bed, and to breathe in a very laboured fashion; wheezing sounds may be present, and the patient may cough up frothy sputum. After a time, it may be a few hours, the attack quickly subsides. These attacks are frequently nocturnal, and the patient is apt to suffer from what are called "night starts"—that is, he starts up with a sensation of suffocation; this is apt to occur when he is falling off to sleep. When a patient suffers from paroxysms of breathlessness, we should always be careful to exclude renal disease, bronchial asthma and hysterical dyspnœa. The syndrome known as Cheyne-Stokes respiration may occur as a symptom in cardiac failure, and is usually of serious import; it should be distinguished from other forms of periodic respiration, such as are occasionally found in children during sleep, and also in meningitis. It may be present for days, or even for some weeks, and yet ultimately disappear. While ordinary dyspnœa on exertion may occur in all forms of heart disease, it is more pronounced in mitral than in aortic disease; in mitral disease, indeed, it is usually the earliest symptom noted by the patient. Cardiac asthma and Cheyne-Stokes respiration are most apt to occur in chronic myocardial disease, especially with supernormal blood-pressure.

Palpitation may be a symptom of cardiac failure; but while this symptom may occur in organic disease of the heart, it should be remembered that it is more frequently met with apart from organic disease. A common symptom of cardiac failure is a sense of exhaustion during or after physical or mental effort; this may even be experienced in slight or very temporary heart failure; in the more serious cases other phenomena also are present.

Pain in the præcordium is a frequent symptom of cardiac failure, being of more common occurrence in aortic disease and in myocardial degeneration than in mitral disease. *The most characteristic feature of pain due to heart disease is that it is brought on by exertion—though it should be noted that the pain may not come on until some hours after the exertion which has induced it.* It may be constant, dull and aching; or recurring and sharp; or may present the characteristic features of angina pectoris. Its severity varies greatly. While pain in the præcordium may occur in organic disease of the heart—and, indeed, is present some time or other during the course of most cases of the severer forms of cardiac disease—it should be remembered that it is also frequently met with apart from organic disease, especially in females. The site of the pain is frequently in the neighbourhood of the apex-beat, but it may be over any part of the præcordial area. The pain of angina

pectoris, on the other hand, is usually over the sternum. Accompanying pain or occurring independently of it, there may be a sense of constriction in the chest, and tenderness in the præcordium may also be associated with it.

Cerebral symptoms, due to a diminished supply of blood to the brain, may depend upon cardiac causes, especially aortic disease and chronic myocardial disease. Among these symptoms are giddiness, syncope or fainting attacks, attacks closely resembling *petit mal*, lack of power of concentration, early fatigue in mental effort, impairment of memory, sleeplessness, disagreeable dreams, nervousness, loss of emotional control, mental irritability, and, in severe cases, delirium, hallucinations, or even insanity. Giddiness may be slight and transient, or severe enough to cause the patient to fall. Syncope or fainting attacks are preceded as a rule by a preliminary sensation of great weakness, giddiness, loss of sight, and, it may be, nausea and vomiting; while during the attack the face becomes of a greenish pallor, the patient breaks out into a clammy sweat, respiration almost or completely ceases, and the pulse at the wrist becomes very feeble or even imperceptible; the return to consciousness is gradual. While giddiness and faintness may, and frequently do, occur in heart disease, they are frequently due to vaso-motor derangement, in which connection it is of fundamental diagnostic importance whether they are more associated with physical exertion or changes of posture. Attacks closely resembling *petit mal* may occur in elderly people, especially in those with arterial disease and chronic myocardial disease, and it is sometimes extremely difficult to distinguish them from fainting attacks. The distinguishing features of the latter have already been described. Adams-Stokes syndrome may occur. This is described on page 797.

In heart disease, especially in affections of the mitral valve, there is often a persistent dusky flush over the cheeks, while later there may be lividity of the lips, ear-tips, and cheeks, and clubbing of the finger-tips may be present in chronic cases. In aortic disease, on the other hand, the face is generally pallid and anxious, though in some cases the colour may be high; while, later, when relative incompetence of the mitral valve has become established, the facies resembles that which is characteristic of mitral cases. An icteric tinge of the skin may also be present.

Loss of flesh may be present in cardiac failure, and, when heart disease occurs in the early years of life, development may be arrested. Digestive disturbances are not uncommon in, and may give early indications of, cardiac failure, being due either to deficient blood supply or chronic venous congestion of the alimentary organs, usually the latter. These may take the form of loss of appetite, a sense of fullness and oppression after meals, pain in the epigastrium and between the shoulder-blades, nausea, vomiting, gastric and intestinal flatulence, and constipation or diarrhœa. Hæmatemesis and melæna are of rare occurrence, and, if severe, are usually due to associated hepatic disease. When tricuspid regurgitation and venous engorgement have become established, there may be tenderness over the liver, which may be palpable, having a sharp edge and smooth surface, and may pulsate. Later, jaundice and ascites may develop. The spleen may be increased in size, though it is generally smaller than normal, unless there is infarction or chronic septicæmia. There may be menorrhagia or metrorrhagia, due to congestion of the uterine mucous membrane.

Œdema is an important manifestation of cardiac failure, and is more liable to occur in mitral than in aortic lesions. It usually commences in the most dependent parts, and generally the patient first notices some puffiness round the ankles in the evening. Even in severe and prolonged cases, the œdema is often confined to the lower extremities; but, occasionally, especially in children, it is first observed in the face, and, when this is the case, renal disease is often suspected. Towards the final stages it may become general, even when the kidneys are unaffected. Œdema may involve the serous membranes, with resultant ascites, hydro-thorax, and occasionally hydro-pericardium. In mitral stenosis, it is not very infrequently limited to the peritoneal cavity. The urine may be scanty, high-coloured, exhibit an excess of urates, and may contain albumin, or even blood.

Affections of the respiratory system, such as bronchitis and broncho-pneumonia, are liable to occur in heart disease, especially in mitral affections. Hæmoptysis is not uncommon; mitral disease, indeed, especially stenosis, is one of the commonest causes of blood-spitting, and the heart should invariably be examined when a patient presents himself with a history of hæmoptysis. Hæmoptysis occurring in chronic valvular disease may be the result of chronic venous congestion or pulmonary infarction. There may be chronic venous congestion and œdema of the lungs, particularly of the bases, and, later, hypostatic pneumonia. More rarely, pulmonary infarction may be present. The existence of pleural effusion should always be borne in mind in cases of dyspnœa, for not infrequently I have seen it completely overlooked; when present, it is generally bilateral. Acute pulmonary œdema is rarely met with; in these cases intense dyspnœa comes on suddenly, and is accompanied by the appearance of frothy mucus which wells out of the mouth and nose in quantities, the patient usually dying within a few hours of the beginning of the attack. Embolism, as well as arterial and venous thrombosis, may be an expression of cardiac failure.

With regard to the pulse, while increased frequency is the rule, bradycardia is occasionally to be noted in cardiac failure. The volume and force of the pulse may become diminished. The arterial pressure varies, and is, therefore, not a reliable indication of cardiac failure; it may be subnormal, but, on the other hand, it may be even supernormal until shortly before death. The apex-beat is usually displaced outwards, may be diffuse, and difficult or even impossible to locate. On percussion, the area of cardiac impairment is generally increased transversely to the right or the left, or both. On auscultation, modifications in the cardiac sounds and the cardiac cycle, as described elsewhere, may be present. Distension and pulsation of the jugular veins and other indications of tricuspid incompetence (to be described later) may be present.

Lastly, sudden death may occur, even without previous indications of cardiac failure.

The indications of failure of the left ventricle are chiefly those of systemic anæmia, the indications of failure of the left auricle are pulmonary in character, while the indications of failure of the right side of the heart are those of tricuspid incompetence. It should be noted that there may at the same time be indications of failure of all the chambers of the heart, with those of one chamber predominating. The symptoms of cardiac failure in mitral disease are principally respiratory in character. The symptoms of cardiac

failure in aortic disease, on the other hand, are at first usually mainly those of systemic anæmia, there being little or no chronic venous congestion; later on, symptoms of relative mitral incompetence are apt to appear. It should be noted that dyspnœa on exertion is perhaps the most frequent symptom of aortic disease, and may be the result of systemic anæmia as well as of some disorder of the respiratory organs. Præcordial pain, as well as cerebral symptoms, are of more common occurrence in aortic than in mitral disease; while gastro-intestinal symptoms, dropsy, and embolism are of less frequency.

PROGNOSIS IN CARDIAC AFFECTIONS

Prognosis in cardiac affections is a subject of the utmost importance, and often presents great difficulties. From the nature of the ailment, the reasons for the importance of prognosis are not far to seek. Among these are the fact that the patient and his friends are naturally anxious for, and have the right to, an opinion, based upon a full consideration of all the circumstances of the case, as to the probable duration of life, the ability of the patient to lead within limits a fairly normal existence, and perhaps also his capacity for employment. This is a very natural anxiety, which if unrelieved may have a most injurious effect upon the general health and well-being of the patient. It is a misfortune that in the popular view there is a tendency to group together all classes of cardiac affections as necessarily of serious import, the result being that in a considerable proportion of cases quite needless anxiety may be occasioned.

In trying to form a prognosis in any given case of cardiac disorder, the following points, among others, require consideration: the family history, age, sex, occupation, mode of life, social conditions, the locality, nature, extent and mode of origin of the lesion, its duration, the condition of the myocardium, whether the lesion is stationary or progressive, the degree of cardiac failure, the risk of sudden death, the immediate cause of the present attack, the number, if any, of previous attacks, the state of the patient's general health, the existence or otherwise of complications, and finally the response to treatment.

With regard to the family history, we should particularly note whether the other members of the family have suffered from any form of cardio-vascular disease, the average period of longevity, and the constitutional strength of the family. The question of age is one of considerable importance, the prognosis of heart disease being less favourable at the extremes of life. This in early life is owing to the fact that the heart is less able to undergo compensatory changes during the period of active growth, while any form of cardiac affection has a deleterious effect upon the general physical and mental development; moreover, rheumatic endocarditis is not infrequently accompanied by pericarditis, and there is also the risk of recurrence of rheumatic infection of the organ. Sudden death, on the other hand, is of rare occurrence. At the other extreme of life, the capacity of the heart for compensatory changes is much diminished, while degenerative processes, and associated disease in other viscera, are not infrequently present. Taking all cases of cardiac affections into account, the prognosis is better in females than in

males. Among other reasons for this is the fact that the former are less subject to physical and mental strain, in them mitral disease is relatively more common than aortic disease, and myocardial degeneration and coronary disease are relatively of less frequent occurrence. On the other hand, mitral stenosis is much more common, and the strain at puberty is greater in females than in males, and, further, the risks of pregnancy and parturition have to be considered. Any occupation or mode of life involving undue physical or mental strain or exposure, and unhealthy habits, such as over-eating or over-drinking, render the prognosis less favourable. The prognosis is considerably modified for the worse also if the patient be unable, when this is found to be necessary, to change an unfavourable occupation for one more suitable; or if he be compelled to live under unsatisfactory hygienic conditions as to food, fresh air and the opportunity for rest so necessary in those suffering from cardiac affections; or, if after suitable treatment has been instituted, a return has to be made to an unfavourable environment.

There appears to be no doubt that, taking cases as a whole, the prognosis of aortic is less favourable than that of mitral disease, and lesions affecting both valves graver than when one only is involved. It is a matter of no small difficulty to give the order of relative gravity of lesions affecting the different valves, but so far as my observations of four varieties of chronic valvular disease are concerned, I should place in order of gravity, aortic incompetence, mitral stenosis, aortic stenosis, and mitral regurgitation. With regard to aortic stenosis, however, a qualification is necessary; for although when due to a previous attack of acute endocarditis the prognosis is better than that of mitral stenosis, when primary chronic endocarditis is responsible it is not so good. Among the points which may be of assistance in trying to form an estimate of the extent of the lesion are how far the character of the pulse is modified, and the size of the heart. It should be noted that the severity of pain in the præcordium is not necessarily indicative of the nature or severity of the morbid changes present; for the pain may be severe in patients who are the subjects of slight lesions, and, on the other hand, may be of trifling severity in those who suffer from grave lesions.

Taking cardiac cases as a whole, when the lesion is due to a previous attack of acute endocarditis the prognosis is not so serious as when due to a primary chronic affection; because in the latter case the lesion is apt to come on after middle life and to be progressive, and to be associated with myocardial degeneration. It should, however, not be forgotten that when the lesion is due to a previous attack of acute endocarditis the patient is liable to recurrent attacks and consequent further crippling of the valve. If the lesion have existed for a considerable time and the health of the patient be still good, the outlook is correspondingly hopeful.

In any estimate of the prognosis of a case of cardiac disorder, it is of the utmost importance that the condition and degree of the integrity of the myocardium, and also whether the lesion is stationary or progressive, should be determined: both of these subjects have been discussed in the preceding section. The degree of cardiac failure is, of course, of great importance, and in any given case the following points, among others, should be noted: the nature and severity of the subjective symptoms, the rate—both while at rest and after physical exertion, the volume and force of the pulse, the

strength of the apex-beat and of the impulse of the right ventricle, the existence or otherwise of secondary dilatation, the character of the cardiac sounds and of the cardiac cycle, whether murmurs have diminished in intensity, the respiratory rate, the extent of œdema, and the size of the liver. It might be helpful if I indicated what, speaking broadly, may be regarded as clinical manifestations of four degrees of cardiac failure—namely: slight, moderate, severe, and extreme. *Slight:* Shortness of breath, palpitation, exhaustion, and, it may be, præcordial pain, on exertion which the patient formerly could do without experiencing this. *Moderate:* Shortness of breath, palpitation, and, it may be, cyanosis, on moderate exertion, such as walking quickly on the level; puffiness round the ankles in the evening; some degree of increased rapidity of the pulse while at rest; slight enlargement of the liver. *Severe:* Shortness of breath on slight exertion, such as walking at the ordinary rate on the level, or on changing position in bed; cyanosis while at rest; a considerable degree of œdema of the lower extremities in mitral cases, and a moderate degree in uncomplicated aortic cases; a considerable degree of tachycardia while at rest; œdema of the bases; a moderate degree of hepatic enlargement: albuminuria; orthopnœa; cardiac asthma. *Extreme:* Continuous shortness of breath; severe dyspnœa on slight exertion; marked cyanosis while at rest; general anasarca in mitral cases, and a considerable amount of œdema of the lower extremities in uncomplicated aortic cases; œdema of the serous membrane; much hepatic enlargement; pulsus alternans in the absence of a severe grade of tachycardia. A point of the utmost prognostic importance in angina pectoris is the ease with which the pain is provoked, and whether it occurs even when the patient is at rest.

With reference to the risk of the occurrence of sudden death in cardiac affections, a fatal issue in this way is most likely to occur in fatty or fibroid degeneration of the myocardium; it is also of not uncommon occurrence in angina pectoris; while of the valvular diseases it is most frequent in aortic incompetence. Another cause of sudden death is complete and abrupt closure of the lumen of a coronary artery, or of one of its main branches.

With regard to the immediate cause of the present attack, inquiry should be made as to whether this can be attributed to some temporary cause, such as a period of undue physical or mental strain, or some such intercurrent malady as acute bronchitis, or whether the symptoms have gradually appeared without any such cause; in the latter event, the prognosis is less favourable. The prognosis is also influenced by the state of the patient's general health, and the existence or otherwise of complications, among the latter being anæmia, bronchitis, supernormal blood-pressure and renal disease. The bearing upon prognosis of the supervention of auricular fibrillation, auricular flutter, pulsus alternans, intraventricular block, or any other variety of disordered cardiac mechanism, in any case of valvular or myocardial disease, will be considered in dealing with these affections.

Finally, the prognosis in cardiac affections must be considered in the light of response to treatment. For example, given a case of auricular fibrillation, with indications of severe cardiac failure, it is impossible to say what the future will be until full doses of digitalis have been administered.

Having now reviewed the various points which may arise in the consideration of the prognosis of most cardiac affections, these need not be again

referred to when the prognosis of individual cardiac affections comes under discussion.

TREATMENT IN CARDIAC AFFECTIONS

Importance of Treatment in Cardiac Affections.—In few departments of medicine is careful and skilful treatment of so great importance as in that of cardiac disorders, and in few is it so well rewarded. For although we cannot rectify the actual lesion in the case of a damaged valve or myocardium, it is none the less true that in a large proportion of cases it is possible by the adoption of proper and adequate therapeutic measures to prolong life for many years, and in most cases to save patients from much suffering. Moreover, the work which has been done in recent years in the realm of cardiac disorders has resulted in a great advance with regard to what can be accomplished in the large class of patients who are the subjects of auricular fibrillation, or of auricular flutter. At the outset, therefore, I would emphasise the fact that the practitioner will be amply rewarded for any time spent and patience exercised in considering and putting into practice suitable therapeutic measures for any given case of heart disease which may come under his care.

It is desirable to devote one section to the consideration of the therapeutic measures which may be applicable to any form of cardiac disorder, in order to save much needless repetition when we come to consider the treatment of the individual cardiac affections.

Objects of Treatment.—If the view previously put forward, that the essential cause of cardiac failure lies in the heart muscle, be borne in mind, certain points of fundamental importance with regard to the management of any case of heart disease can readily be grasped. We should focus our attention on the heart muscle. On the one hand, every factor which has an influence in strengthening it should be taken advantage of, while, on the other hand, everything which may throw an undue strain upon it should be considered carefully and in detail. Our objects should be: (1) To avoid everything which may possibly add to the degree of the already existing morbid affection, or embarrass the heart; (2) to do everything in our power to promote the efficiency of the myocardium; (3) to treat cardiac failure when this be present; and (4) to treat symptoms as they arise.

Instructions regarding Mode of Life.—Given a cardio-vascular affection, whether valvular, myocardial, or arterial, one of the most unfortunate of things we have to face is the fact that such a large proportion of patients endeavour, or are compelled, to live beyond the limits of the heart's strength; a constant strain is thus thrown upon the organ. It is of the utmost importance that the patient should acquire the habit of always living within the limits of the heart's strength, and should on no account attempt to go beyond this. On the other hand, care should be taken not to restrict unnecessarily the normal pursuits of a patient; otherwise he is apt to become unduly nervous and introspective. With regard to the amount and kind of physical exertion which a patient suffering from heart disease may undertake without harmful effects, it is impossible to lay down hard-and-fast rules, because the constitution and temperament of different patients differ greatly. It is possible, however, to enunciate a cardinal principle which will be found to be of inestimable

service in these cases. It is, that any exertion which the patient may undergo should not be attended or followed by breathlessness, palpitation, fatigue, a sense of tightness or oppression, or discomfort or pain in any part of the front of the chest, or giddiness or faintness. On the other hand, any exertion short of producing these symptoms is usually not harmful, provided violent and sudden effort be always avoided, and a sufficient amount of exercise is in every way desirable. It is not enough to regulate the amount of physical exertion only; the importance of attending to the amount of mental work in these cases is not sufficiently appreciated. When the cardiac affection is progressive, the amount of effort, physical and mental, should be correspondingly reduced. Every form of excitement, anxiety, worry, and emotional strain should, as far as possible, be avoided.

The question of focal sepsis is an important one and should receive attention. Prophylactic measures should be adopted with regard to the risk of infection by influenza or other intercurrent disease. It is important to guard against rheumatism in chronic valvular disease, especially when of mitral origin, and particularly so in children or in young adults. An attack of bronchitis or other affection of the lungs, influenza or other febrile disease, should be most carefully and energetically treated, and a sufficient amount of rest during convalescence should be enjoined. When exertion is again allowed it should not be such as will produce any symptoms of cardiac distress.

The patient should be instructed to eat slowly and thoroughly masticate the food, and, where necessary, the teeth should receive attention in order to allow of this. In most cases, the daily amount of fluid should be somewhat restricted, our aim being to lessen the work done by the left ventricle, by diminishing its output. The meals should be as dry as the patient will take them, a sufficient amount of fluid being taken between meals. The three meals of the day should be evenly balanced, as a large meal causes too great variation in the vascular system, to which the heart does not readily adjust itself. The food should be nutritious, but at the same time easily assimilable and not likely to cause indigestion. A diet of carbohydrates is bulky, and is apt to cause flatulence and hyperchlorydria, while a diet consisting of highly nitrogenous food increases the resistance in the peripheral circulation and is equally to be avoided; while, therefore, the diet should be a carefully mixed one, the albuminous element should predominate. Articles of food which the patient knows by experience to cause indigestion should, of course, not be taken. Anything which causes flatulent distension of the stomach or bowels should be avoided, since it, by direct pressure, embarrasses the heart, and is one of the commonest causes of palpitation. In the opinion of most, a salt-free diet is of value as an aid in preventing senile changes in the arteries, and in the treatment of supernormal blood-pressure and atheroma. The excessive use of tea, coffee, tobacco, and alcohol should be avoided. It is better for the patient to abstain from alcohol altogether; but if he has been accustomed to alcohol, and its deprivation be a great hardship, a strictly moderate amount of light wine, or well-diluted spirit, taken with meals, may be allowed.

If the patient suffers from an unduly excitable nervous system, this should receive careful attention. The bromides are often extremely useful, but their long-continued use is not to be encouraged. The ammonium salt is less depressant than the potassium salt, and may be given in doses of 10 to

20 grains, three times a day after food. It is difficult to exaggerate the importance of sleep, and enquiry should invariably be made regarding its amount and character, and if any defect be found it should be adequately and skilfully treated on the lines laid down later on. Any existing anæmia in patients suffering from heart disease requires to be effectively treated by a generous supply of red meat, and iron and arsenic. Patients who exhibit a gouty tendency should have their diet regulated, and take an occasional dose of blue pill, followed by a saline aperient. In adults who are the subjects of heart disease, a course of such tonics as iron, arsenic, phosphorus, strychnine, or quinine may be taken from time to time; while in children, cod-liver oil, the syrup of phosphate of iron, or the syrup of iodide of iron is of especial advantage.

REST.- Needless to say, rest is of cardinal importance in the treatment of cardiac failure; it is difficult, indeed, to exaggerate its value. It is not sufficiently appreciated that cardiac rest is the objective of all therapeutic measures. While bodily rest is indicated in all cases of cardiac failure, it is, in my opinion, of greater value in those cases in which auricular fibrillation is not present, than when it is; indeed, in the former group of cases rest easily holds the first place among the therapeutic agencies at our disposal. In determining the degree to which exertion should be curtailed, a cardinal principle, as has already been pointed out, is that the exertion in which the patient indulges should fall short of producing symptoms of cardiac distress. When there are indications of progressive exhaustion of the heart's strength, the amount of effort should be proportionately reduced, and when the symptoms of cardiac failure are pronounced it will be necessary to order the patient to keep to his bed.

SYSTEMATIC EXERCISES.—Systematic and graduated exercises are sometimes useful in cardiac affections, provided they be judiciously and carefully employed, and their effects watched. They are of special value in cases of slight cardiac failure due to the heart muscle being flabby and lacking in tone, as in fatty infiltration; in these cases they may prove a valuable aid to treatment, but it is essential that the myocardium should be fairly sound. Graduated exercises are contra-indicated in acute affections of the heart, in considerable myocardial degeneration, in cases of severe failure—as, for example, when there is severe dyspnœa on exertion, dropsy, enlarged liver, or angina pectoris, and in cases in which the heart failure is progressive. In my opinion, simple movements are, certainly in most cases, better than the resistance exercises as practised at Nauheim, and of the former I am inclined to favour Swedish exercises. Exercises may be indulged in even when the patient is confined to bed, but in all cases should stop short of producing any indications of cardiac distress, or *maintained* increased frequency of the pulse.

MASSAGE.- Massage is useful in many cases. It may be employed when the patient is confined to bed, but in which absolute rest is not necessary, while, on the other hand, ordinary muscular exercise is not advisable.

BATHS AND SPA TREATMENT.—It is commonly known that immersion of the body in water may exercise a decided influence on the circulation. It is, further, believed by some that certain waters at Nauheim, on account of their ingredients, possess a specific therapeutic value in cardiac affections; but I am very sceptical with regard to this. Patients undoubtedly often derive

very great benefit from a stay at Nauheim and at similar spas; but this appears to be due to the rest, the change of air, the regular mode of life and exercise, the careful dieting, and other factors. Given the same conditions of life, equally good results would be obtainable elsewhere. Spa treatment is particularly serviceable in patients who have indulged in excesses of various kinds.

Drugs.—It is, unfortunately, true that the reputation of many drugs used in the treatment of cardiac affections does not rest upon trustworthy evidence; by this I mean proof that the drug is a definite causal factor in the improvement of the patient. When a combination of various therapeutic agencies is employed, care should be taken to avoid crediting the administration of a particular drug with results which are in reality due to some other agency, more especially rest, or to the natural course of the malady. A problem which was notoriously a source of difficulty and perplexity to the clinician is the extraordinary difference in the results of the administration of digitalis or one of its allies in persons who are suffering from identically the same lesions, and complaining of precisely the same symptoms. As long as the drug has been in use in the treatment of cardiac affections, it has been known that the results of its administration are astonishingly varied; in some cases of cardiac failure it is of very great value, while in others it is quite ineffective. What is the cause of this variability? Is the drug capricious in its action or uncertain in its strength? Or is it due to some particular preparation being active while another preparation is inert? This has been thought to be the case by some, and for this reason special preparations have been prepared and advertised as being more uniformly certain in their action. These opinions have been proved to be wrong. It is of great importance to the practitioner to realise that this problem of the variability in the results of the administration of digitalis has been to a great extent solved. Put briefly, *those cases of cardiac failure which show wonderfully good results are, in the vast majority of instances, cases of auricular fibrillation, or of auricular flutter*, in either case accompanied by a rapid ventricular rate.

The Digitalis Group of Drugs.—This includes, among others, digitalis, strophanthus, squills, convallaria majalis, and apocynum. The most suitable preparations for oral administration are tincture of digitalis (B.P., 1918, dose, 5 to 15 minims); the fresh infusion of digitalis; tincture of strophanthus (B.P., 1918, dose, 2 to 5 minims, effective dose, however, being 5 to 10 minims); and tincture of squills (B.P., 1918, dose, 5 to 15 minims, but it should be administered in twice this dose in order to obtain the same effect as the tincture of digitalis). In this connection, it should be remembered that the tincture and the fresh infusion of digitalis contain all the glucosides. There is no evidence that the more recent preparations of digitalis are either pure substances, or are more reliable than the tinctures or the fresh infusion. They should not be administered orally, and strophanthus, in particular when in pure form, has been found to undergo decomposition in the alimentary canal. None of these preparations can be employed hypodermically in an adequate dose, on account of the local irritant action, and the same applies to intramuscular injections of strophanthin. Strophanthin is suitable for intravenous injection, and may be employed in urgent cases, or when the patient cannot

tolerate any of the other preparations of the digitalis series of drugs by the mouth. The results are the same as those following the administration of digitalis or strophanthus by the mouth, but are much more rapid, improvement in the general symptoms commencing within about two hours and becoming very pronounced 6 to 10 hours later. Strophanthin, 0.5 mg. ($\frac{1}{150}$th gr.), may be injected very slowly into a vein, and digitalis medication by the mouth may be commenced the following day. The injection should not be repeated within 24 hours, and then only in special circumstances (depending on the ventricular rate) and in a smaller dose.

It has been found that samples of digitalis supplied by different firms of chemists proved to be very constant in strength. It is advisable, however, whenever possible, to employ physiologically standardised preparations. The samples of tincture of strophanthus obtained from chemists are not nearly so constant in strength as those of digitalis. The active principles of the tincture of digitalis, strophanthus, and squills not infrequently undergo decomposition when these preparations are freely diluted with water, and this is especially so in the case of strophanthus. For this reason, the tinctures should be dispensed either undiluted, or diluted only with alcoholic preparations, and afterwards taken in water. In some cases, strophanthus and squills seem to have less tendency to induce digestive disturbances, and in a few cases I have found the latter succeed where the administration of digitalis or strophanthus was followed by gastro-intestinal symptoms or headache. On the whole, however, from a therapeutic standpoint, digitalis has proved to be the most reliable of the three drugs, and the others should be regarded as substitutes, which may be tried especially when digitalis appears to induce toxic symptoms.

The special indications which are commonly accepted for the administration of digitalis are increased ventricular rate—say over 80 per minute, weakness of the contractile force of the heart muscle, left- or right-sided cardiac dilatation, anuria due to deficient circulation, and anasarca, the cardinal indication being failure of tonicity. The drug is more generally useful in mitral than in aortic cases, especially with scanty, highly coloured urine, and with dropsy; in all probability, the explanation of this is that auricular fibrillation is much more common in mitral lesions. The drug is often useful when mitral regurgitation has become super-added to aortic disease, and also in many cases of fibroid degeneration of the myocardium, but in the latter group of cases the effects should be carefully watched.

The question is often asked whether digitalis should be given in cases of aortic incompetence. There are divided opinions on this point. A supposed disadvantage of the employment of the drug in aortic incompetence is that slowing of the pulse—if it occur—by prolonging diastole, allows more time for the distension of the left ventricle by the regurgitant current of blood. It should be pointed out, however, that slowing of the pulse may occur independently of the use of digitalis. It is further urged that the drug tends to cause sudden death in this affection. Patients have undoubtedly been known to die during its administration; but it does not necessarily follow that digitalis is responsible for this, for sudden death is apt to occur in aortic disease whether patients are taking the drug or not. In order to prove the contention that sudden death is due to the use of digitalis, there

should be no doubt that a relatively larger proportion of people suffering from aortic disease die when taking the drug than in the case of those in whom it is not being used. *I am not convinced on this point.* To be on the safe side, however, the drug should be given cautiously in this condition, and the patient should be kept in bed when considerable doses are being administered; while in those cases in which auricular fibrillation is not present, the drug should be stopped as soon as the acute symptoms have disappeared. Some authorities adopt the same precautions in cardiac failure associated with mitral stenosis, or suspected marked fatty degeneration. Others, again, prefer strophanthus to digitalis in aortic disease.

Digitalis is, as a rule, contra-indicated in cases of undue slowness of the pulse; in these cases, if given at all, it should be administered cautiously. The same precautions apply in the presence of a forcible apex-beat and bounding arteries. It is possible to do harm in cases of diminished conductivity, though the drug is not necessarily contra-indicated in these cases. Some writers recommend that prior to the administration of digitalis there should be free purgation. In cases of supernormal blood-pressure, Balfour believed in dilating the arterioles, and those who share this view administer one of the vaso-dilators along with digitalis or strophanthus. I myself am not optimistic with regard to the efficacy of vaso-dilators, except perhaps in cases of slight or moderate supernormal blood-pressure; and, as I have already pointed out, my investigations have shown that there is no risk attending the administration of digitalis in those cases in which there is supernormal blood-pressure, or arterial degeneration.

But, while the special indications for digitalis are increased ventricular rate, weakness of the contractile force of the heart muscle, cardiac dilatation, anuria due to deficient circulation, and dropsy, the results of its administration when these are present are variable. The response to these drugs differs according to the cardiac action and character of the rhythm; those cases of cardiac failure which show wonderfully good results are, in the great majority of instances, cases of auricular fibrillation, or of auricular flutter, in either case accompanied by a rapid ventricular rate—whether the lesion be valvular, or myocardial, particularly when subsequent to acute rheumatism or chorea. *In these cases whether dropsy be present or not, the results of the administration of digitalis in the majority of cases are very, and in some cases, extraordinarily good*: the administration of the drug is followed by a rapid fall in the ventricular rate (Fig. 31) and a concomitant improvement in the general symptoms. Two exceptions are: (1) Some cases of marked myocardial degeneration, and (2) cases in which there is accompanying pyrexia. In the latter, apparently, the response to digitalis, if present at all, is as a rule very slight, whether auricular fibrillation or auricular flutter be present or not. With regard to dosage: As a rule a certain amount of improvement may be obtained after a time by the administration of small doses of 5 minims of the tincture three times a day; but, on the other hand, the full effects of the drug are produced in a much shorter period by large doses. It would, therefore, appear to be desirable to commence with full doses, and to go on with these until some physiological reaction is obtained: and then, if required, to continue the administration, but to regulate the amount until it is discovered what is the optimum dose in a given case. A good method is to begin with a drachm of the tincture per diem, or

in urgent cases even 1½ or 2 drachms per diem, and to continue until there is anorexia, nausea or vomiting, diarrhœa, headache, an unduly slow pulse, or what is called *pulsus bigeminus* or *coupling of the beats* (Fig. 53).

In some cases the action of digitalis on the heart is manifested before its effect on the stomach; in others, anorexia, nausea, vomiting, headache or diarrhœa occurs first; in others again the effects on the circulatory and digestive systems are coincident. A physiological reaction usually occurs within a week, sometimes in 3 or 4 days; the time, however, varies greatly In auricular fibrillation, the drug should then be stopped until these symptoms have passed away, which is generally in a few days. In the great majority of cases the patient relapses, and the indication then is to find out what dose suits him best—that is, the dose sufficient to control the action of the heart, without at the same time giving rise to any toxic symptoms; this may require weeks or even months of careful observation, and much perseverance will generally be required. One method is to begin with half the original dose, and this can be increased or diminished according as the rate of the heart increases or diminishes. In this connection help may frequently be obtained from the patient himself, who is often able to say what dose suits him best; in other words, the patient's own sensations are often a good guide, and should be taken into account, as well as the ventricular rate. The dosage necessary in individual cases may exhibit a wide variation; it may be as small as a drachm of the tincture per week, or as large as 45 minims or even more per diem. Having discovered this dose, it will be necessary, in the great majority of cases, for the patient to continue the drug for the remainder of his life. In the course of time variations in the dose may be found to become necessary. The cumulative action of digitalis is apparently not nearly so important as has been believed; at the same time the ventricular rate ought to be watched. Pulsus bigeminus is a danger signal, and we should either stop the drug for a few days or diminish the dose.

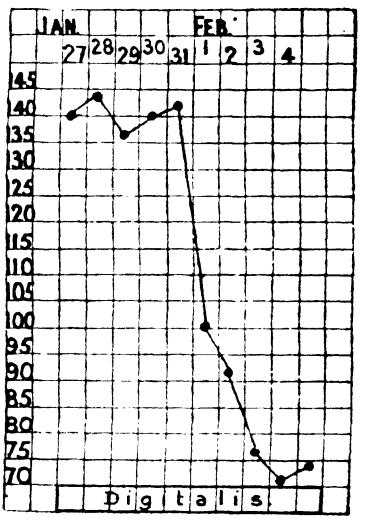


FIG. 31.—Chart showing typical result on the cardiac rate of the administration of digitalis in a case of auricular fibrillation with tachycardia. A drachm of the tincture per diem was commenced on 27th January.

Digitalis has no effect upon the auricular fibrillation itself; but it diminishes conductivity of the auriculo-ventricular junctional tissues, thereby interfering with the pathway of impulses from auricle to ventricle, and so cutting off some of the too numerous impulses reaching the ventricle, and thus leading to a reduction in the ventricular rate, as a result of which the cardiac contraction becomes stronger, with consequent improvement in the circulation and in the general symptoms. In very rare instances, complete auriculo-ventricular block is induced. In the opinion of Cushny, the diminu-

tion of the ventricular rate in auricular fibrillation is due to the direct action of the drug on the heart muscle, and not to stimulation of the inhibitory mechanism, since it is not prevented by atropine. This view is not accepted by others, however, who hold that it is due to stimulation of the inhibitory mechanism.

When auricular fibrillation is not accompanied by a rapid pulse, no marked result usually follows the administration of digitalis; indeed, it is often difficult to be certain how far the improvement may be due to the rest in bed and other measures adopted, apart from the effect of the drug.

In auricular flutter, the administration of full doses of digitalis at first usually induces partial heart-block, or an increase of the degree of block already existing, with a resulting diminution of the ventricular rate. Later on, the drug may induce auricular fibrillation. This may persist, or the physiological rhythm may be restored—either event occurring during the administration of the drug or after it has been discontinued, or the normal rhythm may be interrupted from time to time by paroxysms of flutter, or after the cessation of the drug the flutter may return and continue. The same dosage should be employed as in cases of auricular fibrillation with tachycardia, and should be continued until the full physiological reaction is obtained. After this one of two plans may be adopted: (1) The dosage may be gradually diminished, and afterwards the administration of the smallest dose necessary to control the ventricular rate continued in the hope that the flutter may cease; or (2) large doses may be continued, in the hope of inducing auricular fibrillation, after which the administration of the drug is discontinued for some days, in the hope of a return to the normal rhythm. The first plan is generally to be preferred.

Eggleston, in 1915, introduced the method of the oral administration of massive doses of digitalis, and since then others have advocated this method. A physiological reaction is usually obtained in from 12 to 36 hours. The drug should then be stopped for a time. The employment of massive doses should be restricted to urgent cases of auricular fibrillation or of auricular flutter with a rapid ventricular rate. Only physiologically standardised preparations of digitalis should be used. Three doses of 1½ drachms, 1 drachm, and half a drachm, at intervals of 6 hours, or 1 drachm, or a drachm and a half, 1 drachm, 1 drachm, and 1 drachm, at the same intervals, may be employed.

If the case be not one of auricular fibrillation or of auricular flutter, exceptionally the administration of digitalis induces auricular fibrillation. *Apart from these cases, as a rule, though not always, the beneficial results will be only moderate, almost negligible, or even altogether absent—unless dropsy is present.* The drug appears to act by increasing the strength of contraction and perhaps by augmenting tonicity. In some of these cases, the ventricular rate is diminished—though rarely in so marked a degree as in auricular fibrillation, but this is not an essential factor. In the majority of cases with a normal rhythm, however, the ventricular rate is not diminished more than can be accounted for by the rest in bed and other therapeutic measures. Or, the various grades—even complete—of auriculo-ventricular block, or sinus irregularity, extra-systoles, sino-auricular block, or pulsus alternans, may be induced. The higher grades of heart-block are sometimes induced by full doses of one of the digitalis series of drugs in those exhibiting a slight degree of block who had previously suffered from

a rheumatic infection of the heart. Cushny is of opinion that slowing of the heart, usually auriculo-ventricular and sino-auricular heart-block, and sinus irregularity are due to vagus stimulation; and extra-systoles, and sometimes auriculo-ventricular and sino-auricular block, to the direct action of the drug on the cardiac muscle. My custom in cases of normal rhythm also is to commence with large doses, and to continue until there is anorexia, nausea, vomiting, an unduly slow pulse, or heart-block, extra-systoles, sinus irregularity, or pulsus alternans. In some cases, heart-block or extra-systoles are at first only observed after exertion; after the temporary acceleration produced by the exertion has subsided, the pulse-rate becomes slower than before the exertion, if the individual be under the influence of the drug, and it is during this period of slowing that heart-block or extra-systoles appear. When these symptoms have appeared, the drug should be stopped, or the dosage reduced. If improvement in cases without auricular fibrillation occur, it can usually be maintained without continuing the drug; sometimes, however, it is advisable after stopping the drug for a few days to resume with smaller, but yet sufficiently large, doses. Here again, the patient's own sensations should be taken into account.

Digitalis is contra-indicated in partial heart-block. I have never found it of any value for the irregularity of extra-systoles.

Quinidine: During recent years quinidine has been employed in the treatment of persistent auricular fibrillation and persistent auricular flutter, more especially the former, with the object of arresting either condition—in other words, to restore the normal rhythm; and also in paroxysmal tachycardia, in the intervals between the attacks, to prevent their recurrence. In about half the cases of persistent auricular fibrillation reported, the normal rhythm was restored.

Lewis and his co-workers are of opinion that quinidine has the following effects: (1) It diminishes the sino-auricular rate considerably. (2) It increases the absolute refractory period of the muscle of the auricle. (3) It diminishes the rate of conduction in the auricle, along the auriculo-ventricular junctional tissues, and in the ventricle. The three effects are due to a direct action on the muscle. The drug usually induces paralysis of the vagus—generally partial, rarely complete—both with regard to its action on the sino-auricular rate, and the rate of conduction along the auriculo-ventricular junctional tissues. With regard to the latter, however, exceptionally, vagal stimulation lessens the degree of any existing auriculo-ventricular block. The effects of the administration of quinidine in patients suffering from persistent auricular fibrillation are mainly: (1) A progressive diminution in the auricular rate; (2) a simultaneous increase in the ventricular rate; and (3) a sudden cessation of the auricular fibrillation, with a return to the normal rhythm. The usual sequence of events is coarse fibrillation, impure flutter, pure flutter, a short period of arrest of the whole heart, and the restoration of the normal rhythm. There is a preliminary, and very early and progressive diminution in the auricular rate, even up to 200 per minute, due to (1) a diminution in the rate of conduction in the auricle, and, under certain conditions, (2) an increase in the length of the refractory period, causing the circulating wave to choose a longer path. If the auricular rate falls to about 200 or under, there is a danger of the ventricle suddenly taking on the same rate as the auricle. Rarely a slight rise in the auricular rate results in a long arrest of

the whole heart. Whether the normal rhythm is finally restored or not, an increased ventricular rate, to 120 per minute or more, which may cause attacks of palpitation, is common during the first two days of the administration of the drug. The increased ventricular rate may be controlled by a preliminary course of digitalis medication, in full doses, which almost always causes the oscillations of the fibrillating auricle to become more frequent, and also diminishes conductivity of the auriculo-ventricular junctional tissues. Extra-systoles may be observed after the auricular fibrillation has ceased, and may give rise to palpitation. They may appear isolated, or at irregular intervals, or a single extra-systole may occur regularly after each normal beat—resulting in coupling of the beats, or the extra-systoles may occur in short or long runs—in the latter event lasting even for some hours. The occurrence of extra-systoles is to be noted as a general rule only when the auricular rate has diminished considerably, generally to 250–300 per minute. Their appearance is an indication of poisoning.

In persistent auricular flutter, the administration of quinidine may restore the normal rhythm.

General toxic symptoms, cardiac failure, and embolism may occur during the administration of quinidine. Among general toxic symptoms are headache, giddiness, tinnitus, transitory visual disturbance, nausea, vomiting, abdominal pains, palpitation, tachycardia, præcordial discomfort or pain, sweating, scarlatiniform or morbilliform rashes, urticaria, a mild degree of pyrexia, fainting attacks, and mental symptoms. Among the manifestations of cardiac failure are sudden collapse, sudden cessation of respiration, severe dyspnœa, cyanosis, and disappearance of the pulse—due to ventricular standstill during the transition stages. Naturally these effects are more likely to follow when there is a considerable degree of cardiac failure and of cardiac enlargement, notwithstanding the fact that a course of rest and digitalis medication has been tried. The risk of embolism occurs at the time when the auricle first commences to contract again after the restoration of the normal rhythm. Thrombi are expelled from the auricular cavity into the systemic or pulmonary circulation, and death may result. Embolism is more likely to occur when the patient is the subject of mitral stenosis, when the auricular fibrillation or the auricular flutter is of long standing, and there is a previous history of embolism. Death during the administration of the drug may be due to cardiac failure or to embolism.

In persistent auricular fibrillation or persistent auricular flutter quinidine is most likely to be successful in those cases in which there is either a complete absence, or at the most only a moderate degree, of valvular or myocardial disease, of cardiac enlargement, and of cardiac failure; in those in which the abnormal rhythm is the result of antecedent rheumatism or chorea rather than when due to degenerative changes; in cases in which there is an absence of acute endocarditis, or acute myocarditis; when the onset of the condition has occurred during an acute infection—such as influenza; when the abnormal rhythm has followed paroxysmal attacks, and, in the opinion of some, when of recent origin; and in the case of the young. The majority of successful cases follow the use of only small doses of the drug, and it is rarely successful if more than 30 grains per diem are required. Relapse into the abnormal rhythm occurs, in the majority of cases, sooner or later, after the drug has been stopped. This is less likely to happen when the abnormal

rhythm is the result of antecedent acute rheumatism or chorea; when it is of recent origin; when the onset of cardiac failure coincided with the onset of the abnormal rhythm; and when the administration of the drug is continued.

The degree of improvement in the patient's condition which may follow the administration of the drug depends upon the restoration of the normal rhythm, the permanence of this, and whether the ventricular rate has not been increased by the restoration of the normal rhythm, and how great a factor the supervention of the abnormal rhythm has been in inducing and maintaining the cardiac failure. It is important to try to determine whether and to what extent the abnormal rhythm is responsible for the cardiac failure. In this connection, if the onset of cardiac failure coincided with the onset of the abnormal rhythm, we may assume that the cardiac failure was due to this; the degree of response to rest and digitalis medication is also helpful. In a certain proportion of cases in which the normal rhythm has been permanently restored, and the ventricular rate has not been increased, the standard of health seems to be higher than it was when the ventricular rate was controlled by digitalis, and in some it appears to be even equal to that which existed prior to the existence of auricular fibrillation or of auricular flutter. In some cases after the restoration of the normal rhythm the ventricular rate is higher than when the auricular fibrillation or the auricular flutter existed and the ventricular rate was controlled by digitalis, and it may not be possible to control tachycardia associated with the normal rhythm by digitalis, so that the patient may not be so well, and possibly even a good deal worse. In auricular fibrillation, the consciousness of the irregular action of the heart disappears.

Among the disadvantages of quinidine is the risk– even amounting to a possible fatal issue—attending the administration of the drug, the fact that restoration of the normal rhythm occurs in only about half the cases of auricular fibrillation, there is a danger of relapse into the abnormal rhythm, and in some cases after the restoration of the normal rhythm the general health is worse—possibly even considerably so. Contra-indications for the use of the drug are the presence of a severe grade of valvular disease, widespread myocardial degeneration, great enlargement of the heart, a severe degree of cardiac failure unless this has been remedied by a course of rest and other therapeutic measures, heart-block, existing or recent acute or subacute endocarditis or myocarditis, a recent history of embolism, and in those cases when the patient cannot be confined to bed and be assiduously and carefully watched. The elderly or even the aged need not be excluded on the ground of mere age, but, in the opinion of some, cases of over three years' standing generally are.

A preliminary course of rest in bed and of digitalis medication is advisable. It is the practice of some to stop the digitalis for a few days before commencing quinidine, while others continue its use during the administration of the latter, in order to control the ventricular tachycardia. The patient should invariably be confined to bed, preferably in a hospital or nursing home, absolute rest, physical and mental, should be enjoined, and he should be assiduously and carefully watched. Frequent electro-cardiographic or polygraphic examinations, preferably the former, are very advisable, but they are not indispensable. If the electro-cardiograph is employed, it is better to employ direct leads from the chest, instead of from the limbs, as

the former method supplies a more accurate record of the state of the auricles. If electro-cardiographic or polygraphic examinations are not available, I would lay stress upon the value of auscultation. Quinidine is given preferably in gelatine capsule form. Some people, even those who are not the subject of heart disease, show an idiosyncrasy to the drug. This is as a rule approximately proportionate to the dosage. It is advisable to give a single dose of 5 grains, or two doses of 3 grains at an interval of 2 hours, to test for possible idiosyncrasy, and if none is found to exist, to commence the routine treatment the following day. Five grains three times daily may be commenced with, and the total daily dosage gradually increased until the normal rhythm is restored. The dosage should not exceed 50 grains per diem. The drug should be stopped if severe toxic symptoms, severe cardiac failure, or embolism, occur, or if, according to Lewis, there is an auricular rate of 250 or 240 per minute—because of the risk of inducing 1 : 1 rhythm, or, as a rule, if there is a ventricular rate above 160. After the normal rhythm has been restored, the total daily dosage should be gradually diminished to 5 grains twice, or even once, daily, and this continued for an indefinite time or even permanently. This method lessens the likelihood of relapse.

Recently I have employed 5 grains of quinidine sulphate once daily in a number of cases of paroxysmal tachycardia, in the intervals between the attacks, to prevent their recurrence, and it has been successful in most. Some workers employ about twice this daily dosage.

Investigations which I conducted some years ago showed that *aconite* has no effect upon the pulse-rate.

Caffeine has acquired a certain reputation in the treatment of cardiac affections, but this is, in the main, the result of its diuretic action, which is of great value. It should not, however, be regarded as a substitute for digitalis, for the action of the respective drugs on the heart is not the same. Apart from its diuretic action, caffeine may be tried when digitalis, strophanthus, and squills have failed, particularly where there is no dilatation. It does not slow the pulse, and, therefore, bradycardia is no contra-indication to its use.

Diuretin, agurin, and *theocin-sodium-acetate* have a more constant and marked effect upon the kidneys than caffeine. They may be used in conjunction with one of the digitalis group.

Strychnine has acquired a great reputation in cases of cardiac failure when very rapid effects are required, but there appears to be no absolutely reliable experimental or clinical evidence that in medicinal doses the drug has any effect upon the heart or blood vessels; nevertheless, many are of opinion that the prevailing belief is supported by clinical experience. The action of the drug is probably an indirect one as far as the heart is concerned, its essential action being that of a respiratory stimulant.

Diffusible stimulants (alcohol, ammonia and ether) are of value in some cases of cardiac affections, particularly during temporary attacks of cardiac failure, febrile cases, and for the relief of urgent symptoms. With regard to alcohol, it is often a good thing to begin with a small quantity of wine with food. Ultimately stimulants in larger quantities may be employed, and of these old brandy is the best.

Adrenalin.—The use of adrenalin hypodermically in Adams-Stokes syndrome is referred to on page 799. Intracardiac injection of adrenalin may be tried in cases of complete arrest of the heart and respiration. Its

chief use is in syncope during an operation. It has also been tried in cardiac failure from various causes, but its results here are uncertain. Artificial respiration should always be combined with it. The maximum dose should be 1 mg. (1 c.c. of 1–1000 solution), and the solution employed should not be more than 3 months old. No special needle is required; one for lumbar puncture or for inducing regional anæsthesia, with a syringe 2–5 c.c., suffices. The needle should be introduced in the fourth left intercostal space, close to the sternum, or the upper border of the fifth intercostal cartilage. After passing the needle perpendicularly for 2–3 cm., it should be turned slightly to the middle line. The right ventricle is reached, and on penetrating 4–5 mm. the cavity of the ventricle is entered. Care should be taken that the needle is certainly in the cavity of the ventricle, by withdrawing a little blood, before injecting the adrenalin. The drug should be injected slowly. Artificial respiration should be stopped while the injection is being made, but resumed immediately afterwards. After the heart has become re-animated, adrenalin intravenously may be employed.

Barium chloride.—The employment of this drug in Adams-Stokes syndrome is dealt with on page 799.

Atropine is supposed to paralyse the cardio-inhibitory terminations, and cases of heart-block have been recorded in which the writers have stated that in their opinion the drug was the means of increasing the ventricular rate. If this be so, it should be of service in Adams-Stokes syndrome. One-hundredth of a grain may be given hypodermically, and repeated in half an hour if necessary. I am bound to say, however, that I have never yet seen any good result follow its administration in these cases.

Some believe that *iron* and *arsenic* are cardiac tonics, and, therefore, do not restrict the use of these drugs to cases of heart disease in which there is coexisting anæmia, but employ them in the early stages of cardiac failure. Iron, arsenic, strychnine and quinine are often serviceable during convalescence.

The *bromides* are useful in cases of heart disease in which there is excitability or irritability of the nervous system, and in sleeplessness. The *iodides* are said to be of value in gouty conditions, in supernormal blood-pressure, in arterial disease, in angina pectoris, and, most of all, when there is reason to believe that valvular, myocardial or arterial disease is the result of syphilis, and they may be taken for long periods of time; in the last group of cases they should be given in full doses (15 to 20 grains three times a day). *Mercury* may with advantage be administered along with the iodides when the syphilitic infection is recent. With regard to arterial disease, while iodides may exert a beneficial influence in the earlier stages of the disease, it is practically certain that they are valueless in the later stages.

The *nitrites* may be tried in cases of increased blood-pressure, and in angina pectoris—in the latter even if unattended with high pressure. Nitrite of sodium, erythrol tetranitrate, mannitol nitrate, nitro-glycerine, and nitrite of amyl are most commonly employed.

Purgatives are of value when there are indications of distension of the right chambers of the heart, and dropsy, and also in cases of supernormal blood-pressure; salines, administered from half an hour to an hour before breakfast, are preferable.

Diuretics should be given in cases in which the urine is scanty, especi-

ally if dropsy be present. The best diuretics are digitalis, squills, caffeine, diuretin, aguriu or theocin-sodium-acetate, scoparium, and the acetate, citrate, or bitartrate of potassium.

Oxygen.—This is sometimes of value in cases of cardiac failure, the chief indications for its use being dyspnœa, cyanosis, and angina pectoris, particularly the two former. On the whole, I have been disappointed with the results of its administration, though occasionally substantial good has apparently attended its use. Leonard Hill has introduced a new method of giving it, by which the patient inhales almost pure oxygen. The patient's head is enclosed in a mask, the oxygen entering the mask from a cylinder, and the séance lasting from 10 to 20 minutes at a time. More recently Haldane has introduced a better method.

Blood-letting.—This is of considerable value in a certain class of cases, and I am inclined to think that this mode of treatment is often not used when it might be employed with great advantage. It should be employed when there are indications of great distension of the right chambers of the heart—as, for example, severe dyspnœa, cyanosis, noticeable turgescence of the veins of the neck, and increased area of impairment of the percussion note to the right—especially when the radial pulse is small and weak, while, at the same time, there is forcible pulsation of the right ventricle in the epigastrium. As a rule, venesection should not be performed in aortic incompetence; in these cases it often does harm. My custom is to choose the median basilic vein, and to withdraw a good quantity of blood—occasionally even up to 20 or 30 ounces; sometimes, however, 8 to 10 ounces are sufficient. If venesection be not practicable, or be objected to by the patient or his friends, 6 to 12 leeches over the right ventricle or liver are a good substitute. When blood-letting is employed, it should be accompanied by dry diet and free purgation.

Massage of the Heart.—This desperate measure finds its chief, if not only, indication in arrest of the heart during general anæsthesia. The best route for its application appears to be the subdiaphragmatic. The abdomen is opened, and the heart massaged from below the diaphragm. Artificial respiration should always be maintained at the same time. Not more than 5 minutes should be allowed to elapse before massage is employed after the heart has failed. The compression should at first be rhythmic, and if this method is not successful in 10 minutes, it should be applied intermittently. Adrenalin into the external jugular vein is a useful adjunct.

Treatment when Cardiac Failure is Present

The amount of physical or mental effort should be reduced. In the slighter degrees of cardiac failure it may be sufficient if the patient remain in bed for a couple of hours every afternoon or one day a week, although it is usually better to commence treatment by keeping him continuously in bed for a short time. When heart failure is more pronounced the amount of exertion should be reduced to a minimum, the patient being kept in bed for a period which may extend even to some months. When subject to nocturnal attacks of dyspnœa he may be most comfortable when supported by high pillows or a bed-rest, or he may not be able to breathe with comfort even in bed, and may prefer to sit up in a large easy-chair, leaning forwards and sup-

porting himself with his arms on the back of another chair. In certain cases of cardiac failure, exercise in moderation, provided careful and detailed instructions be given as to its nature and extent, is of value.

In cases of cardiac failure, unaccompanied by nausea and vomiting, light solids form the best diet, and, as a rule, agree better than fluid food, being less likely to cause flatulence; the necessary mastication is also an advantage. The daily amount of fluid taken, particularly at meal-times, should be reduced. Great care should be exercised to see that the patient does not take a larger quantity of food than he can comfortably digest. The food should be easily digestible. When cardiac failure is extreme, the amount of food should be considerably restricted, and only very small quantities at a time, at fairly frequent intervals, should be allowed. Biscuits, small thin sandwiches of potted meat, or small quantities of milk are not infrequently all that can be comfortably digested. Occasionally a pure milk diet, or a modified Salisbury diet, is best. Other therapeutic measures appropriate to the condition should be employed until the requisite effects are obtained; the indications for, and the manner of employment of, each class of these in cardiac failure have already been fully described. When there are indications of distension of the right heart, free purgation, the administration of diuretics, and blood-letting are indicated. Special symptoms should be treated on the lines laid down later on. The return of convalescence should be gradual, and the greatest care should be exercised. Convalescence from severe cardiac failure is sometimes aided at first by gentle massage, and, later, by carefully regulated and gradually increasing exercises—at first passive, and later active—before the patient is allowed to get up. The movements should always stop short of producing symptoms of cardiac distress, and should be followed by a period of absolute rest.

Treatment of Symptoms

Rest, and other measures and remedies previously described in detail, should be employed in the treatment of symptoms.

Sleeplessness.—The ventilation of the bedroom should receive attention, and, while the patient should be kept warm, the bedclothes should not be too heavy. It should be remembered that insomnia may be due to dyspnœa, and that in these cases the patient is sometimes troubled with "night starts" as he is falling off to sleep; the dyspnœa should be treated on the lines to be laid down later. Similarly, if supernormal blood-pressure be present, this should receive attention. It may be necessary to employ hypnotics in the insomnia of heart disease. I generally begin with the bromides, and usually choose the ammonium salt, on account of its less depressant effect, in doses from 10 to 20 grains three times a day, only gradually diminishing the dosage. Failing bromides, or as an alternative to these, I usually employ medinal (grs. v–x), adalin (grs. x–xv), or paraldehyde (℥i–℥ii or more). The last is an extremely valuable drug in many cases, especially when there is dyspnœa. Its unpleasant taste may be partly concealed when administered in an almond mixture, or in an emulsion; or it may be given in capsules, each containing 20, 30, or 40 minims. If the patient is more restless or excited after taking the drug it usually means that the dose has been too small. Bromural (grs. v–x), dial, urethane (grs.

x–lx), trional (grs. x–xx), or sulphonal (grs. x–xxx) may be tried. The last two are especially useful in nervous subjects, but they have the disadvantage of being slow in their action, although this makes them very useful in cases in which the insomnia occurs late at night. If these remedies fail, chloral hydras may be tried. This drug has the reputation of being a dangerous remedy in heart disease, especially in degeneration of the myocardium, but I have used it very extensively and have never found this to be the case. It produces a refreshing sleep, and is especially useful when nocturnal dyspnœa and supernormal blood-pressure are present. It may be given in doses of 5–10 grains by the mouth, gradually increasing to 15 or even 20 grains if necessary, the dose being repeated in 2 hours if required, and the effects carefully watched all the time. Chloralamide (gr. xv–xlv) acts nearly as well as chloral hydras in some, although by no means in all, cases, and is supposed to be safer. Bromidia (℥i or more) is also useful. If these drugs fail, resort should be had to opium or morphine, which are especially useful when there are accompanying restlessness and dyspnœa. The hypodermic administration of morphine is much more efficacious in cardiac failure than when given orally, and there are disadvantages attending the latter method. It is well to commence with very small doses, and gradually to increase them until relief is obtained, the effects being carefully watched. I generally commence with $\frac{1}{8}$th grain, gradually and carefully increasing to $\frac{1}{4}$th grain if necessary; while, later, it may be necessary to increase the dose even still further. Cyanosis is not an absolute contra-indication to the administration of chloral, opium or morphine. Speaking generally, these drugs should not be administered in those cases in which there is much bronchial secretion, or œdema of the lungs, or in Bright's disease; but in individual cases they may be tried if the first dose be extremely small, and the dosage be subsequently increased with the greatest caution. Further, when there is much bronchial secretion, or œdema of the lungs, a sharp look-out must be kept to see whether the administration of the drug increases them; in such a contingency, atropine or strychnine should be administered in combination with the morphine.

Dyspnœa.—If bronchitis, or gastric or intestinal flatulence be present, they should receive attention; and, similarly, fluid in the abdomen may require to be withdrawn. If there be indications of congestion or œdema of the lungs, dry-cupping is indicated, the best time, as a rule, being when the patient desires to go to sleep. The exclusion of hydrothorax as a cause of dyspnœa should always be a matter of consideration, and, when present, paracentesis thoracis should be performed. Oxygen, diffusible stimulants such as ammonia and ether, and strychnine may be tried in dyspnœa. Strychnine undoubtedly has an action on the respiratory centre, and in patients who suffer from "night-starts" and nocturnal dyspnœa may be given in full doses in the evening. Venesection or leeching is sometimes of value. For paroxysmal dyspnœa, vaso-dilators—such as the inhalation of amyl-nitrite, or the internal administration of nitro-glycerine, erythrol tetranitrate, or sodium nitrite—are sometimes efficacious. When these various measures fail, chloral may be tried, and, if this be not successful, opium or morphine. The dosage of these drugs and the contra-indications to their use have already been noted under the head of sleeplessness.

Faintness.—Among temporary measures are plenty of fresh air, fanning,

warmth to the feet, cold to the head, and diffusible stimulants, such as ammonia and ether.

Œdema.—The measures which are of particular value in the treatment of œdema are the restriction of the amount of daily fluid, free purgation, the administration of diuretics, and, in the opinion of most, a salt-free diet. A watery diarrhœa is not necessarily a contra-indication to purgation, because it is frequently due to a passive congestion of the intestinal mucous membrane. Besides the usual purgatives, calomel and colocynth pill, or pil. hydrargyri, followed by Epsom salts or some other saline in the morning, may be given once or twice a week for a time. The infusion of digitalis has a greater reputation than any other preparation of that drug in the treatment of dropsy, but I am not sure that this is warranted. If digitalis fail, theocin-sodium-acetate, agurin or diuretin may be added to it. Many people prefer a combination of drugs, and in many cases this method of treatment appears to be more efficacious. Baillie's or Guy's pill, which consists of mercury, digitalis, and squills, is a well-known combination. It is particularly useful in persistent dropsy due to cardiac failure; indeed, when given along with saline aperients it forms the most useful diuretic in many cases of œdema of heart disease. Among various prescriptions of this combination are:

℞ Pilulæ hydrargyri, Pulveris digitalis, Pulveris scillæ, Extracti hyoscyami, āā gr. i. Ft. Pil. One three times a day after meals.

℞ Pilulæ hydrargyri, grs. ii; Pulveris digitalis, gr. ½; Pulveris scillæ, gr. i. Ft. Pil. One three times a day after meals.

Another good combination is 5 grains of citrate of caffeine, 20 grains of citrate of potash, and half an ounce of infusion of digitalis. It is always best, when possible, to give mercury before commencing the administration of a diuretic, as it appears to start the diuresis.

In early dropsy, bandaging of the lower extremities is often very useful, and this may be combined with massage. When the œdema does not disappear in spite of the measures mentioned, the mechanical removal of fluid should be considered. The means which may be employed are Southey's tubes, acupuncture, and scarification, the first two being better than the third. Whatever method be employed, strict aseptic precautions should be exercised. With regard to acupuncture, the dependent limbs and scrotum may be punctured by means of a sharp broad surgical needle (which is grasped by the finger and thumb from a quarter to half-an-inch from the point), and then wrapped in sterilised dressings to drain. If ascites or pleural effusion do not yield to other treatment, and cause embarrassment, the fluid should be withdrawn. With regard to the former, Southey's tubes or tapping may be employed; in the latter case, tapping is necessary.

Cough.—The cause of the cough, which may be œdema of the lungs or hydro-thorax, should after investigation be suitably treated, and relief may be sometimes obtained by the administration of hot drinks, and the application of a large mustard and linseed poultice over the bases of the lungs. A linctus may be necessary.

Hæmoptysis.—Hæmoptysis is only rarely a serious accompaniment of heart disease, and may be combated by rest, together with the administration of calomel and saline purgatives. It may be necessary, however, to supplement these measures by the administration of morphine. Venesection or leeching is advocated by some writers in severe cases.

PULMONARY ŒDEMA.—Dry-cupping is sometimes beneficial in chronic pulmonary œdema. The treatment of acute pulmonary œdema is dealt with on p. 1064.

VOMITING.—Milk is, in the majority of cases, the best food, to which sodium citrate (15 grains to each 10 ounces) may be added. If milk be not tolerated, peptonised milk, whey, albumin water, milk gruel, koumiss, or strong meat essences may be sipped, the patient not being allowed any solid food. If one of the digitalis series of drugs be indicated for the general condition, and the patient be peculiarly intolerant of digitalis, strophanthus, squills, or one of the other substitutes may be tried. A brisk purge should be administered, and bismuth with hydrocyanic acid may be given. Counter-irritation over the epigastrium is occasionally of some help for the relief of vomiting. If, in spite of these measures, the vomiting still continue, all food, and even water and drugs, by the mouth should be stopped, and resort be had to rectal feeding. The great advantage in these cases of rectal feeding with milk pancreatised for at least 24 hours is not sufficiently appreciated.

PALPITATION.—The possible causes of palpitation should be carefully considered and adequately treated; among these, gastric and intestinal dyspepsia and toxic agents are especially to be noted. Rest is indicated in some cases, and a belladonna plaster applied to the præcordium is sometimes efficacious. If these measures fail, the bromides may be given a trial.

CARDIAC PAIN.—As in the case of palpitation, we should first of all consider the possible causes of cardialgia. Rest is especially indicated when it is obviously due to overstrain or dilatation. Iodide of potassium is sometimes efficacious, even when the pain is not associated with supernormal blood-pressure. A belladonna plaster applied to the præcordium is sometimes beneficial; while sometimes—especially in acute inflammatory conditions—counter-irritation in the form of a mustard leaf, blister, leeching, hot applications, or the use of an ice-bag or Leiter's coil, affords relief. If these measures fail, the bromides may be administered, and in the event of their not being successful it may be necessary to resort to opiates, nepenthe or tincture of opium being tried at first, while if the pain still continue morphine may become necessary.

TACHYCARDIA.—We should first of all review the ætiology of the condition, with a view to treatment. The treatment of tachycardia in organic heart disease has, for the most part, been dealt with in the general consideration of cardiac failure. It has been pointed out that, as a rule, the best remedy for cases unaccompanied by auricular fibrillation is prolonged rest, and for cases accompanied by auricular fibrillation digitalis or one of its allies. The question of toxic agents, such as tea and tobacco, febrile states, neurasthenia, and hysteria, as possible causes of tachycardia, should always be considered. The bromides, with belladonna, pushed to the limits of tolerance, appear to be of value in some cases of tachycardia.

Having now discussed the various therapeutic measures which may be applicable to any form of cardiac disorder, these need not be again referred to when we come to consider the treatment of the individual cardiac affections: in this way much repetition will be saved.

FREDERICK W. PRICE.

FUNCTIONAL DISORDERS OF THE HEART

By functional disorders of the heart are meant those which occur independently of any structural change, whether of the valves, the myocardium, or the arteries; they are merely disorders of function, no organic lesion being necessarily present. It should be remembered, however, that any variety of functional disorder may be found in association with, though independent of, organic disease, especially if cardiac failure be present; and, further, that a persistent functional disorder may terminate in organic disease, although not necessarily so. Some writers deny the existence of functional disorder of the heart altogether, being of opinion that in every case some structural change not only exists but accounts for the malady. Such a view is, in my opinion, untenable. I wish to emphasise at this stage, however, that in a not inconsiderable percentage of cases a diagnosis of functional disorder is erroneously made owing to the fact that the existence of organic disease has not been detected, because the examination has been conducted either with insufficient care or has been incomplete. As far as my experience goes, this applies especially to four classes of cases, namely: (1) Those with enlargement of the heart due to chronic myocardial disease, especially chronic interstitial myocarditis, unaccompanied by valvular disease; (2) cases of arterial disease; (3) less frequently, cases of mitral stenosis; and (4) still less frequently, cases of chronic adhesive pericarditis.

Taking chronic myocardial disease first, I have been surprised at the comparative frequency with which these cases are overlooked, due, in my opinion, to a lack of appreciation of the great importance of determining accurately the size of the heart, especially in cases in which the apex-beat is either faint or absent; and also to a lack of knowledge of the size of the normal heart in persons of different size and weight and age. A combination of the existence of subjective symptoms during or after physical exertion, enlargement of the heart, and an absence of physical signs indicative of a valvular lesion is of the utmost importance in the diagnosis of chronic myocardial disease. With regard to arterial disease, the importance of examining the walls of other arteries than the radial should be remembered; for example, the brachial and temporal, especially the former. How frequently is arterial disease excluded as the result merely of an examination of a short length of the radial artery alone! With regard to mitral stenosis, the lesion is often unrecognised, because the locality of the characteristic murmur is frequently very limited, or because of an omission to examine the patient both in the standing position and on lying down, and before and after exercise, or because in some cases there is from time to time a complete absence of a thrill and murmur. I would emphasise the importance of a searching examination for organic disease of the valves, the myocardium, and the arteries in all cases which on first consideration might be regarded as being merely functional.

Among functional disorders may be included palpitation, tachycardia, bradycardia, irregular action of the heart, paroxysmal tachycardia, "irritable heart"—including "soldier's heart," primary cardiac overstrain, and cardiac pain—including pseudo-angina. No doubt some of these disorders may be either functional, or due to organic disease. With regard to irregular action

of the heart, it depends upon the type. It is almost universally agreed that sinus irregularity is always functional. Extra-systoles may or may not be due to some structural change in the myocardium. It is true that cases of auriculo-ventricular block have been recorded in which there was an absence of any demonstrable lesion of the junctional tissue; but in some of these the vagus was found to be affected. In the vast majority of cases, auricular fibrillation and auricular flutter are indicative of some myocardial change. The same applies almost equally to cases of paroxysmal tachycardia. With regard to what is called "soldier's heart," as the result of a detailed examination of a large number of cases, I am of opinion that the affection is sometimes due to chronic interstitial myocarditis, frequently in association with arterial disease, which has not been diagnosed. I am equally certain, on the other hand, that primary cardiac overstrain may occur in persons with previously sound hearts, and even in those who are properly trained. A history of excessive physical exertion resulting in primary cardiac overstrain is sometimes not obtained because of insufficient care in taking the history of the case.

It is not my purpose to deal with the ætiology of functional disorders of the heart in general, but I would emphasise the importance of always remembering the possibility of toxic conditions affecting the heart. This may occur without producing structural changes. Such toxic conditions may be brought about by tea, coffee, tobacco, Graves' disease, pulmonary tuberculosis, acute infective disease, and focal sepsis—especially from the teeth, the tonsils, the accessory nasal sinuses, the stomach, colon, and the genito-urinary tract.

Palpitation

By palpitation is meant the consciousness of the cardiac impact against the chest-wall, and with this there is frequently, but not always, an increase in rate. The term, as used here, does not include the sensations which may be present in extra-systoles, auricular fibrillation, auricular flutter, or paroxysmal tachycardia; it will further be restricted to those cases in which the consciousness of the cardiac impact occurs in attacks.

Ætiology.—While palpitation may occur in organic disease of the heart—valvular or myocardial—it should be remembered that it is probably more frequently and most characteristically met with apart from organic disease. It is more common in females than in males. The condition is often reflex in origin, as, for example, when the result of dyspepsia—particularly those forms of it which are attended with flatulent distension of the stomach or colon, and in uterine disorders. Among other causes are excessive indulgence in the use of tea, coffee, alcohol, or tobacco; conditions which tend to produce exhaustion or undue excitability of the nervous system, among which may be enumerated puberty, the period of menstruation, the menopause, neurasthenia, hysteria, mental excitement or overstrain, exhausting illnesses, and following the acute fevers. The immediate cause of an attack is frequently emotion or excessive physical exertion.

Symptoms.—The attack may last from a few seconds to a few hours. It is usually, though not always, gradual in onset, and it passes off gradually. The subjective symptoms vary from a sensation of a gentle impact in the slightest attacks, to the consciousness of a violent one against the chest-wall,

accompanied by a sense of great distress, and even associated with actual pain in the præcordium in the severer forms of the attack. In some instances there is a sense of faintness, and more rarely the fear of impending death. Complaint is sometimes made of flushing of the face, tinnitus aurium, a sensation of throbbing in the head, and giddiness. The pulse-rate is, as a rule, increased, though in some cases there is an absence of tachycardia; it is increased by physical exertion, which is not the case in paroxysmal tachycardia. The pulse may be of moderate or only small volume, and its character may resemble that of the pulsus celer. The large arteries, such as the carotid, may exhibit marked pulsation. The apex-beat is found to be in the normal position, and its area and force are generally much increased. On percussion, the area of cardiac impairment shows no increase in size, unless valvular or myocardial disease be present, while on auscultation, the cardiac sounds are found to be abnormally loud, clear, and ringing in character, and the second sound at the base much exaggerated. Excepting in cases of organic disease of the heart or anæmia, as a rule no murmur is audible, although occasionally an apical systolic murmur, soft in character, may be heard during the attack. In dyspeptic patients, complete or partial relief may coincide with the eructation of a large quantity of gas. A sense of exhaustion is usually complained of after the paroxysm has passed off.

Prognosis.—The prognosis is good, if no organic disease be present, although it may be difficult to eradicate the cause of the condition.

Treatment.—This has already been considered.

Cardiac Pain

As has already been pointed out, pain in the præcordium may not only occur in organic disease of the heart, but is also frequently met with apart from organic disease, especially in females. It is often reflex in origin, as, for example, when the result of dyspepsia—particularly those forms of it which are attended with flatulent distension of the stomach or colon, and in uterine disorders. Among other causes are primary cardiac overstrain; toxic conditions, such as occur in influenza and diphtheria, and as the result of excessive indulgence in the use of tea, coffee, tobacco, or alcohol; neurasthenia, hysteria, emotional states, and sexual excess.

Treatment.—This has been discussed previously.

Tachycardia

Definition.—By the term tachycardia is meant frequent action of the heart. It will here be used in a restricted sense, not including the frequent action which is often present during attacks of palpitation—which has already been described, or that due to an abnormal rhythm—which will be discussed later on.

Ætiology.—The condition may be physiological. In some perfectly healthy individuals the normal cardiac rate is always frequent, and has been known, although very rarely, to average 120 a minute. It is difficult, therefore, to decide when an increase of the cardiac rate in an individual is pathological; in this connection, a record of the past history is of value.

The pathological form of tachycardia may be the result of the excessive use of alcohol, tobacco, tea, and coffee, focal sepsis, pulmonary tuberculosis, Graves' disease, most forms of cardiac disease, primary cardiac overstrain, states of exhaustion, acute and subacute inflammatory conditions, pyrexia, tumour or clot in the medulla oblongata, the pressure of a tumour upon the pneumo-gastric nerves, involvement of the vagi in bulbar paralysis or in multiple neuritis, some forms of spinal disease, neurasthenia and emotional states, reflex irritation from uterine or ovarian disease, the use of certain drugs, such as atropine, and as a sequel of influenza.

In the pathological form of the condition, the increase in the cardiac rate may only be induced by change of posture or other forms of physical exertion; or it may be persistently above the normal.

In contra-distinction to tachycardia due to an abnormal rhythm, the only abnormality in polygraphic and electro-cardiographic curves is the acceleration of the cardiac rate.

Treatment.—This has already been described.

Bradycardia

Definition.—By the term bradycardia is meant infrequent action of the heart. It must be distinguished from infrequency of the *pulse rate at the wrist*, since the latter also includes ventricular extra-systole which is so feeble that the wave fails to reach the wrist. The term bradycardia may be used in two different senses: it may be restricted to infrequent action of the heart as a whole, the auricular rate being diminished *pari passu* with that of the ventricle; or it may be employed to include also cases of infrequency of the ventricular rate alone, the auricular rate being unaffected, which group includes partial and complete auriculo-ventricular block, some cases of auricular fibrillation, and some cases of auricular flutter. The term will be employed here in the former sense.

Ætiology.—Bradycardia may be physiological, especially in males. In some perfectly healthy individuals the normal pulse is always infrequent, a pulse-rate of 50 not being very uncommon, and, indeed, cases have been recorded of a pulse-rate of 40 in a healthy individual. Further, it must be noted that as age advances the rate of the heart normally becomes less frequent.

The pathological form of the condition, which is found more frequently in males, may be the result of some form of cardiac disease—especially aortic stenosis and fatty degeneration of the myocardium, coronary disease, and primary cardiac overstrain; states of collapse or exhaustion, and during the convalescence of acute infective diseases, especially influenza, diphtheria, pneumonia, typhoid and typhus; toxic conditions, such as jaundice, diabetes, uræmia, influenza and diphtheria, and the use of certain drugs, such as digitalis, muscarine, opium, coffee, and tobacco; hypothyroidism; affections of the nervous system, such as meningitis, cerebral tumour, or apoplexy, diseases of the medulla, diseases or injuries of the cervical part of the spinal cord, neurasthenia, hysteria, severe pain, epilepsy, melancholia, and general paralysis of the insane; diseases of the digestive system, such as chronic dyspepsia, gastric dilatation, ulcer, and cancer; in the puerperal state; and occasionally in diseases of the urinary or respiratory system, and in sunstroke.

Sino-auricular block is a very rare cause of bradycardia.

Irregular Action of the Heart

The subject of irregular action of the heart is of very great practical importance. Formerly it was notoriously a source of perplexity and difficulty to the clinician. A patient, or, it may be, a candidate for life assurance or for an appointment, was examined, and in the course of physical examination irregularity of the pulse may have been observed—with or without the usual physical signs of organic disease of the heart. What significance was the practitioner to attach to the irregularity of the pulse in itself? It was known that this might, on the one hand, signify definite and even serious impairment or disease of the heart, or, on the other hand, that it might be of no practical importance. It was not possible, however, to determine the significance of the irregularity in any given case, because there were no means of differentiating the types of irregularity, or what any particular type signified. The employment of the clinical polygraph and of the electro-cardiograph has changed all this, and the problem has been solved; for we are now able to classify almost every case of irregular action of the heart into types, and we know what each type signifies. I would emphasise the fact that the work of elucidation having been accomplished by means of the clinical polygraph and the electro-cardiograph, it is not now necessary to employ either of these instruments in the vast majority of cases, the use of a sphygmograph being sufficient, and in a large proportion merely palpation and auscultation. This is of great practical importance to the general practitioner. For example, by means of the aid of palpation and auscultation alone it is almost always possible to determine whether intermission of the pulse occurring during the course of an acute infective disease, such as acute rheumatism, diphtheria, and pneumonia, is due to an extra-systole failing to reach the wrist, or to partial auriculo-ventricular block—a point of great prognostic importance.

All cases of cardiac irregularity, apart from comparatively rare exceptions, fall into one of six groups: (1) What is called sinus irregularity; (2) irregularity due to premature contraction or extra-systole; (3) irregularity due to heart-block; (4) irregularity due to pulsus alternans; (5) irregularity due to auricular fibrillation; and (6) irregularity due to auricular flutter.

The pulse may be irregular in time, or volume, or both. It may be advisable to describe here what is meant by the terms "intermittent" pulse or a "dropped beat," "pulsus bigeminus" or "coupling of the beats," and "pulsus trigeminus."

Intermission of the pulse is a form of irregularity which is not uncommon. By it is meant a condition in which the normal rhythm of the pulse is interrupted, either occasionally or more frequently, either at regular or irregular intervals, by an abnormally long pause during which no wave is felt at the wrist, a beat being missed. *It is of great importance to understand how intermission of the pulse is caused, especially from the point of view of prognosis.* By far the commonest cause is a premature contraction of the ventricle ("extra-systole") which is so feeble that the wave fails to reach the wrist (Fig. 32); the next most common cause is partial heart-block (Fig. 33), while the condition is occasionally due to sinus irregularity, and very rarely to sino-auricular block. The differential diagnosis between extra-systole

and partial heart-block is fully discussed under extra-systole. The differential diagnosis also between occasional dropped beats due on the one hand to sinus irregularity and on the other to partial heart-block is discussed under heart-block.

By *pulsus bigeminus* or *coupling of the beats* is meant a condition in which the pulse-beats occur regularly in pairs, for long or short periods. The paired

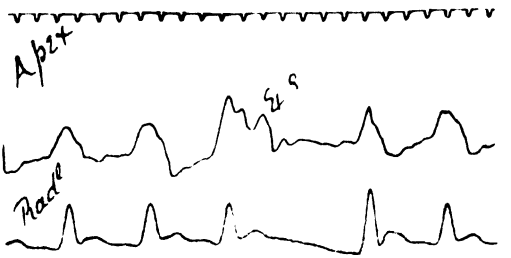


FIG. 32.—Simultaneous tracings of the apex-beat and of the radial pulse, showing intermission of the pulse, due to a ventricular extra-systole failing to send a wave to the wrist.

beats may occur at regular intervals, or at irregular intervals, and some writers restrict the term *pulsus bigeminus* to the former condition, and the term *coupling of the beats* to the latter. When the paired beats fall at regular intervals, the commonest cause is the occurrence of extra-systoles, usually ventricular, in cases in which the fundamental or sinus rhythm is otherwise maintained; either a single extra-systole with its succeeding compensatory

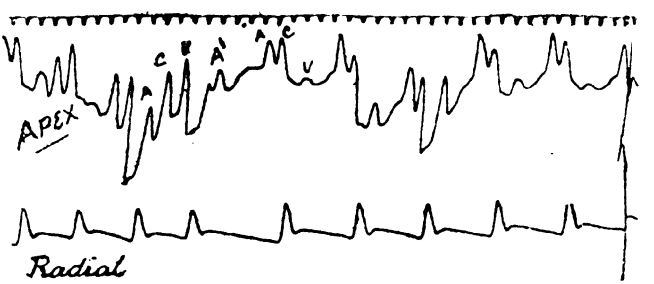


FIG. 33.—Simultaneous tracings of the apex-beat and of the radial artery, showing intermission of the pulse, due to partial heart-block, the ventricle failing to respond to the stimulus of the auricle at A'.

pause occurring regularly after each normal beat (Fig. 34), or such occurring after every two normal beats, the premature contraction in the latter case, however, being so feeble that no wave reaches the wrist. The next most common cause is partial heart-block, when the ventricle fails to respond to every third beat of the auricle (Fig. 35). A rare cause is sino-auricular block, in which the auricle fails to respond to every third impulse generated at the

sinus. When the paired beats fall at irregular intervals, the cause is the occurrence of a ventricular extra-systole occurring regularly after each normal ventricular contraction in cases of auricular fibrillation ; this may occur independently of the action of digitalis, although it is usually due to it (Fig. 53).

By *pulsus trigeminus* is meant a condition in which the pulse-beats are

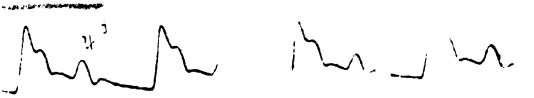
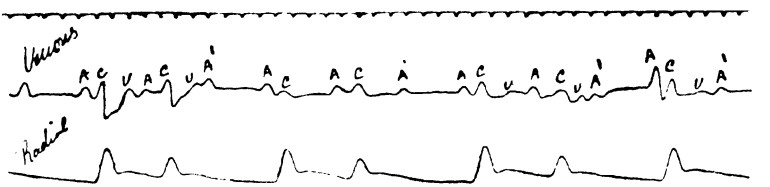


FIG. 34. Pulsus bigeminus, due to a single extra-systole with its succeeding compensatory pause occurring regularly after each normal beat.

grouped in threes. The causes of this condition are : (1) the occurrence of extra-systoles—either a single extra-systole with its succeeding compensatory pause occurring regularly after every two normal beats, or such occurring after every three normal beats and failing to send a wave to the wrist ; (2) partial heart-block, when the ventricle fails to respond to every fourth beat of the auricle ; and, rarely, (3) sino-auricular block, in which the auricle fails



Pulsus bigeminus, due to partial heart block, the ventricle failing to respond to the stimulus from the auricle at *A'*.

to respond to every fourth impulse generated at the sinus. As pulsus bigeminus and pulsus trigeminus are met with in conditions other than extra-systole, they are not pathognomonic of the latter condition. The distinguishing features between pulsus bigeminus or pulsus trigeminus due on the one hand to extra-systole and to partial heart-block on the other hand may be established, with a view to differential diagnosis, in the same way as in the case of an intermittent pulse.

"IRRITABLE HEART"

This term may be used in two ways, namely, (1) the "irritable heart of soldiers," and (2) a condition which is sometimes met with during adolescence. The first of these will be discussed later. The second condition is met with more especially in badly developed subjects, and is often associated with an unstable nervous system, auto-intoxication, and dyspepsia. It may or may not have been brought on by excessive or injudicious physical exertion. The symptoms and diagnosis do not differ from those which obtain in the "irritable heart of soldiers." The prognosis is good, the patient improving as physical and mental development proceeds. With regard to treatment, a searching enquiry should be made for toxic conditions. The patient should

rest before and after meals, all food should be thoroughly masticated, the amount of fluid to be taken with food should be restricted, and digestive disorders treated if present. Breathing exercises, graduated exercises, and all other agencies which tend to physical and mental development, should be tried. Otherwise, the treatment is the same as that of the "irritable heart of soldiers."

SINUS IRREGULARITY

It has already been pointed out that excitability of the heart is most marked in the remains of the sinus venosus at the orifices of the great veins, and that the rhythm of the sinus governs the rhythm of the remaining segments of the heart. Further, it has been shown that the heart possesses

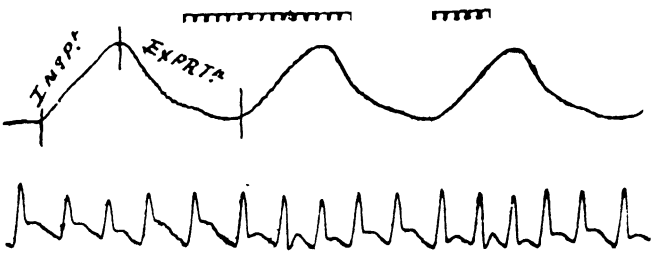


FIG. 36.—Simultaneous tracings of the respiration and the radial pulse, from a healthy boy aged 14, showing sinus irregularity.

the power of contracting and dilating independently of any extrinsic nervous influence; but, at the same time, the activity of the various functions of the muscle-fibres is under nervous control. While normally the rhythm of the sinus is a fairly regular one, in by no means a small percentage of in-

FIG. 37.—Simultaneous tracings of the jugular and radial pulses, from a healthy boy aged 7, showing sinus irregularity.

dividuals the rhythm is not regular. In all probability this irregularity is of vagus origin, due to an unusual susceptibility of the vagus centre to impulses from distant parts, and these impulses being transmitted reflexly to the heart. The chief characteristic of sinus irregularity is the variation in the length of the diastolic period of the cardiac cycle, the systolic period

remaining constant. The irregularity, which may be slight or marked, diminishes, and may even disappear with an increase, while it is apt to increase or return with a diminution, of the cardiac rate.

Ætiology.—Sinus irregularity is much more frequently met with in the young, being indeed fairly common in young adults; but it may occur at all ages. There is a greater tendency to sinus irregularity in children after a febrile illness, and it may be first noticed then. *There is usually a definite relationship to respiration.* The irregularity is most marked during slow respiration, and may indeed only be noted on deep breathing. The rate of the heart usually gradually quickens during full inspiration, and gradually lessens during full expiration; but while generally the rate of the pulse waxes and wanes with respiratory movements, in some cases there is an abrupt slowing of one or two beats with expiration. Sinus irregularity may occur during the administration of digitalis, and even the act of swallowing may produce it—the heart-rate during the act being quickened for a few beats, followed by a reduction in the rate.

Symptoms.—Usually there are no subjective symptoms of the condition; but very rarely the abnormal pause between any two beats of the heart is so long that symptoms of cerebral anæmia, such as giddiness or syncope, occur. On auscultation, the interval between the first and second sounds is found to be constant, while the varying length of the diastolic interval can be detected. If a tracing of the radial artery be taken, the intervals between the beats will be found to vary, but the actual variations are not numerous, while the pulse-beats are of equal or nearly equal size (Figs. 36 and 37). A polygraphic tracing (Fig. 37) and an electro-cardiogram (Figs. 92 to 94) show that a ventricular contraction follows each auricular contraction in the usual way, and that the whole heart is affected by the irregularity.

Diagnosis.—A diagnosis may be made by auscultation, or by a study of a sphygmogram, or of a polygraphic or electro-cardiographic record. When irregularity of the cardiac action is found to be definitely related to respiration, it is in all probability of the sinus type.

Prognosis.—There is no reason to suppose that sinus irregularity is either indicative of an impaired heart, or that it adds to the gravity of any diseased cardiac condition which may be present. The condition itself, therefore, may be entirely disregarded, and the prognosis based upon any other abnormal signs which may exist.

Treatment.—No treatment of this condition is required.

THE EXTRA-SYSTOLE

By extra-systole is meant the premature contraction of the auricle (auricular extra-systole), or of the ventricle (ventricular extra-systole), or of both chambers together (auriculo-ventricular or nodal extra-systole), while the fundamental or sinus rhythm is otherwise maintained in most cases. Usually the extra-systole is followed by a long pause (compensatory pause). Rarely the premature contraction occurs between two normal beats (interpolated extra-systole). Two or more premature contractions of the auricle or ventricle may follow one another (multiple extra-systoles).

It has been shown that, while normally the stimulus for contraction arises in the sinus part of the auricle, if any other portion of the remains of the primitive cardiac tube becomes more excitable the stimulus for contraction arises at that point, and, for this reason, the different parts of the heart are capable of independent contraction. In abnormal conditions the auricle, some part of the auriculo-ventricular junctional tissues—either the auriculo-ventricular node, or the auriculo-ventricular bundle above its division into two branches—or the ventricle below the division of the auriculo-ventricular bundle into two branches, may become temporarily more excitable than the sinus, in which case the stimulus for contraction starts at that particular point, the result being that a contraction takes place before the anticipated time. If the stimulus start in the auricle, there is a premature contraction of that chamber; if in the auriculo-ventricular junctional tissues there is a premature contraction of both auricle and ventricle together; while if it start in the ventricle there is a premature contraction of the ventricle. In each case the sinus rhythm remains unaltered. It will thus be seen that an extra-systole indicates that some portion of the heart below the sinus is temporarily more excitable than the sinus.

Extra-systoles may appear at long, or at frequent irregular intervals, or regularly after each beat, or after every second or third, or more normal beats, or in paroxysms, the last being an infrequent cause of paroxysmal tachycardia. Of the three varieties the auricular and ventricular are the most important from the clinical point of view; the ventricular is the most common; all of them, however, may occur in the same subject.

The Ventricular Variety of Extra-Systole.—We may take this variety for the purpose of illustration. While the chambers of the heart are contracting in the normal fashion, a premature contraction of the ventricle takes place, this arising independently of a stimulus from the auricle, which maintains its usual rhythm and contracts as the result of the normal stimulus from the sinus. The exact time at which the premature contraction of the ventricle takes place is either immediately before the systole of the auricle (Fig. 38), or—as is usually the case—synchronously with it, or after it, but prior to that point of time at which it would have occurred if this had been in response to a stimulus received froin the auricle in the normal way. In most cases the succeeding impulse from the auricle fails to cause a contraction of the ventricle; for this reason the pause which follows the premature contraction is abnormally long, being called the *compensatory pause*. When this prolonged diastole and the preceding shortened diastole together equal in time two normal cardiac cycles, the compensatory pause is said to be *complete*. Since during the prolonged pause the ventricle has had an unusually long period in which to fill and recuperate, the pulse-beat immediately following a compensatory pause has often a greater amplitude than on other occasions. Sometimes, more especially when the cardiac rate is slow, a ventricular extra-systole occurs so early in the cardiac cycle that the ventricle does contract in response to the normal stimulus which is transmitted from the auricle immediately after the premature contraction; in this way a premature contraction is interpolated between two normal beats. This form of the extra-systole is called "*interpolated*" (Fig. 39).

On auscultation, in the vast majority of cases, two heart-sounds are

synchronous with each extra-systole, these forming with those of the preceding normal contraction a group of four sounds. Sometimes, however, the extra-systole occurs early in diastole, and before the cardiac muscle has had sufficient time to recover fully from the preceding systole, in which event the premature contraction is so feeble as to fail to open the aortic valves, and only the first sound is heard; in this way a group of three sounds becomes

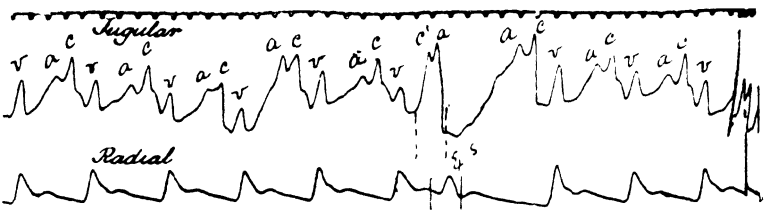


FIG. 38. Simultaneous tracings of the jugular and radial pulses, showing a ventricular extra-systole at *Ex.s.* The usual rhythm of the auricle is maintained. The extra-systole in the jugular tracing is represented by the wave *c'*, immediately before the systole of the auricle. The compensatory pause is complete.

audible. Very rarely the premature contraction is so feeble as not to produce any cardiac sounds whatever.

The amplitude of the pulse-wave of an extra-systole is not so great as that of a contraction occurring at a normal interval, because the heart muscle has not had time to recover from its previous effort. The earlier an extra-systole occurs in the diastole, the more feeble it is; it may be so feeble that no wave is felt at the wrist, so that there is simply an abnormally long pause,

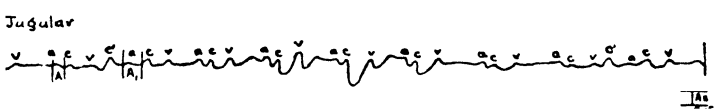


FIG. 39. Simultaneous tracings of the jugular and radial pulses, showing an interpolated ventricular extra-systole (*c'* and *r'*), represented in the diagram by the downstroke *s*. The downstrokes in the space *As* represent the auricular waves (*a*) in the jugular, and the downstrokes in the space *Vs* represent the carotid waves *c*, and the slanting lines connecting them represent the *a c* interval (Mackenzie).

resulting in what is called a "dropped beat" or an "intermittent" pulse (Fig. 32); as has been already noted, an extra-systole which fails to reach the wrist is, indeed, the most usual cause of an intermittent pulse. If a single extra-systole with its succeeding compensatory pause occurs regularly after each normal beat, then the beats at the cardiac apex occur in pairs, as also do the pulse-beats, the condition being called *pulsus bigeminus* (Fig. 34). Similarly, if a single extra-systole with its succeeding compensatory pause occurs after every two normal beats, then the apex-beat occurs in

threes, as also do the pulse-beats, the condition being known as *pulsus trigeminus*; but if the premature contraction is so feeble that no wave reaches the wrist, the pulse-beats are paired.

If a polygraphic record of a case of ventricular extra-systole (Fig. 38) be analysed, it will be found that, as the normal rhythm proceeds as usual, the *a* wave appears at regular intervals; each *a* wave is followed by a *c* wave, except when an extra-systole occurs, when the *c* wave either precedes the *a* wave, or—as is more commonly the case—occurs synchronously with it, in which case the amplitude of the wave is correspondingly increased.

AURICULAR VARIETY OF EXTRA-SYSTOLE.—In this variety there is a premature contraction of the auricle, the stimulus arising in the wall of the auricle prior to the normal stimulus from the sinus. The premature contraction of the auricle is usually followed by a premature contraction of the ventricle, following the usual transmission of the stimulus from the auricle along the auriculo-ventricular bundle. Not infrequently, in the case of extra-systole the stimulus from auricle to ventricle travels slowly, so that the *a–c* interval is lengthened (Fig. 40), and the prematurity of the ventricular

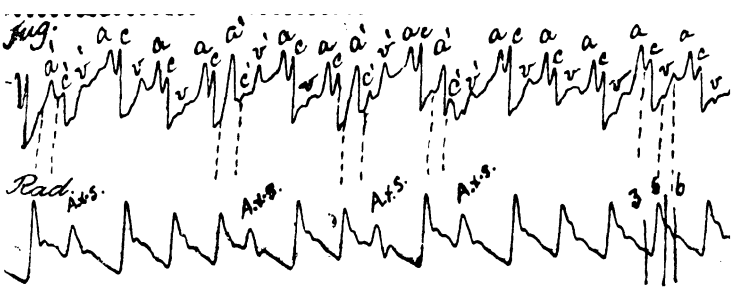


FIG. 40.—Simultaneous tracings of the jugular and radial pulses, showing auricular extra-systoles, marked *A.S.* in the sphygmogram, and *a′c′v′* in the jugular tracing. The *a–c* interval of the premature beat is more than $\frac{1}{5}$th second; with the rhythmic beats it is normal.

systole is consequently not so great as that of the auricle; in this way the compensatory pause is shortened. In some instances the contraction which immediately follows the extra-systole takes place rather earlier than the normal interval, this being probably due to the unusual length of the rest period; in this way there is further encroachment upon the compensatory pause. This is less marked in the case of the second contraction, and it disappears within a few cycles. Sometimes there are variations in the rate of transmission of these auricular premature contractions to the ventricle.

Occasionally the stimulus from the auricle does not reach the ventricle at all, and no premature contraction of this chamber takes place, in which event the premature contraction of the auricle is not followed by a premature contraction of the ventricle, the condition being known as "blocked auricular extra-systoles." In these cases a long pause is to be noted in the sphygmogram. As in the case of the ventricular variety, an auricular extra-systole is followed by a lengthened pause; but, with rare exceptions,

this compensatory pause is not complete. In some cases, however, the compensatory pause is complete.

If a polygraphic record of a case of auricular extra-systole (Fig. 40) be analysed, it will be found that each *c* wave is preceded by an *a* wave, while there is a premature *a* wave and a premature *c* wave, sometimes with an increased *a-c* interval, and an alteration of the relative position of the beats following the extra-systole.

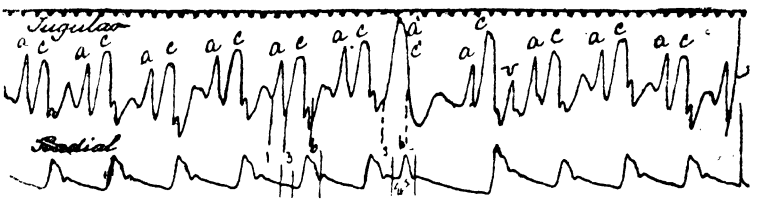


FIG. 41.—Simultaneous tracings of the jugular and radial pulses, showing auriculo-ventricular extra-systoles, marked *ex.s.* in the sphygmogram, and *a' c'* in the jugular tracing. The premature ventricular contraction practically coincides with that of the auricle.

AURICULO-VENTRICULAR OR NODAL VARIETY OF EXTRA-SYSTOLE.—In this variety the stimulus for premature contraction originates in some part of the auriculo-ventricular junctional tissues, travelling upwards into the auricle and downwards into the ventricle, and giving rise to a premature and simultaneous contraction of both auricle and ventricle. The premature ventricular contraction more or less coincides with that of the auricle, but this is by no means absolute; the contraction of both chambers may be absolutely synchronous (Fig. 41), or the ventricular systole may begin after, or before (Fig. 42) that of the auricle. When the auricular contraction occurs

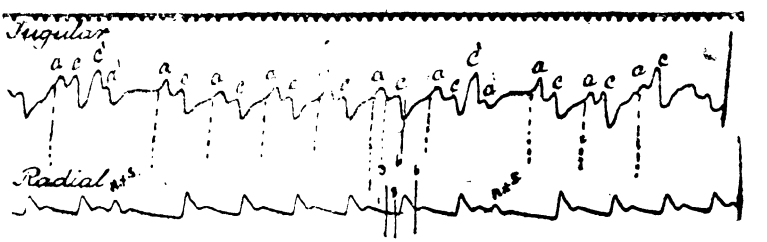


FIG. 42.—Simultaneous tracings of the jugular and radial pulses, showing two auriculo-ventricular extra-systoles (*n.x.s.*). Both auricle and ventricle contract prematurely, but the contraction of the ventricle precedes that of the auricle.

before that of the ventricle, the period of time between the contraction of the upper and lower chambers is shortened. The compensatory pause may or may not be complete.

In a tracing of the jugular vein from a case of auriculo-ventricular extra-systole (Figs. 41 and 42) there is prematurity of the *a* wave, and also of the *c* wave; when the premature contraction of the chambers is synchronous both waves are combined, in which case the amplitude of the wave is in-

creased; when the auricular contraction occurs before that of the ventricle, the *a* wave precedes the *c* wave, but the *a–c* interval is diminished to about 0·10 sec.

In the ventricular and auriculo-ventricular varieties of extra-systoles, in contrast with the "double" venous pulsation in the jugular vein which may be visible in the case of the auricular variety, there is usually an unduly large "single" pulsation coincident with the premature contraction; this is due to the contraction of the upper and lower chambers of the heart occurring synchronously, the result being that the auricle, instead of discharging its contents into the ventricle, does so into the venæ cavæ.

Paroxysms of extra-systoles of auricular origin may occur, and may give rise to short paroxysms of tachycardia, with a regular pulse, or to irregularity of the pulse rhythm when the response of the ventricle to auricular contraction is at irregular intervals. Paroxysms of extra-systoles of ventricular origin may also occur (Fig. 112); as a rule these only persist for a few cardiac cycles.

Ætiology and Pathology.—Extra-systoles may be met with at any age, but they are much more frequent in the middle-aged and elderly than in the young. They are rare during the first decade of life. Extra-systoles are of more common occurrence in men than in women, and are also more usual in the subjects of organic heart disease than in those who are not, and are more frequent in myocardial degeneration than in valvular disease. But there is a large group of cases in which extra-systoles are present without any other manifest cardiac abnormality. They are to be found, for example, in persons with a history of rheumatic infection, the victims of tobacco poisoning, in digestive disturbances, supernormal blood-pressure, neurasthenia, and as a result of the administration of certain poisons, especially digitalis and aconitine; while in a considerable proportion of cases there is no ascertainable cause.

Extra-systoles indicate that at the time of the premature contraction some portion of the myocardium below the sinus is more excitable than the sinus. This may or may not be due to some structural change in the myocardium; it may, for example, be caused by poisoning of the heart wall without structural damage.

Subjective Symptoms.—An individual in whom extra-systoles occur may be quite unconscious of their presence. On the other hand, he may experience certain sensations, which may cause worry and anxiety, particularly if he have retired to bed, and for this reason it is most important that the nature of the complaint should be recognised. The patient may experience a sensation of fluttering in the chest when a premature beat occurs; or he may be conscious of the long pause and complain that the "heart stops"; or the contraction of the heart following the pause may be accompanied by the consciousness of a thud or shock in the region of the heart, sometimes followed by a feeling of exhaustion. The patient may complain of a sensation of a "catch in the breath," or of "gripping in the throat." Very rarely, during a prolonged pause, faintness, sweating and actual syncope may take place, and the anxiety of the patient may be great.

Diagnosis.—Extra-systoles may be recognised with certainty by means of the clinical polygraph or the electro-cardiograph. *But it is important for the practitioner to recognise that in the great majority of cases a correct diagnosis can be made simply by palpation and auscultation.* The normal rhythm of

the heart is disturbed by the occurrence of a premature beat in the radial pulse and at the cardiac apex, followed by an abnormally long pause. The auscultatory signs have already been noted; they are of great diagnostic value. When, on palpation of the radial artery, an apparently otherwise regular pulse is sometimes interrupted by an unusually long pause, it should suggest either an extra-systole which is so feeble that no wave is felt at the wrist, or partial heart-block. *When extra-systole is responsible for this unusually long pause a premature beat can be detected at the cardiac apex, and on auscultation one or two heart sounds will, in the great majority of cases, be audible during the early part of the pause, because the ventricle has contracted; whereas in the case of partial heart-block, there will be absence of an apex-thrust and of heart-sounds during the pause, because the ventricle has failed to contract.* Further, in these cases of extra-systole, a wave is usually present in a sphygmographic tracing, and a premature contraction is always visible in a tracing of the apex-beat. These three features are almost invariably sufficient to distinguish between an intermittent pulse due to an extra-systole which fails to reach the wrist and an intermittent pulse due to partial heart-block. A polygraphic tracing or an electro-cardiogram will place the matter beyond all possibility of doubt. It may here be noted that it is necessary to exclude sinus irregularity, and also sino-auricular block, in cases of an unusually long pause in the radial pulse. The differential diagnosis between pulsus bigeminus, pulsus trigeminus, and infrequency, including halving, of the pulse rate, due on the one hand to extra-systoles, and on the other to partial heart-block, can readily be made, as a rule, by means of palpation and auscultation.

It is sometimes very difficult, if not impossible, by palpation and auscultation alone, to diagnose extra-systoles, occurring frequently and at irregular intervals, especially if of auricular origin, from auricular fibrillation; but in such cases a sphygmographic tracing is almost invariably sufficient. It is also necessary to exclude auricular flutter when the response of the ventricle to auricular contraction is at irregular intervals (page 813, and Fig. 110).

Prognosis.—The question of prognosis of extra-systoles is very important. Unfortunately the lay mind has come to attach an unnecessary significance to them. Furthermore, it is important that the medical practitioner should understand that extra-systoles constitute one of the most frequent causes of irregularity of the pulse, and that an extra-systole which fails to reach the wrist is the commonest cause of an "intermittent" pulse. *When extra-systoles are considered by themselves—that is, without reference to the conditions with which they may be associated*—there is so far no evidence for supposing that they are either indicative of an impaired heart or that they add to the gravity of any existing morbid condition. While it is true that extra-systoles may precede the occurrence of other forms of cardiac irregularity, such as the complete irregularity associated with auricular fibrillation, it should be borne in mind that these might have arisen independently. The prognosis, therefore, should be based entirely upon the causal or associated condition.

Treatment.—Our first duty is to reassure the patient; this may be done with absolute confidence. The ætiology of extra-systole should be reviewed, the general health should receive attention, and if cardiac failure be present it should be treated on the lines laid down elsewhere. I have never found digitalis or quinidine of any value for the irregularity itself. Bromides are

frequently of benefit for the associated symptoms, especially when there is irritability of the nervous system or insomnia.

HEART-BLOCK

Sino-auricular Block

Sino-auricular block is a rare condition. It is sometimes induced by full doses of the digitalis series of drugs. In this condition the stimulus for contraction arises at the normal site, but either there is a delay in the conduction of the stimulus to the auricle, or the stimulus does not always—either occasionally or more frequently—reach the ventricle, in other words, the auricle does not always respond to the stimulus from the sinus, in which event the auricle and the ventricle fail to contract, so that there is an abnormally long pause; as already stated, sino-auricular block is one of the causes of an "intermittent" pulse or "dropped" beats. The length of the abnormally long pause is generally rather less than the duration of two cardiac cycles. Cases have been published in which more than one stimulus in succession has failed to reach the auricle, and in these cases the Adams-Stokes syndrome may occur. A polygraphic tracing reveals the fact that the auricle and ventricle have not contracted—that is, there is an absence of the *a*, *c*, and *v* waves—during the abnormally long pause.

Auriculo-ventricular Block

It has been noted that the stimulus for contraction is conveyed from fibre to fibre by means of a specialised function of the cardiac muscle-fibres called conductivity, and that the *a–c* interval in a polygraphic tracing is a measure of this function.

There are three degrees of depressed conductivity: (1) The stimulus from the auricle to the ventricle may be merely delayed—that is, there is merely a prolongation of the interval which separates the commencement of contraction of the auricle and that of the ventricle, each stimulus of the auricle reaching the ventricle, which duly responds. (2) The stimulus does not always reach the ventricle—in other words, the ventricle does not always respond to the stimulus from the auricle. The first two degrees are called "partial heart-block." And (3) no impulses reach the ventricle from the auricle, so that the auricles and ventricles beat independently of each other; the former in response to stimuli received from the sinus, and at an approximate rate of 72 per minute; and the latter as the result of stimuli arising in the auriculo-ventricular junctional tissues between the site of the lesion and the division of the auriculo-ventricular bundle into two branches, at about 30 per minute, because this is the normal ventricular rate; this is called "complete heart-block," "disassociation of the auriculo-ventricular rhythm," "idio-ventricular rhythm," or the "paroxysmal form of bradycardia." Rarely complete heart-block is associated with auricular fibrillation or auricular flutter.

First Degree of Depressed Conductivity.—This grade of heart-block

may give rise to irregularity of the pulse, on account of variations in the length of the *a–c* interval. Some writers believe that contraction of the auricle produces a faint muffled sound, and that consequently when there is a slight delay between the auricular and ventricular contractions there may be a reduplication of the first sound, while if the delay be considerable, so that the contraction of the auricles falls in early diastole, there may be a

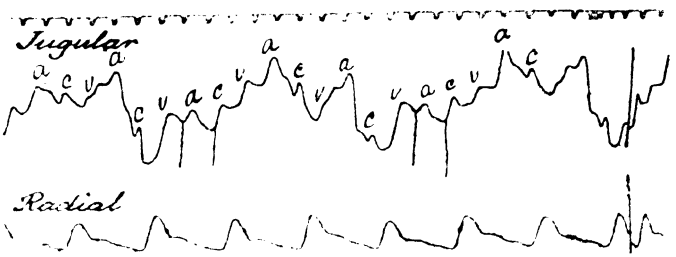


FIG. 43.—Simultaneous tracings of the jugular and radial pulses, from a case of myocardial degeneration. The *a–c* interval is more than $\frac{1}{5}$th second.

reduplication of the second sound. It is also believed by some that in cases of mitral stenosis unaccompanied by auricular fibrillation a slight interval between the auriculo-systolic thrill and apex-beat, as well as between the auriculo-systolic murmur and first sound, is to be noted. In a polygraphic tracing, there is merely an increase in the *a–c* interval, it exceeding $\frac{1}{5}$th of a second (Fig. 43).

SECOND DEGREE OF DEPRESSED CONDUCTIVITY.—In this condition what

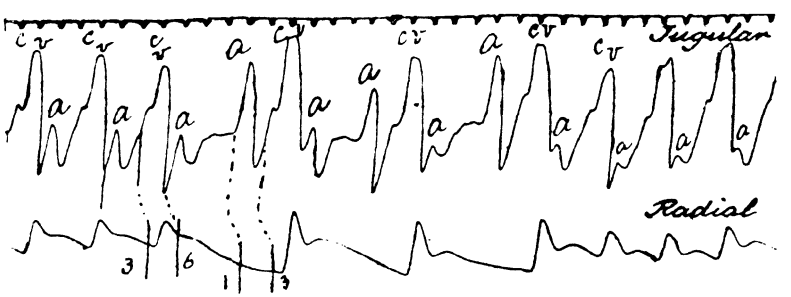


FIG. 44.—Simultaneous tracings of the jugular and radial pulses, from a case of aortic and mitral disease, showing partial heart-block. There are three blocked auricular impulses. The *a–c* interval is $\frac{1}{5}$th second.

are called " dropped beats " occur (Fig. 44). These may be only occasional, or they may be more frequent. Or each third or fourth impulse may fail to reach the ventricle ; in the former case the ventricular beats are grouped in twos (Fig. 35), and in the latter they are grouped in threes, and in this way a bigeminal or trigeminal pulse results. Or every other impulse may fail to reach the ventricle, giving rise to halving of the ventricular rate, the condition being spoken of as 2 : 1 rhythm (Fig. 45) ; or only each third or

fourth auricular impulse may be transmitted to the ventricle, resulting in 3: 1 or 4 : 1 heart-block. In some cases certain ratios alternate.

It might naturally be supposed that the length of the prolonged pause during a dropped beat would be equal to two regular pulse-beats; such, however, is usually not the case, for the following reason. There are variations in the *As–Vs* interval in association with dropped beats, there being a progressive increase of the *As–Vs* interval preceding (Fig. 46) and a

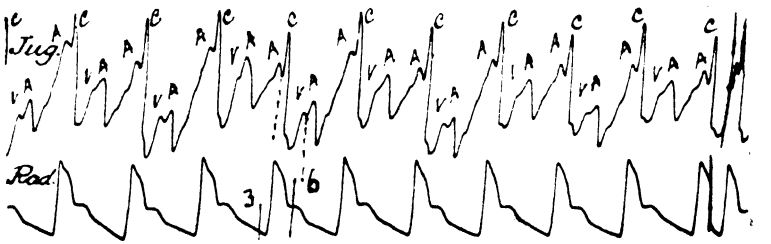


FIG. 45. Simultaneous tracings of the jugular and radial pulses, showing continuous 2 : 1 auriculo-ventricular block. The pulse-rate is 42 per minute.

progressive shortening of the interval following each dropped beat; the former is due to the increasing difficulty the impulses from the auricle have in reaching the ventricle, and the latter to the rest which the ventricle has experienced during the pause. The result of the progressive increase of the *As–Vs* interval prior to, and of the progressive shortening of the *As* to *Vs* interval after, the dropped beat is that the long pause becomes shortened. When, however, there are no variations in the *As–Vs* interval in association

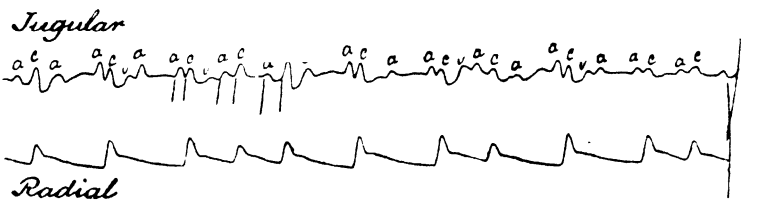


FIG. 46. Simultaneous tracings of the jugular and radial pulses, showing partial heart-block. Note the progressive increase in the *a c* interval of three successive rhythmic beats.

with a dropped beat, the length of the prolonged pause is equal to two regular pulse-beats.

2 : 1 heart-block gives rise to infrequency of the pulse-rate, the rhythm being regular. This grade of heart-block is sometimes continuous, but usually the ventricle responds from time to time to successive stimuli received from the auricle, the pulse-rate, therefore, being usually above 36 per minute.

On analysis of a polygraphic tracing it will be found that the *a* wave is present at uniform intervals, and is of more frequent occurrence than the *c* or *v* waves—it may be even twice, three times, or more

times as frequent, according to the degree of block; but, unlike complete heart-block, each *c* wave is preceded by an *a* wave (Figs. 44 to 46).

COMPLETE HEART-BLOCK.—Here the pulse-rate is slow, usually not more than 36, and not infrequently between 20 and 30 per minute, though some cases have been recorded in which the rate has been up to 60 or more beats per minute; it is little influenced by physical exertion, emotion, or pyrexia, or, as a rule, by atropine. The beats are usually full and strong, and, as a rule, the rhythm is regular, the pulse being irregular, however, when extra-systoles are present. In a tracing of the radial artery small waves occurring at regular intervals on the descending limb of the pulse-beat, probably due to auricular systole, may sometimes be noted (Fig. 47). The systolic blood-pressure is generally high, and during the long pause there is a considerable drop in pressure; the mean blood-pressure is low. There is usually evidence of hypertrophy of the left ventricle. On inspection of the neck, regular pulsations in the jugular veins, at considerably more frequent intervals than, and having a constantly varying time-relation to, those of the radial and carotid arteries and the apex-beat, due to auricular systole, may sometimes be noted;

FIG. 47. Sphygmogram from Webster's case of complete heart-block, showing small waves occurring at regular intervals on the descending limb of the pulse-beat (Mackenzie).

and in some instances a large pulsation in the jugular vein is seen from time to time when the auricular and ventricular contractions happen to coincide. On auscultation a first and second sound are found accompanying each contraction of the ventricle, and, in the opinion of some, faint muffled sounds may occasionally be heard during the long pauses, due to the contractions of the auricle. Some writers, too, have noted an accentuation of the first sound, synchronous with the large pulsation in the jugular vein, when the auricular and ventricular contractions coincide. In the case of a lesion of either main division of the auriculo-ventricular bundle, the gallop rhythm may be audible, due to asynchronism of the two ventricles.

If a polygraphic tracing be analysed (Fig. 48), the disassociation of the auricular and ventricular rhythms is manifest. The *a* waves occur at regular intervals, and are more numerous than the *c* or *v* waves, and the time-relation of the *a* and *c* waves is a constantly varying one—the *a* waves at one time preceding, at another following, and at some times again coinciding with the *c* waves. When an *a* wave falls during the limits of ventricular systole its amplitude is increased. Extra-systoles may be present.

Ætiology.—Heart-block is more common in males than in females. Most of the cases fall within two groups—(1) Patients, usually young adults, who have previously suffered from a rheumatic infection of the heart; and (2) patients, usually elderly people, who are suffering from chronic inter-

stitial myocarditis. In the former group the block is almost always of slight degree; but in these cases the higher degrees of heart-block are sometimes induced by full doses of one of the digitalis series of drugs. In the latter group there is a past history of syphilis in a considerable proportion of cases. The milder grades of heart-block may also be found in patients suffering from acute infective diseases, such as acute rheumatism, influenza, diphtheria and pneumonia; the condition, however, is usually temporary in these diseases.

Pathology.—Sclerotic changes, gummata, or acute inflammatory changes of the auriculo-ventricular junctional tissues—either the auriculo-ventricular node, or the auriculo-ventricular bundle above its division into two branches—are found in most cases of heart-block; when the condition occurs during the course of an acute infective disease, acute inflammatory changes are those most frequently found. Cases have been recorded, however, in which there was an absence of any lesion of the auriculo-ventricular junctional tissues, but in some of these the vagus was found to be affected. It should be remembered that in heart-block the morbid condition is rarely limited to

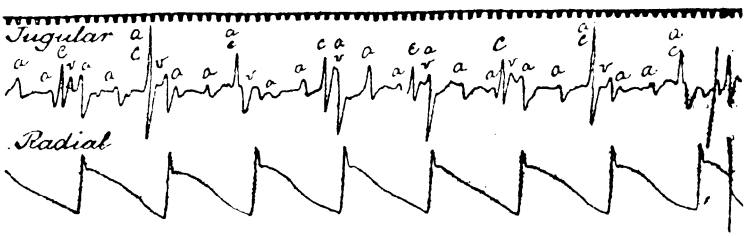


FIG. 48.—Simultaneous tracings of the jugular and radial pulses, from a woman aged 25, with severe heart failure, showing complete auriculo-ventricular block. The auricular rate is 88, and the ventricular rate 30, per minute.

the junctional tissues, the myocardium being usually affected, while valvular disease may also coexist.

Symptoms.—Patients suffering from heart-block may complain of symptoms due to the associated cardiac lesions—whether valvular or myocardial—which are almost invariably present, as well as of those due to the block itself; when, however, the valves and myocardium are normal, there may be a complete absence of subjective symptoms.

The symptoms of valvular and myocardial disease will be dealt with later; the commonest of these are dyspnœa, palpitation, fatigue, and præcordial pain on exertion.

With regard to the symptoms due to the block itself, reference has already been made to the pulse, the blood-pressure, the auscultatory phenomena, and the polygraphic records. In most cases symptoms due to the ventricular bradycardia are present. In the severe grades of partial heart-block and in complete heart-block there may be marked weakness and fatigue; and, owing to temporary anæmia of the brain, brief attacks of faintness, giddiness, or even temporary loss of consciousness. Not infrequently there are temporary periods of excessive slowing, or cessation of ventricular systole for prolonged intervals. Cheyne-Stokes respiration may be present, and the Adams-Stokes syndrome may occur.

ADAMS-STOKES SYNDROME.—Adams-Stokes syndrome is characterised by attacks of loss of consciousness, which may be momentary, and, it may be, also epileptiform convulsions, associated with marked infrequency of the ventricular rate. The patient, as a rule, has no knowledge of an impending attack. During the seizure there may be marked pallor or cyanosis, and deep and even stertorous breathing. Usually the convulsions are confined to the face and the upper limbs, the tongue is not bitten, and urine is not passed involuntarily. There may be repeated seizures. Adams-Stokes syndrome may occur in one of the following conditions: (1) Suddenly developed transient complete auriculo-ventricular block. Several cases of this kind have been reported. The conduction of the stimulus for contraction along the auriculo-ventricular junctional tissues is normal except that there is a liability to transient interruptions. (2) Partial heart-block in which there occurs either an intermittent period of complete heart-block, resulting in a temporary standstill of the ventricles; or, rarely, merely a temporary increase in the grade of the partial heart-block, resulting in a temporary increase in the degree of the bradycardia. (3) Complete heart-block in which the condition has become permanently established, especially if the ventricular rate is below 30 per minute. In these cases pauses of unusual length, due to temporary standstill of the ventricles, the result of diminished irritability of the ventricles, may occur. (4) It may very rarely be met with in marked bradycardia, in such conditions as meningitis, increased intracranial pressure, during convalescence from acute infective diseases, especially diphtheria and influenza, and possibly in fatty degeneration. Taking cases as a whole, Adams-Stokes syndrome is most commonly met with in patients with a severe grade of partial heart-block in whom complete block is developing. When complete heart-block has become permanently established, the ventricles apparently tend to become accustomed to the condition, and the pauses of unusual length referred to are not so likely to occur.

Diagnosis.—Diminished conductivity and the various grades of auriculo-ventricular heart-block are readily recognised by means of the polygraph or electro-cardiograph, since these instruments afford separate records of the movements of both the upper and lower chambers of the heart. The first grade can only be recognised by means of either of these instruments, and a lesion of either main division of the auriculo-ventricular bundle and intra-ventricular block by means of the electro-cardiograph. Fortunately, however, they are not necessary for the recognition of most of the other cases—palpation and auscultation furnishing all the evidence required. As an example of this may be mentioned the differential diagnosis between occasional dropped beats, pulsus bigeminus, and pulsus trigeminus, due on the one hand to extra-systoles and on the other to partial heart-block; this has already been dealt with. It is necessary to remember that sometimes sinus irregularity, and also sino-auricular block, may closely simulate occasional dropped beats due to partial heart-block.

The higher grades of heart-block give rise to infrequency of the pulse-rate. When the ventricular rate suddenly falls to half its former rate, in all probability the case is one of 2 : 1 heart-block. 2 : 1 heart-block must be distinguished from the condition in which an extra-systole occurs after each normal beat and fails to reach the wrist on each occasion. This can be done in the same way as in the case of a less severe grade of heart-block.

It is sometimes difficult to distinguish between partial and complete heart-block without the aid of the polygraph or electro-cardiograph. Most cases with a ventricular rate of 36 or under, however, are cases of complete heart-block. Also the presence of more rapid pulsations in the jugular veins, the presence of small waves occurring at regular intervals on the descending limb of a sphygmogram, and auscultatory phenomena afford help in differential diagnosis. A polygraphic or electro-cardiographic tracing may be taken to determine disassociation of the auricular and ventricular rhythms.

Adams-Stokes syndrome is easily recognised; marked infrequency of the ventricular-rate, rapid pulsations in the jugular veins, and the symptoms already described furnish a characteristic clinical picture.

Prognosis.—*The occurrence of partial heart-block during the course of an acute infective disease is a sign, and may be the only sign, of myocardial involvement.* Persistent heart-block of mild degree also is indicative of myocardial damage. With regard to persistent heart-block of severe degree, there are two questions of importance in considering the prognosis, namely—(1) Whether there be involvement of the heart muscle as a whole, and whether this involvement be progressive; and (2) is the patient subject to syncopal attacks, and, if so, their frequency? When there are no symptoms of heart failure, and when also the patient does not suffer from syncopal attacks, the span of life may be prolonged for many years, and he may be able to live a fairly active life without inconvenience. But when indications of cardiac failure are present, and especially if these be progressive, and when the patient is subject to recurrent syncopal attacks, especially if severe and frequent, life is always in danger; and, apart from the risk of a fatal termination, during an attack, death may occur with the usual clinical picture of cardiac failure. A few syphilitic cases have been recorded in which energetic anti-syphilitic treatment appears to have been rewarded with recovery.

Treatment.—When there is reason to suspect that syphilis is the cause, appropriate and energetic anti-syphilitic treatment should be employed. When heart-block occurs during the course of acute infective diseases, rest in bed is indicated, and the cause, such as rheumatism, should be adequately treated. Persistent heart-block of mild degree requires no treatment in itself. But as there is usually valvular or myocardial disease or both, it is of great importance that the patient should live strictly within the limits of the heart's strength, all the more so in cases of persistent heart-block of severe degree. If the patient be subject to fits, he should be warned to avoid anything known to predispose to the attacks, and, as far as possible, he should be protected from the risks of falling. Digitalis is contra-indicated in partial heart-block. It may be tried in complete heart-block in which there is dropsy or some other indication for its use.

Adams-Stokes Syndrome.—The foregoing therapeutic measures may be indicated. Anti-syphilitic treatment is indicated in Adams-Stokes syndrome due to auriculo-ventricular block when this is the result of gummatous infiltration. Potassium iodide, by its depressing effect on the ventricular muscle, may even aggravate the complaint when the cause is other than syphilis. Thyroid appears to be sometimes of value and may even be completely effective. Atropine, administered between the attacks, in order to prevent their recurrence, is indicated in cases of partial heart-

block in which there is vagal over-activity. Digitalis is contra-indicated in partial heart-block. It may be of value in complete heart-block. Caffeine and theobromine are of no clinical value. Of reported cases, the nitrites were found to be only of doubtful value in one case. Adrenalin is of value in the great majority of cases. It is not often effective in preventing the recurrence of the attacks. When employed for this purpose, it may be administered either subcutaneously or intramuscularly, in a dosage of from 5 to 10 minims of 1 : 1000 solution thrice daily. It is, however, the only potent therapeutic measure at our disposal during an actual attack. It is necessary to point out that when—as in the vast majority of cases—the attack is due to a temporary standstill of the ventricles, with consequent temporary cessation of the circulation, intracardiac injection is necessary, because the beneficial effect of the drug is due to its action in stimulating the sympathetic nerve endings in the heart muscle. The dose should be 0·5 to 1 c.c. of 1 : 1000 solution. In the rare cases in which the attacks are due to merely a temporary increase in the grade of an existing partial heart-block, the drug may be effective even if given subcutaneously or intramuscularly. Ephedrin has recently been employed as a substitute for adrenalin. It differs from adrenalin in that its effect persists for several hours; and, moreover, it has the great advantage of being effective when administered orally. A highly successful case treated by this drug has been reported, and therefore further investigation of it is advisable. Barium chloride, given by the mouth, should invariably be tried for the prevention of the recurrence of the attacks in cases of Adams-Stokes syndrome due to auriculo-ventricular block. If ineffective alone the drug should be employed with adrenalin, the latter administered either hypodermically or intramuscularly. The following is recommended: That barium chloride be administered, at first in doses of ½ gr. thrice daily. This dosage should, if necessary, be cautiously increased—stopping short of toxic symptoms—to 1 gr. thrice daily. With regard to adrenalin, 0·5 c.c. to 1 c.c. of 1 : 1000 solution thrice daily until after the attacks have ceased for some time. The dosage of adrenalin should then be gradually diminished until the drug is omitted altogether. Still later, the dosage of barium should be gradually reduced to the minimal dose found necessary to prevent the recurrence of the attacks.

Congenital Auriculo-Ventricular Block.—A number of cases of congenital auriculo-ventricular block, usually accompanied by some other lesion, have been described during the last 20 years or so, but, owing to the absence of polygraphic or electro-cardiographic examination, some of them were very doubtful. In most cases the pulse was over 50 per minute, and only rarely was there Adams-Stokes syndrome. The condition is usually ascribed to a lesion of the auriculo-ventricular bundle, and among the theories put forward as to its nature are (1) that it consists in a severance of the continuity of the bundle by an intraventricular communication, (2) that it is due to malformation, and (3) that it is inflammatory in origin.

Bundle-branch Block

A temporary or permanent lesion of either the right or left main branch of the auriculo-ventricular bundle is uncommon. The right appears to be much more frequently affected than the left. The ætiology and pathology

are similar to those of auriculo-ventricular block. Sometimes auriculo-ventricular block, and less frequently auricular fibrillation (Fig. 102), may coexist with a lesion of either main branch. Reduplication of the first sound is not infrequently to be observed. The condition can be recognised by means of the electro-cardiograph alone (see page 928). When the condition is permanent, the prognosis is usually very unfavourable.

Intraventricular (Arborisation) Block

In this condition there is diminished conductivity of the sub-endothelial arborisations of the auriculo-ventricular bundle, and also the stimulus for contraction does not reach the various portions of the ventricular muscle in normal sequence. It is believed by some that the condition may be recognised by means of the electro-cardiograph (see page 930). The prognosis is almost always grave.

PULSUS ALTERNANS

Definition.—By pulsus alternans is meant a condition of the pulse in which, while the rhythm is perfectly regular, a large beat and a small beat alternate. It is probably indicative of depressed contractility.

In the most typical cases of pulsus alternans, stimulation and contraction of the sinus, the auricles, and the ventricles occur in the order named, the ventricles contracting only in response to stimuli received from the auricles, and ventricular systole following the auricular systole at the normal interval

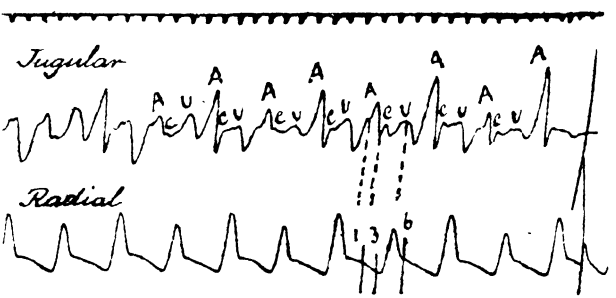


Fig. 49.—Simultaneous tracings of the jugular and radial pulses, showing continuous pulsus alternans, in which stimulation and contraction of the sinus, auricles and ventricles occur in the order named.

(Fig. 49). Sometimes, however, pulsus alternans is associated with conditions in which the mechanism of the cardiac action is abnormal, such as auricular flutter (Fig. 50), or paroxysms of auricular extra-systoles. The condition may be continuous, or it may be only observed on an increase of the pulse-rate, such as follows exercise, or only during a few cycles immediately following an extra-systole.

Ætiology.—Excluding those cases that occur in association with an abnormal cardiac action, such as auricular flutter, in the great majority of cases patients showing pulsus alternans are past middle age, and are the subjects of myocardial degeneration; the condition, however, is sometimes found in

younger people with post-rheumatic valvular disease, and occasionally it has been noted in pneumonia and other acute illnesses.

Symptoms.—The pulsus alternans in itself causes no subjective symptoms. When associated with myocardial disease, evidences of cardiac failure are almost invariably present. It requires long practice to detect pulsus alternans by the finger. Sometimes the small beats are so feeble that no waves are transmitted to the wrist; the condition may, therefore, be a cause of infrequency of the pulse.

Diagnosis.—In the great majority of cases it is necessary to take a tracing of the radial artery in order to recognise the condition. It is necessary to distinguish it from pulsus bigeminus due to extra-systoles. The differential diagnosis can be made with certainty; in pulsus alternans the pause between the large and the small beat is equal to that between the small and the large beat, whereas in the case of extra-systole the pause following the small beat is longer than that following the large one.

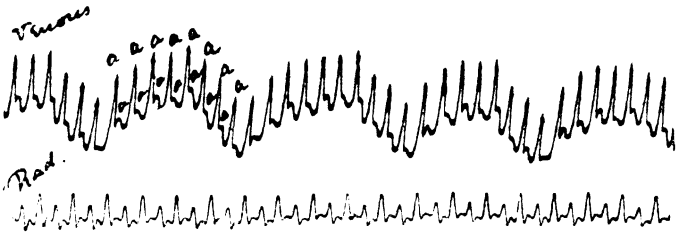


FIG. 50.—Simultaneous tracings of the jugular and radial pulses, showing pulsus alternans associated with an attack of auricular flutter, in which the ratio between the auricular and ventricular rate is continuously 2 : 1.

Prognosis.—When pulsus alternans occurs apart from a disordered cardiac mechanism, it is an indication of extreme exhaustion of the heart muscle; when the condition lasts only for a few cycles, this exhaustion may be only temporary, but even in these cases the prognosis should be guarded; when it is continuous, death may follow within a few months, or at most in a few years. When the condition is associated with tachycardia, it does not appear to have any serious significance in itself.

Treatment.—As pulsus alternans is usually a sign of great exhaustion of the heart muscle, complete and long-continued rest, both physical and mental, is urgently needed.

AURICULAR FIBRILLATION

The discovery of auricular fibrillation is one of the greatest discoveries regarding the functional pathology of the heart which has ever been made. It is of the utmost practical importance that the condition should be recognised, owing to its bearing on the diagnosis, prognosis and treatment of cardiac affections. Auricular fibrillation is a specific clinical condition which can be recognised with certainty. It is characterised in the vast majority of cases by complete irregularity of the arterial pulse, and also by absence of all signs of the normal contraction of the auricles. It accounts for approximately

50 per cent. of all cases of persistent irregularity of the heart, and it is found in from 60 to 70 per cent. of all cases of serious cardiac failure with dropsy. The condition has been known variously as "delirium cordis," "pulsus irregularis," "pulsus irregularis perpetuus," and the "mitral" pulse.

Definition.—By auricular fibrillation is meant a condition in which co-ordinate contraction in the auricle is replaced by inco-ordinate contraction; the individual fibres, instead of contracting in an orderly and simultaneous manner, doing so rapidly and independently of each other, with the result that *systole of the chamber as a whole never takes place. When auricular fibrillation has once set in, in the great majority of cases it persists for the remainder of life.* But, instead of this, it may appear for a few moments only and never return, or it may occur at varying intervals for days, weeks, or months and then cease, either spontaneously or as the result of digitalis medication. Many cases of paroxysmal tachycardia are due to transient attacks of auricular fibrillation. The tendency to occurrence increases, however, until finally the condition usually becomes permanent.

Effect of Auricular Fibrillation on the Heart.—The effect of auricular fibrillation on the cardiac action is mainly threefold: (1) The forcible contraction of the auricles driving the blood through the open auriculo-ventricular valves into the ventricles during the latter part of ventricular diastole is lost. This results in the ventricle being less filled. (2) Instead of the ventricle receiving stimuli from the auricle at regular intervals, it receives them at completely irregular intervals. (3) The impulses which escape from the auricle are numerous, and in the vast majority of cases the junctional tissue is able to conduct too many to the ventricle, resulting in an increase in the ventricular rate. The result of these three factors combined is that some of the ventricular contractions are so feeble as to fail to open the aortic valves, and the pulse is diminished in volume and its rhythm is irregularly irregular. In my opinion, the third factor is the most important. The condition usually has a considerable effect on the heart's efficiency.

Ætiology.—The majority of cases of auricular fibrillation fall within two groups—(1) those with a history of rheumatism, and (2) patients suffering from myocardial degeneration. In the case of the former the condition occurs more commonly in early adult life, and the patients frequently have valvular disease—*much more often mitral than aortic disease, and more especially mitral stenosis.* In the second group of cases the condition is more common after middle age. Auricular fibrillation has been also found occasionally in acute infective diseases, such as pneumonia, infective endocarditis, and diphtheria, in thyrotoxic conditions, whether due to exophthalmic goitre or adenoma, and in the terminal stages of various exhausting diseases. Its onset can now and again be traced to bodily effort, especially in the middle-aged or elderly, and rarely to the administration of full doses of digitalis.

Pathology.—Auricular fibrillation is in the vast majority of cases indicative of some myocardial change. Lewis and his co-workers are of opinion that both auricular flutter and auricular fibrillation are due to a single continuously circulating wave, which may be explained as follows:

G. A. Mines has demonstrated that if a ring of muscle is cut from the auricle of a tortoise, and a single stimulus is applied at any point to the quiescent ring, two waves of excitation travel rapidly from this point in

opposite directions and at the same rate, meeting at the centre point on the opposite side of the ring. At the time that the waves of excitation meet, the whole ring of muscle has passed into a state of excitation, and is, therefore, refractory, so that the wave of excitation on either side cannot proceed any further and consequently ceases; the crest of the oncoming wave on either side finding refractory tissue ahead of it. The whole ring of muscle remains in this state for a period, after which responsiveness is restored, this proceeding in the same order as the wave of excitation, until at last the whole ring is responsive, as was the case prior to the application of the stimulus. If, instead of a single stimulus, rhythmic stimuli be applied at one point of the ring of muscle, as long as the intervals between the stimuli are sufficient to allow of full restoration of responsiveness, the series of events described will occur at each stimulation. If, however, rhythmic stimuli be applied at such a rate that the intervals between them are not sufficient to allow full restoration of responsiveness, it may be that the wave of excitation is able to pass in one direction only, and if at this moment stimulation be abruptly withheld, there is, instead of two crests of waves of excitation travelling to meet each other at the centre point on the opposite side of the ring, only one crest, and as there is no wave of excitation meeting it in the opposite direction, when it comes to each part of the ring it finds the muscle fully responsive; and the wave, therefore, travels round the whole ring until it reaches its starting-point by which time the muscle of that segment of the ring has also become fully responsive, the result being that a single wave circulates continuously and for an indefinite period. There is a gap of fully responsive muscle between the crest of the oncoming wave and its receding wake. This is called circus movement.

It is believed that auricular flutter and auricular fibrillation are due to a single continuously circulating wave—in other words, to circus movement. There is a central or re-entrant path, and each time the wave of excitation travels over this, offshoots or centrifugal waves are thrown on and travel to all the other parts of the muscle of the auricle. The factors which maintain the circus movement are: (1) The length of the central path taken by the wave; (2) the rate at which the wave travels from point to point; and (3) the duration of the effective refractory period at any given point; the refractory period being the time taken for the muscle to become responsive after it has contracted. The third factor controls the second, and in large measure also controls the first; for when several paths are open to the oncoming wave, it will naturally take the shortest. There must of necessity be a gap of a sufficient degree of responsiveness between the crest of the oncoming wave and the wake of the receding wave; for if this gap become closed, the former will find refractory tissue ahead of it and so cease, thus allowing the normal pacemaker of the heart to regain control of the cardiac action. The length of the gap is controlled by the three factors mentioned. Any agency which will sufficiently increase the refractory period, or sufficiently decrease the rate of conduction will close the gap, and thus bring the circus movement to an end. In auricular flutter, owing to the increased rate of auricular contraction, the refractory period is diminished and usually also the rate at which the wave of excitation travels, and both of them tend to induce relatively short circus movements.

While what has been described in the ring experiment, namely, that the gap between the crest of the oncoming wave and its receding wake is fully

responsive, is occasionally observed experimentally, more frequently the gap consists of what is called *partially* refractory muscle. The cycle may thus be divided into three phases: (1) The full refractory phase; followed by (2) the partially refractory phase; and (3) a short phase at the end of the cycle during which the muscle is fully responsive. The end of the second phase, however, instead of being sharply defined, gradually fades into the third. The development of the partially refractory phase hastens the closure of the gap between the termination of the fully refractory period and the end of the cycle. As the rate of auricular contraction increases, the second phase bridges the gap between the end of the first phase and the end of the cycle, in which case the cycle will consist wholly of (1) a fully refractory phase, and (2) a partially refractory phase. In auricular flutter, the gap between the oncoming wave and its receding wake usually consists of partially refractory muscle, so that the oncoming crest encounters some fibres which are responsive and others which are still refractory. The latter act as minute barriers to the progress of the oncoming wave, and deflect it, making its course sinuous and diminishing its rate of progress from point to point. It will thus be seen that the diminished rate at which the wave of excitation travels in auricular flutter is not due to a diminished rate of conduction on the part of the fibres, but to some of the fibres being refractory and acting as barriers. In auricular flutter, the circulating wave is repeated at about 300 times per minute, and the paths along which both the main wave and its offshoots travel are constant and finally sinuous. The path which the central wave usually, but not invariably, follows is round a natural ring of muscle formed by the orifices of the superior and inferior venæ cavæ, and, as looked at from above, in a direction opposite to the hands of the clock. In auricular fibrillation, the circulating wave is repeated at about 450 times per minute. The greater rate as compared with a case of auricular flutter is in all probability due to the path taken being shorter, which is probably due to the effective refractory period being shorter than in auricular flutter. But there are other differences, of still greater importance, than the difference noted in the rate of the auricular movements. In auricular fibrillation, the degree of partial refractiveness of the auricular muscle is greater, so that the barriers to the progress of the oncoming wave are larger. The result is that the paths along which the main wave and its offshoots travel are variable and coarsely sinuous, and both the crest and the wake of the wave are deeply and irregularly crenated, and the crenations of the crest and the wake overlap and intertwine. Prolongation of the refractory period in auricular flutter and in auricular fibrillation will help to close the gap between the crest of the oncoming wave and its receding wake, since this gap is necessary for the maintenance of the circulating wave, whether in auricular flutter or fibrillation.

Symptoms.—Patients with auricular fibrillation very frequently complain of fluttering in the præcordium, or of irregular action of the heart, or of both, possible only on exertion. Apart from this, there is occasionally an absence of subjective symptoms. But, when the ventricular rate is much above the normal, symptoms, as a rule, are present, and these are the same as those of cardiac failure from other causes, such as shortness of breath, a sense of exhaustion, cyanosis and dropsy. It would appear, however, that the subjects of auricular fibrillation rarely suffer also from typical attacks of

angina pectoris. When the pulse-rate is very slow, the Adams-Stokes syndrome may be present.

The degree of cardiac failure which arises as a result of auricular fibrillation may be slight or very severe. It depends upon (*a*) the rate of the ventricular action, and (*b*) the degree of inherent muscle defect. As a rule, the onset of symptoms is gradual, but may ensue rapidly and the patient may become very ill within a few hours. Similarly, the cessation of auricular fibrillation may be accompanied by an equally rapid improvement in the patient's condition.

There is a wide variation in the ventricular rate, according as the path-

FIG. 51. Tracing of the radial artery, from a case of myocardial degeneration with auricular fibrillation, showing complete irregularity of the pulse.

way for impulses to the ventricle is free or interfered with, this ranging from 140 or even 180 to 40, or, very rarely, even 30 per minute in complete auriculo-ventricular heart-block, the average rate being between 90 and 140. The rate of the radial pulse does not necessarily represent the ventricular rate, for many beats of the heart may not be transmitted to the wrist, especially when the ventricle is beating rapidly; the ventricular rate, therefore, should be counted at the apex, either by palpation or auscultation. Apart from the very rare cases of complete auriculo-ventricular block, when the pulse is regular, *the character of the pulse is important.* It is irregular, the irregu-

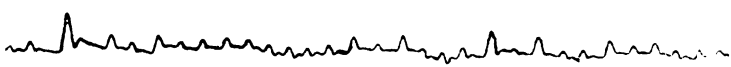


FIG. 52.—Tracing of the radial pulse, from a case of auricular fibrillation, showing complete irregularity of the pulse.

larity being continuous in the great majority of cases and persisting for the rest of the patient's life, in this respect differing from most other types of cardiac irregularity. A feature of even greater importance is the fact that the irregularity is *complete*; the rhythm is irregularly irregular (Figs. 51 and 52). In a sphygmogram, it will be found that two beats of the same length or amplitude rarely follow each other. There is often no relation also between the length of a pause and the amplitude of the beat which follows it—*i.e.* a short pause may be followed by a strong beat, and a long pause by a weak beat. There may be superadded ventricular extra-systoles, occurring either isolated at irregular intervals, or, as is more usually the case, occurring regularly after each normal ventricular beat. In the latter event, there is either

coupling of the beats (Fig. 53), or the premature contraction may be so feeble that no wave reaches the wrist, in which case the pulse-rate is halved. When the ventricular rate is slow (Fig. 54), or very rapid, the irregularity may be only slight, and we may have to adopt careful measurements of the sphygmogram to detect it.

In cases of mitral stenosis in which a presystolic bruit, *due to auricular systole*, is present, this disappears with the onset of auricular fibrillation;

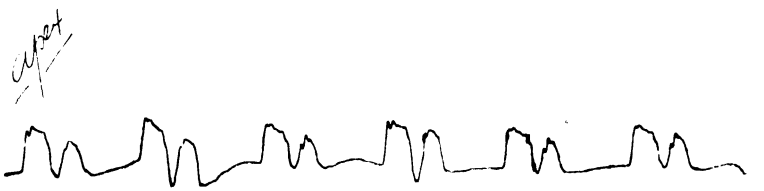


FIG. 53.—Tracing of the apex-beat, from a case of auricular fibrillation, fully under the influence of digitalis, showing coupled beats.

while if a diastolic bruit be present it persists. The jugular veins may be so distended that there is no visible pulsation in them. When pulsation is visible, however, it is of the positive type, only one wave being visible, this occurring during ventricular systole. In a tracing of the jugular vein, apart from the very rare cases of complete auriculo-ventricular block, when the rhythm is regular, the rhythm is completely irregular. There is an absence of the normal *a* wave; in other words, the ventricular form of venous pulse exists (Fig. 54). The normal *a* wave cannot be present because the auricle

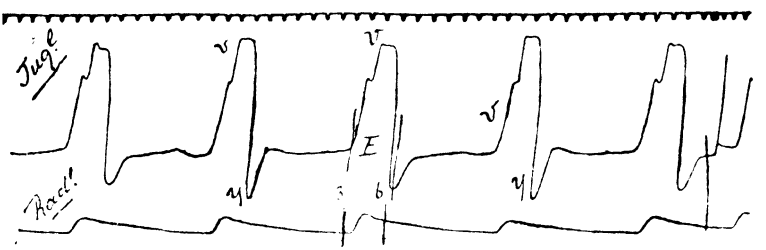


FIG. 54.—Simultaneous tracings of the jugular and radial pulses, from a case of auricular fibrillation, showing the ventricular form of venous pulse, and an unusually slow radial pulse.

does not contract. On the other hand, in cases in which there is infrequent cardiac action, multiple undulations, caused by the fibrillating auricle, may be present during diastole (Fig. 55). There is also an absence of the normal *a* wave in a cardiogram (Fig. 56) and in a tracing of the liver pulse (Fig. 57).

Diagnosis.—Auricular fibrillation can be diagnosed with absolute certainty on electro-cardiographic examination; or when complete irregularity of the arterial pulse, the ventricular form of venous pulse, and multiple

undulations in the jugular pulse are present, together with an absence of all signs of an auricular wave in a tracing of the apex-beat and of the liver pulse. We may be sure that this condition is present when there is complete irregularity of the pulse in conjunction with the ventricular form of venous pulse.

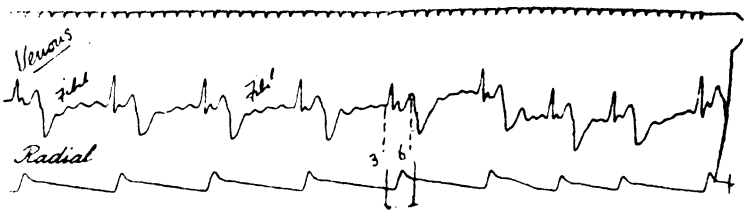


FIG. 55. — Simultaneous tracings of the jugular and radial pulses, from a case of auricular fibrillation, showing multiple undulations (marked Fibl.) in the phlebogram, caused by the fibrillating auricle.

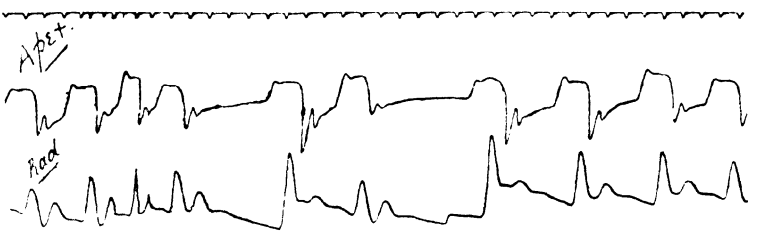


FIG. 56. — Simultaneous tracings of the apex-beat and of the radial pulse, from a case of auricular fibrillation, showing absence of the normal *a* wave in the cardiogram.

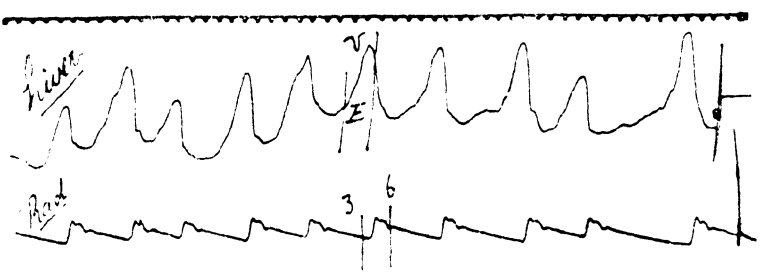


FIG. 57. — Simultaneous tracings of the liver and radial pulses, from a case of auricular fibrillation, showing absence of the normal *a* wave in the former.

Indeed, *we may be reasonably certain of the existence of auricular fibrillation from the mere presence of complete irregularity of the pulse.* It is possible to determine complete irregularity of the pulse in a large proportion of cases by palpation and auscultation alone. When, however, the ventricular rate is slow, or very rapid, the irregularity may be only slight, and it may be necessary to adopt careful measurements of the sphygmogram to detect it.

It is necessary to exclude irregular action of the heart due to extra-systoles (p. 791), or to auricular flutter (p. 813).

Prognosis.—Auricular fibrillation is in the vast majority of cases indicative of some myocardial change. Furthermore, the condition usually has an effect on the functional efficiency of the organ. Put briefly, the prognosis of auricular fibrillation depends upon the capacity of the heart to carry on its work under the new rate and rhythm, and this in turn depends upon the integrity of the cardiac muscle and the ventricular rate. If the integrity of the cardiac muscle be relatively good there may be for years little or no indication of cardiac failure. In the great majority of cases, however, this is not the case, and so heart failure, usually of considerable degree, results, especially when the ventricular rate is rapid and the heart is dilated. A persistent ventricular rate of 120 or over is usually of serious omen. Occasionally, with the inception of auricular fibrillation, grave cardiac failure may supervene with surprising rapidity, and death may follow within a few weeks, or even within a briefer period.

In endeavouring to form a prognosis, a point of the utmost importance is to ascertain how the heart responds to treatment. In this connection, digitalis therapy and quinidine therapy have been fully dealt with on pages 762–770. Another point of the utmost importance is to ascertain how far the patient is able to modify his life so as to bring it within the limits of the heart's strength. As has been pointed out, transient attacks of auricular fibrillation usually have a tendency to become more frequent, until ultimately the condition becomes permanent.

Treatment.—The ætiology should be reviewed, and the various therapeutic measures applicable to any form of cardiac disorder should be considered in detail. Apart from these, treatment of persistent auricular fibrillation resolves itself largely into the consideration of the employment of digitalis (or one of its allies), or of quinidine. The ultimate object of the employment of either of these drugs in the treatment of persistent auricular fibrillation is the same, namely, to regain the degree of cardiac efficiency which existed prior to the onset of the abnormal rhythm. This in the main depends upon the restoration of the pre-existing ventricular rate. As has already been pointed out, the fundamental functions of digitalis and of quinidine differ. The primary object of administering digitalis in auricular fibrillation accompanied by a rapid ventricular rate is to reduce and control the ventricular rate within normal limits. The drug has no effect upon the auricular fibrillation itself. The indications, the dosage, the choice of preparation, and the important question of the long-continued administration of the drug in most cases of auricular fibrillation have been fully dealt with on pages 762–767. The primary object of administering quinidine, on the other hand, is to arrest the auricular fibrillation—in other words, to restore the normal rhythm, and any beneficial effect of the drug is simply due to this. If successful in restoring the normal rhythm in auricular fibrillation, the forcible contraction of the auricles driving blood through the open auriculo-ventricular valves into the ventricles during the latter part of ventricular diastole is restored, the ventricle receives stimuli from the auricle at regular intervals, any increase in the ventricular rate due to the supervention of the abnormal rhythm is usually, but not always, abolished, physical exertion does not cause such a large increase in the ventricular rate, and the conscious-

ness of the irregular action of the heart, which is not rarely a disagreeable subjective symptom, is relieved. Quinidine therapy has been fully dealt with on pages 767–770.

In considering whether digitalis or quinidine should be employed, the degree of response to digitalis or one of its allies is of important consideration, a manifestation on the part of the patient of a particular intolerance for the former being a special indication for the administration of quinidine. It should, however, be remembered that the greater the degree of response to rest and digitalis medication the more likelihood there is of greater benefit following the administration of quinidine. Another special indication for quinidine is the occurrence of cardiac failure coincidently with the onset of the abnormal rhythm. The absence of indications of cardiac failure does not necessarily mean that this drug should not be tried, as cardiac failure may supervene later on. Other considerations are the risk—even amounting to a possible fatal issue—attending the administration of the drug, the degree of probability of restoration of the normal rhythm, the probable degree of success resulting from this, and the degree of probability of relapse. Cases for the administration of the drug should be selected with the utmost care, and in selecting such cases we are justified in taking a comparatively small risk, while in doubtful cases we should clearly put the pros and cons of this method of treatment to the patient or his friends. Finally, it should be remembered that if quinidine fails digitalis medication is still open to us.

AURICULAR FIBRILLATION (OR AURICULAR FLUTTER) OCCURRING IN THYRO-TOXIC CONDITIONS.—Auricular fibrillation (or auricular flutter) is not a very infrequent complication of thyro-toxic conditions, whether due to exophthalmic goitre or to adenoma. In those cases in which a toxic state exists at the time, the beneficial results following the administration of digitalis are, as far as my experience goes, only slight or altogether absent. Although quinidine not infrequently restores the normal rhythm, if the thyro-toxic state persists, relapse always occurs on slight exertion, physical or mental, or on emotion. The primary indication, therefore, is to remove the thyro-toxic state. This may occur naturally, or in response to rest and other therapeutic measures. Restoration of a stable normal rhythm follows in a certain proportion of cases. If this does not take place, digitalis or quinidine may be tried. The latter might conceivably result in the restoration of a stable normal rhythm in some cases. If the thyro-toxic state does not subside naturally or in response to rest, or digitalis and quinidine are still unsuccessful, the question of performing a sufficient degree of partial thyroidectomy should be considered. Restoration of the normal rhythm sometimes occurs spontaneously after operation, though it may be delayed to even 3 to 6 months. In a certain proportion of cases, such operative interference is not followed by restoration of the normal rhythm. In such cases, provided there are no contra-indications, the administration of quinidine should be resorted to, and restoration of the normal rhythm usually follows.

It does not follow that because auricular fibrillation or auricular flutter is found in a person who is the subject of goitre, the abnormal rhythm is caused by the goitre, for it may be due to some other morbid condition, such as organic valvular disease. In this connection, search should be made, on

the one hand, for other known causes of the abnormal rhythm, and, on the other, for evidence of hyperthyroidism, and an estimation of the basal metabolic rate should be undertaken.

The treatment of transient attacks of auricular fibrillation is that of paroxysmal tachycardia.

AURICULAR FLUTTER

The term "auricular flutter" was first used clinically by Jolly and Ritchie, and signifies a morbid condition in which a marked acceleration of the rhythmic, co-ordinate contractions of the auricle occurs. Auricular flutter was first induced experimentally by MacWilliam in 1887, and it is now recognised as a not uncommon clinical condition. *Transient attacks of auricular flutter probably account for the great majority of cases of paroxysmal tachycardia with regular rhythm or with pulsus alternans.*

NATURE OF AURICULAR FLUTTER.—As already noted, the contractions of the auricle are extremely rapid; the rate may range from 180 to 380, perhaps being usually between 280 and 300 per minute. The ventricular rate varies considerably in different cases, this depending upon the auricular rate and the ability of the auriculo-ventricular bundle to receive and transmit impulses sent by the auricle. Excepting in rare cases, each systole of the ventricle is the result of a stimulus for contraction received from the auricle in the normal fashion; rarely complete heart-block is present. In the vast majority of cases, the ventricle does not respond to each auricular contraction, partial heart-block being present. There is usually a constant and uniform ratio between the auricular and ventricular rate, this varying from 5 : 1 to 2 : 1; it would appear that the order of frequency is 2 : 1, 4 : 1 and 3 : 1. There may be a sudden and abrupt change from one ratio to another. In some cases the response of the ventricle to auricular contraction is at irregular intervals, instead of being in definite ratio—this giving rise to irregularity of the pulse rhythm.

The commencement and termination of auricular flutter are sudden and abrupt. The duration of the condition varies in different individuals, as well as in different paroxysms occurring in the same individual. Auricular flutter may appear for only a few moments and may never return; or it may last for hours, days, weeks, months, or even for years, recurring at intervals. It may be succeeded by the normal rhythm, or in many instances followed by auricular fibrillation; I have seen the latter occur during the administration of digitalis, but it may also occur apart from the use of the drug. There may be alternation of auricular flutter, the normal rhythm, and auricular fibrillation, the change taking place with the greatest abruptness and suddenness, and occurring from day to day or even every few moments, one or other condition ultimately becoming permanently established. Sometimes auricular flutter may persist, but, as the result of the occurrence of partial heart-block, the ventricular rate may diminish, and this may take place during the administration of digitalis or apart from the use of this drug. When once a patient has suffered from an attack of auricular flutter, there is a tendency to its recurrence from time to time.

Effect of Auricular Flutter on the Heart.—The effect of auricular flutter on the heart depends upon the ventricular rate and the integrity of the myocardium. When the ventricular rate is rapid and the myocardium is considerably damaged, the condition produces a marked effect upon cardiac efficiency, frequently resulting in cardiac dilatation, dropsy, and other indications of heart failure.

Ætiology.—It is yet too early to speak with certainty of the ætiology of this condition. Possibly this is much the same as that of auricular fibrillation. But while the condition has been observed as early as 5 years of age, it is most common after middle life, is of much more frequent occurrence in males than in females, and in all probability is most commonly associated with myocardial degeneration.

Pathology.—See pages 802–804.

Symptoms.—The symptoms after the onset of auricular flutter may come on gradually or rapidly, and the patient may or may not be conscious of the change in the cardiac action. He may complain of palpitation, but otherwise there may be an entire absence of subjective symptoms, this depending upon the ventricular rate, the degree of integrity of the myocardium, and the duration of the condition.

Taking into consideration all cases of auricular flutter, in a majority of which the condition has existed for some time, the ordinary symptoms of cardiac failure supervene; or, if these were present before the onset of auricular flutter, they increase in severity, until ultimately indications of extreme cardiac failure may appear. When the ventricular acceleration is marked, as the amount of blood propelled from the ventricle at each systole is so small as to give rise to cerebral anæmia, the patient may complain of vertigo, and there may be from time to time attacks of faintness or even complete loss of consciousness. Cheyne-Stokes respiration is also not an infrequent symptom when the condition has lasted for some time.

The rate and rhythm of the arterial pulse vary greatly in different cases, and, it may be, at different times in the same case. If the ventricle responds to each auricular contraction, the ventricular rate is exceedingly rapid, and graphic methods are necessary to determine it. In the vast majority of cases, however, partial heart-block is present, and as 2 : 1 rhythm is the most usual, a ventricular rate of 140 to 150 is frequently found. In other cases of partial heart-block, the ventricular rate may not be much increased, and, indeed, there may even be bradycardia, as in 4 : 1, or more partial heart-block—as well as in complete heart-block. When there is a constant and uniform ratio between the auricular and ventricular rate, the rhythm of the arterial pulse is regular; in these cases, however, if the ventricular rate be above 150, pulsus alternans may be present. When, as is not infrequently the case, the response of the ventricle to auricular contraction is at irregular intervals, there is irregularity of the pulse rhythm, it may be even markedly so; indeed, in some of these cases the sphygmogram may resemble that from a case of auricular fibrillation, detailed measurements being necessary for the purpose of differential diagnosis. On inspection of the neck, the jugular veins may be distended, and no pulsation visible; or extremely rapid movements may be evident. Evidences of cardiac dilatation, as, for example, enlargement of the area of percussion

impairment, may be found. If murmurs of mitral disease were present prior to the onset of auricular flutter, they may become faint or almost disappear if the ventricular rate be greatly accelerated; this applies particularly to the case of a mitral presystolic bruit.

A tracing of the jugular pulse differs in outline according to whether

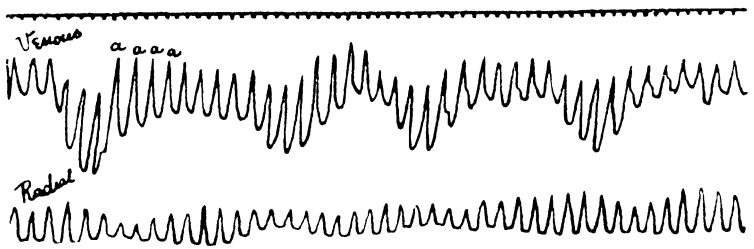


FIG. 58.—Simultaneous tracings of the jugular and radial pulses from a case of auricular flutter, in which the ventricle responded to each auricular contraction. The rate is 188 per minute.

the ventricle responds to each auricular contraction, or to the degree of heart-block which may be present. In the former case there is usually a single wave (Fig. 58). When the ventricle responds alternately to the auricle, there are two *a* waves to each ventricular beat, and these usually fall within the limits of ventricular systole (Fig. 59). In 3 : 1 rhythm the character of the jugular pulse may be seemingly that of normal cardiac

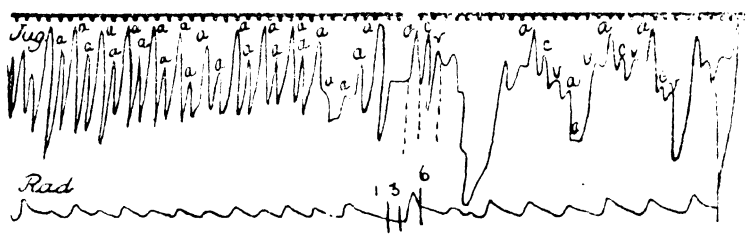


FIG. 59.—Simultaneous tracings of the jugular and radial pulses from a patient with myocardial and arterial disease, showing the termination of an attack of paroxysmal tachycardia, due to auricular flutter. The first part of the tracing shows auricular flutter, with 2 : 1 heart-block, the rate of the auricle being 232, and the ventricular rate 116, per minute. The normal rhythm of the heart is resumed after the long pause with the beat 1, 3, 6.

action, and it is particularly in these cases that an electro-cardiographic examination is required to establish the diagnosis. As has been already noted, complete heart-block is rarely found.

Diagnosis.—The diagnosis of the condition rests on the detection of the extremely rapid contractions of the auricle, and this is not infrequently impossible without the employment of the polygraph or electro-cardiograph; indeed, in some cases a correct diagnosis cannot be made with certainty even

though the polygraph be employed, an electro-cardiographic examination being necessary.

We should consider the possibility of auricular flutter whenever an individual is conscious of a marked increase in the cardiac rate, or complains of attacks of palpitation, in either case occurring suddenly and without apparent cause, or suffers from dyspnœa on exertion and other indications of cardiac failure coming on rapidly, especially if the rhythm of the pulse be regular.

Auricular flutter should be diagnosed from tachycardia associated with the normal rhythm. If the tachycardia be due to an abnormal rhythm, and if the ventricular rhythm be regular, the case is probably one of auricular flutter; while if the rhythm be irregular, it is necessary to consider whether the case may not be one of auricular fibrillation. In this connection, *if a sphygmogram from a case of auricular flutter be carefully studied, it will be found that even though the ventricular rhythm is markedly irregular the pulse-beats measure out into groups of equal length, whereas this is never the case*

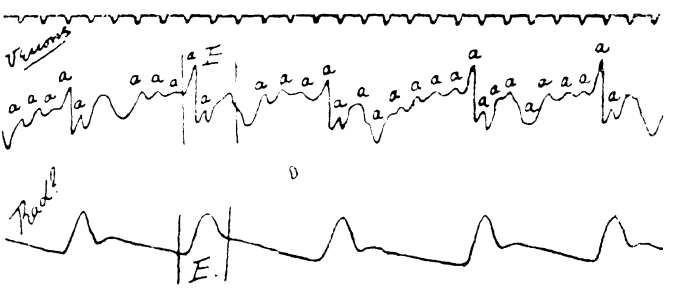


FIG. 60.—Simultaneous tracings of the jugular and radial pulses from a patient fully under the influence of digitalis. The auricular rate is 382, and the ventricular rate is 50, per minute.

in auricular fibrillation. The polygraph and electro-cardiograph are of notable assistance in the differential diagnosis of the two conditions. The diagnosis of auricular fibrillation with a markedly exaggerated ventricular rate in which the irregularity is only slight from auricular flutter should also be considered. Irregularity due to the presence of extra-systoles should also be excluded. Cases of auricular flutter in which the auriculo-ventricular ratio is constantly 3 : 1 to 4 : 1, so that the ventricular rate is not much, if any, increased, and in which the ventricular rhythm is regular, are easily missed. The employment of the polygraph or electro-cardiograph is often necessary in such cases.

Prognosis.—The prognosis of auricular flutter depends upon the frequency and duration of the attacks, the ventricular rate, the condition of the valves, the myocardium, and the vessels, and the results of the administration of digitalis. When once a patient has suffered from an attack of auricular flutter, there is a tendency to its recurrence from time to time. The effect which an attack has upon the heart depends upon the ventricular rate and the degree of integrity of the myocardium; these have been already dealt with. Attacks of loss of consciousness, especially when they occur in the subjects of marked cardiac failure, are attended with danger.

Treatment.—The ætiology should be reviewed. When the attacks are transient, the treatment is that of paroxysmal tachycardia. When they are of longer duration, or the condition has become permanently established, the various measures applicable to any form of cardiac disorder should be considered. Apart from these, treatment resolves itself largely into the consideration of the employment of digitalis or one of its allies, or of quinidine. The action of digitalis, its dosage, the choice of preparation, and the choice of either of two plans after the full physiological reaction is obtained, have been fully dealt with on pages 762–767. Quinidine therapy has been discussed in detail on pages 767–770. I have treated the last six or more cases which have been under my observation by the first method of administering digitalis, and in each case it has been successful, so that my present practice is to keep to this method of treatment. If, however, this should fail, the alternative method of digitalis medication may be adopted, and if this induces auricular fibrillation and the abnormal rhythm persists, the subsequent treatment is that of auricular fibrillation. If the alternative method of administering digitalis also should fail, the question of the employment of quinidine should be considered.

The treatment of auricular flutter occurring in thyro-toxic conditions has been referred to on pages 809–810.

NODAL RHYTHM

In nodal rhythm the stimulus for contraction arises in some part of the auriculo-ventricular junctional tissues, travelling upwards into the auricle and downwards into the ventricle, and giving rise to a simultaneous contraction of both auricle and ventricle. The contraction of both chambers may be absolutely synchronous, or the ventricle may begin after, or before, that of the auricle. In the first instance, the *a* and *c* waves of a polygraphic tracing are superimposed, in which case the amplitude of the wave is increased; in the second, the *a* wave precedes the *c* wave, but the *a*–*c* interval is diminished to about 0·10 sec. Nodal rhythm may occur without or with an appreciable degree of tachycardia. The former is rare. The latter may be persistent, or, more frequently, transient, the latter being one of the forms of paroxysmal tachycardia.

VENTRICULAR FIBRILLATION

Ventricular fibrillation has been observed. It may be induced experimentally by electric and other kinds of stimuli. Complete and abrupt closure of a coronary artery or one of its main branches, and the action of various poisons, including digitalis, may cause it. The experiments of Goodman Levy have shown that in the cat it is very apt to occur under light chloroform anæsthesia. The condition is preceded by a premonitory period, of varying length, of extra-systoles of special form. A certain number of electro-cardiograms showing ventricular fibrillation in the human subject have been published. Recovery in man is rare. It is believed that ventricular fibrillation is the immediate cause of sudden death in complete and

abrupt closure of a coronary artery or one of its main branches, in auricular fibrillation, and some—it may even be most—of the fatalities that occur in chloroform anæsthesia. Unlike auricular fibrillation, the condition is not influenced by increased vagal stimulation.

PAROXYSMAL TACHYCARDIA

Definition.—The term paroxysmal tachycardia is here employed to denote a condition, not uncommon, in which a marked acceleration of the cardiac rate occurs, which commences suddenly and abruptly and without apparent cause, lasts for a varying period, ceases suddenly and abruptly, *and is due to an abnormal rhythm—the stimulus for cardiac contraction, instead of arising at the junction of the great veins with the auricle, having its origin at an abnormal point.* The return of the cardiac rate to what it was prior to the paroxysm is due to the reversion of the cardiac rhythm to the normal. From the definition given, it will be seen that *paroxysmal*

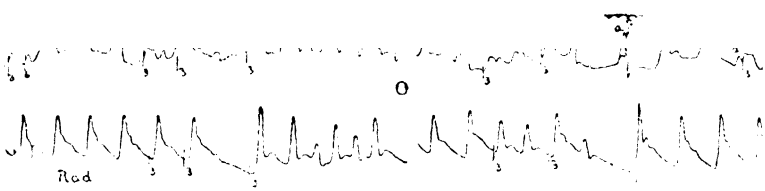


FIG. 61.—Simultaneous tracings of the jugular and radial pulses, showing the commencement and termination of a short attack of paroxysmal tachycardia, due to auricular fibrillation. The first six beats and the last three in the sphygmogram are regular and due to a normal contraction of the heart. The beats between occur during a period of auricular fibrillation. At *O* a period of 15 seconds has been cut out. (Mackenzie.)

tachycardia does not include acceleration of the cardiac rate associated with the normal or sinus rhythm. It should be noted that the nature of the abnormal rhythm is not always the same; in other words, the conditions which gives rise to the paroxysm of tachycardia varies. The point of origin of the new rhythm may be situated in the auricle (Fig. 111), or the auriculo-ventricular junctional tissues—either the auriculo-ventricular node, or the auriculo-ventricular bundle above its division into two branches—or in the ventricle below the division of the bundle (Fig. 112). When in the auricle, the cause of the abnormal rhythm may be transient attacks of auricular flutter with tachycardia (Fig. 59), paroxysms of auricular extra-systoles, or transient attacks of auricular fibrillation with tachycardia (Fig. 61). In the first instance, in the vast majority of cases the ventricle does not respond to each auricular contraction, partial heart-block being present. When the point of origin is situated in the auriculo-ventricular junctional tissues, there is a simultaneous contraction of both auricle and ventricle; the contraction of both chambers may be absolutely synchronous, or the ventricular systole may begin after, or before, that of the ventricle. The individual contractions of extra-systoles and those of the other forms of paroxysmal tachycardia are of the same nature, so that it is of importance to be able to compare the records

of the normal and the abnormal rhythms, especially one or both of the transitional stages; in the case of extra-systoles, the first contraction is premature and the last is followed by a long pause. In the case of auricular flutter, in the vast majority of cases the ventricle does not respond to each auricular contraction, partial heart-block being present.

The paroxysm of tachycardia may last only for a few beats, or may persist even for months; as a rule, it lasts for some hours, and only exceptionally does it continue for several weeks, and rarely for months. The patient may experience one attack, and never have another, or he may be subjected to many in the course of 24 hours, or the attacks may occur at varying intervals, frequent or long, for many years. Permanent auricular fibrillation or flutter may supervene.

Ætiology.—The ætiology of paroxysmal tachycardia is obscure. It may occur at any age after five, but usually first occurs during middle life. It appears to be more common in males, and this certainly agrees with my experience. A history of previous infection by rheumatism is not uncommon, and a fair proportion of cases are the subjects of valvular disease, particularly of mitral stenosis, or of myocardial degeneration; but no evidence of organic disease of the heart is found in a considerable proportion of cases. The condition has been noted in association with alimentary toxæmia, in reflex irritation, neurasthenia and other morbid states. Among exciting causes are physical exertion, emotional excitement, digestive disturbances particularly flatulent distension of the stomach or colon, and in one of my own cases the adoption of a certain posture appeared to bring on the attacks.

Symptoms.—In some cases there is limitation of the field of cardiac response between the attacks, such as dyspnœa and præcordial distress on exertion.

It has been already noted that there is a sudden, abrupt and great acceleration of the cardiac rate, coming on without apparent cause, while at the end of the paroxysm there is a sudden and abrupt return to the rate and cardiac rhythm which preceded the attack. In some cases the patient is able to recognise the onset and termination of the tachycardia, while in others he is unable to do so. After the onset, the patient may be unconscious of the tachycardia, if the attack be brief; but, if it persist for any time, he usually becomes conscious of it, and generally complains of a fluttering sensation in the chest, this sensation being unlike that of palpitation. The patient may also experience a sensation of pulsation in the neck. His face is usually pale, and has an anxious expression. The cardiac rate is usually above 140 per minute, and may reach even 300; in a majority of the paroxysms it is between 150 and 190; it should be counted at the apex, either by palpation or auscultation—unless it is extremely rapid, when graphic methods are necessary. The pulse is of smaller volume than normal, and its character may resemble that of the pulsus celer. It may be quite regular, or very irregular when the condition is due to auricular flutter in which the response of the ventricle to auricular contraction is at irregular intervals, or *completely* irregular when the result of auricular fibrillation. A noteworthy feature is the frequent presence of pulsus alternans; but this can only very rarely be made out by the finger. The blood-pressure is generally lower during the attack. The area and force of the apex-beat may be increased. The jugular veins may be distended, and may show very rapid pulsation.

Analysis of the polygraphic tracings gives different results, according to the nature of the abnormal rhythm.

During the attack the common indications of cardiac failure may be present, their severity depending upon the cardiac rate, the duration of the paroxysm, and the integrity of the myocardium. In some cases, even when the paroxysm lasts for a day or two, there may be only some limitation of the field of cardiac response, with little, if any, cardiac dilatation, hepatic enlargement or dropsy; while, in long-continued paroxysms, and even in some cases in which the paroxysms last for only a few hours, cardiac failure may be extreme. As the amount of blood propelled from the ventricle at each systole is so small as to give rise to cerebral anæmia, the patient may complain of vertigo, and there may be from time to time attacks of faintness or even complete loss of consciousness. Cheyne-Stokes respiration is also not an infrequent symptom when the condition has lasted for some time.

The area of cardiac impairment may become considerably enlarged,—even within a few hours,—the first sound of the heart shortened, sharp, high and clear in pitch, the long pause is often shortened, while the rhythm of the sounds sometimes resembles that of a fœtal heart, and if murmurs were previously present they alter in character or even disappear. There may be tenderness of the præcordium and hepatic area, the liver may be palpable and pulsating, ascites and general anasarca may occur, and the urine may become scanty, high-coloured and albuminous.

A remarkable and characteristic feature of the condition is that with the sudden reversion of the rhythm to the normal there is an extraordinarily rapid recovery to the state in which the patient was prior to the paroxysm; within a few hours there may, indeed, be no evidence of cyanosis, distension of the veins, cardiac dilatation, or enlargement of the liver. In some cases the cessation of the attack is accompanied by the passage of large quantities of wind, and excessive eructations, while a large quantity of urine may be voided. Death during the attack is uncommon

Diagnosis.—The diagnosis of paroxysmal tachycardia is usually not difficult. The most important factors from the diagnostic point of view are: (1) The commencement and termination of the attack of tachycardia. The suddenness and abruptness of the onset and termination of the tachycardia are characteristic features—the maximum rate is attained within a few seconds, and the return of the cardiac rate to what it was prior to the attack occurs equally quickly; whereas in tachycardia associated with the normal rhythm the onset and termination are gradual. (2) The cardiac rate. A persistent rate of over 160 is almost invariably due to an abnormal rhythm, and a persistent rate of over 140 may be due to the same cause. Tachycardia of a rather less severe grade must certainly not be presumed to be due to an abnormal rhythm. (3) With the exception of those cases due to transient attacks of auricular fibrillation, the cardiac rate is not influenced by posture, physical exertion, emotion, pressure upon the vagus, or pyrexia, as is the case in tachycardia associated with the normal rhythm. Electrocardiographic examination will put the diagnosis beyond all doubt.

Prognosis.—The difficulty in forming a prognosis in any case of paroxysmal tachycardia is great. The prognosis may be considered from two standpoints—(1) That of a particular paroxysm, and (2) the question of recurrence of the attacks. With regard to the former, it may be noted that death during an

attack is comparatively infrequent, although this may occur when the duration of the attack is prolonged. The points which should be taken into account in considering the prognosis of an individual attack are the ventricular rate, the duration of the attack, and the degree of cardiac failure present. When the ventricular rate is not very high, and there is little or no cardiac dilatation, and an absence of œdema of the lungs, hepatic enlargement and anasarca, the outlook is good as far as the risk to life is concerned; while, on the other hand, if the clinical picture be the reverse, the outlook is uncertain, although it should be remembered that the paroxysm may cease at any time, and there is no means of knowing when this may occur, and the patient improves with extraordinary rapidity.

With regard to the question of the recurrence of the attacks, it is impossible to give an answer. For in some cases the patient may never suffer from a second attack; while, on the other hand, they may recur even several times in the course of 24 hours, or at frequent intervals for many years, or, lastly, permanent auricular flutter or fibrillation may supervene even after a few attacks.

Treatment.—This resolves itself into two parts—(1) Prevention, if possible, of the recurrence of the attacks; and (2) treatment during an attack.

With regard to the first of these, the general condition, and whatever appears to be the exciting cause of the paroxysm, should receive close attention. Any gastro-intestinal disorder should always be corrected. Bromides may be tried. In a few cases in my experience the continuous administration of digitalis has proved effective. More recently I have employed 5 grains of quinidine sulphate once daily, in a number of cases, and it has been successful in most. Some workers employ about twice this dosage.

The results of treatment during the attacks are in the great majority of cases very unsatisfactory. It is true that the paroxysm not infrequently ceases when various remedies are applied: thus, bringing up of wind, the act of vomiting, the adoption of a certain posture, pressure upon the vagus—particularly the right, friction of the chest-wall, and local applications in the form of an ice-bag, mustard leaves, or warmth to the præcordium may be followed by relief. But it should be remembered that the nature of the disorder is to stop suddenly, and, therefore, the question of post hoc and propter hoc always arises. The patient should go to bed. If 5 grains quinidine sulphate once daily is being administered, the dosage may be increased (see p. 770). As far as my observations have gone, the remedy which offers most encouragement is strophanthin injected intravenously. Failing this, digitalis may be given by the mouth and pushed to the full physiological reaction. If there be indications of heart failure, such as dyspnœa, cyanosis or dropsy, treatment on the lines laid down elsewhere should be adopted. Bromide and chloral, or morphine may be tried.

FREDERICK W. PRICE.

CARDITIS: THE RHEUMATIC INFECTION OF THE HEART IN CHILDHOOD

Definition.—By carditis is meant inflammation involving the endocardium, myocardium and pericardium simultaneously.

Before dealing with endocarditis, myocarditis, and pericarditis individually, it may be advisable to discuss the rheumatic infection of the heart in childhood. This is a subject of the utmost importance, for by far the larger number of cases of heart disease under 30 years of age, and a considerable proportion of those of later life, are the direct result of this infection. And, notwithstanding the fact that this subject has received a great deal of attention, it is still not sufficiently realised that it is very easy to overlook a rheumatic infection in childhood, and, even when we are especially on the look-out for it, it is not infrequently very difficult to come to a definite conclusion whether the heart is affected or not. This is unfortunate, because the future welfare of the patient in large measure depends upon the adoption of sufficiently prolonged, careful and adequate treatment during the stage of infection.

In all probability the reason why infection of the heart by the rheumatic poison is so frequently overlooked, is that the clinical picture of acute and subacute rheumatism was originally drawn from the disease as it appears in adult life, the result being that many practitioners do not even now realise that rheumatism, as it appears in childhood, presents many and important points of difference.

It is important to bear in mind the following facts: In adult life arthritis is the chief manifestation of the rheumatic infection, and is looked upon as constituting a typical attack, while cardiac involvement is regarded as a complication. In children, on the other hand, arthritis is usually slight, and may be entirely absent, while affections of other parts are more frequent, and constitute a more conspicuous feature in the disease. Thus, sometimes the affection is confined to the tendons or the fascia in the neighbourhood of the joints, as, for example, the tendons of the hamstring muscles under the knee. Subcutaneous nodules, certain exudative erythemata, and purpura rheumatica are more frequent manifestations of the rheumatic infection. Chorea is a common indication. Tonsillitis is, perhaps, more commonly of rheumatic origin than in adult life. Lastly, cardiac involvement is a much more frequent manifestation of the rheumatic infection in childhood than in adults; it is, at least, as frequent an indication of the rheumatic infection as any other, and should not be regarded as a "complication"; and it may occur in association with any of the foregoing, or with an indeterminate febrile attack, or alone—that is, it may be the only manifestation of rheumatism. Another point to bear in mind is that while endocarditis may occur acutely in children as it does in adults, it often occurs in a subacute and insidious form. There is not infrequently a total absence of subjective symptoms, which if present are often masked by other manifestations of the rheumatic infection. The diagnosis, therefore, rests largely upon physical signs, and the existence of the condition is frequently unknown or unsuspected until the heart is examined. The physical signs,

however, are not infrequently slight and vague in character, and the diagnosis is consequently often attended with extreme difficulty.

Now, if the foregoing be facts, it is clear that when a child complains of pain in the joints, muscles, or tendinous structures, or what are called "growing" pains; or has subcutaneous nodules in the tendons or round the joints, or subperiosteal nodules on the bones; or exhibits an erythematous eruption; or if there be a suspicion of chorea; or if he suffer from malaise and unexplained pyrexia; or complain of pain in the chest, or shortness of breath, or present marked pallor, he should at once be put to bed, and a systematic and most careful examination of the heart be performed daily, and if there be any doubt whether the heart is involved or not, the patient should be kept in bed till this has been set at rest.

ENDOCARDITIS

Definition. — By endocarditis is meant inflammation of the lining membrane of the heart. In the great majority of cases the inflammation involves chiefly the endocardium of the valves, and is not infrequently so limited. The term valvulitis is applied to endocarditis of the valves, while inflammation of the endocardium lining the cavities of the heart is referred to as mural endocarditis. The surface of the valves next the blood stream, namely, the ventricular surface of the semilunar valves and the auricular surface of the auriculo-ventricular valves, is affected. In adults the left side of the heart is far more commonly affected than the right, the mitral valve being more frequently attacked than the aortic; while, on the other hand, during fœtal life the opposite is the case. Some degree of myocarditis is probably always present with endocarditis.

A satisfactory classification of endocarditis is not easy, that most commonly adopted being as follows: (1) Acute, (*a*) simple or benign, and (*b*) infective, ulcerative or malignant; and (2) chronic or sclerotic. It should be noted that it is impossible to draw a sharp line of distinction between these varieties on grounds of ætiology, pathology, or morbid anatomy. Clinically, however, the distinctive features of each are fairly marked, although even in this case the distinction is not absolute. E. Libman, following Osler and Horder, has recently described a subacute variety, ulcerative in its character (see Infective Endocarditis).

Acute Simple or Benign Endocarditis

Ætiology.—Acute simple endocarditis occurs most commonly in childhood and adolescence, and is rarely, if ever, a primary disease. Acute rheumatism is responsible for the great majority of cases, the onset of endocarditis occurring usually about the end of the first week. The association between the rheumatic infection and acute endocarditis has been previously dealt with. Chorea and scarlet fever are common causes of acute simple endocarditis; less frequently tonsillitis, pneumonia, small-pox, measles, chicken-pox, diphtheria, and other acute infective diseases; while Bright's disease, gout, diabetes, and pulmonary tuberculosis are also supposed to be responsible for a certain number of cases.

Acute simple endocarditis not infrequently occurs in individuals who are the subjects of the chronic or sclerotic form of the disease—the so-called recurring endocarditis.

Pathology.—In this form of endocarditis the parts affected become swollen, as the result of œdema and connective tissue proliferation, and cauliflower-like or warty excrescences, varying in size from that of a pinhead to a bean, called vegetations, make their appearance on the segments of the valve or on the mural endocardium. The valvular vegetations are usually not situated at the extreme margins of the cusps, but at those parts which come into apposition during closure, namely, a short distance from their margins. The vegetations consist of blood platelets, leucocytes, and fibrin. Carey Coombs has found foci containing large multinuclear cells in the inflamed valves. Various micro-organisms have been described in association with the vegetations, but they are not present in large numbers in the acute simple form of endocarditis. Fragments may become detached from the affected valves, be carried by the blood to remote parts, and ultimately become impacted in a vessel; this process is known as embolism, and the impacted fragment as an embolus. This may result in obstruction of the circulation, and (1) necrosis, or hæmorrhage, or both, within the area of distribution of the occluded vessel, and the formation of infarcts; or (2) gangrene of the area supplied in the case of one of the larger arteries of the limbs. Infarction most generally occurs in the spleen or kidneys, although it is not infrequently found in the brain or its membranes, the retina, lungs (in right-sided endocarditis), intestines, and skin. In cerebral infarction, softening of the area supplied by the affected vessel takes place rapidly, while in pulmonary infarction localised pneumonia is a frequent sequel.

An attack of acute simple endocarditis may be followed by (1) resolution, a rare event; (2) organisation, which is the usual sequel; or (3) ulceration. When organisation occurs, it results in the formation of fibrous cicatricial tissue, which tends to contract as life advances, giving rise to various deformities of the valves and ultimately to permanent stenosis, or incompetence, or both.

Symptoms.—It has already been noted that while endocarditis may occur acutely in children as in adults, it often occurs in a subacute and insidious form. There is not infrequently a total absence of subjective symptoms, or, when present, they are often masked by other manifestations of the causal infection. Sometimes the onset is accompanied by a rise of temperature above that already existing, this increased pyrexia occurring without any increase in the arthritic symptoms in the case of rheumatism; the degree of pyrexia is usually not marked, but occasionally there is a sharp rise of temperature. There may be toxic rashes, in the form of urticarial erythema, erythema multiforme, or erythema nodosum.

The patient may suffer from palpitation, mild or severe; dyspnœa and præcordial distress may be also present, the former being usually not pronounced, while the latter generally takes the form of an uncomfortable feeling in the præcordium, not amounting to actual pain. Faintness, actual præcordial pain, and œdema are rarely met with until the affection is far advanced. In cases of severe carditis, however, in which great and rapid dilatation occurs, symptoms of marked cardiac failure may be present even

at the onset of the illness. The symptoms of embolism are discussed elsewhere.

The pulse is usually increased in frequency, and is in some cases irregular. The apex-beat may be tumultuous in character, and displaced outwards, and there may also be evidence of enlargement of the area of cardiac impairment transversely; these signs may occur very early in the disease. The first sound at the mitral or aortic area, according to which of these valves is affected, may become slightly prolonged, or roughened, or may exhibit a lack of clearness; within 24 hours it may be accompanied by a distinct murmur, soft and blowing in character, the cardiac sound, however, not being abolished. The murmur is strictly limited to either area. In the case of mitral incompetence, the pulmonary second sound later on becomes accentuated, and may be reduplicated. In the case of the aortic valve, the second sound may become altered, and a soft, blowing, diastolic bruit may subsequently develop; the latter, however, is of much less frequent occurrence during the course of the illness. Reduplication of the second sound and slight accentuation of the first sound at the apex are believed to be early signs of mitral stenosis. A soft, blowing, diastolic bruit in the mitral area is rarely heard during the course of the illness. A mitral presystolic murmur and a short, sharp first sound do not usually make their appearance until some time after the onset of the rheumatic infection, the mitral orifice having become permanently stenosed.

Diagnosis.—The diagnosis of acute simple endocarditis is often a matter of great difficulty. We should suspect its existence in those cases in which there is an increase in the degree of pyrexia without any aggravation of the joint symptoms during the course of acute rheumatism, or when pyrexia persists without any ascertainable cause; or when there is palpitation, dyspnœa, acceleration or irregularity of the pulse, together with the existence of a murmur not previously present.

Increased frequency of the pulse-rate, provided other causes can be excluded, is of considerable diagnostic importance. The same can also be said of the sudden appearance of partial heart-block; it is important, therefore, to be on the look-out for an intermittent pulse, and, if this be found, to ascertain whether it is due to the presence of extra-systoles which fail to reach the wrist or to partial heart-block, as *the latter occurring during the course of infectious disease is a sign, and may be the only sign, of myocardial involvement, with which endocarditis is usually associated.* The differential diagnosis between extra-systole and partial heart-block has been previously dealt with. When the apex-beat is tumultuous in character it is suggestive of involvement of the endocardium or pericardium. Displacement of the apex-beat and evidence of enlargement of the area of impairment transversely are not necessarily indicative of acute endocarditis, as a certain degree of cardiac dilatation is met with in most of the acute fevers, as the result of toxæmia or anæmia. Neither does a recently developed mitral systolic murmur necessarily indicate endocarditis, for it may be due to anæmia or to simple dilatation. A preliminary prolongation, roughening, or want of clearness of the first sound at the mitral or aortic area is strongly suggestive of valvulitis, as is also the early appearance of the murmur; a murmur which is due to anæmia or to simple dilatation of the left ventricle does not usually make its appearance in the early stages of rheumatism. An aortic systolic is not so

suggestive of acute endocarditis as a mitral systolic murmur, while a pulmonary systolic murmur may be almost disregarded. In acute endocarditis the murmur is definitely limited to the mitral or aortic area. The character of the murmur is of some diagnostic value, a soft blowing, in contrast with a harsh, murmur being in favour of endocarditis. Accentuation of the second sound in the pulmonary area later on in the illness is also suggestive of mitral incompetence. An altered second sound, with later on a diastolic murmur, in the aortic area is indicative of involvement of the endocardium; the latter, however, is rarely heard during the course of an acute illness, and practically never during its early part. The early signs of mitral stenosis have already been noted.

It is necessary to distinguish the murmur of acute endocarditis from that due to previously existing valvular disease. The existence of subcutaneous nodules or pericarditis, the sudden appearance of partial heart-block (indicative of coincident acute myocarditis), or the appearance of new murmurs or the disappearance of old ones, is in favour of a fresh attack of acute endocarditis, whether simple or infective. Embolism is not pathognomonic of acute endocarditis, as it may occur in chronic valvular disease, especially in mitral stenosis. In acute endocarditis, however, it is not infrequently multiple and recurrent, and is of more usual occurrence in the systemic than in the pulmonary circulation.

If acute endocarditis occur in an individual already the subject of valvular disease, the murmur is not of recent development, it is often loud or harsh, audible over a considerable area, and evidence of cardiac enlargement is usually present.

Prognosis.—The immediate prognosis of acute simple endocarditis is, as a rule, favourable, death being of rare occurrence; this may happen, however, if there be accompanying pericarditis or severe myocarditis. With regard to the ultimate prognosis, it has been pointed out that complete resolution in all probability rarely occurs. Organisation is the usual sequel, ultimately giving rise to permanent stenosis, or incompetence, or both; in a certain percentage of these cases, the early murmur may disappear, and a permanent murmur may not become established until much later on, even several years. It should be noted that the future prognosis of a case of acute simple endocarditis largely depends upon whether convalescence is sufficiently prolonged. In a certain number of cases, ulceration of the valve results.

Treatment.—The management of a case of acute simple endocarditis is of great importance, especially with regard to the future of the patient. When there is no doubt that the heart is affected by rheumatism, suitable anti-rheumatic treatment should be adopted. In the opinion of some, salicylates should be avoided when there is undoubted cardiac involvement, in the belief that when given for considerable periods they depress the heart and cause further dilatation. I myself do not share this view. Some prefer iodides, given in full doses over considerable periods. When the cause is other than rheumatism, such as diphtheria, this should be treated.

In all cases, whatever the cause, we should endeavour to arrest the morbid process as early as possible, and to give the heart the best chance of the fullest possible repair. Absolute rest in bed is indispensable. In grave cases, the

foot of the bed may, with advantage, be raised to the extent of 1 or 2 feet. At no stage in the management of a case should the heart be allowed to work beyond the limit of its capacity. In the majority of cases, absolute rest in bed is necessary for 3 months, and in some cases the period should be even longer. The patient should remain in the recumbent posture for at least a month after the fever has subsided. If tachycardia, or irregularity indicative of partial heart-block or of auricular fibrillation, or if pulsus alternans be present, this period should be prolonged, even to 3 or 4 months. During this time he should on no account be allowed to sit upright in bed or to get out of bed for an action of the bowels. Afterwards, the amount of exertion should be most carefully graduated. At first, an extra pillow may be allowed. A few days later, the back may be slightly raised, and this may be gradually increased until the patient is moved to a couch, to which he should be confined for a further period of 3 months. After the first 2 or 3 weeks of this period, massage, at first very gentle and for short periods only, and gradually increased, may be allowed; and during the latter 6 weeks, active movements may be enjoined, and the patient may be gradually allowed to sit up. Later, slight walking exercise may be permitted. For some months later, great care should be exercised with regard to exertion, and the patient should be given rules as to the amount and kind of exercise; for, on the one hand, exercise may do much harm unless carefully regulated, while, on the other, in moderation it is of great value. If, during any of these stages, exertion be accompanied or followed by breathlessness, palpitation, a sense of fatigue, præcordial pain or distress, or unduly increased frequency of pulse, the patient is doing too much and the amount of exertion must be reduced.

The diet should be light, small in bulk, yet highly nutritious, and preferably solid. The daily amount of fluid taken by the mouth should be restricted to 2 pints per diem. Saline infusions per rectum, or in grave cases intravenously, may be used. Strict attention should be paid to the condition of the bowels. The internal administration of iodide of sodium in the later stages is employed by some. Dr. Caton recommended small blisters applied repeatedly to the præcordium; I myself have been disappointed with the results so obtained. Mustard leaves may be used in a similar manner. Alcohol, of which the best forms are good old brandy or champagne, should not be given unless there is much exhaustion, dyspnœa, cyanosis, or an unduly rapid pulse; in these cases, oxygen may also be employed. The amount of alcohol required of course varies with each individual case; it is well to begin with 2 or 3 ounces of brandy per day, gradually increasing the quantity as required, and leaving it off by degrees as the patient improves. Other diffusible stimulants, such as ether and ammonia, may be used. Camphor and tincture of musk are employed a good deal on the Continent. Strychnine has a great reputation in the treatment of cardiac failure due to associated acute myocarditis. It may be tried when there is great exhaustion. In my opinion, it is much better given hypodermically; in urgent cases up to $\frac{1}{60}$th grain, or even $\frac{1}{30}$th grain, every 2 hours. Adrenalin, pituitary extract, and ergot are advocated by some in cases in which the blood-pressure is very low. The results of the administration of the digitalis series of drugs are, as a rule, very disappointing; the response is usually very slight, if at all, whether auricular fibrillation is

present or not. In suitable circumstances quinine may be administered, and, if anæmia be present, iron and arsenic may be prescribed.

The treatment of symptoms has, in the main, been dealt with previously. For præcordial pain or distress a hot linseed poultice may be applied to the præcordium; if this fail, the continuous application of an ice-bag may be tried, as recommended by Lees. Dover's powder (10 to 15 grains), or, if necessary, morphine, may be given by the mouth. In less acute pain, a fly-blister is not infrequently efficacious. Sleeplessness and other symptoms should be treated as described elsewhere.

It is well to examine a patient who has suffered from acute endocarditis at regular intervals after the attack, and careful inquiry should be made as to his mode of life. In children, we should be especially on the look-out for any rheumatic manifestation, and, as soon as detected, the condition should be immediately and adequately treated.

FREDERICK W. PRICE.

INFECTIVE ENDOCARDITIS

Synonyms.—Ulcerative Endocarditis; Malignant Endocarditis.

Objections have been raised against each of these names: that all endocarditis is infective, that ulceration is not invariable, and that some cases recover. But that some distinctive name is necessary to mark off a disease-process which is quite different from "simple" or "rheumatic" endocarditis is generally recognised. The assertion frequently made, that no sharp line of demarcation can be drawn between simple and ulcerative endocarditis, though true, does not dispose of the fact that in the great majority of cases the distinction is of fundamental importance and not very difficult of recognition.

The disease has an importance somewhat out of proportion to its frequency, partly on account of its great gravity and partly on account of the difficulties which often beset the diagnosis. The incidence of the disease in the wards of a large general hospital is about 1 in 170 cases.

Ætiology.—*Relation to rheumatism and other diseases.*—In more than half of all cases of the disease there is a clear history of acute or subacute rheumatism or of chorea. In the majority of these cases the patient has suffered from rheumatic endocarditis some time previous to his present illness, and has been left with definite and recognised valvular disease; in a few the condition of rheumatic endocarditis has passed directly, but often imperceptibly, into that of the ulcerative condition. Usually the interval between the occurrence of the rheumatic fever and the onset of ulcerative endocarditis is measured by several years, and these have been for the most part years of good general health. To those few cases in which the transition between the rheumatic endocarditis and ulcerative endocarditis is a gradual one the term "malignant rheumatism" has been applied by some authorities. But the term introduced confusion in respect of the bacteriological questions involved, and is perhaps on this account to be avoided. Next in frequency to the rheumatic group of diseases in the patient's history, but insignificant in comparison, are scarlet fever, gonorrhœa, influenza, typhoid fever, malaria, syphilis, Graves' disease, dysentery and pneumonia.

Influence of congenital defects.—A congenital defect in the heart pre-dis-

poses it to infection, apparently through the medium of that chronic thickening of the endocardium which is often found in connection with these defects.

Other ætiological factors.—Strain is present in some cases as a definite causative factor, either as leading to the original valve defect, or as determining the onset of the ulcerative endocarditis in an old-standing case of valvular disease.

Age.—The chief incidence is between the ages of 15 and 50. Out of 150 cases collected by the writer 122 occurred between these ages. One-half of all the cases occurred between 20 and 40, no doubt on account of the predisposition created by the presence of sclerosis of the heart valves after acute rheumatism, the chief age incidence of which is a decade earlier than this. The youngest case of the series was that of a child aged 2½ years, the subject of congenital heart defects. The oldest cases were those of a woman aged 64, and of a man aged 63, both of whom developed pneumococcus endocarditis with lobar pneumonia.

Sex.—This does not appear to be a determining factor.

Pathology.—The essential pathological condition in infective endocarditis is a progressive microbic infection of one or more of the heart valves, or of the mural endocardium. *The infecting micro-organisms*, as judged by positive blood cultures during life rather than by post-mortem investigations, are very variable. An analysis of 40 cases of the disease in which positive blood cultures were made during life showed streptococci in 26, pneumococci and Pfeiffer's bacillus in 5 each, gonococcus in 2, *Staphylococcus albus* in 1, and an unclassified micro-organism of bacillary form in 1. If post-mortem results are taken, *Staphylococcus aureus* bulks largely in the analysis and the pneumococcus is represented more frequently. A few other organisms, relatively unimportant, also appear—*B. typhosus*, *B. coli* and *B. diphtheriæ*. Streptococci are certainly the most common organisms concerned, and the characters of those members of the group found in this disease deserve special attention. If we except acute cases due to *S. pyogenes*, the type of streptococcus most often found is not highly pathogenic, but of low virulence, such as are found in normal fæces and in normal saliva. They are for the most part short-chained cocci, not lethal for mice, and they yield a set of biochemical reactions that mark them off quite sharply from *S. pyogenes*. These facts harmonise with certain broad clinical and pathological observations and serve to explain them: the chronicity of many of the cases, and the latency of others; the scanty leucocytosis often seen; the afebrile periods not infrequently present; the absence of suppuration in the embolic infarcts which is such a feature of the disease; the absence of any visible focus of infection in the great majority of the cases; the enormous number of living micro-organisms that may be present in the blood stream at a time, it may be, when the patient is not acutely ill. The writer has shown that it is not difficult to set up a condition of infective endocarditis in the rabbit by the intravenous injection of "saprophytic" streptococci from healthy human saliva and fæces.

The condition of infection once established in the endocardium, a state of "arterial pyæmia" results, the circulation being fed by micro-organisms from the infected area. Minute vessels become plugged by masses of these microbes. Larger emboli, formed of pieces of the fungating vegetations, and of various sizes, add to the pyæmic process. Destructive and vegetative

processes proceed together at the site of infection, which spreads to adjacent structures in the heart, both by contact and by direct extension.

Symptoms and Course.—The disease may be *latent*, and only discovered post-mortem. It may be *fulminating*, in which case it may be suspected, but rarely diagnosed. In the fulminating cases the infection is usually by *S. aureus*, and the ulcerating endocarditis is only one part of the *S. aureus* pyæmia. Such is the endocarditis complicating acute osteomyelitis, and that seen in very acute pyæmia resulting from *S. aureus* infections of the skin. Neither the latent nor the fulminating forms need be further dealt with here. The more important types are the *acute* and *subacute*.

The acute form.—The onset is usually abrupt, often with a rigor, and the symptoms are those of an acute specific fever. Pain in, and swelling of, joints is common, with acid sweats, often leading to a diagnosis of rheumatic fever and calling for the use of salicylates. Not infrequently the failure of response to full doses of salicylates is the first observation to throw doubt upon the diagnosis. The pneumococcus cases are generally of this type, pneumonia or pleurisy with effusion being usually present; the patient remains very ill after the eighth day of his disease, infection of the endocardium being perhaps the most serious cause of absence of crisis. Gonococcus infection is also usually of this form. The duration of the acute cases is from 7 to 30 days. A very few cases undoubtedly recover.

The subacute type ("Subacute bacterial endocarditis").—This is probably the most common type of the disease. Attention has of late years been drawn to it by Osler, Horder, Libman and others. The onset is gradual, often insidious, so that it may not be possible to determine with accuracy when the disease began: it seems certain that in many of the cases the process of endocardial infection has existed much longer than is suspected. The initial symptoms are general weakness with anæmia, or a condition somewhat resembling subacute rheumatism, or fever which is unexplained by the physical signs. The duration of these cases is very variable; from 2 to 6 months includes the majority of them; but a few may last for 12 months or even longer. The infecting micro-organisms are streptococci of the fæcal and salivary type (*Streptococcus viridans*, *Streptococcus endocarditidis*). Pfeiffer's bacillus and occasionally the pneumococcus. In some of these cases the pre-existing valve lesion is very slight, although its presence is generally known if the patient is of the private class.

The heart.—In the great majority of cases signs of valvular disease are present at the outset. In a few cases these signs appear during the course of the disease. Rarely, there may be no evidence of valvular disease at any time: this experience is almost confined to cases in which the infection is of a terminal kind, occurring in patients who are too ill to admit of thorough examination, or in whom there is early and considerable dilatation of the heart. As the disease progresses it is common to get evidence of the involvement of other valves than the one originally infected, such as the appearance of signs of aortic regurgitation in a case originally one of mitral disease. Undue importance is perhaps attached to changes heard in the character of the murmurs from day to day. When the heart symptoms are prominent, the case is said to be of the "cardiac type," and such a clinical picture does quite commonly present itself: in which event the patient has, in most instances, been a heart invalid for some time previously. But in a con-

siderable proportion of the subacute cases it is a striking thing that the heart shows little recognisable defect, at least for a considerable time. For the greater part of its course it may be said that subacute bacterial endocarditis is very largely destitute of cardiac symptoms. Arrhythmia, signs of restriction of the field of cardiac response to effort, and the results of so-called decompensation—not only may all of these be conspicuous by their absence, it is unusual to see them.

Embolism.—This event is extremely common and constitutes one of the cardinal signs of the disease. *The importance of the search for emboli and their effects in a suspected case cannot be over-estimated.* But to obtain an adequate conception of the disease-process here considered it is necessary to enlarge considerably the earlier notions of the embolic process in two directions: the diffuseness of the embolic site and the minuteness of the embolic fragment. The **skin** shows two distinct lesions, both highly characteristic of the disease—(*a*) Petechiæ, varying greatly as to their number in different cases—there may be no more than two or three, and only discovered after careful search, or there may be a great number, presenting an appearance as though the patient has been flea-bitten. (*b*) **Discoloured areas**, usually tender, and most often affecting the terminal phalanges, coming and going in the course of a few hours or days. The appearance of one of these red areas is often accompanied by sudden pain or acute tenderness on pressure. These lesions are of considerable diagnostic importance. They do not occur in rheumatism.

In the **kidney** there may be gross embolic events leading to infarction and hæmaturia. Of equal if not of greater importance is the occurrence of very minute microbic embolisms in the glomeruli, leading to the appearance of red blood cells and traces of albumin in the urine, and ultimately to a state of true glomerular nephritis, demonstrable under the microscope post-mortem (Bæhr; Gaskell). The **retina** may be affected, exploration of the fundus revealing hæmorrhages. One of the most common seats of emboli of the massive kind is the **spleen**, leading to enlargement and usually a palpable organ. Acute and severe pain may concur with the event, and friction, due to perisplenitis, may be heard. The **brain** may suffer, the most common result being hemiplegia. The embolus may lead to infective arteritis, with aneurysm formation and hæmorrhage which may be abruptly fatal. The vessels of the **limbs** are frequently involved, either the main artery or, more often, their branches, and especially the radial and posterior tibial. Here, again, aneurysms may develop, and gangrene occasionally.

Pyrexia.—Fever is present in nearly all the cases, perhaps in all at some time or other in the course of the disease; but occasional afebrile periods may occur, lasting from 2 or 3 days up to a fortnight, in the subacute cases. In the acute cases a high continued fever is not uncommon, and when this is so the patient is highly toxic and asthenic and the heart symptoms are apt to be in abeyance ("typhoid type"). Irregular remittent fever is the most common form, both in the acute and in the subacute types. A high and regular quotidian intermittent fever is not uncommon—the gonococcus cases are particularly prone to this variety of fever. **Rigors** are common in the fulminating and acute cases; they also occur in subacute cases when embolism is rife. Whatever the form of the fever the temperature is apt to take a lower range shortly before death. *A fall in the temperature, the patient remaining very ill, is of no service and must not be taken for a good prognostic.*

Such a fall of temperature may occur when signs of renal inadequacy supervene.

The blood shows a progressive and ultimately severe anæmia. The degree of leucocytosis varies with the type of the disease. In acute cases it is generally high (20,000 to 40,000), though this, again, varies with the degree of the patient's response to the infection. In the subacute cases the leucocytosis is rather remarkably constant about the figures 9000 to 12,000. Blood cultures are extremely important in the matter of diagnosis. And yet it not uncommonly happens in the subacute cases that the diagnosis is certain and no growth of micro-organisms is obtained. Of this apparent anomaly we do not at present possess the explanation. The hypothesis that such a state of things indicates that the microbe has died out does not perhaps take sufficient cognizance of the peculiar difficulties seen in the cultivation of certain of the streptococci found in association with the disease. In the great majority of cases, however, positive blood cultures are obtained, given proper technique.

General state.—Loss of flesh is invariable, but rarely a marked feature. Pains are common, and are usually arthralgic in character; they are prone to develop suddenly, are rarely accompanied by effusions, and when severe, are most often due to embolic events. The complexion in the subacute cases tends to a *café-au-lait* tint, which is a point of diagnostic value to the trained eye. Clubbing of the fingers is very common, quite apart from the influence of possible old-standing valvular disease. The patients are often singularly optimistic concerning themselves. Libman lays stress upon areas of deep tenderness about the lower end of the sternum and the sterno-costal junctions. Albuminuria is very common, tending to increase with the progress of the disease, and doubtless associated with the glomerular nephritis to which reference has already been made.

Modes of Termination. — 1. *Recovery.* — A rare event, yet one which certainly occurs at times, even when the diagnosis is beyond doubt. It is probably less rare in the acute than in the subacute type.

2. *Death.*—Out of 149 cases studied by the writer, the recorded terminal events occurred in the following order of frequency: heart failure (66), coma (23), sudden death (19), uræmia (18), exhaustion (8), hyperpyrexia (2). Cases dying in coma were for the most part those in which cerebral embolism, with or without hæmorrhage, had taken place. Sudden death was due to perforation of a valve cusp, rupture of aneurysms in the sinus of Valsalva, perforation of the interventricular septum and cerebral hæmorrhage.

Diagnosis.—Evidence of endocarditis, the occurrence of multiple arterial embolism, and the isolation of micro-organisms from the blood stream: the coexistence of these three facts makes the diagnosis of infective endocarditis indubitable. But, as has already been remarked, the diagnosis may sometimes be made quite confidently in the absence of a positive blood culture in certain of the subacute cases. Seeing that the prognosis is so serious, it follows that a diagnosis of infective endocarditis should never be made unless convincing evidence be forthcoming. In the differential diagnosis the following diseases call for consideration:

1. *Pneumonia.*—There may be considerable difficulty here, seeing that consolidation of the lung is usually present in pneumococcus infection of the endocardium. Care must be exercised, because hæmaturia and splenic enlargement in a case of pneumonia do not necessarily imply infarction.

Nor does a positive blood culture in pneumonia necessarily mean endocarditis. But petechiæ, and the presence of emboli in arteries, in a case in which signs of valvular disease and a positive blood culture are present, justify a diagnosis of ulcerative endocarditis.

2. *Typhoid fever.*—A positive Widal test with a leucopenia may be regarded as almost decisive in favour of typhoid fever. Typhoid infection of the endocardium is very rare.

3. *Rheumatic fever.*—The recurrence of acute rheumatism in a patient who has previously developed valvular disease often gives rise to considerable anxiety on account of the similarity which may exist between the symptoms present and those of pyogenic infection of the endocardium. The rheumatic process may spread itself over several months, salicylates notwithstanding. These difficult cases usually occur in children between the ages of 10 to 16 years. Endocarditis is always present, and often there is pericarditis, or pleurisy, or both. There may be considerable loss of flesh and marked anæmia. The form of the temperature chart rarely affords help. The facts which help to exclude ulcerative endocarditis are the presence of nodules, or of chorea, and the absence of petechiæ, of hæmaturia, of enlarged spleen, and especially of micro-organisms in the blood stream.

4. *Peliosis rheumatica* may cause even greater difficulty, but the condition is uncommon. The association of fever, purpura, anæmia, albuminuria and joint pains in a case of old-standing aortic regurgitation under the writer's care naturally raised fear of infection of the damaged valve cusp. But the purpuric spots and the joint pains were bilateral and symmetrical, there were ecchymoses in addition to the petechiæ, there were effusions into the joints, and blood cultures yielded no growth.

5. *Malaria.*—The resemblance is but superficial, owing to the fact that in some cases of infective endocarditis the fever may be markedly intermittent, and rigors with heavy sweats may occur. The absence of malarial parasites in the blood and the absence of leucopenia are much against a diagnosis of malaria.

6. *Tuberculosis.*—General tuberculosis may be closely simulated by acute ulcerative endocarditis with continued fever when the heart signs are equivocal. But there is leucopenia in general tuberculosis, a sterile blood stream (on repeated culture), and signs of embolism do not occur. Sometimes cases of infective endocarditis find their way into sanatoria for the treatment of phthisis, on the ground that they are cases of "phthisis without physical signs."

Prognosis.—As has already been stated, recovery occasionally takes place in the acute, and still less frequently in the subacute form of the disease. All the same, the diagnosis once definitely established, the outlook is of the gravest, treatment notwithstanding. That the patient is very little affected in general health, that he is extremely hopeful concerning his condition, that the state of the heart in itself gives no cause for concern and that the number of micro-organisms per c.mm. of blood has fallen very considerably—none of these things should tempt the physician to abate anything from the serious view he takes of the case. Periods of improvement often occur, with or without special lines of treatment, but the fatal issue seems only to be delayed. It is very difficult to surmise the length of time the patient will live after the diagnosis is made. If there are already present

the signs either of renal or of cardiac failure the end is not far off: weeks measure it. Otherwise, developments may proceed quite slowly, and the patient may live some months. But there remain to be reckoned with the various accidents attending upon the dissemination of the endocardial vegetations, or the ulceration of the valves, either of which accidents may bring about a speedy termination. Not seldom, when it seems certain that the course of the disease has been checked, death, more or less sudden, and due to some purely mechanical cause, cheats the physician and those who watch his efforts.

Treatment.—PREVENTIVE MEASURES.—Reference has been made to the undoubted fact that the source of the infecting agent in most cases is the mouth or intestine. This suggests that special attention should be directed to these regions in all persons who are the subjects of valvular disease. Oral sepsis of all sorts should receive treatment. Dead teeth, crowned or not, should be sacrificed. Septic tonsils should be removed. The condition of the intestinal tract should be investigated, and measures adopted to lower the content of streptococci if this appears high.

CURATIVE.—The general (non-specific) measures adopted in the treatment of all cases of septicæmia are applicable here: plenty of fresh air and light, good food frequently administered, and hæmatinic drugs for the anæmia. The writer considers that open-air treatment, as for cases of pulmonary tuberculosis, should be adopted whenever possible. The various measures that have from time to time been tried in order to inhibit the bacterial factor in the disease are the following:

Chemical antidotes.—"Blood antiseptics" have, as a rule, proved very disappointing in the history of the treatment of septicæmia. Quinine, mercury, arsenic, carbolic acid, formalin, the sulpho-carbolates and many others, whether administered by mouth, subcutaneously or intravenously, lead to no results worth recording. Salvarsan and its equivalents, given intravenously, have not, in the experience of the writer, justified further trials, and these remedies are not without immediate disasters in the matter of the production of embolism. Silver salts, in combination with nuclein, and colloid silver preparations, have their advocates; so also has yeast; but it does not appear that any of these remedies has a recovered case to its credit. More recently, one or other of the hypochlorite solutions has been used intravenously, following some promising results in surgical cases of septicæmia. The writer has seen three cases so treated, and although there was apparent improvement in two of the cases, there was no cure. Mere absence of fever, as already remarked, is of no benefit if the general state of the patient is not improved. In one of the cases there certainly was an afebrile period of some 12 to 15 days after the treatment (by eusol), but during all this time the patient's general condition was worse than it had been just prior to the injection. The technique is simple: from 200 to 500 c.c. of a 0·05 per cent. solution of the drug in normal saline is given slowly as an intravenous injection. In one case the writer tried the effect of a saturated solution of ether in normal saline. When considering these methods of "irrigation" of the blood stream it should be remembered that the condition to be combated is not merely one of free bacteria in the circulation—there is also a very great deposit of bacteria lying in the sub-endothelial tissue of the endocardium.

Anti-sera.—As most cases of infective endocarditis are of streptococcal origin, it was hoped that the use of anti-streptococcus serum might lead to cure. The result of a good many trials has been very disappointing. Nor has the use of an autogenous serum, as first attempted by the writer in 1904, led to any better result. The same may be said in general of the use of anti-pneumococcus serum in the pneumococcus cases.

Inoculation.—The experience of vaccine therapy in this disease is not much more cheering than that of serum therapy. Certainly the use of "naked" vaccine has on the whole been singularly disappointing. The writer has not had a case so treated which recovered, although he has seen periods of marked and prolonged improvement which he felt could be attributed to the vaccine. Latham and Hunt have put on record a streptococcus case which recovered after the administration of vaccine *per os*. The writer considers the most hopeful method to be by the employment of sensitised vaccine, augmented in its action by the use of liberal quantities of an autogenous serum whenever this can be obtained. In conjunction with Hemsted the writer described a case of considerable duration treated successfully in this manner. The infection was in this case grafted upon a congenital heart lesion.

Transfusion sometimes acts as a very useful adjunct to whatever specific measures are being employed.

It would seem that we still lack a scientific method of control of the disease process by any of the measures yet adopted. It seems certain that cure can only come through inhibition of the bacterial growth in the endocardium, and not merely through cleansing the circulating blood of micro-organisms. This, and a method of detaching the thrombi which hang from the valve cusps in such a fine state of subdivision that no vessel of conspicuous size is obstructed by the particles cast into the blood stream, constitute the therapeutic problem with which the physician is faced. The chief hope would seem to lie in establishing the diagnosis at a very early date so as to employ whatever measures promise success before the vegetations have attained any size and the sub-endothelial colonisation has become established.

THOMAS HORDER.

CHRONIC OR SCLEROTIC ENDOCARDITIS

Chronic endocarditis is a sclerosis of the valve, and may be (1) secondary to the acute—especially the rheumatic form, which is the more common event or (2) primary.

Ætiology and Pathology.—When the condition is the result of a previous attack of acute endocarditis, it is more apt to occur in earlier life, the mitral valve being more commonly affected; while if it is primary it is more apt to occur in middle or later life, the aortic valve being more commonly affected than the mitral.

With regard to the ætiology of primary chronic endocarditis, heredity is certainly a factor, and the condition is more common in males, and during or after middle life. Prolonged muscular or mental strain, over-indulgence in food or drink, auto-intoxication—especially from the teeth, the tonsils, and the colon, the various forms of chronic rheumatism and gout, chronic

metallic poisoning—particularly that due to lead, and supernormal blood-pressure are among the most common causes. Chronic renal disease probably has no direct relation with primary chronic endocarditis, but the associated high blood-pressure is an important causal factor. With regard to syphilis, see pages 888–889.

When organisation occurs in acute simple endocarditis, the result is the formation of fibrous tissue, which tends to contract as life advances, and as a result there may be thickening, shortening, puckering, chronic vegetations, coalescence of two or more segments, cartilaginous changes, or calcification of the valves; there may also be shortening and thickening of the chordæ tendineæ and apices of the papillary muscles. These structural changes ultimately give rise to permanent stenosis, or incompetence, or both, and there is a tendency in these cases to recurrent attacks of valvulitis, resulting in still greater deformity.

In primary chronic endocarditis there is sclerotic thickening of the endocardium, often occurring in patches, and frequently associated with fatty or calcareous changes, to which the term atheroma is usually applied. There may be thickening, small nodular prominences, shortening, puckering, coalescence of two or more segments, and calcification of the valves; the chordæ tendineæ and apices of the papillary muscles may also be affected. These structural changes also ultimately give rise to permanent stenosis, or incompetence, or both.

Primary chronic endocarditis is frequently associated with atheroma, which may be widespread. When it affects the aortic valve it may be limited to the valve, or, as is more frequently the case, may also affect the walls of the aorta. In the latter event, diffuse dilatation of the aorta may follow; and the neighbourhood of the mouths of the coronary arteries is often involved, frequently resulting in narrowing or occlusion of one or both of these vessels (see page 860).

It may here be noted that fœtal endocarditis is usually of the sclerotic form, the right heart being more commonly affected than the left.

Symptoms.—Primary chronic endocarditis produces no symptoms until a certain degree of structural changes in the valves has taken place, when stenosis, or incompetence, or both occur.

FREDERICK W. PRICE.

CHRONIC VALVULAR DISEASE

Definition.—By chronic valvular disease is meant a chronic affection of the cusps of the cardiac valves, or of the orifices, or both. Not only may the orifices and cusps be affected, however, but also the chordæ tendineæ and the musculi papillares. In many cases the cusps are only secondarily affected; to illustrate this it may be mentioned that incompetence of a valve may be due entirely to dilatation of its orifice, or, in the case of the auriculo-ventricular valves, to an affection of the musculi papillares or chordæ tendineæ. Whatever the nature and form of the valvular lesion, it gives rise to stenosis or narrowing, which results in obstruction to the flow of blood; or to incompetence, which allows of regurgitation; or frequently to both of these together. Along with the

valvular lesions there are usually coincident changes in the cardiac musculature, the aorta, or coronary arteries.

THE RELATIVE PROPORTION AND THE COMBINATIONS OF THE DIFFERENT VALVULAR DISEASES.—It should be noted that not infrequently more than one valve is involved at the same time, especially in the case of rheumatic valvular disease.

If we include what is termed the *relative* variety of incompetence, tricuspid incompetence will be found to be the most common chronic valvular disease. If this be not included, the mitral is the valve most commonly affected, accounting for half the number of the cases of chronic valvular disease, incompetence of this valve being more frequent than stenosis. When mitral incompetence results from a previous attack of acute endocarditis, there is usually some degree of stenosis as well; when it is due to causes other than lesions of the cusps, it is often associated with tricuspid incompetence. Pure mitral stenosis is comparatively infrequent; in the process of thickening and contraction, there is usually some degree of incompetence.

In the majority of cases of aortic disease a double murmur is present; but this does not necessarily indicate the presence of stenosis as well as of incompetence, for there are other causes of an aortic systolic bruit besides aortic stenosis. Aortic regurgitation is very common; a greater or less degree of stenosis, however, not infrequently accompanies the incompetence. Pure aortic stenosis, on the other hand, is one of the rarest of valvular affections. Tricuspid incompetence is the most common form of right-sided valvular affections. It is rarely primary, however, and then stenosis is usually present with it, and also mitral or aortic disease, particularly the former. Tricuspid incompetence is a common result of mitral disease, there being no lesion of the cusps, but *relative* incompetence of the valve. When tricuspid incompetence occurs alone, it is in all probability congenital. Tricuspid stenosis is extremely rare. Though murmurs with their area of maximum intensity at the pulmonary area are common, disease of the pulmonary valve is rare, and is usually of congenital origin. Pulmonary stenosis is one of the most frequent forms of congenital heart disease, and is usually associated with other lesions, such as a patent interventricular septum; as an acquired condition it is very rare. Pulmonary incompetence is the rarest of valvular lesions.

Ætiology.—Chronic valvular disease may be of congenital origin (*vide* Congenital Heart Disease), or may be due to a previous attack of acute endocarditis resulting in chronic endocarditis, or to primary chronic endocarditis, new-growths, traumatism or, in the case of the aortic valve, to syphilitic mesaortitis. This list does not include *relative* incompetence of a valve. The causes of acute endocarditis, and also of primary chronic endocarditis, have been fully dealt with. When chronic valvular disease is due to a previous attack of acute endocarditis, it is more apt to occur in early life, and when due to primary chronic endocarditis in middle or later life. Neoplasms may arise from the walls of the heart or from the valves. They rarely cause obstruction. A traumatic lesion of a cusp or of the chordæ tendineæ, the result of excessive physical exertion, may cause stenosis or incompetence of a valve, and is of much more common occurrence in the case of the aortic than the mitral valve. It rarely takes place, however, in the absence of pre-existing disease of the valve.

In *relative* incompetence of a valve the cusps themselves are healthy. This is more common on the right than on the left side of the heart, and is almost unknown in aortic disease, and is not nearly so frequent as in the case of the mitral valve. The condition may occur from the following causes: (1) Dilatation of the cavity of the ventricle—this produces an alteration of the relation of the cavity and of the cusps, the segments of which cannot properly approximate, with consequent regurgitation through the orifice. (2) Enlargement of the orifice on account of relaxation of the surrounding muscular structures; in these cases the tonicity of the muscular ring is impaired, and the cusps do not completely come together. (3) Enlargement of the ventricular cavity and dilatation of the orifice combined. (4) Shrinkage or stretching of the musculi papillares or chordæ tendineæ as a result of disease.

Pathology.—See chronic endocarditis and syphilitic mesaortitis.

Effects of Valvular Disease upon the Walls of the Heart and other Organs.—In the case of stenosis of a valve, there is beyond the narrowed orifice a tendency to a diminished blood supply, and in consequence to diminished general nutrition. As the progress of the narrowing of the orifice is as a rule slow, the muscular wall of the chamber immediately behind the orifice usually hypertrophies, this process enabling the chamber to overcome the obstruction, and being referred to as "compensatory" hypertrophy. In a large majority of cases there is also dilatation, owing to the fact that the cardiac chamber has to accommodate a larger amount of blood than normal.

In the case of valvular incompetence, on the other hand, there is not necessarily a diminished blood supply beyond the orifice. The cavity immediately behind the orifice has to accommodate the regurgitant stream of blood in addition to the normal amount of blood arriving in the normal manner, and, therefore, an increase in its capacity is necessary; in other words, dilatation occurs. This excess of blood must be propelled with each systole of the chamber, with resultant hypertrophy of the muscular wall. It can be readily understood that in order to maintain the circulation adequately it is necessary that a larger quantity of blood be propelled, in order to compensate for the amount of blood which regurgitates. In this way dilatation with hypertrophy ensues, the former being greater than in the case of pure stenosis.

When in valvular disease dilatation is not in excess of hypertrophy we have what is termed complete or perfect "compensation." When dilatation is in excess of hypertrophy, we have failure or loss of "compensation." In order that hypertrophy may take place there must be an inherent capacity for development in the cardiac musculature. This is greater in the young, and is more notable in the case of the ventricle than the auricle, and of the left rather than the right side of the heart. It should also be noted that the nutrition of the myocardium is a most important factor in determining the relative preponderance of hypertrophy and dilatation, as for the development of full hypertrophy an adequate blood supply is necessary, and in this connection the state of the general nutrition, as well as the anatomical and physiological condition of the coronary arteries, are factors of considerable importance. In any circumstance, however, long-standing hypertrophy is apt to be followed by dilatation.

Valvular disease of the left side of the heart is apt to cause dilatation of the pulmonary veins and capillaries, giving rise to passive hyperæmia and œdema, dilatation of the pulmonary artery, and subsequent changes in the right side of the heart. Valvular disease of the right side of the heart is apt to cause dilatation of the venæ cavæ and their tributaries, and consequent cyanotic changes in the liver, spleen and kidneys, chronic venous congestion and catarrh of the mucous membranes of the hollow viscera, œdema or anasarca, and transudation of fluid into the serous sacs.

Passing to the consideration of the different valvular lesions: In pure aortic stenosis the left ventricle hypertrophies, it may be in a very great degree. For some time—perhaps for a very considerable time—there may be no corresponding degree of dilatation, although some believe that dilatation of slight degree is always present. In time, however, the degree of dilatation increases, and still later, owing to dilatation of the ring supporting the mitral valve, relative mitral incompetence and regurgitation into the left auricle may occur. In that event, dilatation and hypertrophy of the left auricle, passive hyperæmia of the lungs, and changes in the right side of the heart are apt to supervene.

In aortic incompetence, dilatation and hypertrophy of the left ventricle take place. These reach their greatest limit in this form of valvular disease, and there may be enormous enlargement of the heart, the organ in such cases being spoken of as a "beefy heart" or a "cor bovinum." The balance between hypertrophy and dilatation for the time may be perfect; but later on the dilatation may become greater in degree than the hypertrophy, and cardiac failure supervenes. Mitral incompetence may ensue, either as the result of dilatation of the ring supporting the valve, or owing to damage to the cusps due to their being subjected to strain.

On account of the regurgitation of blood into the left ventricle, the peripheral arterial circulation is apt to suffer. The difference between the arterial pressure during cardiac systole and diastole is augmented, and there is a rapid fall at the beginning of diastole; as a result the flow in the arterial system is less continuous. The larger vessels near the heart are subject to great variations in blood-pressure, while the distal vessels do not receive the blood supply which they get in health. Further, the coronary arteries are not well supplied with blood, and may also undergo degenerative changes: as a result of these changes the myocardium in turn suffers from an insufficient blood supply.

In mitral stenosis the left auricle hypertrophies. There are some who believe there is always coincident dilatation also, but others are of opinion that it is only when cardiac failure supervenes that dilatation of that chamber occurs. In a mild degree of stenosis there may be, for a time, enlargement of the left auricle only. Eventually, however, in the great majority of cases changes occur on the right side of the heart. The increased pressure in the left auricular chamber causes obstruction to the return of blood from the pulmonary veins. This results in increased pressure in the pulmonary circulation, and a greater demand is put upon the right ventricle, which as a consequence hypertrophies. Compensation is then said to be complete. Hypertrophy is usually accompanied by some degree of dilatation. In time the dilatation increases, and relative tricuspid incompetence (to be described later) may supervene. The pulmonary artery and veins some-

times become atheromatous, on account of the increase of pressure. In mitral stenosis the quantity of blood passing from the left auricle to the left ventricle may be less than normal, and when this is so the latter chamber has less blood to propel into the aorta, so that in uncomplicated mitral stenosis the left ventricle may be actually smaller than normal. In a considerable proportion of cases of mitral stenosis, however, there is a certain amount of hypertrophy of the left ventricle. This may be due to mitral regurgitation, aortic valvular disease, pericardial adhesions, supernormal blood-pressure, arterial disease, or kidney disease. When there are pericardial adhesions there is apt to be dilatation and hypertrophy of the whole heart. The immediate effect of mitral incompetence is dilatation of the left auricle, since that chamber has to accommodate the regurgitant stream of blood in addition to the normal amount of blood arriving from the lungs by means of the pulmonary veins. In this case also to dilatation is added hypertrophy of the auricular walls. As a larger quantity of blood is driven by the auricle into the ventricle during auricular systole, dilatation of that chamber occurs, and its walls hypertrophy. Changes in the pulmonary circulation and right side of the heart, as described above, may follow.

In pulmonary incompetence, hypertrophy and dilatation of the right ventricle, and usually of the right auricle also, occur; in tricuspid stenosis there is hypertrophy and a certain amount of dilatation of the right auricle; while in tricuspid incompetence, dilatation, and sometimes hypertrophy, of this chamber takes place. There may follow dilatation of the venæ cavæ and their tributaries, and consequent chronic venous congestion and other systemic changes as already described.

Aortic Stenosis

Aortic stenosis may be absolute or relative. In absolute stenosis the orifice is less than its normal size, while in relative stenosis the size is normal, but dilatation of the aorta just above the valve is present.

Ætiology.—Aortic stenosis is more commonly found in middle or later life, and in males. Absolute stenosis may be due to a previous attack of acute endocarditis, in which case the mitral valve is also as a rule similarly affected. It is, however, commonly due to primary chronic endocarditis, and is for this reason more common in middle or later life and in males. Syphilitic mesaortitis is occasionally the cause. The affection may be congenital, and is rarely due to injury, direct or indirect.

Symptoms.—When aortic stenosis is the result of a previous attack of acute endocarditis, the subjective symptoms are as a rule long delayed, and indeed the condition may be latent all through life. The most common subjective symptoms are giddiness, sleeplessness, a sense of oppression or constriction behind the sternum, pain and dyspnœa on exertion. Later, dilatation of the left ventricle and relative insufficiency of the mitral valve, and ultimately dilatation of the right side of the heart, may occur. Even when the stenosis is the result of primary chronic endocarditis, so long as the lesion is slight, there are usually no subjective symptoms; when, however, this is considerable, the symptoms just enumerated may be present, and angina pectoris may be superadded.

The pulse is sometimes very characteristic; indeed, not infrequently, the diagnosis of the lesion is greatly assisted by the peculiar character of the

Fig. 62.—Sphygmogram from a case of aortic stenosis.

pulse. In moderate degrees of stenosis the pulse may not show any striking abnormal features. As the lesion increases, however, it becomes infrequent, and the sphygmogram shows a pulse of smaller amplitude, the percussion wave is oblique, and the summit is gradual and slow, while to the finger the pulse is full between the beats (Fig. 62). It may be anacrotic, or of the bisferiens type. When in addition to stenosis aortic incompetence is present, which is not uncommon, the pulse which is characteristic of the former will be modified by the latter condition. The blood-pressure is variable; it tends to be subnormal, but is often supernormal, as the result of coexisting arterial disease, or chronic interstitial nephritis. When aortic stenosis is associated with atheroma, as is frequently the case, the vessel wall may be thickened and tortuous.

Almost always there are signs of hypertrophy of the left ventricle. There is sometimes a certain amount of bulging of the præcordium. The apex-beat is displaced chiefly downwards,—it may be as far as the sixth intercostal space or lower,—but as a rule only slightly outwards. The area and force of the apex-beat are increased; it may be heaving or thrusting in character. A characteristic sign of aortic stenosis is a gradual, slow rise of the apex-beat—a "slow heave,"—which is sustained. A thrill, systolic in time, is often palpable; this has its maximum intensity in the aortic area, and may be felt over the whole præcordium, and, indeed, sometimes all over the chest and the large vessels of the neck. On percussion, the area of deep cardiac impairment is almost always increased, the enlargement being chiefly downwards, and to a less extent to the left, while in uncomplicated cases the right border extends very little beyond the normal limit. The area of superficial cardiac impairment is as a rule unaffected. On auscultation, a systolic murmur is audible, with its point of maximum intensity in the aortic area, or over the manubrium sterni, or to the left of the sternum. The murmur, however, may be audible all over the chest, and even at the back, in which case it is loudest at the level of the fourth vertebra close to the left border of the spinal column. The direction of selective propagation is upwards along the vessels of the neck. It is usually loud, and has been heard several feet away from the patient. It is generally rough and grating, but may be musical, or soft and blowing. The first sound in the mitral area is sometimes long, low in pitch and muffled—as in hypertrophy of the left ventricle from other causes. The second sound in the aortic area varies considerably in loudness, largely according to the nature of the lesion of the valve (for example, the fusion of the cusps may be such as not to allow such apposition as is necessary to cause an aortic second sound), and the presence or absence of arterial disease. It is usually diminished and may be practically absent, but occasionally may be louder than normal. Later, owing to dilatation of the ring supporting the mitral valve, relative mitral incompetence may occur, when enlargement of the left auricle, passive hyperæmia of the lungs, and

changes in the right side of the heart are apt to supervene; diminution of the force of the apex-beat and increase to the right of the area of cardiac impairment are among the other physical signs to be noted.

DIAGNOSIS.—It is not sufficiently appreciated that *it is not justifiable to make a diagnosis of aortic stenosis from the mere presence of a systolic murmur over the aortic area, additional evidence being required, as the murmur may be due to other causes.*

A diagnosis of aortic stenosis can readily be made when the characteristic pulse and apex-beat, an aortic systolic thrill and murmur, with the direction of selective propagation upwards along the vessels of the neck, and a diminished or absent second sound are present. These features combined distinguish the condition from others that may give rise to a systolic bruit with its point of maximum intensity over the aortic area; when, however, only one or few of these characteristic features are present, difficulty with regard to the diagnosis may easily arise. An anacrotic pulse is characteristic, but not pathognomonic, since other conditions besides aortic stenosis may produce it; nevertheless, it is of greater diagnostic value than pulsus bisferiens. While the presence of a thrill is a valuable diagnostic sign, it should be remembered that it may also be found in dilatation of the aorta. A systolic murmur with the direction of selective propagation upwards along the vessels of the neck is at least strongly presumptive, and, in the opinion of some, is almost sufficient evidence.

Certain conditions must be excluded in considering the diagnosis of aortic stenosis; among these are bruits due to anæmia, cardio-pulmonary or cardio-respiratory murmurs, pulmonary stenosis, patent ductus arteriosus, pressure upon the aorta by a mediastinal tumour where no definite pulsation is present, mere roughening or stiffness of the aortic cusps or orifice, fusiform dilatation of the aorta just above the valve—what is called "relative stenosis" and aneurysmal dilatation of the ascending aorta.

Hæmic murmurs are always systolic in time, and are most frequently heard in the pulmonary area, next most commonly in the mitral area, the tricuspid area, and the aortic area—in the order named, the last named being comparatively rare. The "bruit du diable" is frequently present as well. Cardio-pulmonary murmurs are not absolutely synchronous with the beginning of systole or diastole and may precede or follow either; the point of maximum intensity does not coincide with any of the valvular areas, the murmurs being usually heard best over the margins of the lungs; and they vary with the phases of respiration. One point alone is sufficient to distinguish aortic stenosis from pulmonary stenosis; in the latter the murmur is never propagated into the arteries at the root of the neck. Further, the character of the respective pulses differs materially, while in aortic stenosis there is evidence of hypertrophy of the left, and not of the right, ventricle, and the apex-beat is characteristic. The physical signs of patent ductus arteriosus are described elsewhere. In the case of pressure upon the aorta by a mediastinal tumour where no definite pulsation is to be felt, the murmur is often audible over the vessels of the neck. An area of impairment may usually be detected, however, and there is rarely any alteration in the character of the second sound. When an aortic systolic bruit is due merely to roughening or stiffness of the aortic cusps or orifice, there is an absence of the characteristic pulse, of hyper-

trophy of the left ventricle in a young person who is free from kidney disease, and of the characteristic apex-beat. In fusiform dilatation of the aorta just above the valve, the murmur is often heard over the vessels of the neck, but occasionally the area of impairment at the level of the second and third costal cartilages extends farther out to the right than the normal limit, and the second sound is not only accentuated, but is low-pitched, ringing, and usually audible over a much wider area. As a rule, there is very little difficulty in diagnosing aortic stenosis from aneurysmal dilatation of the ascending aorta.

Prognosis.—In the opinion of some the prognosis of pure aortic stenosis is more favourable than that of any other chronic valvular lesion; others again place it after mitral incompetence. In my experience, it largely depends upon whether the affection is due to a previous attack of acute endocarditis, or is the result of primary chronic endocarditis. In the former case, the lesion is less serious than any other chronic valvular lesion, and the risk of sudden death is slight. In the latter case, however, the prognosis is less favourable than in mitral incompetence, as degenerative processes are apt to be progressive, and while these may be limited to the valve, more frequently they affect the walls of the aorta also. The neighbourhood of the mouths of the coronary arteries also is often involved, and partial occlusion of one or both of these vessels is of not infrequent occurrence; in this case, chronic myocardial degeneration is likely to ensue, and sudden death may result.

Treatment.—This (together with the treatment of the other forms of chronic valvular disease) will be discussed later.

Aortic Incompetence

Ætiology.—Aortic incompetence is more commonly found in middle or later life, and in males. There are three main causes. (1) A previous attack of acute endocarditis, in which case the mitral valve is, as a rule, similarly affected. This is the commonest cause of the condition in young adults. (2) Secondary involvement of the valve by syphilitic mesaortitis of the ascending part of the aorta just above the valve is an important cause, and should always be thought of in a person who has not suffered from a previous attack of acute endocarditis. (3) Primary chronic endocarditis, more particularly when the affection occurs at a later period of life. Aortic incompetence is the most frequent cardiac lesion due to injury, and may follow sudden physical overstrain, causing a rupture of a valve segment; in such cases it is apt to end fatally. The condition is extremely rarely of congenital origin. *Relative* incompetence of the aortic valve is almost unknown. In relative incompetence there is no affection of the valve segments, the incompetence being due to stretching of the fibrous aortic ring—in other words, to widening of the orifice itself. This may occur in great dilatation of the commencement of the arch of the aorta.

Symptoms.—There may be an absence of subjective symptoms for some time. When the condition is due to primary chronic endocarditis, the onset of symptoms is usually very insidious. When of syphilitic origin, see pages 889–891. Shortness of breath on exertion is perhaps the most frequent symptom. The face is usually pallid and anxious, although in some cases

the colour is flushed; while if relative mitral incompetence supervene, the facies resembles that of mitral disease. Cerebral symptoms are more apt to occur early than in mitral disease, the patient complaining of giddiness, syncopal attacks, headache, or sleeplessness. Præcordial pain is usually more severe in aortic than in mitral disease. At first there may be merely a sense of oppression behind the sternum, becoming worse on physical exertion; or there may be more or less continuous pain. Ultimately, angina pectoris is apt to occur, especially when the lesion is due to primary

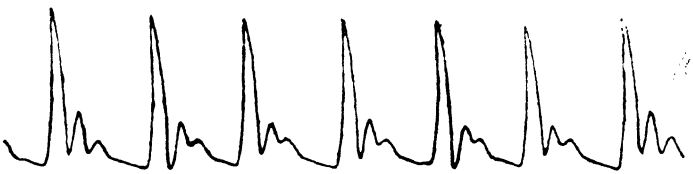


FIG. 63.—Sphygmogram from a case of aortic incompetence.

chronic endocarditis, or to syphilis. Angina pectoris may be associated with, or alternate with, syncopal attacks. The patient may complain of palpitation. There may be a sensation of beating in the head, nose bleeding is not a rare occurrence, and there may be loss of flesh.

Whether the lesion is post-rheumatic or not, increasing dyspnœa, cough, hæmoptysis, physical signs of pulmonary congestion and œdema, especially of the bases, hepatic enlargement, dropsy, and other evidence of mitral incompetence and dilatation of the right heart, may supervene; while in the late stages mental symptoms, such as delirium, hallucinations, delusions, or even a suicidal tendency, may be present.

The typical pulse is very characteristic, and is called the collapsing, the water-hammer, or Corrigan's pulse. Its collapsing character may be intensified by raising the arm above the head, and this method of examination should always be employed in suspected aortic regurgitation. The typical pulse is one of great amplitude, with an abrupt upstroke and a sudden fall. The tidal wave may be considerable, but is maintained only for a short period, the dicrotic notch falls low on the downstroke, while the dicrotic wave may be well marked, small, or altogether absent (Fig. 63). The

FIG. 64.—Sphygmogram from a case of aortic stenosis and incompetence. The characteristic pulse of the latter condition is modified by the presence of stenosis.

artery is empty between the beats. When in addition to aortic incompetence stenosis is present, the characteristic pulse of the former will be modified by the latter condition; *this is of great diagnostic importance in stenosis* (Fig. 64). A high pulse-pressure is almost invariably a feature of aortic incompetence; the minimum pressure is sometimes considerably below and the maximum sometimes considerably above, the normal. When the condition is associated with atheroma, as is frequently the case, the vessel wall may be thick and tortuous. A characteristic feature of aortic incompetence is exaggerated pulsation of the arteries; this may be especially

noted in the carotid, temporal and brachial arteries. Increased pulsation of the retinal arteries is sometimes to be noted with the ophthalmoscope. The phenomenon of the capillary pulse may be observed, and pulsation in the superficial veins, especially in the veins of the back of the hand, when hanging down, is sometimes to be noted. In the opinion of some writers, pulsation over the upper part of the præcordium, and in the second and third right intercostal spaces, is occasionally to be noted, even in the absence of dilatation of the aorta.

In aortic incompetence signs of hypertrophy of the left ventricle are almost constant, and there is some bulging of the præcordium—it may be to a considerable extent. The apex-beat is displaced, sometimes to a marked degree; the displacement is to some extent outwards, but more markedly downwards, sometimes reaching to the sixth or seventh interspace and the mid-axillary line. The extent and force of the beat are usually considerably increased, and it is frequently heaving or thrusting in character.

A diastolic thrill is rarely present; when it is, its maximum intensity is not infrequently at a lower level than the aortic area, and may even be felt towards the lower part of the sternum and in the neighbourhood of the apex-beat.

The area of deep cardiac impairment is usually increased downwards, it may be markedly so, and to a slight degree to the left. In uncomplicated cases the right margin of the heart extends only a little beyond the normal limit. On auscultation, a diastolic murmur is audible, which may continue for a variable distance into the long pause, becoming fainter and fainter. Its point of maximum intensity is very variable, the typical position being over the inner end of the second right intercostal cartilage. Frequently, however, it is in the second left space, or immediately over the sternum. More rarely it is at a lower level than this, approaching even the level of the apex-beat, and in the writer's experience more often nearer the left than the right border of the sternum. The murmur has a tendency to be propagated downwards towards the lower end of the sternum. It is often heard over a wide area, and is usually soft and blowing, but may be musical, and more rarely rough and grating. An aortic systolic bruit is also usually present, but, as has been already pointed out, its presence does not necessarily indicate stenosis. The second sound may be audible or may be absent. The first sound at the apex is sometimes long, low in pitch, and muffled. Austin Flint believed that in certain cases of aortic incompetence a presystolic murmur is audible at the apex, and most writers agree with him. A diastolic murmur may be audible in the carotid, brachial and femoral arteries; the last of these is referred to as the murmur of Duroziez. Physical signs of dilatation of the aorta are sometimes also present.

Later, dilatation of the left ventricle may occur, in which case the force of the apex-beat becomes diminished, and the left border of cardiac impairment is found to have extended still farther to the left. Owing to dilatation of the ring supporting the mitral valve, relative mitral incompetence may supervene, and then enlargement of the left auricle, passive hyperæmia of the lungs, and changes in the right side of the heart are apt to supervene, so that the area of cardiac impairment is also further displaced to the right.

Course.—The course of aortic incompetence is very uncertain. Gradual

cardiac failure is the rule, but, on the other hand, death may occur suddenly, from syncope or angina pectoris.

Diagnosis.—There is little or no difficulty in recognising aortic incompetence in the great majority of cases. The characteristic radial pulse, the high pulse-pressure, the greatly exaggerated pulsation of the arteries, the physical signs of hypertrophy of the left ventricle, the characteristic murmur, capillary pulsation, and, rarely, visible pulsation in the superficial veins, present a definite clinical picture with regard to the diagnosis of which there should be no mistake. It should be remembered, however, that the phenomenon of the capillary pulse and pulsation of the superficial veins are occasionally also seen in other conditions. The murmur of Duroziez is pathognomonic of the lesion.

When the point of the maximum intensity of the murmur is in the pulmonary area, the condition may be mistaken for pulmonary incompetence. In this event, the points which should be remembered in considering the differential diagnosis are that pulmonary incompetence occurs more frequently in early life, that the pulse is not collapsing in character, that there is an absence of greatly exaggerated pulsation of the arteries and of capillary pulsation, that there is evidence of hypertrophy of the right, and not of the left, ventricle, and that the accompanying murmur is very rarely propagated as far down as the apex of the heart, and is never audible over the carotid artery. Dyspnœa, cyanosis, and clubbing of the fingers are also more suggestive of pulmonary incompetence. It should be remembered, however, that both lesions may occur in the same individual, in which case there is usually a blending of the physical signs of both conditions. I have occasionally seen a diagnosis of mitral stenosis made in cases of aortic incompetence, when the point of maximum intensity of the diastolic bruit—especially when the bruit is only audible towards the latter part of the long pause—is as low as, or lower than, half-way down the sternum and on the left side of the middle line, and especially so when it is near the apex-beat. The points of differential diagnosis are the following: In mitral stenosis the pulse is markedly different from that of aortic incompetence, and, further, there is an absence of greatly exaggerated pulsation of the arteries and of capillary pulsation, there is evidence of hypertrophy of the right, and not of the left, ventricle, the murmur is harsher in character, the first sound is short, sharp and clear, and the area of the thrill and murmur is usually very limited. The diagnosis of syphilitic aortitis is discussed on pages 890–891.

Prognosis.—The prognosis of aortic incompetence is usually serious. Sudden death is more frequent than in any other form of chronic valvular disease, and may occur even when there are no indications of cardiac failure. In attempting to form a prognosis, we should endeavour, among other inquiries, to ascertain the extent of the lesion, and whether it is due to a previous attack of acute endocarditis, or to primary chronic endocarditis or to syphilis, the condition of the myocardium and coronary arteries, and whether the affection is stationary or progressive. In the absence of cardiac failure, the pulse-pressure is an indication of the degree of aortic incompetence. When the lesion is the result of a previous attack of acute endocarditis, the prognosis is, other things being equal, much more favourable than when due to primary chronic endocarditis or to syphilis; indeed, if there be no indications of cardiac failure, and if the rate and character of the pulse, the

pulse-pressure, and the size of the heart, exhibit little or no alteration, and if the murmur accompany, but do not replace, the second sound, the patient may live to an advanced age. If, on the other hand, the lesion be due to primary chronic endocarditis, and be progressive, the patient in all probability will not survive for more than 4 or 5 years. For syphilitic aortitis, see page 891.

It is a matter of vital importance to ascertain whether the myocardium and coronary arteries are also affected. In this connection it may be noted that, when the affection is due to a previous attack of acute endocarditis, the myocardium and coronary arteries may not be implicated for a long time and may even escape altogether; whereas, when due to primary chronic endocarditis or to syphilis, they are apt to be affected at an early period. Needless to say, when aortic incompetence is due to rupture of a cusp, the prognosis is still graver, and a fatal termination may rapidly supervene. When the result of dilatation of the orifice, the affection is likely to be progressive. Syncopal attacks and attacks of angina pectoris are of grave significance. The gravity of the prognosis is in every case increased by widespread atheroma and kidney disease.

Mitral Stenosis

Ætiology.—Mitral stenosis is always organic. It commences much more commonly in early life, and is much more frequent in females than in males. It is usually the result of a previous attack of acute endocarditis. It sometimes originates in adults as a result of primary chronic endocarditis, not infrequently in association with chronic interstitial nephritis. In a not inconsiderable proportion of cases its ætiology is obscure.

Pathology.—In mitral stenosis the commonest type of lesion is for the cusps to be united by their margins; but it may be situated elsewhere, as, for example, at the level of the auriculo-ventricular ring. When the lesion consists of a union of the margins of the cusps, two well-marked types of stenosis may result—(1) The "funnel-shaped mitral," which is more common in childhood; and (2) the "button-hole mitral," which is by far the more common in adults and persons of advanced years.

In the former, the united cusps form a funnel-shaped membrane which projects downwards into the left ventricle, the wide mouth of the funnel being situated at the ring, and the smaller end being drawn down towards the apex of the heart, by shortening of the chordæ tendineæ and papillary muscles. In the case of button-hole stenosis, the united cusps form a diaphragm, perforated by a narrow slit-like aperture, which almost closes the orifice. A combined form, that is, a funnel having a narrow slit at its lower end, instead of a circular aperture, has also been described.

Symptoms.—In mitral stenosis there is not very infrequently an absence of subjective symptoms for many years, except that dyspnœa, palpitation, or præcordial pain may accompany any sudden severe demand made on the cardiac muscle. Later, the heart muscle is liable to fail, and dilatation may result. Dyspnœa is induced by less and less effort, cough is a frequent symptom, the patient is liable to attacks of bronchitis and broncho-pneumonia, palpitation and præcordial pain may be present, and epistaxis, hæmoptysis and infarction may occur; embolism is of more frequent occurrence

in mitral stenosis than in any other variety of chronic valvular disease. There is often a persistent dusky flush over the cheeks, and clubbing of the finger-ends, gradual loss of flesh, and, in the young, stunted growth are sometimes to be noted. Later, there may be lividity of the lips, ear-tips, and cheeks, and puffiness around the ankles in the evening. Ultimately dyspnœa may become continuous, and there may be orthopnœa and cardiac asthma, especially at night-time, sleeplessness and restlessness, evidences of congestion and œdema of the lungs and hydro-thorax, a sallow hue of the skin, watery bile-stained conjunctivæ, marked cyanosis, loathing of food, vomiting, enlargement of the liver and spleen, ascites, anasarca, and albuminous and sometimes smoky urine. Sudden death is rare, a fatal termination being usually the result of gradual cardiac failure.

The subjects of mitral stenosis are liable to subacute and acute rheumatic attacks, and chronic renal disease may be a complication.

Usually the pulse is small, the upstroke being short and soon attaining its maximum, the pulse-wave is long, and dicrotism is absent (Fig. 65). The maximum blood-pressure is usually rather below the normal, but the minimum pressure is rather high, so that the pulse is full between the beats. When cardiac failure supervenes, both the systolic and diastolic pressures fall.

FIG. 65. Sphygmograms from cases of mitral stenosis.

The complete irregularity of the pulse which is associated with auricular fibrillation is often found in mitral stenosis with cardiac failure.

On inspection and palpation the following points may be noted in cases of pure mitral stenosis. Sometimes, more especially in children, there is a certain amount of bulging of the præcordium in the region of the ensiform cartilage, due to enlargement of the right ventricle. The apex-beat may be in the normal position or displaced. In pure mitral stenosis the displacement is usually directly to the left, it may be beyond the nipple line; less frequently it is also somewhat downwards. The apex-beat may be normal, diffuse or indefinite. On palpation, there is sometimes a peculiar sudden tap communicated to the fingers, which is very characteristic. Not infrequently there is pulsation in the epigastrium, diastolic in time. There may be a heaving impulse in the epigastrium and over the lower sternum and costal cartilages when marked hypertrophy of the right ventricle exists; in these cases this is the chief impulse, being more marked than that of the left ventricle. Occasionally there is systolic pulsation in the third or second left interspace, near the sternum; this may be due to enlargement of the conus arteriosus or of the pulmonary artery.

In many cases there is a thrill, having its maximum intensity at the apex or somewhat nearer the parasternal line. This may be absent at some periods and present at others; it may be absent when at rest, and in evidence after exertion or when the arms are extended. Examination for the characteristic thrill and murmur of mitral stenosis should be conducted with the patient

lying down, sitting up and inclined forwards, standing up with the arms extended, and after gentle exercise. The thrill is usually presystolic in time, but may be diastolic. When presystolic, on palpation of the præcordium there is a sensation communicated to the hand resembling that produced by the purring of a cat. Sometimes an impulse may be made out at the base of the heart, coincident with the closure of the semilunar cusps, with its maximum intensity in the second left intercostal space.

On percussion the area of cardiac impairment may be found to be unaltered when the obstruction is slight; but usually the transverse diameter is increased, especially to the right. The left border may be displaced outwards, even beyond the nipple line. The upper border of the area of impairment is sometimes found to be higher than normal, and may reach as high as the second costal cartilage, and an extension of the area of impairment outwards along the third and fourth intercostal spaces, due to enlargement of the right auricle, may be occasionally detected.

On auscultation the physical signs are very characteristic. In the large majority of cases a murmur is present. This may be audible at some times and not at others. It is heard at the apex, or between this point and the left border of the sternum. The murmur is usually presystolic in rhythm; as in the case of the presystolic thrill, it is due to the systole of the auricle driving blood through a narrowed orifice, *and disappears with the onset of auricular fibrillation*. The murmur is almost invariably rough; it may be harsh and vibratory, and this quality of the murmur is almost pathognomonic; Laennec compared the sound to the rasping noise made by a file. The first sound which terminates the murmur is altered in a characteristic way, to be described later. *The locality of the murmur is almost always very limited and the area may not be larger than 1 inch in diameter; this should be particularly noted, because it accounts for the fact that the lesion is so often unrecognised.* Instead of presystolic the bruit may be diastolic in time. Diastolic murmurs tail off, and do not have, as a rule, the harsh and vibratory character of the presystolic bruit; they are, instead, soft and blowing in type, and are due to the passive inflow of blood from auricle to ventricle. There may be a combination of two murmurs; there may be a long murmur beginning immediately after the second sound, and continuing all through ventricular diastole and auricular systole, the early part being diminuendo and the latter part crescendo. Or, at one time, there may be a presystolic, and at another time a diastolic, murmur. Sometimes a diastolic murmur, usually soft and blowing in character, with its point of maximum intensity in the pulmonary area, due to *relative* pulmonary incompetence, is to be heard. It is often called the Graham Steel murmur.

The first sound becomes short, sharp and clear, like a sudden snap. It may resemble the second sound so closely as to be mistaken for it, especially when the second sound is not well heard at the apex. As mitral stenosis is usually accompanied by incompetence, a mitral systolic murmur is usually audible. The second sound is usually accentuated, particularly in the pulmonary area, and may be reduplicated, the effect resembling a "postman's knock." According to the late Sir William Broadbent, in a later stage of the disease the second sound at the apex may disappear, the short, sharp first sound may become louder, and the murmur become more frequently diastolic in time. In the absence of a diastolic, as well as of a

presystolic, murmur, all that is audible at the apex now is the altered first sound.

When cardiac failure supervenes, the pulse-rate increases, the apex-beat becomes diffuse and less forcible, the transverse area of cardiac impairment increases, and all the signs of tricuspid incompetence may be present.

Diagnosis.—When the characteristic physical signs of mitral stenosis—the pulse, the thrill, evidence of hypertrophy of the right ventricle, the murmur, the short, sharp and clear first sound, and the reduplicated second sound—are present the diagnosis is easy. The thrill is almost pathognomonic. Some writers believe that a similar thrill may be present in aortic incompetence, and therefore that this affection should always be first excluded. The thrill must be distinguished from a mere vibration of the chest-wall, which may be occasioned by a forcibly acting heart when the ribs are rigid. In this case, by separating the fingers and placing them in the intercostal spaces the osseous vibrations are not felt.

The murmur is sometimes not detected, on account of the area over which it is audible being very limited; or in some cases there is from time to time a complete absence of a thrill and murmur. In the latter case we are justified in inferring that in all probability mitral stenosis is present from the character of the pulse and first sound, together with evidence of hypertrophy of the right ventricle, and accentuation or reduplication of the second sound.

Some writers are of opinion that a rumbling presystolic bruit is sometimes heard in the case of adherent pericardium in children. Even if this be so, the bruit is not rough and vibratory in character, neither does it terminate abruptly at the first sound, nor is the first sound modified in the way already described, and, further, there are usually definite physical signs of adherent pericardium. As it is generally believed that a presystolic murmur at the apex is heard in certain cases of aortic incompetence, the question whether mitral stenosis is present in addition to aortic incompetence has occasionally to be considered. In this connection it may be noted that Flint's murmur has not the harsh and vibrating character which is commonly found in a presystolic bruit due to mitral stenosis, and if a thrill be present it is not "purring" in character. It should be borne in mind that both lesions may be present at the same time, and, therefore, it is sometimes difficult to say whether the murmur is that described by Flint or one due to the presence of mitral stenosis. In coming to a decision, the character of the murmur, the thrill and the pulse—the characteristic collapsing pulse of aortic incompetence being modified if mitral stenosis be present as well—will be of assistance.

Mitral stenosis is sometimes unrecognised in cases in which there is associated incompetence; the presystolic murmur, instead of ending in the first sound, ends in a systolic murmur, and a diagnosis of a long systolic murmur is erroneously made. There is, however, a difference in character between the former and the latter parts of this continuous bruit, the earlier portion being rough and vibratory in character, and the latter blowing or musical. Further, we can observe the position in the cardiac cycle of the two parts of this continuous murmur by placing the fingers upon the apex-beat or over the carotid artery. When the second sound at the apex has disappeared, the presystolic murmur may be mistaken for a systolic murmur, and the modified first sound for the second sound. In this event a differential

diagnosis can be made from the difference in character of the two murmurs, from the fact that a presystolic murmur ends, while a systolic murmur begins, with an accent, and by timing the murmur in the manner already indicated. When, in addition to the absence of a second sound at the apex, there is also no bruit present, mitral stenosis may not be diagnosed, and a diagnosis of dilatation of the left ventricle made ; in dilatation, however, a second sound is audible.

The differential diagnosis between aortic incompetence and mitral stenosis has already been discussed. A differential diagnosis may have to be made between tricuspid and mitral stenosis. The former is extremely rare, and the point of maximum intensity of the thrill and murmur is in the tricuspid area. Occasionally a mere reduplication of the first sound is mistaken for mitral stenosis ; but no careful observer should make this mistake.

Prognosis.—Mitral stenosis ranks after aortic incompetence in gravity among the chronic valvular lesions, and the prognosis is much less favourable than in the case of mitral incompetence.

There is apparently a tendency for mitral stenosis to be progressive, pulmonary complications are frequent, chronic renal disease may also accompany it, and embolism is relatively frequent. When the lesion occurs in the early years of life, physical and mental development are apt to be retarded, and the patient is liable to fresh attacks of rheumatic valvulitis. The prognosis depends upon, among other things, the degree of stenosis, which when considerable is almost invariably accompanied by incompetence. It has been pointed out that in a later stage of the disease the second sound at the apex may disappear, the short sharp first sound become louder, and the murmur more frequently diastolic ; these phenomena, therefore, signify a downward grade. Sudden death is of rare occurrence, a fatal termination being usually the result of gradual cardiac failure, which in most cases is associated with the supervention of auricular fibrillation.

Mitral Regurgitation

Mitral regurgitation may be organic or relative, the latter being also termed functional.

Ætiology.—When organic, by far the most common cause is a previous attack of acute endocarditis, but sometimes it is due to primary chronic endocarditis. Rarely it is due to trauma, in which case there is usually a rupture of a chorda tendinea or of a cusp. *Relative* incompetence is a somewhat common cause of mitral regurgitation. It may be due to simple overstrain of the heart, wasting states, toxic conditions—such as alcoholism, lead, pneumonia, and diphtheria—acute febrile affections, anæmias, Graves' disease, acute myocarditis, fatty or fibroid degeneration of the myocardium, supernormal blood-pressure, chronic Bright's disease or aortic incompetence.

Symptoms.—In by no means an inconsiderable proportion of cases the disease is latent throughout the whole course. When symptoms are present the clinical picture resembles that of mitral stenosis ; it should be noted, however, that hæmoptysis and embolism are of less common occurrence.

When the lesion is slight, the pulse, as a rule, scarcely differs from the normal. When the lesion is considerable, the amplitude is apt to be smaller

than normal, the upstroke rather steep, there is often very considerable dicrotism, the pulse being easily compressible and not felt between the beats, and the blood-pressure is low. The complete irregularity which is associated with auricular fibrillation is often found in mitral incompetence with cardiac failure.

In mitral incompetence, due to organic valvular disease, there is sometimes, more especially in children, a certain amount of bulging of the præcordium. The apex-beat is usually displaced outwards, it may be even as far as the anterior axillary line; as there is hypertrophy of the left ventricle, the apex-beat may be also displaced somewhat downwards. Usually its area and force are greater than normal, and it may be heaving in character. Sometimes there is pulsation in the epigastrium, diastolic in time; and when there is marked hypertrophy of the right ventricle, there may be a heaving impulse in the epigastrium and over the lower sternum and costal cartilages. Occasionally there is visible pulsation in the second or third left intercostal space, and more rarely a thrill, systolic in time, which has its maximum intensity at the apex. A shock, accompanying the second sound, may be occasionally detected, particularly in the pulmonary area.

On percussion the area of cardiac impairment is found to be enlarged. Its transverse diameter is increased, the left border being displaced outwards, even as far as the anterior axillary line, and the right border as much as an inch and a half or more to the right of the sternum. The upper border of cardiac impairment may be as high as the second rib, and an extension of the area of impairment outwards along the third and fourth intercostal spaces, due to enlargement of the left auricle, may occasionally be detected.

On auscultation a systolic murmur is audible. This usually commences with the first sound, which it may entirely replace or merely accompany—usually the latter—and may extend all through the short pause; rarely it follows the first sound. Its point of maximum intensity is at or near the apex-beat, and its direction of selective propagation towards the axilla and the angle of the scapula. Occasionally it can be heard over the whole chest. The area of conduction of slight mitral systolic murmurs is frequently not large. A mitral systolic murmur is usually soft and blowing, occasionally musical, and more rarely rough and grating. It is usually louder when the patient lies down, and becomes feebler in the sitting or standing posture; in any doubtful case, therefore, the patient should be examined in these several positions. The second sound at the pulmonary area is, in the great majority of cases, accentuated, and may be reduplicated.

When cardiac failure supervenes the pulse-rate increases, there is usually present an increased degree of dilatation of the left ventricle—the apex-beat becoming more diffuse and its force lessened, and the left cardiac border being found still farther to the left—and in addition dilatation of the right heart, while all the signs of tricuspid incompetence may be present.

In *relative* mitral incompetence the apex-beat may be displaced outwards, but not downwards, and instead of being more forcible than normal it is usually less so. The systolic murmur is, as a rule, not propagated beyond the mid-axillary line, and there is often no accentuation of the pulmonary second sound.

Diagnosis.—At the outset it is necessary to point out that a systolic bruit audible over the apex of the heart is not infrequently erroneously inter-

preted as indicative of organic disease of the mitral valve, when in reality the murmur is functional. In order to say that a mitral systolic murmur is indicative of organic mitral incompetence, we must satisfy ourselves that certain other physical signs are present. With this object in view, it is advisable to note—(1) The position and character of the apex-beat; (2) the area of propagation of the murmur; and (3) the existence or absence of accentuation of the pulmonary second sound. In the case of a mitral systolic murmur due to organic valvular disease, owing to the presence of hypertrophy of the left ventricle, the apex-beat is usually displaced downwards as well as outwards. When the degree of valvular disease is so slight that no definite downward displacement of the apex-beat is present, its force is almost invariably increased, whereas in functional conditions it is apt to be less forcible than normal. If the murmur be propagated towards the angle of the scapula beyond the mid-axillary line, we may be practically certain that it denotes the existence of organic disease. A definite accentuation of the pulmonary second sound, provided there is no condition of the lungs to account for it, is in favour of the view that we are dealing with organic disease. The diagnosis is further strengthened by evidence of the existence of mitral stenosis. The diagnosis of relative mitral incompetence due to chronic Bright's disease or to aortic disease from organic mitral incompetence is particularly difficult, since chronic nephritis and aortic disease in themselves give rise to hypertrophy of the left ventricle. In these cases the history of the case is of importance.

In addition to the points of differential diagnosis just enumerated, murmurs due to anæmia and those associated with respiration have other distinguishing features. These have been discussed on page 839.

Prognosis.—The prognosis of mitral incompetence is more favourable than that of aortic stenosis or incompetence, or mitral stenosis. If the lesion be slight and the conditions of life favourable, the individual may even live to the normal span of life without experiencing much, if any, inconvenience. When, on the other hand, the lesion is severe, as indicated by marked cardiac enlargement, and more especially when symptoms of cardiac failure are present,—more particularly pulmonary symptoms,—the patient may live only for a few years, especially when the lesion is accompanied by pericardiic adhesions. It should be remembered, however, that even when considerable or marked cardiac failure exists, if rest and other suitable therapeutal measures be adopted, the patient may improve for a considerable time. In attempting a prognosis, we should note, among other things, the pulse-rate, the degree of displacement of the right margin of cardiac impairment, and the existence or otherwise of any indications of venous stasis.

With regard to the prognosis of mitral regurgitation due to *relative* incompetence, this depends upon the cause.

Mitral Stenosis and Regurgitation (Double Mitral Disease)

It has been already explained that when mitral incompetence results from a previous attack of acute endocarditis, there is usually some degree of stenosis as well, and also that pure mitral stenosis is comparatively infrequent, as it is usually accompanied by incompetence. We thus get the double lesion.

Ætiology.—Double mitral disease is always organic; it is usually due to

a previous attack of acute endocarditis, although in elderly people it may be due to primary chronic endocarditis.

Symptoms.—The symptoms partake of the character of both lesions. Auricular fibrillation, cardiac failure, and tricuspid incompetence are more likely to supervene than in the case of a single lesion. There is usually considerable enlargement of the heart, and on auscultation the combined murmurs may be heard, but not infrequently a mitral systolic is the only murmur present. Accentuation of the pulmonary second sound is usually more marked than in the case of a single lesion.

Pulmonary Stenosis

Pulmonary stenosis may be due to a lesion of the cusps of the conus arteriosus, or of the pulmonary artery.

Ætiology.—The disease is almost always congenital; indeed, it is perhaps the most common congenital cardiac affection. When it occurs as an acquired condition, it may be the result of a previous attack of acute endocarditis, of which rheumatism and the eruptive fevers are the principal causes; and when this is so, it is usually associated with tricuspid stenosis. It has been supposed that the condition sometimes results from atheroma of the pulmonary artery, or from pressure of an aortic aneurysm. In some cases the ætiology is obscure.

Symptoms.—The symptoms of the congenital form of the disease will be discussed under Congenital Heart Disease. In the acquired form, the degree of dyspnœa is, as a rule, not great, and some authorities are of opinion that there is little tendency to cyanosis in these cases; similarly, there is a difference of opinion as to the existence of clubbing of the fingers and toes. The tendency to chronic venous stasis is not great, and as a consequence œdema of the lower extremities and ascites are not prominent features, although there may be tenderness over the liver, hepatic enlargement and pulsation, and the urine may become scanty, high coloured, exhibit an excess of urates, and may contain albumin or even blood.

Prognosis and Treatment.—These will be discussed later.

Pulmonary Incompetence

Pulmonary incompetence is the most rare of all valvular lesions.

Ætiology.—The condition occurs more commonly in early life, and with about equal frequency in both sexes. It is frequently a congenital affection, and is then usually accompanied by pulmonary stenosis. In the majority of cases it is the result of a previous attack of acute endocarditis, of which rheumatism and the eruptive fevers are the principal causes. It is believed by some that the condition may be caused by primary chronic endocarditis. *Relative* incompetence may occur, and is more common than was formerly supposed; the incompetence is due to dilatation of the pulmonary artery and its ring, caused by increased blood-pressure in the pulmonary circulation, such as may be found in chronic valvular disease of the left side of the heart, more especially mitral stenosis, in pulmonary fibrosis, fibroid tuberculosis, emphysema, and chronic diseases of the bronchi.

Symptoms.—There may be a certain degree of cyanosis and dyspnœa,

usually only present on exertion, while not infrequently there is also clubbing of the fingers. At a late stage cyanosis becomes marked, dyspnœa occurs apart from exertion, there may be anasarca of the dependent parts, catarrh of the mucous membranes, enlargement of the solid abdominal viscera, transudation of fluid into the serous sacs, the urine may become scanty, high coloured, exhibit an excess of urates, and may be albuminous or even bloody, while affections of the respiratory system are especially apt to occur. There may be evidence of chronic venous congestion and œdema of the lungs, particularly of the bases, and more rarely pulmonary infarction occurs.

The pulse may be small and feeble, and the blood-pressure is, as a rule, subnormal. Occasionally there is visible pulsation in the third and fourth intercostal spaces to the right of the sternum. There is also frequently some bulging of the præcordium in the region of the ensiform cartilage, due to enlargement of the right ventricle, while the apex-beat is usually displaced to the left. There may be pulsation in the epigastrium, diastolic in time, and when there is marked hypertrophy of the right ventricle there is frequently a heaving impulse in the epigastrium, and over the lower sternum and costal cartilages. Distension or pulsation of the jugular veins may be present. Rarely a diastolic thrill is present, having its point of maximum intensity over the pulmonary area. On auscultation, a diastolic murmur, with its point of maximum intensity in the pulmonary area, usually soft and blowing in character, is audible, sometimes over a considerable area, its direction of selective propagation being downwards towards the lower end of the sternum.

Diagnosis.—The diagnosis of pulmonary incompetence is frequently a matter of considerable difficulty. The lesion with which it is most likely to be confounded is aortic incompetence, because the point of maximum intensity of the thrill and murmur of the latter is not infrequently to the left of the sternum. The differential diagnosis between these two conditions has been discussed under aortic incompetence. It should be noted that both lesions are rarely present in the same individual. The symptoms of pulmonary incompetence and patent ductus arteriosus resemble each other; in the case of the latter the murmur occupies both systole and diastole.

Prognosis.—When due to organic disease and when unaccompanied by any other valvular lesion, the prognosis in pulmonary incompetence may not be unfavourable; instances, indeed, have been recorded in which life has been prolonged almost to the normal span. In *relative* incompetence, on the other hand, the prognosis is always grave. Death in either case may result from right-sided cardiac failure, bronchitis or broncho-pneumonia, or pulmonary tuberculosis

Tricuspid Stenosis

Ætiology.—Tricuspid stenosis occurs much more commonly in males than in females—in a proportion of at least three to one. While a considerable proportion of cases are congenital (in which case there is usually also some other cardiac lesion), the majority arise after birth. The acquired form is usually associated with mitral stenosis, and is due to a previous attack of acute endocarditis caused by rheumatism, chorea, or more probably one of the acute specific fevers. In many cases, however, the cause cannot be ascertained.

Symptoms.—In the acquired form of the disease, cyanosis is the most conspicuous symptom, and may be very marked; dyspnœa is less evident, and may be only present on exertion. The skin temperature of the extremities is often subnormal, and the individual complains of feeling cold and is very susceptible to any fall of temperature. The cerebral functions are not infrequently affected. Œdema about the ankles is sometimes present, and at a later stage may become general, together with tenderness over the liver, hepatic enlargement, and pulsation, ascites, splenic enlargement, and scanty high-coloured urine, which may contain albumin and even blood.

The radial pulse may show no abnormality, or its rate may be increased and its volume diminished. The apex-beat may be displaced to the left, and there is usually distension, and it may be pulsation, of the jugular veins. There may be a presystolic, or more rarely a diastolic thrill, with its point of maximum intensity in the tricuspid region. On percussion, the right border of the heart is found to be displaced to the right, on account of enlargement of the right auricle, and the left border may be found to be displaced outwards. On auscultation, a murmur may be present, limited in extent, having its point of maximum intensity in the tricuspid area. It is usually presystolic, but may be diastolic. The presystolic murmur is almost invariably rough; it may even be harsh and vibratory in character. The diastolic murmur, on the other hand, is usually soft and blowing. In some cases no murmur of any kind is audible. In certain instances, some writers have recorded a short, sharp first sound in the tricuspid area. When pulsation of the liver is present, the pulsation is of the auricular and not of the ventricular type.

Diagnosis.—In by no means an inconsiderable proportion of cases of tricuspid stenosis the lesion is entirely overlooked, no doubt on account of the absence of any murmur. In the opinion of Mackenzie, we may infer that tricuspid stenosis in all probability exists when pulsation of the liver is found to be auricular in type.

The differential diagnosis of tricuspid and mitral stenosis is often a matter of great difficulty. The early appearance of marked cyanosis and of extensive dropsy are features in favour of the existence of the former lesion. When the point of maximum intensity of the murmur is strictly in the tricuspid area, we can be fairly certain of the diagnosis. It should be remembered that both lesions may be present; in this case a murmur with its point of maximum intensity midway between the tricuspid and mitral areas, or two murmurs with separate points of maximum intensity, may be detected. The value of the auricular type of hepatic pulsation has been noted.

Prognosis.—The prognosis in this affection is by no means easy. It largely depends upon whether mitral stenosis also exists, and if present, in what degree; if this be present, the prognosis is usually very unfavourable.

Tricuspid Incompetence

Ætiology.—It should be remembered at the outset that the reflux of a certain amount of blood through the tricuspid orifice may occur under physiological conditions. In severe muscular exertion, for example, where the intracardiac pressure on the right side of the heart is excessive, a natural function of the tricuspid valve is to provide for a certain amount of regurgita-

tion, and thus afford relief to the temporary embarrassment due to distension of the right ventricle.

Pathological tricuspid incompetence is rarely congenital, and when it is, is usually associated with pulmonary stenosis. Apart from those of congenital origin, there are two classes of cases—(1) Those in which the incompetence of the valve is primary, that is, due to a lesion of the cusps themselves—a rare condition; and (2) cases of *relative* tricuspid incompetence, in which the cusps are normal, the incompetence being due to dilatation of the right ventricle. The latter constitute the great majority of cases.

With regard to the first group, the lesion may be the result of a previous attack of acute endocarditis, in which case the tricuspid incompetence rarely occurs alone; there is usually tricuspid stenosis, and also some other valvular lesion, more especially some structural alteration of the mitral cusps. Infective endocarditis may affect the tricuspid valve alone.

Relative incompetence is always consequent on some other condition. It may result from chronic Bright's disease or aortic disease, resulting in dilatation of the left ventricle and venous stasis in the lungs, mitral disease, and affections of the lungs which cause embarrassment in the pulmonary circulation, such as emphysema, cirrhosis, chronic fibroid tuberculosis, and chronic diseases of the bronchi. Among other causes are pulmonary stenosis or regurgitation, wasting states, toxic influences (such as alcoholism, lead, pneumonia, and diphtheria), acute febrile conditions, anæmia, acute myocarditis, and myocardial degeneration.

Symptoms.—There is always a tendency to cyanosis, which may be marked, while dyspnœa on exertion is almost always present. Headache and giddiness are of common occurrence, while insomnia or disagreeable dreams, hallucinations, and even insanity may occur. Digestive disturbances and even jaundice may be present, and in rare instances hæmatemesis and melæna. Œdema about the ankles may also be noted. These patients are very liable to attacks of bronchial catarrh, while, later, there may be evidence of chronic venous congestion and œdema of the lungs, particularly of the bases, hæmoptysis, and hydro-thorax, the latter being more likely to occur in tricuspid incompetence than in affections of the left side of the heart. Hepatic enlargement and pulsation, ascites, general anasarca, and albuminous and even bloody urine may be also present in the later stages of the disease.

The pulse is usually small. In children a certain amount of bulging of the præcordium may be present in the region of the ensiform cartilage, due to enlargement of the right ventricle, and there may also be pulsation in the epigastrium, diastolic in time. A powerful heave in the epigastrium may be sometimes noted when the right ventricle is hypertrophied, and less commonly also visible pulsation in the fourth and fifth right intercostal spaces near the sternum. More rarely a systolic thrill is present in the tricuspid area. Visible distension and pulsation of the jugular veins may exist. If the vein be emptied from below by means of the finger, and its upper extremity kept closed by pressure, it rapidly fills from below. The pulsation of the jugular vein is usually of the ventricular form, but occasionally is of the auricular type. The liver may be enlarged and pulsating, the pulsation being strictly systolic in time—unless tricuspid stenosis also exists.

The area of cardiac impairment is increased to the right, sometimes to a considerable extent.

On auscultation, a murmur, systolic in time, having its point of maximum intensity in the tricuspid area, and usually soft and blowing in character, is usually, but by no means always, audible. It is conducted towards the right, but as a rule its area of conduction is slight. The pulmonary second sound is diminished in cases of tricuspid incompetence uncomplicated by a mitral or pulmonary lesion.

As relative incompetence of the tricuspid valve is always consequent upon some other condition, the physical signs of the primary affection are, of course, present.

Diagnosis.—When, after being emptied from below by means of the finger, the jugular vein rapidly fills from below, and when pulsation of the liver occurring synchronously with the apex-beat, evidence of enlargement of the right side of the heart, a soft blowing systolic murmur having its point of maximum intensity in the tricuspid area, and diminution of the pulmonary second sound are also present, no doubt need arise regarding the diagnosis. In marked tricuspid incompetence the murmur may be absent in which case a positive diagnosis can be made when the first three signs mentioned are present; most writers, indeed, agree that the first sign is sufficient for a diagnosis. In slight cases, a systolic murmur audible in the tricuspid area may be the only existing physical sign; but we should make certain the murmur is not propagated from any other area. Lastly, it has been pointed out that on severe muscular exertion a natural function of the tricuspid valve is to provide for a certain amount of regurgitation, and thus a tricuspid systolic murmur may appear under physiological conditions.

Prognosis.—The prognosis of tricuspid incompetence depends upon the cause and associated condition. When the affection is due to organic disease, the outlook is serious.

With regard to the prognosis of tricuspid regurgitation due to *relative* incompetence, when this is the result of aortic or mitral disease it is usually serious; it may be the precursor of a fatal termination in the near future. When, on the other hand, it is due to intercurrent pulmonary affections, wasting states, toxic conditions, acute febrile states, or anæmia, the prognosis may be good.

Treatment of Chronic Valvular Disease

The ætiology should be reviewed. In this connection, the treatment of syphilitic aortitis is described on page 892. Explicit and detailed instructions with regard to his manner of life—as fully described under Treatment in Cardiac Affections—should invariably be given to the patient. The importance of always living within the limits of the heart's strength, and avoidance of sudden and violent effort, should be specially emphasised in aortic disease. The question of oral sepsis is an important one, and this should receive attention, with the object of diminishing the risk of infective endocarditis. In mitral disease the patient is liable to attacks of bronchitis and broncho-pneumonia, and in both mitral and aortic disease in children and young adults there is a liability to recurrent acute and subacute rheumatic attacks; preventive measures should therefore be adopted, and if, notwith-

standing, an attack of either occur, it should be immediately and adequately treated.

When there are indications of cardiac failure, such as dyspnœa, it is imperative that the work of the heart should be lessened by rest. If the cardiac failure be slight in degree, continuous rest in bed is often not necessary; it is often advisable, however, to begin the treatment by keeping the patient in bed for a short time. Other measures which may be adopted in addition to rest, as well as the treatment of symptoms, have been dealt with.

The Surgical Treatment of Mitral Stenosis.—Samways, in 1898, anticipated that, with the progress of surgery, some of the most severe cases of mitral stenosis might be relieved by "slightly notching the mitral orifice." Lauder Brunton, in 1902, suggested elongating the natural opening, or cutting through the valves at the middle at right angles to the normal opening. Doyen, later, operated on a case, but the patient died very shortly afterwards. Cutler and Levine, in 1923, published the case of a girl, aged 12, on whom they had operated. A valvulotome was plunged into the left ventricle an inch from the apex, and pushed upwards for 2½ inches, until it had reached as far as what was thought to be the mitral orifice. They believed that the aortic leaflet was cut. The patient recovered from the operation, but it was too early to form an opinion as to any benefit that might have accrued. They were of opinion that the mitral diastolic thrill and murmur had diminished in intensity, while the systolic murmur had increased. A pericardial to-and-fro friction had developed, and had gradually grown fainter. Numerous experiments have also been made by Cushing and others. Goodall and Rogers discussed the subject in a paper, and expressed the opinion that the auricular route is better than the ventricular, as an instrument passed from the ventricle into the auricle is more likely to injure the latter than it is to damage the ventricle if passed in the opposite direction. The reasons for and against the ventricular and auricular routes were considered. The same writers published another paper on the subject, almost identical with the former. Souttar published a case in which he used the auricular approach, and dilated the valve with the finger. The patient was a girl, of 15 years of age. She recovered, and, although still breathless, was much improved. Jarotzky, while not putting the operation into practice, suggested that, in cases of mitral stenosis where the general condition is good, but in which the patients from time to time suffer from the formation of infarcts, an opening should be made between the two auricles by passing an instrument through the jugular vein and the superior vena cava directly into the right auricle.

FREDERICK W. PRICE.

DISEASES OF THE MYOCARDIUM AND CORONARY ARTERIES

Affections of the myocardium are of profound importance. It has been pointed out that valvular defects, diseased conditions of the blood vessels, and disturbances of the cardiac mechanism should be regarded from the point of view of their relation to the myocardium, and not so much as specific affections in themselves. It has also been noted that, along with valvular lesions, coincident changes in the cardiac musculature, the aorta, or coronary arteries are, as a rule, present. We are, however, now concerned with affec-

tions of the myocardium occurring independently of valvular disease, and of these inflammation of the myocardium, or myocarditis, is undoubtedly of most importance.

Myocarditis

Varieties.—The varieties which may be met with are—(1) **Acute,** (*a*) simple, and (*b*) suppurative—of uncommon occurrence; and (2) **chronic.** Chronic myocarditis will be discussed under chronic myocardial disease. (3) Tuberculous myocarditis is rare.

Acute Myocarditis

Ætiology.—Acute simple myocarditis is usually due to one of the acute infective diseases, especially acute rheumatism, diphtheria, influenza, pneumonia and scarlet fever. Some degree of myocarditis is always present with pericarditis, and probably also with endocarditis. Suppurative myocarditis is usually the result of pyæmia or infective endocarditis. Tuberculous myocarditis is almost always the result of extension from a tuberculous pericarditis.

Pathology.—Acute simple myocarditis may be general, or limited to one or more portions of the cardiac wall. Acute degenerative processes, especially fatty degeneration, of the muscle-fibres are usually found; the interstitial connective tissue, on the other hand, may show little or no change, or may exhibit considerable cellular infiltration. It has been noted by Romberg, Carey Coombs, and others that this cellular infiltration is often focal, the foci being from 0·1 to 0·2 mm. in diameter, and situated in the neighbourhood of the mitral orifice; these foci have a homogeneous centre, surrounded by a zone of giant cells, and are believed by some to be pathognomonic of the rheumatic infection. Some writers recognise two forms of myocarditis, the parenchymatous and the interstitial; in most cases, however, both the parenchyma and interstitial tissue are affected. Dilatation of one or more chambers of the heart usually supervenes. In suppurative myocarditis, large abscesses in the myocardium are of rare occurrence; they may perforate into the ventricle or pericardium. Minute abscesses, on the other hand, generally at the base of the left ventricle, are not rare. Tuberculous myocarditis usually takes the form of miliary tubercles.

Acute simple myocarditis may be followed by—(1) Complete resolution, in which no permanent changes supervene; or (2) organisation, with the formation of connective tissue, which tends to contract as life advances, and which may occur in limited areas or may involve the whole myocardium. The latter condition is known as chronic myocarditis.

Symptoms.—The clinical picture in acute myocarditis varies considerably in different cases; not infrequently it is indefinite, and, indeed, in rare instances the condition may remain latent during its whole course and is only discovered post mortem, death being due to the severity of the primary illness. The onset may be insidious, or there may be a definite change in the clinical picture of the causal disease. If pyrexia be already present, there may be a further rise of temperature, or if there have been no pre-existing pyrexia it may develop; it may be signalised by a rigor, and be slight or considerable in degree. Not infrequently dyspnœa and cough are present, respiration shallow and more rapid, while Cheyne-Stokes

breathing may be occasionally noted. There may be great prostration, and syncopal attacks may occur if the affection be severe. There is pallor or lividity of the face, according to the degree of severity of the disease. Vomiting not infrequently occurs, and, indeed, may be the first symptom. Jaundice has been noted in some cases. Dropsy may develop, and the urine contain albumin and blood; in the severe form of diphtherial myocarditis, albuminuria is generally present. As the illness progresses, the patient may sink low in bed, complain of headache, with restlessness, insomnia, convulsions, muttering delirium, stupor, and even coma. *The severity of the subjective symptoms may be out of all proportion to the physical signs.*

The pulse is feeble and soft; it is usually, but by no means always, increased in frequency, and, indeed, bradycardia may be present. Bradycardia may be met with during the convalescent stage of diphtheria, influenza, and pneumonia, and occasionally during the febrile stage, and may be due to irritation of the vagus, or sometimes to partial heart-block. In some cases there is irregularity of rhythm, due to extra-systole (Fig. 66) or partial

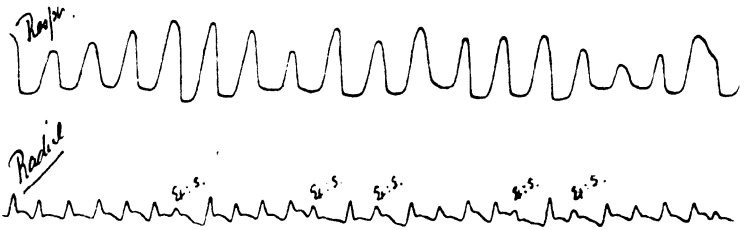


FIG. 66.—Tracing of the radial pulse, from a child suffering from croupous pneumonia, showing extra-systoles. Note the slight pulsus alternans following the extra-systoles.

heart-block (Fig. 67), or auricular fibrillation; exceptionally, complete heart-block is present. The apex-beat, which may or may not be displaced, is diffuse and diminished in force, and even abolished in severe myocarditis. The area of cardiac impairment is usually increased transversely, both to the left and right, as the result of dilatation, which may sometimes come on rapidly.

On auscultation, the first sound is short, sharp and clear, and diminished in intensity, and in the case of rapidly acting hearts the fœtal type of cardiac action may be approximated. The second sound over the pulmonary area is sometimes accentuated, and occasionally reduplicated. The gallop rhythm may be present. A systolic murmur is not infrequently heard over the mitral, and sometimes over the tricuspid, area, due to functional inefficiency of the valves; a systolic bruit is perhaps more commonly noted over the base of the heart. Not infrequently physical signs of œdema of the lungs, bronchitis, or effusion of fluid into the pleural sac are to be found.

In diphtherial and influenzal myocarditis, the symptoms may appear either during the febrile stage of the disease or during convalescence; this applies also, but less frequently, when some other cause of myocarditis is present. When the symptoms appear during convalescence, they are not so acute or so severe. Among them may be noted anorexia, languor and pallor; dyspnœa, fatigue, præcordial distress or actual pain, and, possibly,

syncopal attacks on exertion; tachycardia, subnormal blood-pressure, an enfeebled cardiac impulse, evidence of slight cardiac dilatation, a modified first sound at the apex, an accentuated pulmonary second sound, and sometimes a mitral systolic bruit.

The diphtherial form of myocarditis may be mild or severe. There may be bradycardia; in the severe form there is usually albuminuria, and a fatal termination may take place rapidly from cardiac failure. A severe form of myocarditis may also occur as the result of influenza. A grave form of myocarditis has been met with in septicæmia and in severe cases of enteric fever.

Diagnosis.—The diagnosis of acute myocarditis is often extremely difficult, the condition not infrequently presenting an indefinite clinical picture, and at times, indeed, remaining latent; we may often suspect or infer its existence, although it may not be possible definitely to affirm it. It is necessary at the outset to emphasise the *importance of being on the look-out for the occurrence of partial heart-block during the course of an acute in-*

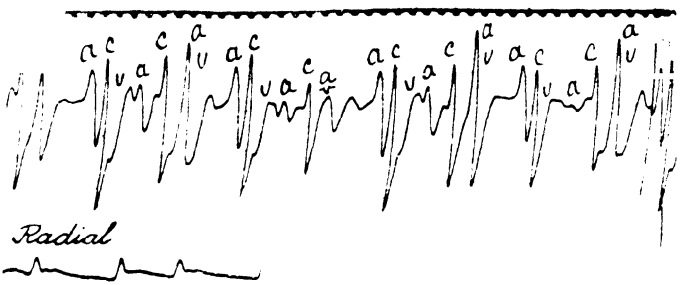


FIG. 67. Simultaneous tracings of the jugular and radial pulses, from a case of acute myocarditis occurring during diphtheria, showing partial heart-block. Every third stimulus from the auricle fails to reach the ventricle.

fective disease, for it is a sign, and may be the only sign, of myocardial damage. The presence of severe myocarditis may be presumed when there are indications of marked cardiac failure coming on rapidly during the course of an infectious disease, and out of proportion to the severity of the latter—cyanosis, vomiting and increase of the area of cardiac impairment being perhaps especially significant. A diagnosis of the mild form of myocarditis occurring during or after the febrile stage of an infectious disease may be arrived at from a consideration of the symptoms already enumerated. It may be necessary in a given case to differentiate myocarditis from acute endocarditis, and this is often a matter of extreme difficulty, for it should be remembered that both conditions may coexist, and a mitral systolic murmur may be due to either.

Prognosis.—The prognosis of the severer forms of acute myocarditis is extremely grave, the mortality being high; the course of the disease is rapid, a fatal termination occurring usually within a week, and in some cases even within 24 hours, although life may be prolonged for several weeks. Death is usually due to cardiac failure, which may occur suddenly; in rare instances to rupture of the wall of the heart. Sudden death is particularly prone to occur in diphtherial myocarditis, and may take place even when the patient is considered convalescent. Among the symptoms of bad

omen are marked pallor, restlessness, syncopal attacks, vomiting, a greatly accelerated pulse of low tension, bradycardia, and a modification of the heart-sounds resembling the fœtal type. In the milder forms, however, recovery is the rule, if early and adequate therapeutic measures be adopted.

Treatment.—The treatment of acute myocarditis is of great importance, and is the same as that of acute simple endocarditis.

Diseases of the Coronary Arteries

Before dealing with the various forms of chronic myocardial disease, it may be advisable to discuss the diseases of the coronary arteries, as they bear an important causal relation to some of them, coronary disease being usually accompanied by morbid changes in the cardiac musculature.

Ætiology and Pathology.—Syphilitic mesaortitis and atheroma of the ascending aorta may give rise to narrowing or complete occlusion of the orifice of one or both of the coronary arteries. Among diseases of the coronary arteries themselves, the two most important are: (1) chronic arteritis, and (2) atheroma. In syphilis of the coronary arteries the aorta is usually affected at the same time. Chronic arteritis and atheroma give rise to narrowing of the lumen, and eventually a thrombus may form, resulting in complete occlusion of the vessel.

Complete occlusion of a coronary artery or of one of its main branches is more frequent than has hitherto been supposed. It is much more common in males than in females, and is found particularly in middle or later life. Atheroma is a more frequent cause than chronic arteritis. It is rarely due to embolism, usually intracardiac in origin. The left coronary artery, or one of its main branches, is much more commonly affected than the right.

If the lumen of a coronary artery or of one of its main branches be completely and abruptly closed, as the result of one of the causes mentioned, sudden death, without the occurrence of structural changes, may occur; or infarction may ensue. The latter usually occurs near the apex of the left ventricle, or, less frequently, near the base of that chamber or in the intraventricular septum. Later, the infarct becomes surrounded by dense fibrous tissue, from which strands radiate between the adjacent muscle-fibres, resulting finally in scar formation. The result of this infarction is a weakening of the cardiac wall, which may lead to aneurysm or rupture. Thrombi may form within the aneurysm, or before it has formed, and result in embolism and consequent infarction in the brain, kidneys, spleen or elsewhere.

In those cases in which closure of a coronary artery or of one of its main branches is gradual, or is only partial, and in cases of narrowing or occlusion of the terminal branches, infarction does not take place; local anæmia results, and consequent atrophy of the muscle-cells and secondary fibrosis.

Symptoms of Coronary Disease.—The symptoms of those cases in which closure of a coronary artery or of one of its main branches is gradual, or is only partial, and of cases of narrowing or occlusion of the terminal branches, are those of chronic interstitial myocarditis.

Complete and abrupt closure of a coronary artery or of one of its main branches results in sudden death—this, indeed, being one of the common causes of sudden death; or the symptoms of infarction ensue.

Infarction of the Heart

Symptoms.—Pain is the most frequent and prominent symptom. Its onset is usually sudden, and the pain usually occurs without physical or mental exertion, or emotion. The pain is felt most commonly in the retro-sternal region, next most frequently across the front of the chest, next most commonly over a wide area of the back of the chest, and occasionally in the præcordium or in the epigastrium. It may be localised, or may radiate in certain directions, the latter being less frequent than in the case of ordinary angina pectoris. If the pain does radiate, the direction of the radiation is usually the same as that in angina. It may vary from that which is moderate to intense anguish. It is usually sudden, and may persist for hours or even days. The expression of the face is usually anxious or even one of intense anguish. The skin is usually pallid or even cadaveric in hue, and there is frequently a clammy sweat. There may be nausea or vomiting. The breathing is usually shallow, and the patient is afraid to make an effort to breathe normally. Cardiac asthma, or, less frequently, Cheyne-Stokes respiration, may be present. Acute pulmonary œdema is rarely met with. The mind is usually clear, but occasionally there is mild delirium. The pulse is usually increased in frequency, and is of smaller amplitude and weaker. I have seen a few cases in which there has been bradycardia, even pronounced. The blood-pressure almost invariably falls, usually considerably and it may be markedly so, and frequently continues to do so and rapidly. The transverse area of cardiac impairment becomes increased, usually considerably and it may be even markedly so, and the dilatation is generally rapid. On auscultation, both cardiac sounds are found to be weaker, and, further, the first sound is often short, sharp and clear, resembling the second sound. The long pause is often diminished, and occasionally a tic-tac heart-beat is present. Rarely gallop rhythm is to be heard. Extra-systoles, or, less frequently, paroxysmal tachycardia, transient or persistent auricular fibrillation, or auriculo-ventricular block, may be present. A mitral, and a tricuspid, systolic bruit may develop—due to *relative* incompetence of the valves. There may be signs of chronic venous congestion and œdema of the lungs, particularly the bases. Localised pericardial friction in the area of the infarct may sometimes be noted, and if so, is of great diagnostic importance. If the patient lives for a day or two, there is usually slight or moderate pyrexia and frequently a moderate leucocytosis, the polynuclear cells being relatively increased in number.

The forms of the electro-cardiograms which may be met with are described on pages 922–923.

Diagnosis.—A correct diagnosis is practically always possible from a careful consideration of the clinical features, including the onset, together with the results of electro-cardiographic examination; indeed, it may usually be made without the aid of the latter. All that may be usefully added to the clinical features already described is that the pain is not relieved by vaso-dilators. The electro-cardiograms are usually characteristic and of great diagnostic value. Those of the first stage are perhaps pathognomonic; those of the second stage are not so characteristic as those of the first, but, taken together with the clinical features, they afford strong

corroborative evidence; while even the changes in the *T* deflections in lead III sometimes found ultimately are very suspicious.

The pain of ordinary cardiac failure, ordinary angina pectoris, rupture of a saccular aneurysm of the thoracic aorta, colic, whether of intestinal, hepatic or renal origin, perforated gastric or duodenal ulcer, acute pancreatitis and other abdominal emergencies should be excluded.

Prognosis.—Death may occur within a few minutes or a few hours. If the patient lives for a few days, he may die from chronic venous congestion within a few weeks or months; or, more frequently, he survives. In the latter event, progress is very slow; there is subsequent cardiac impairment, although rarely the patient is almost as well as previously; while subsequent attacks may occur.

Treatment.—The various measures which may be applicable to any form of cardiac disorder should be considered in detail. Complete and long-continued—at least 3 months—rest, both physical and mental, is imperative. Depletive measures should be avoided. The food should be nutritious and easily digestible, and given in small quantities at frequent intervals. In the early stages, warmth to the body, stimulating liquid foods, and diffusible stimulants are indicated, and the bowels should be opened by means of enemata. For the pain, morphine hypodermically, in sufficient dosage, and preferably with atropine, should be employed. No attempt should be made to hurry convalescence.

Chronic Myocardial Disease

Of the various forms of chronic myocardial disease, the three most common are fatty infiltration or cardiac lipomatosis, fatty degeneration, and chronic interstitial myocarditis; the last of these has also been variously termed chronic myocarditis, fibrous myocarditis, sclerotic myocarditis cardio-sclerosis, fibroid infiltration and fibroid degeneration. Fatty degeneration and fibroid degeneration often coexist, and to this condition the name of fibro-fatty heart is sometimes given.

Fatty Infiltration

Fatty infiltration consists in an excess of fat in those situations in which it is naturally found, and also in its deposit between the fasciculi of the cardiac musculature.

Ætiology.—Heredity is certainly a factor, and the condition is more common in males, and during or after middle life, being rare in early life, and comparatively rare before middle age. It is usually associated with general obesity, a generous appetite, and lack of exercise and fresh air. It is more especially found in connection with over-indulgence in carbohydrates, fats and alcohol, particularly malt liquors and sweet wines, and faulty metabolism is generally present. It is also apt to occur in individuals suffering from affections of the lungs which cause embarrassment of the pulmonary circulation, such as emphysema, cirrhosis and chronic fibroid tuberculosis.

Pathology.—The affection is chiefly distributed along the arterial branches, often causing atrophy of the muscle fibres by compression. It is usually most marked over the right ventricle. The deposit of fat commences

in the subepicardial fat, and may even extend to the subendocardial tissue. In some instances the atrophied muscle fibres become the seat of true fatty degeneration, due to interference with their nutrition. In fatty infiltration, more or less dilatation of the cardiac chambers is usually present, and is often accompanied by hypertrophy.

Symptoms.—The patient is usually stout and flabby, and the subjective symptoms are those of an enfeebled circulation. Exertion is frequently accompanied by dyspnœa, a sense of oppression in the chest, and slight cyanosis, with a tendency to perspire easily; the association of cyanosis with dyspnœa on exertion is one of the most usual features of the affection. The patient is easily fatigued by physical or mental effort, and there is often giddiness or faintness. The digestive functions are, as a rule, little, if at all, impaired; on examination, however, there may be evidence of gastric dilatation and of hepatic enlargement. The functions of the nervous system are often affected; there is frequently impairment of memory, and not infrequently the patient is soporose, although, on the other hand, he may complain of insomnia. Cheyne-Stokes respiration is occasionally to be noted. The urine may be large in quantity, pale in colour, and of low specific gravity. The characteristics of the pulse vary considerably; as a rule the rate is increased, it is weak, the vessel is empty, there is hypotension, and the vessel wall is not thickened. On the other hand, the vessel may be full, the blood-pressure supernormal, and the wall thickened. The pulse is usually regular, but may exhibit one of the forms of irregularity. The cardiac impulse is usually feeble, unless hypertrophy is also present, when its area and force may be increased, and pulsation in the neck may be noted. The area of cardiac impairment is generally increased, as the result of dilatation or hypertrophy. On auscultation, the heart sounds, especially the first, are found to be weak, low in tone and muffled; indeed, in the advanced stage the first sound may be almost inaudible: this may be due not only to an enfeebled left ventricle, but also to the unusual thickness of the thoracic parietes in these cases. Murmurs are usually not present, but a soft mitral or tricuspid bruit may be audible, owing to cardiac dilatation.

Later on, there may be evidence of œdema of the dependent parts and of the lungs, while the urine may be scanty, high coloured and albuminous.

Diagnosis.—Fatty infiltration may be diagnosed from the indications of an enfeebled circulation, together with evidence of weakness of the cardiac impulse and sounds, occurring in a person who is the victim of obesity.

Prognosis.—If appropriate therapeutic measures be carried out, the prognosis is usually favourable; otherwise the condition is apt to be progressive. As has been already noted, if fatty infiltration persist for some time, true degeneration is apt to arise.

Treatment.—This consists mainly in dieting, systematic elimination, and abundance of fresh air, while carefully regulated exercise and other measures which have for their object the reduction of bodily fat should also be employed. The diet should be strictly moderate in amount, and sugars and starches, especially bread and root vegetables, should be proportionately diminished; the diet, therefore, should be mainly nitrogenous. The food should be eaten slowly and thoroughly masticated. The amount of fluid with meals should be restricted, and taken at the end of the meal, while,

on the other hand, a considerable quantity of fluid between meals is advisable. It is better to avoid alcohol altogether; but, if this be not possible, brandy or whisky, well diluted, Moselle, or claret is much preferable to malt liquors, Burgundy, port, or champagne.

Regulated exercise in the open air, such as walking, riding, golfing, and cycling, is valuable. Graduated exercises are of special value in cases of slight cardiac failure due to fatty infiltration. In my opinion the simple forms of movements are, certainly in the majority of cases, better than the resistance exercises as practised at Nauheim, and I am inclined to favour Swedish exercises. With regard to any form of physical exertion, care should be taken that it is at first limited in amount, and only gradually increased, while it should in every case stop short of producing any indications of cardiac distress. Systematic elimination, by means of purgatives, Turkish baths, or a visit to some spa, is sometimes useful.

Fatty Degeneration

In fatty degeneration the muscle-fibres are more or less replaced by fat.

Ætiology.—Heredity is certainly a factor, and the condition is more common in males. While it may occur at any period of life, it is far commoner during middle life and in the elderly. The condition is found in altered states of the blood, especially pernicious anæmia and leucocythæmia, while it has been noted in scurvy, purpura, hæmophilia and diabetes. The chemical poisons, especially alcohol, phosphorus, arsenic, antimony, and lead, and the acute infective fevers, especially typhus, enteric fever, diphtheria, erysipelas, small-pox, septicæmia, pneumonia, and influenza, as well as cachectic states the result of cancer, tuberculosis, long-continued suppuration, and other wasting diseases, are also responsible factors in the production of the disease. Among other causes are the retention of waste products in chronic gout and nephritis; chronic venous congestion due to mitral disease and those affections of the lungs which cause embarrassment of the pulmonary circulation; long-standing valvular disease with dilatation; and as a sequel to fatty infiltration. It may be noted that phosphorus, even in small doses, may cause fatty degeneration within a few days.

Pathology.—The affection may be general or local in its distribution, the latter being the more common. In both cases, but especially in the local form, the ventricles are affected to a greater degree than the auricles, and the left ventricle than the right, and the musculi papillares and the muscle beneath the endocardium are principally involved. The heart may or may not be enlarged; indeed, in pure degeneration it may be even smaller than normal. In this connection it may be stated that fatty degeneration may accompany or succeed dilatation or hypertrophy, while, on the other hand, dilatation may follow degeneration. The organ is softer in consistence and flabby, and is more easily torn. The colour may be uniformly pale yellowish, or buff, or light yellowish brown—the so-called "faded-leaf" colour. The condition is, however, more apt to occur in patches, resulting in a streaked or mottled appearance as a whole, which has been likened to that of the breast of a thrush—"thrush's-breast," or to that of the fur of a tabby cat—"tabby cat striation." On microscopic examination of a section which has been

stained with osmic acid, the small fat globules are seen inside the muscle-fibres, their envelopes being blackened by the acid.

Symptoms.—The clinical picture is in most cases indefinite; in rare instances, indeed, the disease is latent during its whole course, until a fatal termination occurs, due to syncope or angina pectoris, or from some other cause.

The general appearance of the patient varies, which may be due to the causal factor, *e.g.* pernicious anæmia. The countenance not infrequently is pale and waxy, but, on the other hand, it may be ruddy, or even cyanotic; cyanosis, however, is rarely seen unless there is much cardiac dilatation. Arcus senilis, coldness of the extremities, and a subnormal temperature may be present. The most common subjective symptoms are dyspnœa, together with some degree of cyanosis of the face, and perhaps giddiness and acceleration of the pulse-rate, on exertion—dyspnœa on exertion being an early and persistent symptom. In some cases there is a sense of uneasiness, and even actual pain, in the præcordium on exertion, but it should be noted that cardiac pain is not usually a prominent feature of the disease except in those cases in which angina pectoris accompanies it; the latter, however, is by no means uncommon. Complaint is sometimes made of debility and general lassitude. The digestive functions are usually impaired, as evidenced by anorexia, drowsiness after meals, atonic dyspepsia, with a tendency to flatulent distension of the stomach, torpidity of the functions of the liver and bowel, and occasionally gastro-intestinal catarrh. Cerebral symptoms, as described on page 754, due to a diminished supply of blood to the brain, are often present and of great diagnostic importance. It is possible that very rarely Adams-Stokes syndrome may occur. There may be a persistent tendency to sighing or yawning, while occasionally Cheyne-Stokes respiration is present; this, however, is usually not met with until an advanced stage of the disease, when it is not infrequent, and occurs for the most part during sleep.

The urine is usually of low specific gravity, and not infrequently contains a trace of albumin and tube casts. There is sometimes a certain amount of œdema about the ankles, but general dropsy is rare, unless there is much cardiac dilatation.

The pulse is almost always altered, the rate varying considerably in different cases; it may be increased, especially in the more acute forms of the disease. On the other hand, there may be bradycardia, even of marked degree, in the more chronic forms, especially in the senile variety. The pulse is usually small, ill-sustained, and the blood-pressure is almost always subnormal; but, on the other hand, its volume may be full. It may be perfectly regular, or irregular. The vessel wall may be normal in the acute forms, or thickened, as occurs in a large proportion of cases of the senile type.

The apex-beat is frequently not visible, and may not be palpable; if present at all, it is usually extremely weak, giving the impression to the hand of a short feeble tap, and there is usually an absence of pulsation in the epigastrium. Stokes pointed out that the impulse may only be felt in the neighbourhood of the left border of the lower end of the sternum. The apex-beat is, as a rule, not much displaced outwards. The area of cardiac impairment is generally enlarged, but usually not to any great extent, unless much dilatation has supervened or hypertrophy exists.

On auscultation the first sound is usually found to be short, sharp and clear, and diminished in intensity; indeed, in the advanced stage of the disease it may be almost, if not entirely, inaudible at the apex, although faintly heard in the neighbourhood of the left border of the lower end of the sternum. In the case of rapidly-acting hearts, the fœtal type of cardiac action may be approximated. A mitral and tricuspid systolic murmur may be present, especially when the cause is anæmia or one of the acute infective fevers.

Diagnosis.—The diagnosis of fatty degeneration of the heart is often extremely difficult, as the clinical picture is in most cases indefinite, and indeed in rare instances the disease is latent during its whole course until the occurrence of a fatal termination. We may often suspect the existence of fatty degeneration without being able to confirm it; a positive diagnosis, indeed, is in the opinion of some not possible. The presence of arcus senilis is in itself of no diagnostic importance, but is of some value when accompanied by other symptoms. Cheyne-Stokes respiration is not pathognomonic of fatty degeneration, since it is also to be met with in other morbid affections.

The following points are of importance in a consideration of the question of diagnosis: a causal factor, an absence of valvular disease, the presence of dyspnœa and cyanosis on exertion, the occurrence of angina pectoris, cerebral symptoms, especially syncopal and epileptiform attacks, a pulse of small volume and of low tension, an enfeebled cardiac impulse, general enlargement of the area of cardiac impairment, and an alteration of the cardiac sounds as already noted.

In the opinion of some the differential diagnosis between fatty and fibroid degeneration is impossible, and it should also be remembered that they often occur in association. The existence of constant torpor, Cheyne-Stokes respiration, and apoplectiform attacks, and the occurrence of a fatal termination before marked cyanosis, general anasarca, hepatic enlargement, and other indications of a failing right heart occur, are more suggestive of fatty degeneration. Further, in the fibroid form of myocardial degeneration, the pulse is usually more frequent, stronger, and of normal or supernormal tension, while the vessel wall is thickened, the enlargement of the area of cardiac impairment is usually greater, and the aortic second sound accentuated. It should, however, be borne in mind that fatty degeneration may supervene upon the hypertrophy of valvular disease. In the differential diagnosis from valvular disease with cardiac failure, the history may be helpful, as also the characteristic murmurs of the various forms of valvular disease. In mitral disease, for example, hypertrophy is more marked, and, if cardiac failure be present, the usual clinical picture is one of chronic venous stagnation—a condition which is comparatively rare in fatty degeneration—and the degree of cardiac dilatation is greater.

Prognosis.—Taking the cases as a whole, the prognosis of fatty degeneration is grave, as it is one of the commonest diseases in which sudden death occurs. The duration of life, however, may vary from a few months to many years. In considering the probable duration of life, among the points which should be considered are the following. When the affection supervenes upon fatty infiltration the patient may live for many years. In the acute forms, as, for example, when due to acute infective diseases or anæmia, the im-

mediate prognosis is grave—especially if cardiac failure makes its appearance at an early stage of the disease—but the ultimate prognosis is not infrequently favourable; the outlook in diphtheritic cases is, however, uncertain. In the chronic forms, as, for example, in coronary disease, the immediate prognosis is more favourable, but the ultimate prognosis is not so good; and yet even in these cases life may be prolonged for some years, if the patient be able to live a carefully regulated life.

A fatal termination may result from gradual or rapid cardiac failure, or from sudden death, the latter occurring perhaps in a majority of cases, and may be due to syncope, angina pectoris, or rupture of the heart. Rupture of the heart is perhaps not so common in fatty as in fibroid degeneration.

Treatment.—The treatment of fatty degeneration is the same as that of chronic interstitial myocarditis.

Chronic Interstitial Myocarditis

Definition.—By chronic interstitial myocarditis is meant an increase of the interstitial fibrous tissue of the cardiac wall, as a consequence of which atrophy and degeneration of the muscle-fibres result.

Ætiology.—Heredity is certainly a factor, and the condition is more common in males in about the proportion of two to one, and during or after middle life. It is to be found in occupations involving prolonged muscular or mental strain. The condition may follow acute myocarditis. Disease of the ascending aorta involving the orifice of one or both of the coronary arteries and, still more frequently, disease of the coronary arteries themselves, constitute the commonest causes. They are fully described on page 860. Chemical poisons, conditions of defective metabolism, such as chronic gout, and increased peripheral resistance, as, for example, in arterial hypertrophy and granular kidney, also play a part in the ætiology of the disease. Among other causes are chronic venous congestion, due to mitral disease and those affections of the lungs which cause embarrassment of the pulmonary circulation; old standing valvular disease; the chronic adherent form of pericarditis; acute infective fevers; and perhaps altered states of the blood.

Pathology.—The affection may be general or local in its distribution, the latter being usually due to coronary disease. When the affection follows acute myocarditis, a more or less diffuse fibrosis, usually most marked beneath the pericardium and endocardium, is found. In both forms the auricles are little, if at all, affected, and the left side of the heart is much more commonly affected than the right, especially in the neighbourhood of the apex and the lower part of the interventricular septum. When the condition is the result of chronic venous congestion, however, it is more in evidence on the right side of the heart. There is an increase in the thickness of the cardiac wall—the so-called false hypertrophy—and ultimately dilatation occurs. White masses of fibrous tissue, varying in size from that of a pea to a five-shilling piece or even larger, and irregular in shape, are to be observed replacing portions of the cardiac wall or interventricular septum. When the condition has continued for some time and the increase of fibrous tissue is extreme, the affected muscle-fibres may be entirely replaced by dense scar-like tissue. When the coronary arteries are diseased, the aortic

cusps are not infrequently the seat of primary chronic endocarditis, and there may also be widespread atheroma and cirrhosis of the kidneys.

Symptoms.—The clinical picture of fibroid degeneration is a varied one; if the morbid condition be general or extensive, the disease may be difficult to distinguish from fatty degeneration, with which it often coexists. In very rare instances, the disease is latent during its whole course and is only discovered on post-mortem examination. The onset of the symptoms is gradual, and the clinical features are those of chronic heart failure. The most common symptoms are progressive dyspnœa on exertion, together with slight cyanosis of the face; there may also be a sense of oppression in the præcordium, and not infrequently pain on exertion, and slight œdema about the ankles, especially at night. There may be a sensation of fullness and throbbing in the head, noises in the ears, and flashes of light before the eyes. There may be symptoms of cerebral anæmia, as described on page 754. The urine is usually diminished in quantity and of high specific gravity, and may contain albumin, which is frequently present in the later stages of the disease. The patient may suffer from attacks of cardiac asthma, especially at night, and angina pectoris is of common occurrence. Cheyne-Stokes respiration is sometimes found. The usual indications of failure of the right side of the heart may supervene. Ultimately the patient is apt to suffer from marked dyspnœa on the slightest exertion, orthopnœa, and the most distressing cardiac asthma, while the quantity of urine steadily diminishes, and anasarca increases.

The pulse may be of normal rate, or increased in frequency, or bradycardia may be present, the last of these being relatively common. The character of the pulse varies considerably. It is usually fuller than normal, with heightened pressure, although the latter is not pronounced, unless cirrhosis of the kidney or some such affection exists; when cardiac failure is present, however, the pulse may present the opposite characteristics. The wall of the radial artery is usually thickened. When the affection is the result of chronic venous congestion or of chronic adhesive pericarditis, the pulse may be feeble, of subnormal pressure, with no evidence of thickening of the radial wall. The apex-beat is displaced downwards and to the left, its area and force are increased, the area, however, being proportionately greater and the force of the apex-beat proportionately less than in pure hypertrophy. The area of cardiac impairment is increased in all directions. When the affection is due to mitral disease or emphysema, the impulse is most obvious near the ensiform cartilage, and the increased area of impairment to the right of the sternum. On auscultation, the first sound is prolonged and muffled at the apex, with often a soft systolic murmur; the first sound is barely audible at the base, and may be entirely absent. The second sound in the aortic area may be accentuated and reduplicated; when due to mitral disease, however, the second sound in the pulmonary area may be accentuated, but at the same time is less ringing in character than in the earlier stages of valvular disease. A tricuspid systolic bruit is sometimes heard.

Diagnosis.—An absolute diagnosis of chronic interstitial myocarditis is not infrequently a matter of extreme difficulty. The differential diagnosis between this condition and fatty degeneration has been already dealt with on page 866. It is also necessary to distinguish the affection from the cardiac failure of valvular disease, as for example, relative mitral incompetence

occurring in fibroid degeneration from mitral incompetence due to primary organic disease of the valve—a problem of the utmost difficulty. In the former case there is no history of valvular disease, the subjective symptoms are frequently out of proportion to the physical signs, and angina pectoris, and syncopal and epileptiform attacks are of more frequent occurrence.

Prognosis.—The prognosis of the affection closely resembles that of fatty degeneration. Here also the duration of life may vary from a few months to many years. A fatal termination may take place as the result of gradual or sudden cardiac failure. In estimating the prognosis, among other things which should be taken into consideration are the presence or absence of the pulsus alternans, angina pectoris, and syncopal attacks.

Treatment.—It is of great importance that the patient should curtail his physical and mental activities so as not in any way to exceed the limited strength of the heart. His daily life should be considered with great care and in detail. Carefully regulated exercise in the fresh air is permissible, but violent and sudden efforts should be strictly forbidden. Such exercise as walking against a wind and cycling uphill are contra-indicated; on the other hand, quiet walking on the level, or even slow walking up an incline, quiet cycling, croquet, and even riding or golf may sometimes be allowed in suitable cases. In all cases, exertion should stop short of producing breathlessness, palpitation, fatigue, a sense of tightness across the chest, or præcordial pain or distress. If these precautions be not taken, there is real danger. High altitudes are better avoided. Only warm bathing should be allowed. The clothing should be warm. Particular care should be taken with regard to diet; it should be most carefully regulated on the lines previously laid down. Gastric and intestinal dyspepsia, especially with flatulence, should be avoided, or treated when present. What fluid is taken with meals should be taken *at the end*. Overloading the stomach should be avoided. Rest before and after food, and in the afternoon, should be enjoined. The state of the bowels should receive most careful attention. In these cases it is sometimes of advantage to diminish the body weight. If there be supernormal blood-pressure, it should be regulated by the methods described previously. If anæmia be the cause or an accompaniment of the condition, it should be adequately treated.

When there are indications of cardiac failure, rest, proportionate to the degree of failure present, is imperative; other therapeutic measures also, as previously described, should be adopted. The indications for one of the digitalis series of drugs have already been discussed.

Hypertrophy of the Heart

In cardiac hypertrophy there is an increase in the thickness of the walls of one or more of the cavities of the heart, due to an increase in the actual size, and possibly also in the number, of the muscle-fibres. The hypertrophy may include the musculi papillares, columnæ carneæ, and musculi pectinati.

It is customary to divide hypertrophy of the heart into three kinds, namely—(1) The concentric, in which with the increased thickness of the walls the cavities are diminished in size; (2) the simple, in which the cavities are normal in size; and (3) the excentric type, in which the cavities are increased in size—in other words, there is hypertrophy with dilatation.

In the opinion of some, the concentric variety only exists as a post-mortem change.

Ætiology.—Hypertrophy is apt to occur when the heart has been subjected to an excessive amount of work. It is more common, therefore, in men, on account of their greater exposure to long-continued excess of muscular effort and to mental strain. Among other causes are long-continued over-indulgence in food, alcohol, or tobacco, lithæmia, supernormal blood-pressure and arterial disease independent of kidney disease, nephritis—especially the chronic interstitial form, chronic valvular disease, congenital atresia of, or pressure upon, the aorta, chronic adhesive pericarditis, certain affections of the nervous system causing persistent increased cardiac rate, hyperthyroid secretion, chronic disease of the lungs—such as emphysema, cirrhosis, and chronic fibroid tuberculosis, chronic disease of the bronchi, and atheroma of the pulmonary artery. Drinking large quantities of beer, chronic interstitial nephritis, and aortic disease may give rise to enormous hypertrophy.

In the case of long-continued muscular effort and mental strain, long-continued over-indulgence in food, alcohol, or tobacco, affections of the nervous system, and hyperthyroid secretion, the hypertrophy is likely to be general; in supernormal blood-pressure and arterial disease, nephritis, and aortic valvular disease, the left ventricle is more especially affected; whereas in the chronic affections of the lungs or of the bronchi, and disease of the pulmonary artery, the right ventricle is principally involved.

Pathology.—Hypertrophy of the heart may be general or local. In the former, all the chambers of the heart are involved. The ventricles are more affected than the auricles, for the walls of the latter contain more fibrous tissue. When the condition is local, which is much the more common, while all the chambers are not affected, there is, as a rule, hypertrophy of more than one, though in varying degree. The following is the comparative order of frequency: left ventricle, right ventricle, left auricle, right auricle. When the left ventricle is affected, the apex of the heart is accentuated, and the whole organ is elongated and rather conical in form. When the right ventricle, on the other hand, is concerned, the apex is less pronounced, and the whole organ broader and somewhat quadrate in form. The excentric variety of hypertrophy may give rise to enormous enlargement of the organ, in which case the heart is often spoken of as a "beefy heart" or a "cor bovinum." This is especially apt to occur in aortic valvular disease.

For the development of full hypertrophy, an adequate blood supply is necessary, and in this connection the state of the general nutrition, as well as the anatomical and physiological condition of the coronary arteries, is of considerable importance.

Symptoms.—The symptoms of the morbid condition which is the cause of the hypertrophy, whether of the left or right side of the heart, may be present. With regard to the hypertrophy itself, there may either be a complete absence of subjective symptoms, or, on account of increased tension in the cerebral circulation, a sensation of fullness and throbbing in the head, headache, usually in the occipital region, flushings, noises in the ears, flashes of light before the eyes, and giddiness. Sometimes patients complain of discomfort or even of actual pain in the præcordium, especially when lying on the left side, and this sensation is aggravated by exertion. Actual pain,

however, is not common, unless perhaps in the case of neurasthenics and of subjects of tobacco poisoning. Another symptom of which the patient may complain is palpitation. When cardiac failure supervenes, complaint may be made of dyspnœa on exertion and other symptoms.

Hypertrophy of the left ventricle is characterised by a full strong pulse, of prolonged duration, and by a blood-pressure above the normal. The pulse-rate, on the other hand, is apt to be rather lower than normal. There may be some bulging and widening of the intercostal spaces in the præcordial area to the left of the sternum, especially when the hypertrophy occurs during the growing period of life. The apex-beat is displaced downwards and outwards; it may be as low as the sixth, seventh, or even eighth intercostal space. Its extent and force are increased, and its character "heaving" or "thrusting," the beat being slower and longer than normal. *This heaving or thrusting of the apex-beat is the most characteristic feature of the condition.* The area of impairment is increased, both from above downwards and transversely; it may even extend downwards to the eighth interspace, and transversely to the anterior axillary line. On auscultation, the first sound in the mitral area is frequently long, low in pitch, and muffled; the short pause may be lengthened, and the long pause shortened, while the second sound in the aortic area is frequently accentuated. Sometimes the first sound is reduplicated, and then is usually best heard rather to the inner side of the apex-beat. The aortic second sound also is occasionally reduplicated.

When there is considerable dilatation with the hypertrophy, occurring either in the first instance or subsequently in association with cardiac failure, the pulse increases in frequency, the blood-pressure becomes lower, the apex-beat becomes more diffuse, weaker, abrupt and rapid, and is of a tapping character. The transverse area of impairment becomes enlarged, and the first sound may be accentuated, sharp, clear, high in pitch, and considerably shortened. Other indications of cardiac failure, such as œdema, may also supervene.

In hypertrophy of the right ventricle there may be, more especially in children, a certain amount of bulging in the region of the ensiform cartilage, while not infrequently there is pulsation in the epigastrium, diastolic in time. When the condition is marked, there may be a heaving impulse in the epigastrium, and over the lower sternum and costal cartilages, and in such cases even more marked than that of the left ventricle. The apex-beat is displaced chiefly to the left and only slightly downwards, and may be normal, diffuse and indefinite, or altogether invisible. When the right ventricle is much enlarged, that chamber may displace the left ventricle backwards, so that the clinical apex-beat is formed entirely by the right, instead of the left, ventricle; in these cases systolic recession over the lower part of the præcordium is sometimes observed. Systolic recession in the third, fourth and fifth intercostal spaces between the margin of the sternum and the parasternal line on the left side, or in the fourth and fifth intercostal spaces on the right side, may be present. The area of cardiac impairment is usually increased, especially to the right. The left border may also be displaced outwards, but rarely extends beyond the nipple line. The first sound in the tricuspid area is not infrequently louder than normal, and the second sound in the pulmonary area is usually accentuated and may be reduplicated. Later, the symptoms of tricuspid incompetence may supervene.

When hypertrophy of the auricles occurs, it is accompanied by dilatation. In hypertrophy of the left auricle, the area of impairment may be higher than normal. When the right auricle is affected, there may be an extension outwards of the area of impairment in the third and fourth right intercostal spaces.

Diagnosis.—A diagnosis of hypertrophy of any chamber or chambers of the heart should not be made merely from the presence of pulsation or percussion impairment in an abnormal area, for these may be due to causes other than hypertrophy, as, for example, morbid conditions of the lungs or pleuræ. The most reliable sign of hypertrophy of the heart is a heaving or thrusting impulse. It should be remembered that mere increase of force of the apex-beat is sometimes met with in nervous subjects, especially in the young whose chest-walls are thin; but in these cases there is no displacement of the apex-beat, the impulse is sharp and short, the area of impairment is not increased, and the sounds of the heart are not altered in the characteristic manner described. I have seen an incorrect diagnosis of hypertrophy of the left ventricle made in cases of retraction of the left lung; in these cases there is an increased area over which the healthy heart comes into direct contact with the chest-wall. The apex-beat, however, is displaced upwards, is not heaving or thrusting in character, and there are signs of a pulmonary lesion. Hypertrophy of the right ventricle can be diagnosed when the objective signs already mentioned are present. The diagnosis of hypertrophy of the left auricle is exceedingly difficult; hypertrophy of the right auricle is more easily detected.

Prognosis.—This depends upon, among other things, the cause, the degree of hypertrophy, the degree of dilatation present, the condition of the systemic and coronary arteries, and of the myocardium. With regard to the first, the prognosis depends very largely upon whether this is serious and irremediable, as when renal cirrhosis is present, in which case dilatation is apt to supervene; or whether it is merely transitory, as, for example, when the result of a period of excessive muscular strain, in which case it seems clearly established that hypertrophy may disappear when the cause no longer exists. Long-continued hypertrophy is apt to be followed by dilatation which adds to the gravity of the condition as a whole.

With regard to the condition of the coronary arteries, it need only be pointed out that anginal attacks in all probability point to the existence of coronary disease, in which case the supply of blood to the hypertrophied heart will be insufficient, with a resultant tendency to degeneration. With regard to the integrity of the myocardium, the importance of testing the cardiac response has already been fully considered.

Treatment.—The hypertrophy itself does not need treatment. It is always advisable, however, to consider the cause, and, in some cases, as, for example, when chronic Bright's disease, supernormal blood-pressure, or arterial disease is present, it should be suitably treated. In order to provide a good supply of food to the heart-muscle, we should see that the patient obtains plenty of fresh air, and an adequate supply of nutritious and easily digestible food, and any dyspepsia or anæmia present should receive attention. Undue physical or mental strain should be avoided. If cardiac failure supervene, it should be treated as described elsewhere.

Dilatation of the Heart

In cardiac dilatation there is an increase in the capacity of one or more of the cavities of the heart.

Looking at the condition from the pathological standpoint, the muscular walls of the chambers may be of normal thickness, which is not common; more usually they are either thinner or thicker than normal. The last is by far the most common, *i.e.* in the great majority of cases there is some hypertrophy with the dilatation: this is called excentric hypertrophy, and has already been described. It should be remembered that when dilatation has existed for a long time, the walls become thin, although, perhaps, in the first instance thickened.

Looking at the subject from the clinical standpoint, however, dilatation means an increase in the capacity of one or more of the cavities of the heart as the result of impairment of the function of tonicity; this form of dilatation is associated with cardiac failure. From this point of view, dilatation with hypertrophy is only included when the dilatation is in excess of the hypertrophy. Hypertrophy is apt to be followed by dilatation, and the latter, therefore, may be secondary to the former.

In dilatation a larger quantity of blood exists in the affected chamber than normal, while the propulsive power is diminished; the chamber, therefore, cannot empty itself. As the dilatation progresses, the contraction of the chamber becomes less effective, and the amount of residual blood progressively increases.

Ætiology.—Cardiac dilatation is more common in men, on account of their greater exposure to long-continued excess of muscular effort and to mental strain; this is especially so in certain occupations. General cardiac dilatation may occur in any of the following conditions: severe or prolonged pyrexia, more especially in the case of pneumonia, scarlet fever, typhoid or typhus fever; toxæmias, as influenza and diphtheria, alcoholism, tobacco poisoning, and overdosage by the salicylates; various forms of anæmia; cachectic conditions; myocardial degeneration: rheumatic carditis; and affections of the coronary arteries causing defective blood supply. In the case of toxæmia of influenza and diphtheria, as well as in the acute carditis of rheumatism, dilatation may be acute.

Dilatation may occur secondarily to hypertrophy, especially when the nutrition is defective. One of the most common causes of secondary dilatation is some form of mechanical obstruction, slowly produced, either in the blood vessels or in the valves. Some of the causes of hypertrophy may produce acute dilatation by acting quickly, before there is time for hypertrophy to occur; this is especially the case when the muscular fibres are already impaired. Thus, whereas prolonged and continued excess of muscular effort tends to produce hypertrophy, a sudden physical strain is apt to produce acute dilatation, especially if the individual be not in training (see primary cardiac overstrain); further, in cases of completely established hypertrophy, dilatation may be produced with apparent suddenness by a comparatively trivial ailment, such as bronchitis, influenza, or any febrile attack.

It should be particularly noted that a very common clinical condition in which acute cardiac dilatation occurs is the supervention of a new heart rhythm, such as auricular fibrillation.

In addition to disease of the pulmonary artery, and the chronic pulmonary affections enumerated in the ætiology of hypertrophy, acute dilatation of the right side of the heart may occur in pneumonia, œdema of the lungs, and in pleurisy with effusion.

Pathology.—Dilatation rarely affects one chamber alone, all of them being usually affected in some degree, although unequally so. The heart becomes larger, and when the condition is more or less general the organ approaches the globular form, particularly when the right side is affected. With the increase in the capacity of the ventricles, the dimensions of the auriculoventricular orifices also increase, and this results in what is known as *relative* incompetence. In dilatation of the auricles there is usually enlargement of the venous channels.

Symptoms.—The symptoms of the cause are sometimes to be noted, and in addition there is usually languor, and fatigue on physical exertion, while strain is liable to induce a sensation of faintness, or even actual syncope. Shortness of breath and palpitation on exertion are of common occurrence, while there may be an uncomfortable feeling, amounting to actual pain, in the præcordium. Some degree of cyanosis of the face may also be noted. The digestive functions are usually impaired, as shown by anorexia, drowsiness after meals, atonic dyspepsia with a tendency to flatulent distension of the stomach, torpidity of the functions of the liver and bowel, and occasionally gastro-intestinal catarrh. Cerebral symptoms, such as giddiness, lack of power of concentration, early fatigue on mental effort, a tendency to drowsiness, disagreeable dreams, nervousness, and even symptoms of mental derangement may be noticeable. Jaundice is not infrequently present, and also vomiting, hepatic enlargement, œdema of the feet, and sometimes splenic enlargement. The urine may be scanty, and contain albumin, and even blood and tube casts. There is a tendency to chronic congestion and œdema of the lungs, particularly of the bases, and ascites and pleural effusion are occasionally present. As the case progresses, dyspnœa may occur on the slightest exertion, and orthopnœa, cardiac asthma, anasarca and a still further diminution in the amount of urine.

The pulse is usually found to be more frequent, of smaller amplitude, and weaker, while the blood-pressure is lower than normal. Distension and pulsation of the jugular veins may take place.

Sometimes, particularly in children, in dilatation of the right ventricle there is a certain amount of bulging of the præcordium in the region of the ensiform cartilage. The apex-beat is displaced chiefly outwards. It is diffuse and often difficult or even impossible to locate, but if it can be determined is found to be weaker than normal and tapping in character. In dilatation of the left ventricle a diffuse wavy impulse may be present in the anterior axillary line. In enlargement of the right ventricle the clinical apex-beat may be formed by the right, instead of the left, ventricle, in which case there may be a more diffuse systolic recession over the lower part of the præcordium, in place of the normal apex-beat; also systolic recession in the third, fourth and fifth intercostal spaces between the margin of the sternum and the parasternal line on the left side, or in the fourth and fifth intercostal spaces on the right side, may be present. The area of cardiac impairment is increased transversely, and is more marked to the left when the left ventricle is chiefly involved and to the right in the case of the right ventricle. In dilatation of the

left auricle the area of impairment may be higher than normal, and in dilatation of the right auricle it may extend outwards in the third and fourth right intercostal spaces. On auscultation, both cardiac sounds are found to be weaker; and, further, the first sound is short, sharp and clear, resembling the second sound in character. The long pause is often diminished, on account of acceleration of the rate of the heart, and sometimes the tic-tac heart-beat is present. Occasionally gallop rhythm is to be heard. A mitral, and in a still larger proportion of cases a tricuspid, systolic bruit may be present—on account of *relative* incompetency of these valves.

The physical signs of dilatation enumerated above may be modified by those of the cause of the condition, or of accompanying hypertrophy. In the case of valvular disease, the original murmurs may become weaker or even inaudible when dilatation occurs.

The symptoms of cardiac dilatation may come on rapidly in the acute forms or more gradually in the more chronic cases. In many of the cases associated with the onset of a new cardiac rhythm the dilatation takes place so rapidly that in the space of even a few hours there are urgent dyspnœa, extreme hyperæsthesia of the chest-wall, evidence of œdema of the lungs, and enlargement and pulsation of the liver. When dilatation is due to a sudden physical strain, faintness passing into actual syncope, together with vomiting, and even fatal syncope, may occur before the signs of venous stasis have had time to develop.

Diagnosis.—A diagnosis of cardiac dilatation can readily be made when the physical signs described are present. The diagnosis of dilatation from hypertrophy is easy on a comparison of the physical signs of the two conditions. When hypertrophy and dilatation coexist in the same individual, there is a blending of the signs of both. It is sometimes difficult to diagnose great dilatation, especially of the right ventricle, from pericardial effusion. The points relating to the differential diagnosis will be fully discussed under pericarditis. Cardiac dilatation must also be distinguished from those cases of mitral stenosis in which there is an absence of a presystolic murmur at the time of examination. It is, further, sometimes necessary to exclude a right-sided pleural effusion displacing the heart to the left, in which case signs of fluid in the right pleural sac will be found.

Prognosis.—The prognosis of cardiac dilatation depends, among other things, upon the cause, the degree of dilatation and whether this is out of proportion to the cause, the degree of any coexisting hypertrophy, the severity of the symptoms, the rate and force of the pulse, the vigour of the apex-beat or of the impulse of the right ventricle, and the size of the heart. Taking cases of cardiac dilatation as a whole, the prognosis is unfavourable.

In acute dilatation from temporary causes, such as sudden physical strain or acute disease, if immediate danger can be tided over, there is a prospect of complete recovery, provided an adequate period of rest is available. The same applies to those cases due to the inception of a new cardiac rhythm, if the rhythm return to the normal. In chronic dilatation from a permanent cause, *e.g.* chronic valvular disease, complete recovery is improbable; it may take place, however, in some instances under suitable treatment. The prognosis is very unfavourable when dilatation supervenes upon marked arterial disease or myocardial degeneration, and this applies also to cases of Bright's disease.

Treatment.—The first thing that requires consideration is the recognition of the cause of the condition, whatever its nature, and suitable therapeutic measures should be employed in this connection. Added to this is the treatment of the affection itself, which is that of cardiac failure, and consists of an adequate period of rest, dieting, perhaps the administration of cardiac tonics or stimulants, and symptomatic treatment. Rest is imperative, and in acute cases must be absolute. Graduated exercises may be of service in a small group of cases, as, for example, in fatty infiltration. With regard to the administration of cardiac tonics, such as digitalis, the reader is referred to the appropriate section for their indications, dosage, and method of administration. When dilatation is due to bacterial poisoning, digitalis appears to be ineffective. In acute cases, strychnine, alcohol, ether, and ammonia, by the mouth or subcutaneously, may be given. When venous engorgement and other indications of distension of the right chambers of the heart are present, purgatives, diuretics, and blood-letting by means of leeches or venesection, are indicated. The special indications for the practice of venesection in these cases, as well as the treatment of gastro-intestinal and other symptoms, have already been noted.

FREDERICK W. PRICE.

DISEASES OF THE PERICARDIUM

PERICARDITIS

The varieties of pericarditis which may be met with are the fibrinous or dry, sero-fibrinous, purulent, hæmorrhagic, and chronic adhesive, *i.e.* adherent pericardium. Some writers describe a chronic form of pericarditis; this, however, is practically synonymous with chronic adhesive pericarditis.

ACUTE PERICARDITIS

Ætiology.—It is questionable if pericarditis be ever primary or idiopathic. The affection is more common in children, especially those of the second decade, and in males. By far the commonest cause, especially in young people, is rheumatism, under which chorea is to be included, the pericardial inflammation usually appearing during the second half of the first week or the first part of the second week of the rheumatic attack. The relation between rheumatism and pericarditis has been already discussed. The terminal stages of Bright's disease, especially of the two chronic forms, and in particular the chronic interstitial variety, and pneumonia, more especially affecting the left side, are frequent causes of pericarditis; in pneumonia, infection may take place either by means of the blood stream or by extension. Other causes of pericarditis are scarlet fever, measles of severe type, small-pox, enteric fever, influenza, diphtheria, tuberculosis, gonorrhœa, and other acute infective conditions; constitutional diseases, such as gout and diabetes; disordered blood states, such as leucocythæmia, lymphadenoma, purpura, and scurvy; new-growths; affections of the neighbouring parts, as, for example, the pleuræ, lungs, mediastinum, ribs, vertebræ, and peritoneum; injuries to the chest-wall; and in conjunction with myocarditis.

When pericarditis is due to Bright's disease, there is a tendency to the purulent, hæmorrhagic, or chronic adhesive variety of the disease. The pericarditis which occurs in connection with malignant disease is usually of a chronic type, and is generally accompanied by the effusion of fluid, which is usually hæmorrhagic, but may be purulent or serous. Purulent pericarditis is usually due to pyæmia, septicæmia, as in the exanthematous fevers, or suppuration in the neighbourhood of the pericardium, as, for example, empyema, or the rupture of a pulmonary vomica. It may also occur in Bright's disease, and in tuberculous deposits in the pericardium. Among the micro-organisms which may be found are staphylococci, streptococci, pneumococci and gonococci. Hæmorrhagic pericarditis is more frequently met with in the aged, in Bright's disease, in acute infective conditions, such as small-pox, tuberculosis, scurvy and purpura, malignant disease, either by direct extension or secondary, wounds of the heart, and in leakage from an aneurysm.

Pathology.—Pericarditis may be general or local; if the latter, the base of the heart, close to the region of the great vessels, is, as a rule, principally affected.

In the fibrinous form, the free surface of the pericardium becomes more vascular and loses its smooth shiny appearance, owing to the transudation of lymph, which coagulates and forms a fibrinous exudate, which in the course of time may involve the entire surface, visceral and parietal, and may reach $\frac{1}{8}$th in. in thickness. In the majority of cases the exudate may easily be separated from the underlying surface, often leaving a honeycomb or reticulate appearance. In the fibrinous form there is little or no effusion of serum into the pericardial sac. In the sero-fibrinous form, on the other hand, complete resolution of the fibrin, and, in the latter case, absorption of the effusion, may take place, so that no trace of the inflammation is left. When, however, resolution of the fibrin and absorption of the fluid occur slowly, which is the rule in the sero-fibrinous form of the disease, organisation takes place. This may give rise to white patches of thickening ("milk spots") upon the pericardium, or may result in its two layers becoming adherent by permanent fibrous adhesions; in the latter case, chronic adhesive pericarditis or adherent pericardium is produced. In purulent pericarditis the pus rarely perforates the pericardium, and has been known to become absorbed, leaving behind a pultaceous mass.

It may be noted that some degree of myocarditis is always present with pericarditis.

Symptoms.—The symptoms of the primary affection are generally to be noted. The severity of the symptoms of the disease itself exhibits great variation, and there may be a complete absence of subjective symptoms throughout the whole course; on auscultation, however, pericardial friction is usually found.

If pyrexia be already present, there is usually a further slight rise of temperature, although this may not be noted, and, in the opinion of some, there may even be a slight fall. This applies equally where there has been no pre-existing pyrexia. When effusion has occurred, there is, as a rule, no increase of temperature, and, indeed, if the pyrexia have been marked, there is a tendency for it to become lower. Occasionally the onset of the disease is marked by a rigor.

The patient is usually pale, and sometimes cyanotic; when effusion has

occurred, these features become more pronounced, and he usually wears an anxious expression. Præcordial uneasiness, or even pain, is frequently present; the pain may be located in the epigastrium, the left scapular or interscapular region, instead of in the præcordium, and varies greatly in severity and character. It may be constant and dull, or recurring, sharp and stabbing; anginal attacks are rarely to be noted. When pain is present, there is usually accompanying hyperæsthesia. Sometimes palpitation and breathlessness are complained of, and there may be faintness. The respiratory rate may be increased, and there may be even cardiac asthma or Cheyne-Stokes respiration. Interference with the respiratory functions is more pronounced when effusion has occurred, and may be greatly aggravated unless the effusion of fluid is gradual. Not infrequently a dry cough is present. Dysphagia is of uncommon occurrence, being more marked in cases of effusion and when the patient is in the recumbent posture. When the recurrent laryngeal nerve is implicated, the voice becomes affected, while if the phrenic nerve be involved the patient may suffer from hiccough.

There may be headache, restlessness, insomnia, convulsions, mild nocturnal delirium, or, less frequently, noisy delirium, stupor, and even coma. Hepatic enlargement is of comparatively common occurrence. A certain amount of œdema may become evident; it is usually general and is more marked in the dependent parts. Not infrequently pulmonary œdema occurs. The urine may become scanty and albuminous.

The pulse is more frequent in rate and smaller in volume than normal. After a shorter or longer period, the blood-pressure becomes lower. At first the apex-beat may be excited and its force considerably increased; later it becomes diminished in force, sometimes tapping in character and displaced outwards. Friction-fremitus can sometimes be noted in fibrinous pericarditis. Its area of maximum intensity does not absolutely correspond with that of a thrill due to valvular disease. As a rule, friction-fremitus accompanies ventricular systole and diastole, having a to-and-fro character, but sometimes it is only systolic; in any case it is not exactly synchronous with either systole or diastole. It gives the impression to the hand of being superficial. After a shorter or longer period, the area of deep cardiac impairment may become enlarged to the left, upwards, and to the right. Auscultation reveals the most characteristic and reliable physical sign, namely, that of pericardial friction. It may accompany every phase of the cardiac cycle. As a rule, it accompanies ventricular systole and diastole, is of a to-and-fro character, with usually a short pause between the two portions. Sometimes it is only ventriculo-systolic, while at other times, when the inflammation involves the auricle, it accompanies auricular systole, ventricular systole, and ventricular diastole, giving rise to a triple rhythm. In any case, the different portions of the friction sounds do not absolutely coincide either in rhythm or duration with any period of the cardiac cycle, being rather later than any of them and usually heard during portions of more than one period. The sound is usually first audible over the base of the heart, but later on may become audible over the whole præcordium. The area of maximum intensity does not absolutely correspond with that of any of the valvular areas. A characteristic feature is that, as a rule, the sound is either not at all or only slightly conducted, and there is no definite selective direction of propagation. It is of a rubbing quality, either fine and creaking or coarse and grating, and is superficial, giving the

impression of being produced immediately beneath the stethoscope, while moderate additional pressure with the stethoscope usually causes an increase in its intensity. The friction may not be so well heard when the patient is lying down as when he is sitting up, and its loudness may be also influenced by respiration, being, as a rule, louder during inspiration—in contra-distinction to pleural friction.

The heart sounds are usually audible. There may be doubling of the first sound, giving rise to a triple rhythm, while a mitral systolic murmur is not infrequently present, due either to coexisting endocarditis or to cardiac dilatation.

As the exudate is absorbed the friction gradually disappears, but it usually remains, unless the quantity of fluid is great, and even then it may persist—this being in marked contrast with friction occurring as the result of pleuritis. If the friction persist, it occupies a higher level than before. When pericarditis is secondary to pleurisy or pneumonia, there is often pleuro-pericardial friction along the left border of the heart, where the pleura lies in front of the pericardium. This also occurs in cases of pericarditis in which the outer surface of the pericardium and the opposing pleural surface become involved.

The early physical signs of sero-fibrinous pericarditis are those of the fibrinous variety. The pulse becomes still more frequent, smaller in volume, and the blood-pressure lower. At times the pulse is somewhat collapsing in type. The pulsus paradoxus may be present. Not infrequently there is prominence of the præcordium, and, if so, the intercostal spaces may be widened or even bulge, as well as the ribs, and there may also be prominence of the epigastrium. The apex-beat is often displaced upwards, and is usually found in the fourth, but sometimes in the third, interspace, in which case it is not the normal apex of the heart, but a point nearer to the base-line and the impulse is more diffuse than normal; it may be to the left of the nipple line, and sometimes is more mobile than normal. It is diffuse and its force is diminished. It is more distinct in the recumbent posture than when the patient sits upright, on account of the tendency of the fluid to gravitate backwards when lying down, and forwards when sitting up. As the amount of effusion increases, the apex-beat becomes less and less distinctly felt, until it may be quite imperceptible. Friction-fremitus may be present, but not in the same degree as in the fibrinous variety. The most characteristic physical signs are those obtained by percussion. The areas of superficial and deep cardiac impairment are increased, in some cases considerably; this increase takes place in all directions, and is progressive. Some observers believe that in the early stage of pericardial effusion, impairment of the percussion note may be found in the fifth right intercostal space, between the costal cartilages, where the right margin of the heart forms an angle with the liver (Rochs sign). When the effusion is considerable, the form of increased area of cardiac impairment is characteristic, its outline, as a rule, closely resembling that of a pear hanging downwards by its stalk. The area of relative impairment often extends well to the left of the apex-beat; it may be almost to the left mid-axillary line. The right border may be found considerably to the right of the sternum. The extension upwards may be as high as the left clavicle, the upper lobe of the left lung being compressed. The lower limit may reach the lower margin of the sixth rib. In the recumbent posture the area is smaller

than when the patient sits upright, on account of the tendency of the fluid to gravitate backwards in the one case and forwards in the other. The degree of impairment is absolute.

On auscultation, the heart sounds are found to become progressively indistinct and muffled, and may be lost, though sometimes, even when the quantity of fluid is large, they may persist, especially at the base; this also holds good with regard to friction. The pressure of the effusion upon the lungs may result in the production of dullness and diminished breath sounds at the extreme left base close to the spinal column; as well as skodaic resonance, tubular breathing, and ægophony, not only over a patch in the neighbourhood of the angle of the left scapula, but also over the borders of the lungs anteriorly; the upper limit of the area of impairment posteriorly may shift on change of position. The liver and spleen also may be pushed downwards. The extent of the effusion, as well as the displacement of the organs, can be recognised by X-ray examination. Finally, physical signs of tricuspid incompetence, including enlargement of the liver, may supervene.

As the fluid becomes absorbed, the area of cardiac impairment diminishes, the heart sounds gradually return to the normal, and, as the two surfaces of the pericardium come once more into contact, friction may reappear.

The symptoms of purulent pericarditis are those of the sero-fibrinous variety, except that rigors, a high and fluctuating temperature, profuse perspirations, great wasting, pallor, rapid prostration, marked rapidity of the pulse-rate, a subnormal blood-pressure, a smaller area of cardiac impairment, and an absence of pericardial friction, are more likely to occur. It should be noted, however, that the temperature may be almost normal, and cases have been reported in which it was even subnormal; there may also be little alteration in the frequency of the pulse or respiration. Sweatings may occur without the existence of rigors. An examination of the blood usually reveals a leucocytosis. When pus is present from the first, the subjective symptoms may be obscured by those of the associated condition, and only the physical signs of pericarditis with effusion may be noted; though even then there may be no increased area of impairment, and an absence of friction.

Diagnosis.—It has been pointed out elsewhere that it is extremely important to be on the look-out for an insidious or masked attack of pericarditis.

The diagnosis of the fibrinous variety of pericarditis is not, as a rule, difficult, and rests not upon subjective symptoms, but upon physical signs. Of these the most characteristic sign is the presence of friction sounds of the type already described. This is pathognomonic of fibrinous pericarditis, or of tuberculous, cancerous, or gummatous deposits, and should be differentiated from an endocardial murmur (especially if the friction sound be single), and from pleuro-pericardial friction. With regard to the first, in exocardial sounds, whether due to pericardial friction or to pleuro-pericardial friction, the different portions of the friction sounds do not absolutely coincide either in rhythm or duration with any period of the cardiac cycle, being rather later than any of them and usually heard during portions of more than one period; the area of maximum intensity does not absolutely correspond with that of any of the valvular areas; the friction sounds are, as a rule, conducted either not at all or only to a slight extent, and there is no definite

selective direction of propagation; they are of a rubbing quality; they give the impression of being produced immediately beneath the stethoscope, while additional pressure with the stethoscope usually causes an increase in their intensity; and, further, their position, intensity and character may alter in a few hours. With regard to the second, the friction is either much reduced or ceases when the patient stops breathing, while it is increased by respiration. Further, pleuritic friction usually disappears with the effusion of fluid, whereas in pericarditis with effusion, friction is not abolished unless the quantity of fluid is great, and even then it may persist.

Sero-fibrinous pericarditis can be diagnosed from the physical signs described, such as a progressive enlargement of the area of cardiac impairment, synchronous with a progressive muffling of the cardiac sounds.

In the diagnosis of sero-fibrinous pericarditis, we should be careful to exclude dilatation of the heart, hydro-pericardium, left localised pleural effusion, pulmonary consolidation, thoracic aneurysm, new-growth, enlarged glands and abscess of the mediastinum. In each case the causation, mode of onset and physical signs should be considered.

It is sometimes difficult to diagnose pericardial effusion from great dilatation of the heart, especially of the right ventricle. In pericardial effusion there is often bulging of the præcordium, with obliteration of the intercostal spaces; the apex-beat is internal to the left margin of percussion impairment, and may be displaced upwards to the fourth or even third interspace; the area of cardiac impairment may extend to the second left costal cartilage, the extension often coming on rapidly, and in form is pear-shaped, instead of increased transversely; the angle formed by the heart and liver impairment is obtuse, whereas in the case of an enlarged right heart it is acute or is at most a right angle; the percussion note is absolutely dull and the sense of resistance greatly increased; and there may be evidence of displacement of the liver and spleen. On auscultation, the heart sounds are muffled, whereas in cardiac dilatation the characteristic physical signs already described are present.

Hydro-pericardium may be detected by noting the cause, the absence of friction during any period of the illness, and the presence of general anasarca, ascites, or pleural effusion.

A positive diagnosis of purulent pericarditis may be made by an exploratory puncture.

Prognosis.—In most cases the immediate prognosis of pericarditis is not unfavourable. The prognosis is more unfavourable at the extremes of life, and with a history of alcoholism. When the affection is due to rheumatism, the immediate prognosis is favourable in the great majority of cases; a fatal termination, however, sometimes occurs at the extremes of life. When due to Bright's disease, pneumonia, tuberculosis, acute infective conditions, and new-growth, the prognosis is unfavourable. A severe degree of dyspnœa, or of cyanosis, or pronounced mental symptoms are of unfavourable omen.

If the effusion be serous and moderate in degree, recovery is the rule, although adhesions result; if, on the other hand, the amount of fluid be large, the termination may be fatal, and this usually occurs during the second or third week. When the effusion is purulent, the prognosis is grave, especially if the pus be putrid, and a fatal termination may occur

within a few days. The outlook is likewise grave when the effusion is hæmorrhagic in character. Death may be due to asphyxia, sudden syncope, especially on exertion while in bed, and more rarely asthenia.

With regard to the ultimate prognosis of pericarditis, time is necessary to determine whether adhesions have resulted, and, if so, their site and degree, and whether the myocardium has been permanently damaged and to what extent.

Treatment.—The primary condition should be treated, and if rheumatism be the cause, the procedure suggested on page 823 should be carried out. If the pyrexia continue notwithstanding the administration of salicylates, the best way of reducing the temperature is by tepid sponging of the body; if drugs be employed, the best of these is quinine, although some place reliance upon antipyrin, phenacetin, and antifebrin, but they are not advisable except for occasional use. In septic cases, the sulphocarbolates and quinine may be administered.

In all cases, whatever the cause, absolute rest in bed is essential; excitement and worry of every kind should be avoided. The diet should be light, and during the acute stage it may be advisable to restrict it only to milk. An aperient should be administered at the outset, and during the illness strict attention should be paid to the state of the bowels. The internal administration of iodides is recommended by some. If there be much exhaustion, dyspnœa, cyanosis, or an unduly rapid pulse, alcohol may be given and oxygen employed, the quantity of alcohol varying with the individual requirement. Other diffusible stimulants, such as ether and ammonia, may be administered, especially in cases of sudden collapse. Strychnine may be tried when there is great exhaustion: it is better withheld, however, in the early stages of the illness when the cardiac action is excited.

For præcordial pain and distress, a hot linseed poultice or hot fomentations may be applied to the præcordium, or, if these fail, the continuous application of an ice-bag may be of service; other remedies, such as dry or wet cupping, mustard leaves, the application of the Paquelin cautery, or leeches to the præcordium, are recommended. In some of these cases there may be indications for the use of venesection; this has been referred to on page 772. Internally, Dover's powder (grs. x to xv), or, if necessary, morphine, may be administered. In the less acute cases, a fly blister is not infrequently efficacious. If insomnia or other symptoms be present, they should be treated on the lines previously laid down.

In cases of moderate effusion, the former treatment should be continued. If, however, the effusion become considerable, counter-irritation, the administration of iodide of potassium, purgatives, and diuretics, and limitation in the amount of fluid taken, are indicated. If the amount of effusion do not diminish, or if there be marked dyspnœa, cyanosis and a small rapid pulse, paracentesis pericardii should be performed. The site chosen for this procedure varies. It may be performed in the fifth left intercostal space just inside the mammary line; or quite near the margin of the sternum in the same space; or in the angle between the ensiform cartilage and the left costal margin of the sternum, near the lower end of the body of the sternum, and passing upwards and inwards behind it into the pericardial sac. Formerly a trochar and cannula, or a fine aspirating needle, was employed, but the use of an aspirator is now found to be preferable.

The stage of convalescence requires careful management, on the same lines as those of acute endocarditis.

The treatment of purulent or hæmorrhagic pericarditis consists in free incision and drainage of the pericardial sac, unless the state of the patient is too grave to allow of it—in which case paracentesis may be performed, and, if improvement occur, incision and drainage may be subsequently permissible—or unless the condition is associated with a hopeless primary cause.

Chronic Adhesive Pericarditis or Adherent Pericardium

In this form of pericarditis the two layers of the pericardium are bound together by permanent fibrous adhesions.

Ætiology.—The condition usually results from a previous attack of acute pericarditis, especially if accompanied by effusion, or it may follow a primary chronic inflammation; the latter may be due to an extension of inflammatory processes from the neighbouring parts.

Pathology.—The degree of chronic adhesive pericarditis varies. It may amount to only a few fine bands, most commonly situated at the base of the heart close to the great vessels, crossing the pericardial sac; or, in more severe cases, it may result in the formation of a layer of connective tissue, occasionally of considerable thickness, which more or less completely unites the two layers of the pericardium. The formation of partial synechiæ, however, is a much more common result than obliteration of the sac. Sometimes extra-pericardial adhesions exist. In this way adhesions may form between the pericardium anteriorly and the anterior chest-wall; laterally with the pleuræ and lungs; posteriorly with the aorta, œsophagus, or vertebral column; and below with the diaphragm. In rare instances, extra-pericardial adhesions are found in the absence of adhesions between the two layers of the pericardium. In advanced cases, pericardial adhesions may become more or less completely calcified, owing to the deposition of lime salts.

In a large proportion of cases, cardiac, especially ventricular, hypertrophy, usually accompanied by dilatation, exists, even in the absence of coexisting valvular disease. The degree of cardiac enlargement varies with the position and nature of the adhesions: it may be small or altogether absent, even when the sac is completely obliterated, provided the sac is not thickened and there is an absence of extra-pericardial adhesions; whereas it may be very great if the reverse be the case. Fatty or fibroid degeneration of the myocardium may occur.

The openings of the large vessels entering and leaving the heart may be constricted, and thus may interfere with the influx and egress of blood.

Symptoms.—The condition may be latent throughout its whole course. If symptoms be present, they may exhibit considerable variation in different cases. Dragging pain in the præcordium, sometimes extending considerably beyond it, is not an uncommon symptom, and anginal attacks have been known to occur. There may be also palpitation, dyspnœa, and cyanosis. Œdema is present in a certain proportion of cases; ascites and hydro-thorax are occasionally to be noted, as also hepatic and splenic enlargement, and scanty and even albuminous urine. The pulse may exhibit the characteristics of pulsus paradoxus. The præcordium may be prominent: less commonly there is flattening. The apex-beat is usually displaced, and

its position does not vary with change of posture—a fact which also applies to the area of cardiac impairment. The area of pulsation is usually greatly increased, and may even extend from the second to the sixth intercostal space, and almost from the right parasternal line beyond the left mammillary line; it may be wave-like and undulatory in character. If adhesions between the pericardium and chest-wall exist, indrawing of the apex-beat may occur, also with systolic recession of the intercostal spaces on either side of the sternum, of the lower end of the sternum and adjacent costal cartilages, and in the epigastrium; while systolic retraction of the lateral and posterior walls of the left side of the chest, upon the latter of which Broadbent has laid great stress as indicating adhesion between the pericardium and diaphragm, is occasionally to be noted. A diastolic rebound or shock, after the systolic retraction, is rarely present at the apex-beat, or over a larger area of the præcordium, or even over the left lateral or posterior aspect of the chest; this is supposed to be pathognomonic of the affection. The position of the apex-beat and the area of cardiac impairment may be unaltered on deep respiration. Diminished expansion of the left side of the chest, and incomplete descent of the left half of the diaphragm during inspiration, as shown by diminished movement of the upper part of the abdominal wall on the left side, may be noted. Collapse of the veins of the neck during diastole—Friedreich's sign—may occasionally be observed.

The area of cardiac impairment is usually much increased, both to the right and to the left. Bruits indicative of relative incompetence both of the mitral and tricuspid areas may be present. Some authorities are of opinion that a rumbling mitral presystolic bruit is sometimes heard in adherent pericardium in children; this bruit, however, is not rough or vibratory in character, nor does it terminate abruptly in the first sound, as in the case of mitral stenosis. Lastly, there may be physical signs of coexisting heart disease.

Diagnosis.—The diagnosis may be a matter of considerable difficulty. A positive diagnosis should not be made from the presence of one sign only, except when diastolic shock or rebound exists, and perhaps also in those cases in which systolic recession of the sternum itself is present. It should be noted that the pulsus paradoxus, indrawing of the apex-beat, and systolic recession in the intercostal spaces on either side of the sternum, or in the epigastrium, or even of the lateral or posterior walls of the left side of the chest, do not necessarily indicate the existence of chronic adhesive pericarditis, and, further, that an absence of alteration of the position of the apex-beat and of the area of cardiac impairment with change of posture or deep respiration may also be present in pleural adhesions. When, however, several or all of the physical signs of the affection are present a positive diagnosis is warranted, especially if there be indications of right-sided cardiac enlargement or failure in the absence of mitral or pulmonary disease. A history of acute pericarditis or of acute rheumatic infection is of additional assistance, although, on the other hand, it should be remembered that the affection may be chronic from the beginning.

Prognosis.—This depends upon the situation, extent, and nature of the adhesions, the size of the heart, the existence or otherwise of valvular disease, the degree of integrity of the myocardium, and the degree of cardiac failure which may be present. The prognosis may be good, and, indeed, the

patient's longevity may not be affected; or, on the other hand, it may be grave, especially in early life.

Treatment.—The treatment of the condition consists in counter-irritation externally, and the internal administration of iodide of potassium during the later stage of the attack of acute pericarditis as a prophylactic. When adhesions have formed, detailed instructions should be given to the patient to curtail his physical and mental activities so as not in any way to exceed the limited strength of the heart. When cardiac failure supervenes, it should be treated on the lines previously laid down.

It may be necessary to consider the advisability of performing the operation of "cardiolysis" in some cases of severe adhesions between the pericardium and the chest-wall. This operation was introduced by Brauer in 1902, and is indicated when there is also evidence of cardiac failure and ordinary treatment has failed; but the operation should not be unduly delayed. It is usually not necessary during childhood or adolescence, because of the flexibility of the chest-wall. The operation consists in the resection of the fourth, fifth and sixth ribs on the left side, and, where possible, freeing the adhesions.

Chronic Pericarditis

It has been already noted that some writers describe a chronic form of pericarditis. This, however, is practically synonymous with chronic adhesive pericarditis or adherent pericardium, although it sometimes happens that in acute pericarditis with effusion, especially when due to tuberculosis, the effusion may persist for an indefinite period and the condition become a chronic pericarditis, resulting in considerable thickening of both layers of the pericardium. Further, but less frequently, pericarditis may be chronic from the first, especially in the aged, in alcoholism, and in nephritis.

When the result of acute pericarditis, the symptoms are those of that stage of the disease at which it became chronic. When chronic from the first, the affection is not infrequently latent throughout its whole course; there may, however, be dyspnœa, a sense of oppression, and rarely pain, in the præcordium, an increase in the area of cardiac impairment, feeble cardiac sounds, and sometimes pericardial friction.

TUBERCULOSIS OF THE PERICARDIUM

Tuberculosis of the pericardium may be primary, or part of an acute general tuberculosis, or secondary to that of the lungs, the pleuræ, the mediastinal or bronchial glands. It may give rise to—(1) Tuberculous pericarditis, in which the effusion may be clear, purulent or bloodstained, and in which tuberculous nodules with giant cells are sometimes found in the fibrous tissue consequent upon organisation; (2) miliary tubercles, which may be seen along the course of the small blood vessels in the epicardium, especially in the sulci; and (3) larger tubercular masses in the epicardium, situated particularly at the base of the heart, and presenting a yellow caseating centre. The two latter conditions are much less common than the first. There is a greater tendency to the chronic type of pericarditis in

the case of tuberculosis than when due to other causes, the condition persisting for several weeks or even months, and not infrequently giving rise to a layer of connective tissue of considerable thickness, more or less completely uniting the two layers of the pericardium; there may or may not be fluid, which is frequently bloodstained, and is occasionally purulent.

Symptoms.—The affection (1) may be entirely latent throughout its whole course; (2) may present the symptoms of acute pericarditis, with, in addition, loss of weight and strength, a fluctuating temperature, a tendency to chronicity, and ending in effusion of fluid or the formation of adhesions; (3) may be a chronic adhesive pericarditis, with consequent hypertrophy and dilatation, and ultimately indications of cardiac failure; or (4) may present the symptoms of acute tuberculosis.

Diagnosis.—This can be made from an absence of any history of rheumatism or other cause of pericarditis, and, further, there may be evidence of tuberculosis elsewhere.

Prognosis.—This is very grave.

Treatment.—The treatment is that of pericarditis due to other causes, together with that indicated in ordinary tuberculosis, such as an abundance of fresh air, a generous diet, and the administration of cod-liver oil.

HYDRO-PERICARDIUM

Definition.—A certain amount of fluid is usually found in the pericardium after death; in hydro-pericardium, or dropsy of the pericardial sac, this is in excess. The fluid is clear, pale amber in colour, and has a specific gravity of about 1015.

Ætiology.—The condition is always secondary. It may occur along with ascites, hydro-thorax, and general anasarca, in valvular or myocardial disease, or in nephritis. Or it may occur alone, as the result of pressure upon the veins of the pericardium or of the heart by aneurysm, enlarged glands, or new-growth of the heart, pericardium, or mediastinum; from constriction of the veins by adhesions; and in various cachectic conditions, scarlet fever, and some purpuric conditions.

Symptoms.—The symptoms of the primary affection are usually to be noted. The condition in itself does not give rise to pyrexia or præcordial pain. There may, however, be a sense of oppression in the chest, dyspnœa, cyanosis, attacks of faintness or even unconsciousness, œdema, hepatic enlargement, and scanty urine. In some cases there is drowsiness or mild muttering delirium. The pulse is soft, and of subnormal pressure. On examination of the heart, the physical signs are found to be those of pericarditis with effusion, except that there is an absence of friction on auscultation.

Diagnosis.—A diagnosis may be arrived at by a consideration of the cause, signs of fluid in the pericardial sac, and an absence of friction.

Prognosis.—The prognosis is that of the primary affection.

Treatment.—This is based upon the causal condition, and, in addition, a lessened intake of fluid, together with the use of purgatives and diuretics, are indicated. If urgent symptoms appear to demand it, paracentesis may be performed; this, however, is rarely necessary.

PNEUMO-PERICARDIUM

Definition.—By pneumo-pericardium is meant the presence of air in the pericardial sac. It is a very rare condition. Pericarditis is always present, with serous (pneumo-hydropericardium), purulent (pneumo-pyopericardium), or hæmorrhagic (pneumo-hæmopericardium) effusion.

Ætiology.—The affection may be due to wounds through the chest-wall, or the result of communication with an air-containing cavity, such as occurs in abscess or gangrene of the lung, malignant disease of the œsophagus, gastric ulcer, and hepatic abscess. It is further believed by some that gas may be spontaneously generated within the pericardial sac *intra vitam*.

Symptoms.—Breathlessness, præcordial discomfort or even pain, faintness and cyanosis are the most constant symptoms. There may be a certain amount of bulging of the præcordium, and the apex-beat is diminished in force or even absent. On percussion, a tympanitic note is to be observed, the area of which changes with an alteration of posture. In the recumbent position it may be heard over most of the præcordium, while if the patient be sitting upright the lower part of the præcordium becomes impaired and the upper part hyper-resonant. On auscultation, metallic and splashing sounds, resembling those produced by a water-wheel or a churn, synchronous with the movements of the heart, are audible; these sometimes become more pronounced on shaking the patient, and occasionally may be heard at a considerable distance. Pericardial friction is sometimes also to be noted.

Diagnosis.—The diagnosis is not difficult when the physical signs enumerated are present. Care, however, should be taken to exclude a large pulmonary vomica in the neighbourhood of the heart, a left-sided pneumothorax, and dilatation of the stomach.

Prognosis.—The majority of cases die within the course of a few days. Traumatic cases, however, have been known to recover; the wound may heal and the air be absorbed.

Treatment.—In traumatic cases, paracentesis of the pericardial sac, with free incision and drainage if the fluid be purulent, is advisable. In other cases, treatment is usually only palliative.

HÆMO-PERICARDIUM

Definition.—By this is meant the presence of blood in the pericardial sac, occurring apart from pericarditis.

Ætiology.—It may be due to punctured wounds, perforation of the œsophagus by a dental plate, rupture of the aorta, of one of the coronary arteries, or of the heart, or as the result of purpura or scurvy.

Symptoms.—Death may take place suddenly, or there may be sudden collapse, marked pallor, perspiration, or syncope, with a rapidly fatal termination. On examination, the pulse will be found to be feeble, and of low tension, with, perhaps, increased area of cardiac impairment.

Prognosis.—Except in some traumatic cases, where surgical interference is possible, the outlook is always hopeless.

Treatment.—This is limited to immediate surgical operation in certain cases.

OTHER DISEASES OF THE HEART AND PERICARDIUM

SYPHILITIC AFFECTIONS OF THE AORTA, THE HEART, AND THE PERICARDIUM

This subject is one of great importance, and also of great difficulty, more especially with regard to the relative frequency and the diagnosis of the condition, for these are intimately bound up with ætiological and pathological considerations. I shall confine my remarks to the acquired form of the disease.

Pathology and Relative Frequency.—Acquired syphilis may attack the aorta, the cardiac valves, the coronary arteries, the myocardium, the auriculo-ventricular junctional tissues, and the pericardium. With regard to the aorta, Professor H. M. Turnbull found that in 288 necropsies at the London Hospital in which lesions of acquired syphilis were present, the most common syphilitic lesion was mesaortitis. This affection is the result of inflammation of the vasa vasorum and their terminations in the external and middle coats of the aorta. Its pathology is described on pages 860–861. It should be noted that while syphilis is not a cause of primary atheroma of the aorta, in the later stages atheroma usually occurs in the thickened intima over the areas of inflammation; also that syphilitic mesaortitis and primary atheroma may coexist, especially in later life. The ascending part of the aorta is the most commonly affected. The disease process in the aorta may involve the aortic valve, and occasionally it extends to the base of the aortic cusp of the mitral valve. In the case of the aortic valve, it results in incompetence and occasionally in stenosis. Syphilitic mesaortitis may also give rise to narrowing or complete occlusion of the orifice of one or both of the coronary arteries. Syphilis may also affect the terminal branches of the coronary arteries. In syphilis of the coronary arteries the aorta is usually affected at the same time. The results of coronary disease have been described on pages 860–862. Gummatous deposits, with secondary fibrosis, also occur in the cardiac wall, but they are of comparatively rare occurrence. It will thus be seen that in syphilis, fibrosis of the myocardium may be the result of syphilis of the aorta or of the terminal branches of the coronary arteries, or of gummata in the cardiac wall. Any of these lesions may involve the auriculo-ventricular junctional tissues, and give rise to auriculo-ventricular heart-block. Syphilis of the pericardium is of rare occurrence. The disease more commonly attacks in the form of an infiltration, with consequent formation of fibrous tissue, resulting in adhesions between the two layers of the pericardium, while in some cases there is effusion of fluid into the pericardial sac. Gummata are of rare occurrence.

The foregoing is a brief summary of the lesions which it is generally agreed syphilis may produce. But this does not by any means exhaust this part of the subject. Thus, in addition to the fact that syphilitic mesaortitis may

involve the aortic valve and the base of the aortic cusp of the mitral valve, is syphilis among the causes of primary chronic endocarditis of one or more of the cardiac valves? There is no evidence that it is. Again, apart from inducing secondary fibrosis in the manner described, may syphilis give rise to fibrosis of the myocardium independently—in other words, is it among the causes of primary chronic myocarditis, *i.e.* a true inflammation? There is no doubt that syphilis may give rise to a primary chronic inflammation elsewhere; and it would appear that congenital syphilis does so in the case of the myocardium. Some authorities are of opinion that acquired syphilis may cause a patchy or a diffuse fine fibrosis independently of the coronary arteries, while others are not. In any case, the histological diagnosis is very difficult even in the early stage, and is perhaps impossible in the later stage, so that it is probable that many of the cases of fibrosis of the myocardium in elderly people which are thought to be the result of syphilis are not so. Syphilis is the cause of a large proportion of all cases of aortic incompetence, and also an important ætiological factor of angina, especially under the age of 40. But, in considering the relative frequency of syphilis in affections of the heart and aorta, there is now a danger of going to the other extreme. Thus, statements to the effect that syphilis is responsible for a quarter to a third of the total number of cases of organic disease of the heart, for about three-quarters of all cases of aortic regurgitation, and almost invariably for cases of aortic incompetence in which there is an absence of a definite history of acute rheumatism, should be accepted with the greatest reserve.

Symptoms.—In aortitis pain is the most frequent and characteristic symptom, and it is exceedingly important to recognise its characteristic features. It is situated behind the upper part of the sternum, and is generally localised there, but it may radiate to the arms and neck. It may vary from slight discomfort or a sensation of pressure to an intense pain. It may be more or less constant, or intermittent. Occasionally there are paroxysms of pain, accompanied by a feeling of suffocation. The pain may come on spontaneously—that is, apart from physical exertion, especially when lying down—or it may occur only on exertion; it is usually aggravated by exertion; it may not completely disappear on cessation of exertion. There may be hyperæsthesia over the painful area. Occasionally severe attacks of suffocation occur, and tachycardia may often be noted. The pain may disappear after a few months or weeks, either spontaneously or as a result of treatment. It may be followed by angina pectoris. Some observers are of opinion that sometimes, during the early stage, rubbing sounds along the right border of the sternum may be noted, especially when the patient leans forward; personally I have never been able to detect this. At a later stage there may be indications of fusiform dilatation of the aorta. There may be pulsation in the neck, particularly in the suprasternal notch, and in the first and second intercostal spaces on either side of the sternum; impairment of percussion over the manubrium sterni and on either side of it; a systolic murmur over the aortic area; while the second sound may exhibit a musical, bell-like, or clanging quality. With the X-rays the aorta may show diminished translucency and an increased diameter. Alteration in the voice and tracheal tugging are occasionally to be noted.

Later, the clinical picture of aortic incompetence or of myocarditis or saccular aneurysm may develop. With regard to the first, shortness of

breath on exertion is probably the most frequent symptom of all. The largest group presents symptoms of systemic anæmia. Cardiac asthma is comparatively frequent. Indications of chronic venous congestion supervene in a comparatively small proportion of cases. General œdema is only occasionally met with. I would emphasise the great importance of an early and most careful search for the presence of a diastolic murmur over the base of the heart, over and on either side of the sternum, and at the apex—in fact, over the whole precordial area. There is less tendency for the systolic blood-pressure to rise, and still more so for physical signs of left ventricular hypertrophy to develop, than in the case of aortic incompetence due to other causes. Involvement of the myocardium may reveal itself on polygraphic, and, more frequently, on electro-cardiographic examination, by the presence of the first or second grade of auriculo-ventricular block, and rarely by bundle-branch or intra-ventricular block, and in one case of my experience by transient attacks of auricular fibrillation. Subacute bacterial endocarditis may supervene. Sudden death may occur, and may be due to complete and abrupt closure of a coronary artery, or rupture of the heart, fatal syncope, or angina pectoris.

The foregoing description covers the great majority of cases. It is necessary to add the following: Relative, and even complete, recovery—either the result of specific treatment or spontaneous—may occur at any period. There may be exacerbations of the disease all through life. Sometimes aortitis escapes notice altogether, and the clinical picture is that of aortic incompetence developing insidiously. The clinical picture may be that of acute general cardiac failure, it may be proceeding to rapid dissolution. Sometimes the condition is only discovered post mortem.

In the early stages the Wassermann reaction is almost invariably positive, but as the disease becomes more chronic it is increasingly negative, although I have been surprised at the frequency with which a positive Wassermann persists even in the case of patients who, from a clinical point of view, have done well.

Diagnosis.—This is sometimes comparatively easy, but it may be very difficult. In its consideration the following points, among others, require consideration: The age, the previous history, the history of the present illness, the subjective symptoms, the results of physical and instrumental examination, the Wassermann reaction, the presence or otherwise of syphilitic stigmata, and the course of the disease. With regard to the previous history, it is very easy to overlook a rheumatic infection in childhood. There may also be a history of rheumatic and syphilitic, and even other, infection in the same patient. There may be a combined lesion. I would emphasise the importance of pain behind the upper part of the sternum, presenting the characteristic features described. If it has been possible to obtain a full and accurate history, it will be found that in the vast majority of cases it has been present in the early stages. The pain differs from that of angina pectoris in that it is less paroxysmal, its location is higher, it has a far less tendency to radiate to a distance, and it is more likely to come on spontaneously and not to cease completely after exertion is over. The presence of a systolic murmur over the aortic area, an altered second sound in the manner described, and the result of an examination with the X-rays, are of considerable diagnostic importance. It is necessary to exclude aortitis due to infection by pyogenic

organisms of a subacute or chronic type, by the tubercle bacillus and other organisms, aneurysm, and atheroma. The last-named when limited to the aorta, however, does not cause pain presenting the characteristic features described. A cardiac lesion coming on in middle life, if antecedent rheumatic infection can undoubtedly be excluded, is strongly suggestive of syphilis, as also is angina pectoris occurring before the age of forty. A combination of aortic and mitral valvular disease, especially before thirty years of age, is strongly suggestive of being of rheumatic origin. Atheroma much more frequently causes aortic stenosis than incompetence. A Wassermann test should be done in all doubtful cases, and in all cases of aortic disease, even if there is a history of acute rheumatism. A negative Wassermann is not so valuable as a positive reaction, a single negative reaction does not exclude syphilis, and in some cases it may be advisable to employ a provocative dose of salvarsan or one of the other organic arsenical preparations. We should, on the other hand, be careful not to place too much reliance on the result of the Wassermann reaction; it should be considered in conjunction with other clinical data. A positive Wassermann does not indicate that the malady from which the patient is suffering is necessarily syphilitic; the same applies to the coexistence of other specific stigmata. There may also be a double lesion.

Prognosis.—This depends largely upon early diagnosis and the kind of treatment adopted. Taking cases as a whole, the prognosis is very unfavourable, due, no doubt, to the fact that a correct diagnosis is not often made until the later stages of the disease. When untreated, the lesion is usually progressive, it may be rapidly so, and the mortality is high. If, on the other hand, a diagnosis is made early, and treatment is prompt and adequate, especially when the patient has not received specific treatment previously, there is a reasonable prospect of relative recovery, and occasionally recovery is even complete. Naturally the prognosis is much more favourable in the absence of aortic incompetence, involvement of the coronary arteries and of the myocardium, angina pectoris, and aneurysm. Prompt and adequate treatment of aortitis may prevent the aortic valve, coronary arteries, and the myocardium becoming involved, and the formation of a saccular aneurysm. Even in the absence of angina pectoris and aneurysm, in aortic regurgitation the prognosis is usually very unfavourable, death often taking place within two or three years after the onset of subjective symptoms. Two important points in all cases are the degree of cardiac failure present, and its rate of advance. Help is sometimes obtained from the results of polygraphic and, still more frequently, of electro-cardiographic examination. Thus, the presence of pulsus alternans in the absence of a severe grade of tachycardia is an indication of extreme exhaustion of the heart muscle; the occurrence of partial heart-block is a sign of myocardial involvement; persistent heart-block of mild degree is also indicative of myocardial damage; bundle-branch block is usually of very unfavourable significance; and intra-ventricular block is usually of grave import. A few cases of complete auriculo-ventricular block have been recorded in which energetic specific treatment appears to have been rewarded with recovery, but as far as my experience is concerned anti-specific treatment is of no avail at this stage. Lastly, in all types of cases, marked and surprising improvement is occasionally met with when adequate specific treatment is adopted.

Treatment.—The various measures which may be applicable to any form of cardiac disorder should be considered in detail. Apart from these, the indication is for anti-specific treatment. This should be adopted in every case in which a definite diagnosis of syphilis of the heart and aorta is arrived at, even if the Wassermann reaction is negative; and in every case of disease of the heart and aorta in which there is a positive Wassermann or other manifestations of active syphilis, even in the absence of clinical evidence that the lesions of the heart and aorta are of specific origin. Cardiac failure is not a contraindication. It is impossible to exaggerate the importance of the adoption of this method of treatment *promptly*. It should also be *prolonged*. I am a firm believer in the employment of the arsenical preparations—but only under certain conditions. Their indiscriminate use is attended with danger, even of grave degree; they may result in further swelling of the intima of the small vessels, and thus increase the risk of thrombosis. I always recommend a preliminary course, of three weeks duration, of mercurial inunction and of iodide of potassium by the mouth—10 grains thrice daily during the first week, increased to 15 grains during the second week, and to 20 grains during the third. This to be followed by one of the arsenical compounds administered cautiously, commencing with small doses and only gradually increasing the dosage. The scheme I advise is the result of two or three conversations I have had the privilege of having with Colonel L. W. Harrison, to whom I desire gratefully to acknowledge my indebtedness. This consists of a series of courses of one of the sulpharsenobenzene preparations (kharsulphan, myosalvarsan, sulfarsenol, or sulphostab), injected deep subcutaneously, with mercury injected intramuscularly. The first course makes a cautious start with 10 centigrammes of sulpharsenobenzene, and the dosage is increased, in bi-weekly injections, to 24 centigrammes, the total amount given in the first 54 days being 2·76 grammes in sixteen injections, with 8 grains of mercury in eight injections. The reason that the dosage of sulfarsenol in the first course is cautious is that patients with syphilis of the heart or aorta seem easily to be upset at first by arsenobenzene preparations. After the foregoing course of injections, potassium iodide is given for three weeks, to be followed three weeks later by a course of five injections of sulfarsenol and mercury. This time it may be possible to proceed more boldly with the sulfarsenol—three injections of 48 centigrammes and two of 60 centigrammes. Thereafter the treatment is continued with courses of ten injections totalling 5·8 grammes sulfarsenol and 10 grains of mercury at intervals increasing from two to five months, with potassium iodide for a month at a time between the courses. In place of mercury, one of the bismuth preparations may be injected deep subcutaneously or intramuscularly. In this event, the individual dose should contain from 20 to 30 centigrammes of metallic bismuth. The treatment is continued on these lines for two years. After the completion of this scheme, I suggest a three weeks' course of potassium iodide every two or three months during the rest of the patient's life. It may be advisable to continue anti-syphilitic treatment as long as the Wassermann is positive, even in the absence of other manifestations of active syphilis, for there is a risk of exacerbations all through life, and the small vessels around the principal lesions may become involved.

ANEURYSM OF THE HEART

Aneurysm of the heart may occur in its valves or walls, or in the coronary arteries.

Acute aneurysm of the valves may occur in malignant endocarditis, the semilunar being more commonly affected than the auriculo-ventricular valves. The aneurysm bulges in the direction of the blood current; rupture may take place, giving rise to perforation and valvular incompetence.

Acute aneurysm of the walls of the heart may take place in acute mural malignant endocarditis, usually in the interventricular septum, in the neighbourhood of the undefended space. A diagnosis of this affection is scarcely possible.

Chronic aneurysm of the walls of the heart occurs as the result of fibroid degeneration, and is more frequent in males. In the majority of cases it arises in the left ventricle near its apex. The aneurysm consists of a sac or localised depression, communicating with one or more chambers of the heart. It is lined by thickened endocardium, and the wall is formed of fibrous tissue and muscle-cells, in varying proportion, according to the length of time it has been in existence. Occasionally a certain amount of calcareous matter is present. The visceral layer of the pericardium may be thickened, and its parietal layer also involved. The aneurysm generally contains laminated fibrinous coagulum, and its size may vary from that of a small marble to an orange or even larger. The symptoms are those of general heart failure. The area of cardiac impairment may be increased, and occasionally a tumour in the region of the apex may be detected. Sudden death is not of uncommon occurrence, although rupture is comparatively rare.

Aneurysm of the heart may also result from a stab.

Aneurysm of a coronary artery occurs rarely, and is usually due to atheroma.

WOUNDS OF HEART

Wounds of the heart are not of very uncommon occurrence. They may be the result of stabbing, bullet wounds, or the passage of foreign bodies from the œsophagus. Recovery occurs in a fair proportion of cases, especially when due to stabbing.

Treatment of these cases is purely surgical.

RUPTURE OF THE HEART

Rupture of the heart is a rare event, and is usually due to fatty degeneration or infiltration of the myocardium. It is occasionally the result of abscess or aneurysm of the myocardium, or of traumatism. The left ventricle is most commonly involved, usually its anterior wall. Rupture of the heart occurs nearly always during physical exertion. It may result in sudden death, or its occurrence may be indicated by sudden agonising pain, intense dyspnœa, pallor, and collapse; in the latter case, the patient may live for some hours or even days.

NEW-GROWTHS OF THE HEART AND PERICARDIUM

Neoplasms may arise from the walls of the heart or from the valves. They, as well as tuberculous deposits, are usually secondary. Primary carcinoma and sarcoma of the pericardium are extremely rare, and secondary deposits are also of unusual occurrence; in the latter case they may be secondary to those of the œsophagus, mediastinal glands, lungs, or pleuræ; more rarely from distant parts. Instances of hydatid cysts and actinomycosis of the myocardium and pericardium have occasionally been noted post-mortem; they are not diagnosable during life.

The symptoms of new-growths of the pericardium are those of pericarditis, especially of the chronic type, together with the cachexia characteristic of the primary cause. The diagnosis rests upon the recognition of these features, with possibly evidence of malignant disease elsewhere. The prognosis is hopeless, and treatment at the best is only palliative.

FREDERICK W. PRICE.

CONGENITAL HEART DISEASE

Ætiology and Pathology.—Congenital heart disease is more common in males than in females. It may be the result of some developmental defect, or of fœtal endocarditis—due to rheumatism or one of the other causes of acute endocarditis affecting the mother during pregnancy. Syphilis is said to be a causal factor. Both developmental defects and fœtal endocarditis are more common on the right than on the left side of the heart, as the result of a relatively higher pressure. The pulmonary orifice is more commonly affected than the tricuspid. The lesion of congenital heart disease may give rise to stenosis, or incompetence, or both. The endocarditis is usually of the sclerotic type, although vegetations may occur. It may be noted that there is a predisposition to endocarditis in the fœtus the subject of some developmental error, and this increases the primary malformation; endocarditis may also occur after birth.

VARIETIES.—There are many varieties of this condition, and I shall not attempt to deal with them all. *As a rule, several lesions coexist, a single lesion being uncommon.*

In ectopia cordis the heart is situated outside the thoracic cavity; it may lie in the neck (ectopia cervicalis), or outside the chest-wall (ectopia pectoralis), or in the abdominal cavity (ectopia abdominalis). In mesocardia the heart occupies the mesial position of the thoracic cavity, the apex-beat being in the epigastrium. In dextro-cardia or dexio-cardia, the heart lies on the right side of the thoracic cavity; this variety of congenital heart disease is usually associated with transposition of the viscera. More or less complete absence of the pericardium is rarely found.

The development of the heart may become arrested at the stage when only an auricle, a ventricle, and a bulbus arteriosus exist, a comparatively rare condition, to which the term "bilocular" heart has been applied. Another comparatively rare form is complete absence of the interventricular

septum, in which case the heart consists of two auricles and one ventricle, and is said to be "trilocular." The tricuspid and mitral orifices are usually present, and the bulbus arteriosus is usually divided into a pulmonary artery and an aorta. Another rare condition is complete absence of the inter-auricular septum, in which case the heart consists of an auricle and two ventricles. One of the most frequent forms of congenital heart disease is an incomplete septum ventriculorum, due to an arrest of development; it is a much commoner condition than complete absence of the septum. The aperture of communication between the two ventricles is usually situated in the region of the pars membranacea. This condition is frequently associated with pulmonary stenosis or atresia, and hypertrophy of the right ventricle; less frequently with other defects. When coexisting with pulmonary stenosis or atresia, the blood can pass from the right to the left ventricle. When not so associated, the aerated blood after birth passes from the left to the right ventricle, and the walls of both chambers undergo hypertrophy. There may be complete absence of the septum of the ductus arteriosus, or this may be incomplete, with resultant communication between the pulmonary artery and the aorta; in these cases, the right ventricle is generally hypertrophied.

The septum between the auricles may be incomplete, due to arrest of development, and is much commoner than complete absence of the septum. The defect is usually situated at the foramen ovale, due to mal-development of the membrane of the fossa ovalis. It should be noted that the absence of an absolute closure of the foramen ovale is not pathological. The majority of cases of patent foramen ovale are associated with pulmonary stenosis, or a defect in the ventricular septum, or some other congenital defect. Some writers believe that in the larger number of cases a patent foramen ovale results from pulmonary stenosis, while others hold a different view. Whichever view be correct, pulmonary or tricuspid lesions are often found associated with it, and occasionally lesions at the aortic or mitral orifice. In the case of a patent foramen ovale, the blood passes from the right to the left auricle, instead of into the right ventricle and thence to the lungs.

Pulmonary stenosis is perhaps the commonest form of congenital heart disease. A patent interventricular septum is present in the great majority of cases, and a patent foramen ovale is of not infrequent occurrence, while the ductus arteriosus may remain patent. Further, owing to increased pressure in the cavity of the right ventricle, there is sometimes a deviation of the interventricular septum to the left; in this case, the right ventricular cavity is enlarged, and the aorta takes its origin, either completely or partially, from this chamber, the left ventricle being small and atrophied, and communicating with the right ventricular cavity. In pulmonary stenosis the blood accumulates within the right ventricle, and is compelled to take a new channel. If the defect have occurred before the ventricular septum is completed, the septum remains incomplete, and blood passes through the opening and thence to the aorta, the right ventricle being the chief agent in carrying on the systemic circulation. Owing to the increase in pressure in the right heart, the right ventricle and auricle hypertrophy. If the lesion be severe, much of the blood to the lungs must reach them from the aorta through the ductus arteriosus, which does not, therefore, close after birth. If the interventricular septum have completely closed before pulmonary

stenosis takes place, the pressure in the right auricle becomes increased, if the foramen ovale be patent, the blood passes from the right to the left auricle, and in this way a patent foramen ovale is not infrequently found. The right auricle is small and atrophied, and the tricuspid orifice becomes smaller. The cavity of the left ventricle enlarges, and its walls hypertrophy, as it carries on both the systemic and pulmonary circulation. In almost all these cases the blood is carried to the lungs by the patent ductus arteriosus. It will thus be seen that the circulation in cases of pulmonary stenosis depends upon the patency of the foramen ovale or interventricular septum, and of the ductus arteriosus. Pulmonary atresia or obliteration of the pulmonary artery is much less common. When complete, and the interventricular septum is closed, the right ventricle is small and atrophied, the right auriculo-ventricular opening ultimately closes, and the heart becomes trilocular.

Stenosis and atresia of the aorta are of much less common occurrence than of the pulmonary artery. Stenosis may exist at one of the following sites: (1) at the orifice, (2) above the entrance of the ductus arteriosus, and (3) just below the entrance of the duct. In the first of these, the ventricular and auricular septa do not close, and the left ventricle remains undeveloped. Most of the systemic circulation is carried on by the pulmonary artery through the ductus arteriosus. The second, or new-born type, is often associated with other malformations, as, for example, pulmonary stenosis. The ductus arteriosus remains open, and most of the systemic circulation is carried on by the right ventricle, through the duct. The third or adult type of stenosis is more common. By coarctation of the aorta is meant stenosis of the aorta at or just below the junction of the ductus arteriosus with the aorta, *i.e.* in the region of the aortic "isthmus." The condition is more common in males than in females. The ductus arteriosus may remain patent or may close. When the condition is present in adults and in children who have survived the period of infancy, it is supposed to have arisen gradually after birth, in association with the closure of the ductus arteriosus. Usually in such cases an elaborate system of collateral arterial circulation has developed, so that the arterial blood from the upper part of the body—that is to say, from the great arteries given off by the aorta above the site of the obstruction—can pass by enlarged anastomosing branches to the lower part of the trunk and the lower extremities. Hypoplasia of the aorta, or narrowing of the lumen of the vessel throughout its whole extent, with diminished size of the heart, was first described by Virchow, and there is sometimes accompanying chlorosis. Other malformations of the heart are occasionally also present. The condition known as double aorta is a form of congenital heart disease very rarely found.

Persistence of the ductus arteriosus occurring alone is also a rare condition. It is a common accompaniment of pulmonary stenosis or atresia, when a patent inter-ventricular septum is also present; it may also accompany aortic stenosis or atresia, and congenital disease of the auriculo-ventricular valves. Premature closure of the ductus arteriosus and of the foramen ovale is of rare occurrence.

Transposition of the pulmonary artery and the aorta may be found, the aorta arising from the right ventricle and the pulmonary artery from the left. Among other lesions which may be present are a patent foramen ovale, a

patent septum ventriculorum, and a patent ductus arteriosus. Other forms of malposition of the pulmonary artery and of the aorta have been recorded, such as both trunks taking their origin from the left ventricle. A communication between the pulmonary artery and the aorta has been known to occur.

Supernumerary or defective cusps of the cardiac valves have been noted; the number of cusps may be increased or decreased, and in the latter case incompetence of the valves may result.

Congenital lesions of the auriculo-ventricular valves may occur. Stenosis or atresia of the tricuspid or mitral orifice is much less frequent than of the pulmonary artery or of the aorta. A considerable proportion of cases of tricuspid stenosis are congenital. Tricuspid incompetence is rarely congenital; it may be associated with pulmonary atresia. Congenital lesions of the mitral orifice are of much rarer occurrence than those of the tricuspid orifice.

Symptoms.—The subjective symptoms of congenital heart disease vary in their intensity according to the site and degree of the lesion. It may be laid down as a broad principle that septal defects have a less disturbing effect upon the circulation than stenosis or atresia; indeed, in some of the former cases there may be a complete absence of subjective symptoms throughout the whole course, and the affection is only discovered on physical examination or post mortem. The results of physical examination also show variation.

Cyanosis and dyspnœa on exertion are the two chief symptoms. The former may be present within a few weeks of birth, or may only make its appearance after some years. It is a more conspicuous feature of this form of cardiac disease than of any other, the term "morbus cœruleus" being, indeed, frequently used for congenital heart disease. This is most marked in the lips, nose, the malar region, and the fingers and toes, being especially noticeable in the nails, and may be confined to these localities, or may be more general. The degree of cyanosis varies up to a deep purple, and is increased by exertion. The lips and nostrils may exhibit thickening, and clubbing of the ungual phalanges of the fingers and toes is usually present, due to chronic venous engorgement. There may be an absence of dyspnœa while at rest, but it may make its appearance on exertion, while in some cases paroxysmal dyspnœa occurs.

While the temperature taken in the mouth or rectum is usually normal, the skin temperature is usually subnormal. The subject of congenital heart disease often complains of feeling cold, is very susceptible to any fall of temperature, and is liable to attacks of bronchitis. On examination the blood is found to have an increased viscosity, and its specific gravity may be as high as 1070. There is a large increase in the number of the erythrocytes, which may even reach 9,000,000 per c.mm., the hæmoglobin is increased, and may be as high as 160 per cent., while the leucocyte count may show an average of 15,000 per c.mm. There is usually retardation of growth, and in some cases wasting; the mental condition is backward, and the patient is frequently dull and lethargic. There may be syncopal attacks, even resulting in prolonged unconsciousness, while epileptiform attacks may also occur. In certain instances there is a tendency to hæmorrhage from the nose, gums, and less frequently from the lungs. Œdema is sometimes present, which at

a later stage may become general, and hæmoptysis, hepatic enlargement, albuminuria, and transudation of fluid into the serous sacs may also occur. Not infrequently other bodily malformations are to be noted.

The veins of the retina are almost always dilated and tortuous, the lumina appearing in some places to be unduly wide, and in others abnormally narrow; both arteries and veins are much darker than normal.

The pulse is usually quickened in rate. There is usually evidence of cardiac enlargement, although perhaps not of severe grade, the right side of the heart being particularly affected. Distension or pulsation of the jugular veins may also be present. Sometimes a thrill and frequently a murmur, usually systolic in time, are to be noted. The point of maximum intensity may be over the pulmonary area, but it may be difficult or impossible to define. The murmur is usually rough and grating, and, perhaps, extremely loud; on the other hand, it is sometimes very faint. The pulmonary second sound may be normal, diminished, or loud and ringing.

The subject of congenital heart disease may ultimately die from gradual cardiac failure—the clinical picture resembling that of mitral disease, or infective endocarditis, bronchitis, broncho-pneumonia, pulmonary tuberculosis, one of the acute infective diseases, cerebral thrombosis or abscess, or convulsions, while instances of sudden death have been known to occur.

Passing now to a consideration of the symptomatology of the individual lesions, in dextro-cardia the apex-beat is on the right side of the thorax, and the point of maximum intensity of the aortic second sound is on the left, instead of the right side. For the result of electro-cardiographic examination, see page 922. When patency of the interventricular septum exists alone, the subjective symptoms are usually slight. A certain amount of dyspnœa and cyanosis on exertion may occur, but cyanosis is not a prominent feature, and there is usually no clubbing of the ungual phalanges of the fingers and toes. There may be evidence of enlargement of the right side of the heart. In some instances a systolic thrill and a loud and harsh murmur over the præcordium are present. Writers also differ in regard to their point of maximum intensity; according to some, *e.g.* Roger, it is in the median line in the upper third of the præcordium, while in the opinion of others it is near to the left margin of the sternum in the third left interspace, or even as low down as the xiphisternum. There is a diversity of opinion also in respect of the question of the direction of selective propagation of the bruit, some believing that there is none, and that the bruit is not audible over the carotid artery, whereas others affirm the opposite. Some writers say that the second sound in the pulmonary area is accentuated. When patency of the interventricular septum is secondary to other lesions, the symptoms of the primary affection predominate.

When patency of the inter-auricular septum exists alone, there is not infrequently an absence of subjective symptoms, and the condition, therefore, may not be discovered during life. In other cases, however, they are present, the results of physical examination then exhibiting considerable variation. A murmur or murmurs may be present over the præcordium, being in some cases systolic, in others diastolic, or, according to some writers, even characteristically presystolic, and having the point of maximum intensity over the base of the heart.

In congenital pulmonary stenosis, cyanosis occurs in the vast majority

of cases, and usually within a few weeks of birth, but in rare instances it only makes its appearance after some years. Clubbing of the fingers and other symptoms of congenital heart disease are usually present. The pulse may present no special peculiarity, or it may be small and empty. Sometimes a thrill, systolic in time, and with its point of maximum intensity over the pulmonary area, is present. On percussion the left border of the heart is often, and the right border is almost always, found to be displaced outwards. The most characteristic physical sign is to be found on auscultation; this is a murmur, with its point of maximum intensity in the pulmonary area, systolic in time, usually rough and grating, and, it may be, extremely loud. The murmur may be heard over a considerable area of the chest; occasionally it is quite distinct as high as the first rib; sometimes, indeed, all over the chest. As a rule, it has no direction of selective propagation, and in the vast majority of cases is not audible over the vessels of the neck. The pulmonary second sound is usually diminished or even absent; sometimes there is a pulmonary diastolic bruit present, owing to incompetence of the valve.

The physical signs of congenital stenosis at the aortic orifice are the same as those of the acquired form of the disease. In stenosis above the entrance of the ductus arteriosus, cyanosis is usually present, but the physical signs are indefinite; systolic and diastolic bruits may be audible over the front and back of the thorax. In typical cases of the "adult" type of coarctation of the aorta, a number of thickened tortuous arteries can be both seen and felt pulsating beneath the skin of the back and front of the trunk.

When a patent ductus arteriosus occurs alone, there may be no subjective symptoms, or they may be only slight, such as slight cyanosis and dyspnœa on exertion. The area of cardiac impairment is usually displaced to the right, also sometimes to the left, and other evidence of enlargement of the right heart, such as systolic retraction, may also be present. There is sometimes a certain amount of fullness, a thrill, and a murmur, having their point of maximum intensity in the second left intercostal space at least 2 inches from the middle line. The murmur is prolonged, and occupies both systole and diastole; it commences shortly after the beginning of the first sound, and extends into a considerable part of the diastole; indeed, it may persist almost throughout the whole cardiac cycle. It is not propagated to the vessels of the neck. The second sound in the pulmonary area may be accentuated. Other writers have noted the presence of systolic pulsation, a small area of impairment of percussion note, and a shadow on skiagraphic examination.

In congenital lesions at the tricuspid orifice, cyanosis, dyspnœa and clubbing are not conspicuous features, and the latter is not infrequently entirely absent. The physical signs are the same as those of the acquired form of the disease.

Diagnosis.—While it is usually not difficult to say that congenital heart disease exists, it is a much more difficult task to diagnose the form of the disease, and, further, it should be remembered that several lesions often coexist. In considering the question of diagnosis, the history of the case, the subjective symptoms, the existence or otherwise of evidence of enlargement of the right side of the heart, and the time of occurrence, the point of

maximum intensity, and direction of selective propagation of any existing murmur, are all points which should be taken into account.

With regard to the diagnostic value of the various symptoms, it may be remarked that cyanosis, even of marked degree, may be present during an attack of acute bronchitis in infancy and early childhood, especially in anæmic and rickety subjects, and also in cretinism; and that clubbing of the fingers may exist in the acquired form of heart disease, more especially in mitral stenosis, while it may be absent in the slighter forms of congenital disease. It is also necessary to point out that in some cases of congenital heart disease the right side of the heart may be only slightly enlarged. The murmurs are usually systolic in time and loud, and their point of maximum intensity and direction of selective propagation are not so typical as those of the acquired form of heart disease. In cases of a non-functional systolic murmur having its point of maximum intensity over the pulmonary area, we should think of the possibility of congenital heart disease. It may, however, be exceedingly difficult, and indeed impossible, to distinguish functional basic murmurs from those of congenital heart disease during infancy and childhood by means of auscultation alone. It should be noted that a prolonged thrill and murmur occupying both systole and diastole may also be met with in arterio-venous aneurysm.

In those subjects of heart disease who have attained to adult life, and even in the case of young children, it is difficult to say whether the lesion is congenital or acquired. If there be a history of marked cyanosis soon after birth, and there have been known to be clubbing of the fingers, evidence of enlargement of the right side of the heart, and a systolic thrill and murmur whose point of maximum intensity and direction of selective propagation are not so typical as those of the acquired form of heart disease present in early life, a positive diagnosis of the congenital form of heart disease is not difficult.

Prognosis.—The prognosis of congenital heart disease exhibits wide variation. If the defect be slight, as, for example, a patent foramen ovale or a small opening in the interventricular septum, a considerable proportion of cases live to an advanced age without experiencing subjective symptoms; whereas if the defect be serious, the duration of life is brief in a large proportion of cases, and, indeed, the individual may die within a few hours. The degree of cyanosis is not absolutely reliable. The occurrence of paroxysms of dyspnœa, syncopal attacks, and convulsions is a very unfavourable omen.

Meso-cardia, dextro-cardia, and absence of the pericardium are conditions compatible with long life. On the other hand, life cannot exist with a bilocular heart. Trilocular heart is compatible with life for some years, and, indeed, instances have been recorded in which individuals have lived to adult age; usually, however, the period of life is short. Persons suffering from septal defects not infrequently live to an advanced age. When patency of the interventricular septum occurs alone and the opening is not large, the individual may live to past middle life; when, however, it occurs in association with other lesions, the prognosis depends upon the latter. The prognosis of an individual suffering from pulmonary stenosis depends upon, besides those points already mentioned, whether there is a patent interventricular septum to afford relief to the over-distended right heart. Death may occur,

on the one hand, within a few hours after birth, while on the other, in the case of lesions of slighter grade, life may be prolonged for 5, 10 or 20 years, and occasionally even to middle life; indeed, if a patent interventricular septum be present in these slighter lesions, cases have been recorded in which patients have lived to the age of 60. Taking cases of pulmonary stenosis as a whole, however, most of the patients die at an early period of life. Pulmonary atresia is a much more serious condition, and life is prolonged for only a brief period. Cases of stenosis at the aortic orifice do not survive birth, and in those in which stenosis exists above the entrance of the ductus arteriosus life is prolonged at the outside for a few months only, but when just below the entrance of the duct it may be prolonged till middle age. Persistence of the ductus arteriosus is not infrequently compatible with adult life, and individuals have been known to have lived even to old age. Cases of transposition of the pulmonary artery and the aorta do not, as a rule, survive infancy, but instances have been recorded in which these patients have lived to middle age.

Treatment.—The general measures previously laid down are applicable also to this affection. It is particularly important that the patient should be kept warm, and it is imperative that careful and detailed measures should be adopted for the prevention of bronchitis; if bronchitis should occur, adequate treatment should be adopted without delay. When cardiac failure supervenes, it should be treated on the lines previously laid down.

PRIMARY CARDIAC OVERSTRAIN

Definition.—By primary cardiac overstrain is meant a cardiac disorder which is the immediate result of excessive physical exertion in an individual whose heart has been sound, or in whom the heart has been already somewhat impaired. It formerly included the condition known as "soldier's heart" or the "irritable heart of soldiers," which I shall describe separately.

Ætiology.—The affection is the direct result of excessive physical exertion, and is most frequently met with in persons of athletic habits and in soldiers. It is more apt to occur in those who undergo excessive physical exertion while not in training; indeed, it is questioned by some whether the affection can occur in persons with previously sound hearts who have been properly trained. It is also more likely to occur in older persons, and where there is a history of rheumatism or of some other acute infection, in anæmia, and in those who have indulged in excesses of any kind.

Symptoms.—When the malady is due to sudden physical strain, as in boat-racing or Alpine climbing, there may be lividity or cyanosis of the face, giddiness, faintness, passing into actual syncope, together with vomiting and even fatal syncope, and possibly evidence of acute dilatation of the right heart. Later on, there may be collapse, cyanosis, coldness of the skin, præcordial uneasiness and even actual pain, quick and shallow respiration, and a quickened, small and thready pulse; while later, in severe cases, there may be evidence of œdema of the lungs. These acute symptoms may be followed by general lassitude, impaired digestive functions, an increase of rectal temperature, and a pulse of subnormal pressure, although at the same

time the apex-beat may be forcible and tumultuous; tachycardia, and a forcible and tumultuous apex-beat being especially noticeable on the least exertion. For some weeks, dyspnœa and an increase of cardiac rate from 30 to 40 per minute above the normal on even slight physical exertion, nervousness, languor, and a sense of fatigue on mental exertion are apt to occur.

In the chronic form of the affection, among the symptoms are palpitation, even of severe degree, a feeling of oppression or of constriction of the chest, and sometimes actual pain over the præcordium, extending to the left shoulder, and occasionally down the arm; as a rule there is no sense of impending death. Among other symptoms which may be noted are dyspnœa and faintness on exertion, tremors, nervousness, insomnia, noises in the ears, flashes of light before the eyes, vertigo, a dull headache, hebetude, and languor, while the digestive functions are often impaired. There may be some degree of cyanosis. These symptoms may pass away with rest, only to reappear on exertion. The pulse-rate is usually increased, but is rarely over 120 per minute while at rest, although exertion causes a further increase—up to as much as 140 or 150. The pulse is usually small, weak, and of subnormal pressure, while the apex-beat may be diffuse and diminished in force or even absent, but on exertion may become unduly forcible and tumultuous. The area of cardiac impairment is usually increased to the left, and not infrequently also to the right. The cardiac sounds may be feeble, or short and sharp, and may be reduplicated, or a mitral or tricuspid systolic murmur may be audible, while the second sound in the pulmonary area may be accentuated.

Diagnosis.—The diagnosis in large measure resolves itself into the question whether the case is one of primary cardiac overstrain, or whether the heart has been previously damaged; in the latter case, excessive physical exertion is merely the exciting cause. In considering this problem, the presence or absence of a previous history of one of the acute infections and the state of the general health, and whether there is evidence or otherwise of myocardial, valvular, or arterial disease, are points of material importance.

Prognosis.—The prognosis of primary cardiac overstrain exhibits a wide variation, ranging from a slight illness on the one hand to a severe and even irremediable affection on the other. In the less severe degree of acute cases occurring in the young and previously sound and vigorous, recovery is the rule; the patient may be well in a few days or weeks, although, on the other hand, progress may be slow, and a long time may elapse before the individual is capable of an ordinary amount of work. If tricuspid regurgitation be present, this, unlike mitral regurgitation, usually passes off quickly. But if the heart have been previously affected by rheumatism or by some other infection, and in the case of older persons, the prognosis is serious; recovery may be long delayed, or the patient may be always compelled to lead a sedentary life, and, in some cases, even a fatal termination may result. In all cases of primary cardiac overstrain a diminishing increase of pulse-rate on exertion is of favourable omen.

Treatment.—In the acute cases, a very hot bath is to be commended, the patient being lifted out of it in a blanket, or a hot pack, together with the administration of one or two 15-grain doses of diuretin. A strictly limited amount of food, both solid and liquid, is indicated in the early stages,

and no tea, coffee, alcohol, or tobacco. Oxygen may be required in some cases; morphine and strychnine are rarely necessary. Later on, tea and coffee may be allowed in limited quantities, but the patient should still abstain from alcohol and tobacco. The bromides are often extremely useful in persons who suffer from an unduly excitable nervous system or from insomnia. When the patient is able to get up, extreme caution should be enjoined as to the amount and character of any exertion. The use of electricity is contra-indicated. Warm baths, followed by a cold douche, may in individual cases be tried, if followed by a reaction. Such general tonics as iron, arsenic, and quinine may be indicated.

In the more severe or chronic cases, prolonged physical and mental rest may be necessary, although massage may be employed at an early stage with advantage, provided it is at first very gentle and at all times stops short of causing fatigue. The diet should be small in quantity, nutritious, and easily digestible, and if atonic dyspepsia be present it should be treated.

SOLDIER'S HEART

Synonyms.—The Irritable Heart of Soldiers; Disordered Action of the Heart (D.A.H.); Effort Syndrome.

This condition was first fully described by Da Costa in 1862 and later, and by Myers in 1870. It is necessary to point out, however, that in the light of recent discoveries some of the cases described by these writers were in all probability cases of auricular fibrillation, the onset of the latter condition having in many cases been associated with undue physical exertion. Since the Great War much attention has been paid to the subject, owing to the large number of cases which have arisen, apparently as a result of the conditions attendant upon the life of the soldier in modern warfare.

Ætiology and Pathology.—The affection is more common in those of sedentary occupation, and there is frequently a history of acute rheumatism.

The prevailing view prior to the Great War was that the malady was due either to the accoutrements of the soldier, such as tight belts and closely fitting uniforms, or to over-exertion, such as "setting-up drill." It may be pointed out, however, that in a discussion reported in the *Journal of the Royal Army Medical Corps*, 1910, R. J. S. Simpson pointed out that the method of training can only be subsidiary as a cause, and expressed the belief that the affection is congenital, or at least developmental; while W. Bezley Thorne put forward the view that it depends upon toxæmia, and recommended the removal of this condition as part of the treatment. Speaking broadly, investigations conducted during and after the Great War appear to show that in a large proportion of the cases of soldiers invalided home for so-called soldier's heart affections, the heart is not the *fons et origo* of the malady, and that the circulatory symptoms are but a manifestation of the general state. On inquiry, it has been found that in many of the cases there has been a history of some slight illness, such as diarrhœa, or a febrile attack pointing to some infection.

Among the hypotheses which have been advanced in explanation of the condition are the following:

1. *Glandular.*—The glands blamed are the thyroid and the suprarenals. Some consider that the condition is one of hyperthyroidism, and state that enlargement of the thyroid is present in nearly every case. But as Lewis found this in only 4 per cent. of the cases, and other observers have scarcely ever noticed it or other signs of hyperthyroidism, this theory cannot be said to be proved. The irritation of the sympathetic, with its concomitant results, noted in the condition, has led some to blame the suprarenals; but it is difficult to believe that this is the true cause, especially as the administration of adrenalin appears to aggravate the condition.

2. *Nervous system.*—All the symptoms point to the nervous system as bearing the full force of the blow; it is not, however, the primary but the secondary factor, the exciting cause falling chiefly on this system.

3. *Myocardial factor.*—It has been suggested that, as a history of rheumatic fever is so frequent, the myocardium is chiefly to blame. Rather does it seem that the myocardium is affected secondarily by the exciting cause.

4. *Bacteræmia.*—At one time this was thought to be the cause of the disease, but the failure of Dimond and Briscoe to find the presence of any bacteria in the blood has disposed of this claim.

5. *Poisoning following some microbic invasion.*—Numerous authorities subscribe to this view, as in 50 to 60 per cent. of cases the symptoms have been first noted after an infection. I do not consider, however, that a case has been made out in support of this view. It may be asked, for example, what about the other 40 per cent. in whom there is no such history, and why should infection cause soldier's heart in one case and not in another?

Personally, I consider that the view of Simpson and others, namely, that the malady is congenital, or at least developmental, has much to commend it. One person is constitutionally not so strong as another (called by some "constitutional inferiority"), the reason of which cannot be discovered. This view would explain why alteration of accoutrements and avoidance of over-exertion do not obviate the condition. I incline to the view that numerous factors play a part in the production of the malady, and that the following may explain the pathology: As in the case of civilians, one soldier is constitutionally not so strong as another, as a result of congenital or developmental weakness, and any evil effect weakening the system by infection, fright, shock, or emotion of any kind, overstrain, or other concomitants of warfare, will in those soldiers less able to bear these produce the symptoms of soldier's heart, while their stronger brethren will escape; especially will this be the case in those who before enlistment have been employed in sedentary occupations. During the pre-war period the condition may have remained latent, as there had not been a sufficient excitement to make it evident; but directly this is increased by the conditions of warfare the system breaks down.

It may be added that soldier's heart in no way differs from what may be met with in civilian life.

Symptoms.—Thanks to Lewis and other workers, the individual symptoms have received thorough investigation, but nothing of any importance has been added to the symptomatology since the classic description given by Da Costa. Among the commonest symptoms complained of are invariably breathlessness; almost always a sense of exhaustion after effort, physical or mental, giddiness and headache; frequently palpitation, præ

cordial discomfort or pain, depression of spirits, and irritability of temper; and less commonly fainting attacks, nervousness, loss of emotional control, lack of power of concentration, impairment of memory, sleeplessness, disagreeable dreams, tremors of the hands, and vasomotor symptoms, such as flushing, and numbness, coldness, and pallor or lividity of the extremities. Shortness of breath is usually related to exertion or emotion, being out of proportion to either, and the respiratory rate may rise to 40 or even 70 per minute. The respiratory rate is always normal while asleep, and usually so apart from physical exertion and emotion. The sense of exhaustion after effort may be extreme. Giddiness is associated with physical exertion or with change of posture, especially the latter; as also are fainting attacks, which may be accompanied by loss of consciousness. Headache usually occurs after exertion, and may be severe, throbbing and localised in the frontal region. Palpitation is generally induced by physical exertion or emotion, but it may be nocturnal, and occasionally occurs apart from these. Pain is usually related to exertion, less frequently to emotion, and is occasionally nocturnal. It is commonly limited to the præcordium, but sometimes radiates to the back, to the neck, or down the left arm. The cardiac rate is increased, and also the increase in rate on physical exertion, emotion, and the assumption of the upright posture after lying down is in excess of the normal, as is also the time which elapses before the pulse-rate returns to its rate prior to exertion. The blood-pressure is usually not increased, but the increase on physical exertion and as a result of emotion is exaggerated. The apex-beat is often unduly visible and palpable, but it is not heaving in character. On X-ray examination, the heart is not found to be enlarged. Not infrequently the first sound is shortened and sharp, and the second sound at the apex accentuated. A systolic murmur is sometimes audible, often having its point of maximum intensity in the pulmonary area. There is nothing abnormal revealed on electro-cardiographic examination. The deep reflexes are usually exaggerated. There is a moderate leucocytosis, the lymphocytes being relatively increased in number.

Diagnosis.—There are certain fundamental distinctions between primary cardiac overstrain and "soldier's heart." In the latter, the sense of exhaustion after effort is more prominent; giddiness and fainting attacks are more associated with change of posture and less with physical exertion; and there is much more likely to be depression of spirits and other nervous symptoms, as well as vasomotor symptoms. It is necessary to diagnose the condition from cardiac hypertrophy; in the latter, the apex-thrust is slower and longer than normal, and the first sound is long, low in pitch, and muffled.

Prognosis.—This is, generally speaking, not good, from the point of view of complete recovery, a majority not being able to return to their occupation.

Treatment.—*Prophylactic.*—Slow and carefully graduated training is especially advisable in recruits whose occupations have been sedentary. *Curative.*—Investigations should be conducted for septic infection, especially from the teeth, the fauces, and the colon. Efforts should be directed towards the restoration of the patient's general bodily and mental health. To this end, fresh air and graduated exercises, especially in the form of games to begin with, are enjoined. It is of great importance to secure an ample amount of sleep, and for this, as well as for excitability or irritability of the

nervous system, bromides, at first in the usual dosage and continued in smaller dosage, are frequently of value. Digitalis is of no avail. Those cases in which there are indications of a slack vasomotor system are sometimes greatly relieved by wearing a belt to act as a general support for the abdomen.

ANGINA PECTORIS

Definition.—The term angina pectoris is usually employed to denote a paroxysmal attack of pain, usually in the retrosternal region, with a tendency to radiate in certain directions, and often accompanied by a feeling of constriction within the chest, and sometimes by a sense of impending death. I wish to emphasise at the outset, however, that *there are many grades and modified forms of the affection.*

Ætiology.—Heredity is a factor, for it is well known that certain families are more prone to degenerative processes of the arterial system and of the heart than others. The affection is much more frequent in males than in females, and is found more particularly in those who are passing from middle into elderly life. It is much more prevalent in those classes of society who are subject to excessive mental wear-and-tear, whether from overwork, worry, or anxiety, and is commoner in those who have been subjected to long-continued physical overstrain. The other important predisposing causes are gout, syphilis, rheumatism, some of the acute infective diseases, especially influenza and enteric fever, and toxic chemical substances, such as alcohol, and perhaps tea, coffee and tobacco. *In persons under 40, syphilis is an important causal factor.* Arterial disease, from whatever cause, predisposes to the disease and is present in the majority of cases, and in many there is in addition supernormal blood-pressure.

Among the exciting causes which induce attacks, the most common is physical exertion, such as walking uphill or hurrying to catch a train, especially after meals and against a cold wind; sometimes even the effort of dressing, or stooping to lace the boots, is sufficient to precipitate an attack. Other exciting causes may be cold in the sense of getting chilled from whatever cause, emotional excitement, less frequently mental effort, and dyspepsia —particularly those forms attended with flatulent distension of the stomach or colon. It must be remembered, however, that flatulent distension is also a frequent concomitant of the paroxysm. Only rarely do attacks occur apart from some exciting cause; occasionally the attack comes on whilst the patient is in bed, but this happens usually at the end of a fatiguing day.

Pathology.—The commonest structural changes found in angina pectoris are narrowing or occlusion of one or both coronary arteries, acute or chronic aortitis, fibroid or fatty degeneration of the myocardium, chronic disease of the aortic and much less frequently of the mitral valves, fusiform dilatation of the aorta, sacculated aneurysm, fatty infiltration, adherent pericardium, and arterial disease.

The hypotheses which have been advanced in explanation of the attacks are numerous, and include the following: (1) That angina pectoris consists in the distension of an enfeebled ventricle; (2) that it is of the nature of a cramp, or spasm, of the heart, analogous to cramp of a voluntary muscle; (3) that it is an "intermittent claudication"; (4) that it consists in a myo-

cardial ischæmia, generally due to an affection of the coronary arteries (atheroma, functional constriction, thrombosis, etc), this ischæmia being the direct cause of the pain; (5) that it is "neural" in origin—a neuritis, a neurosis, a neuralgia, a vasomotor storm, local or general. The third hypothesis is based upon the analogous phenomena sometimes met with in the legs in partial occlusion of the arteries. In this condition, a cramp-like pain and loss of function of the muscles are experienced on quick or prolonged walking. It is supposed that the circulation is sufficient for rest or quiet and limited exertion, but not for active or prolonged exertion. But, in the opinion of the late Sir Clifford Allbutt, the heart does not "claudicate" in angina pectoris. He himself regarded the phenomena as generally, but not always, due to tension of the first part of the aorta, which is the seat of some inflammatory or degenerative lesion; sudden death, when it occurs, being due not directly to the aortic lesion, but being the result of "vagus inhibition," the shock of the paroxysm causing asystole. He described certain rarer cases in which the morbid stress falls on the pericardium. The late Sir James Mackenzie's view was the following: That angina pectoris is "an expression of cardiac exhaustion and also an expression of a susceptible nervous system." The pain is a viscero-sensory reflex; the sense of constriction a viscero-motor reflex, giving rise to spasm of the intercostal muscles.

Symptoms.—As has been already stated, angina pectoris is characterised by a paroxysmal attack of pain, usually in the retrosternal region, with a tendency to radiate in certain directions, and often accompanied by a feeling of constriction within the chest, and sometimes by a sense of impending death.

Pain is the cardinal feature. It is felt *most commonly in the retrosternal region*, next most frequently across the front of the chest, and occasionally in the præcordium, the epigastrium, or over a wide area of the back of the chest. The severity of the pain varies from slight discomfort to intense anguish. In some cases it attains its maximum with extraordinary suddenness, while in others this happens gradually. The pain, as stated, has a tendency to radiate in certain directions. It frequently spreads to the left shoulder and armpit; occasionally to both sides; in many cases down the arm, generally on the ulnar side, usually not beyond the elbow, although it may reach as far as the finger tips. It sometimes strikes through to near the angle of the scapula, on one or both sides, or to a wide area on the back of the chest. Occasionally it extends to the neck and occiput, or to the jaw, and rarely it radiates in a downward direction, being felt even in the lower part of the trunk and lower limbs. The pain may begin in the left arm, in the jaw, the left pectoral muscle, the left leg, or in the abdomen—the so-called angina abdominis—and remain localised.

The feeling of constriction in the chest already referred to is described in different terms by different individuals; in some cases the sensation is as if the chest were held in a vice, in others as though a heavy weight were pressing on the chest. When the sensation of impending death is present, this overshadows the most severe pain. It may be present without the pain—the "angina sine dolore" of Gairdner.

When an attack occurs, the patient, if in motion, stops short and rests. The expression of the face is often anxious or even one of intense anguish. The skin is often pallid, or even cadaveric in hue, and there is frequently a

clammy sweat. The breathing is shallow, and the patient is afraid to make an effort to breathe normally. There may be a sensation of numbness, more particularly of the arm; this may be present only during a paroxysm, while in other cases it is a constant symptom. Among other subjective phenomena which may be present are tingling and giddiness, while hyperæsthesia over the painful area may often be noted. In almost every grave case the patient complains of a sensation of sinking, and of a feeling as if the heart were stopping, but rarely loses consciousness, unless fatal syncope occurs. The pulse-rate seems to vary in different cases; in some it is increased, while in others it is diminished. Very considerable changes are frequently found in the character of the pulse in different cases; at times it appears to be quite unaffected; at others it may become irregular, and different forms of irregularity have been observed, but there does not seem to be anything definitely known on the subject. The blood-pressure is often considerably increased at the crisis of the attack, but it should be remembered that this is not by any means a universal rule. The patient may yawn continuously, and there may be hiccough, flatulence, retching, or vomiting. The attack, as a rule, passes off gradually, but sometimes ceases suddenly; as it subsides the patient may belch up a large quantity of air, and it is often followed by the passage of abundant pale urine. After the attack the patient may be much exhausted, and may feel ill for some days. Death may occur at the height of an attack, and this may take place even in the first.

The attack may last for a few seconds, a few minutes, or longer; so frequently may they recur that for hours or even days the patient appears to be suffering from one continuous attack—status anginosus.

The above description is that of a typical and severe attack, but *there are many grades and modified forms*. For example, there may be on physical exertion or emotion only a little discomfort or pain felt over the sternum, radiating to the arm and neck, and accompanied by a feeling of uneasiness and distress, which may at first disappear as soon as the existing cause ceases, but at a later stage may continue for some minutes after its cessation.

Diagnosis.—Angina pectoris is not infrequently missed altogether. A diagnosis is practically always possible if full advantage be taken of all the avenues of investigation in each case. The age, sex, and previous history of the patient, the site of the pain, its paroxysmal character, its severity, its tendency to radiate in certain directions, the fact that *it is usually first noticed during or after exertion*, that it is often accompanied by a feeling of constriction within the chest and a sense of impending death, and evidence of cardio-vascular disease, together go to form a typical clinical picture.

Among the conditions which should be excluded are pseudo-angina, aneurysm, pleurodynia, acute pleurisy, cervico-brachial neuritis, and colic, whether of intestinal, hepatic or renal origin. The differential diagnosis between the true form of angina pectoris and pseudo-angina will be discussed later.

Prognosis.—This is very difficult. While the proportion of cases in which the immediate outlook is grave is not large, and while the great majority of other cases respond to treatment to a very considerable extent, the prognosis is usually serious, the occurrence of sudden death being not uncommon. In trying to forecast the future, it is necessary to consider—(1) The nature and severity of the underlying cause; and (2) the frequency

and severity of the attacks. With regard to the first, naturally the outlook is much better when the disorder is due to fatty infiltration than when associated with coronary disease, fatty or fibroid degeneration of the myocardium, or general arterial disease. When there is no doubt that the case should be placed in the latter group, the outlook is usually grave, and is still more so if in addition there be aortic incompetence or chronic renal disease. A point of great importance is to ascertain how far the patient is able to modify his life so as to bring it within the limits of the heart's strength, and also the response the patient makes to treatment.

Secondly, it is obvious that the more frequent and severe the attacks, and if provoked by slight exciting causes, the worse the prognosis. Very rarely is the disease fatal in the first attack. Apparently there is a tendency for the paroxysms to become less frequent and less severe if dilatation of the heart supervene.

Treatment.—The treatment resolves itself into two parts—(1) Prevention, if possible, of the recurrence of the paroxysm; and (2) an endeavour to relieve it.

With regard to the first of these, we should try to improve the general health, more especially the circulatory and nervous systems; and since the disease occurs usually in association with exhaustion of the cardiac muscle, a cardinal indication is to try to remedy this condition, and to prevent its recurrence. In this connection it is advisable first of all to review the ætiology, and to endeavour to find out the cause of this exhaustion; and for this purpose it will be necessary to inquire in detail into the past and present life of the patient.

In all cases the clear indication is to enjoin rest, proportionate to the degree of cardiac failure, and with this object in view it may be necessary to order complete rest in bed for some time, and even to give sedatives, such as chloral or opium. Morphine in most cases of this kind is more useful than opium. After a period of rest, explicit instructions should be given that in future the patient should live within the limits of the heart's strength, the daily life, physical and mental, being carefully regulated. He should avoid exertion which produces symptoms of cardiac distress; as well as hurry, sudden effort, walking or hurrying against a cold wind, and cold in the sense of getting chilled. Cold sheets at night, and a cold bath in the morning, should be prohibited. It should not be forgotten that the nervous system may be a factor in the production of angina pectoris, and when there is reason to believe that this is the case, appropriate measures should be employed. When the patient has suffered from a period of mental strain or sleeplessness, and, indeed, whenever there is any excitability or irritability of the nervous system, the administration of bromide of ammonium in doses of 10–20 grains three times a day, is often of great value. Emotional excitement, gastro-intestinal dyspepsia—particularly that form which is accompanied by flatulent distension—constipation, and all other possible exciting causes of an attack should be carefully treated. Over-indulgence in food, alcohol, or tobacco should be avoided. Flannel should be worn next to the skin, both summer and winter. When there is reason to believe that syphilis is the cause, appropriate and energetic anti-syphilitic treatment should be employed. Similarly, if high tension be present, this should be treated on the lines previously laid down. In fact, we should review the

whole of the causes of angina pectoris, predisposing and exciting, with a view to treatment.

Of drugs which may be given with the hope of preventing an attack, the most hopeful are iodide of potassium and nitro-glycerine. The former is probably in most respects the best, and is particularly indicated when arterial disease is present, more especially if there be a history of syphilis. In some cases 5-grain doses are sufficient, while in others the drug should be pushed. Sometimes syrup of hydriodic acid, in doses of from ½ to 2 drachms, well diluted with water, is better tolerated. Nitro-glycerine may be given in the form of tablets, or the 1 per cent. solution of trinitrin. The usual dose is $\frac{1}{100}$th grain; this may be given three or four times a day, and gradually increased to $\frac{1}{20}$th grain or even $\frac{1}{10}$th grain. Either drug should be given intermittently for 2 or 3 weeks at a time, while in some cases it is good to alternate them. Sodium nitrite, erythrol tetranitrate, mannitol nitrate, and nitrite of potash are other drugs which may occasionally be employed. Taken altogether, the nitrites are not so valuable as the iodides.

Within recent years, diathermy and radiotherapy have been advocated. Operative treatment has also been resorted to. T. Jonnesco, in 1916, removed the last two cervical ganglia and the first thoracic ganglion of the sympathetic on the left side. Four years afterwards the patient had remained completely free from an attack, and the pulse-rate had increased from 44–52 to 72–74. He explained the beneficial effects as due to suppression of the centripetal path between the cardio-aortic apparatus and the nerve centres following resection of the cervico-thoracic sympathetic, the aortic reflexes to the nervous centres and the reaction of these centres which would result being thus eliminated, it having been found that ascending sensory nerves pass from the cardio-aortic plexus into the cervico-thoracic sympathetic, and terminate in centres in the brain and medulla. Daniélopolou and Hristide are of opinion that Jonnesco's method should be supplanted by resection of the posterior roots corresponding to the sensory nerves of the heart; and if this operation be too serious, resection of the left corresponding spinal nerves. V. Pleth has published four successful cases of cervical sympathectomy.

For the paroxysm, the most efficacious remedy in most cases is the inhalation of nitrite of amyl; the action of the drug is almost immediate, and the relief is usually complete, this being particularly the case with widespread arterial constriction. It is best administered in the form of the glass capsules or perles, each containing from 2 to 5 minims, which the patient should carry about with him. This dose may have to be repeated. A similar effect may be obtained by nitro-glycerine, but its action is not so rapid, although its effect is more prolonged. The patient may nibble one or more of the tabellæ nitro-glycerini until the pain disappears; or the liquor trinitrini may be given, beginning with one, and increasing, if necessary, to 5-minim doses, in a little water. If flatulent distension be present, a draught of carminative mixture, or, if this be not available, some very hot water with a little essence of peppermint or brandy, sipped slowly, may be given with the amyl inhalation or the nitro-glycerine drops. In cases in which there is pronounced heart failure, brandy or ether, preferably the latter, in doses of 20 to 60 minims, in which 1 to 2 minims of a 1 per cent. solution of trinitrin may be dissolved, may be injected subcutaneously. Erythrol tetranitrate and sodium nitrite are not so suitable.

If the drugs enumerated fail, chloral by the mouth, hypodermic injections of morphine, or inhalations of chloroform, should be employed. Twenty grains of chloral hydrate may be tried. As a rule it is necessary to give morphine in large doses—$\frac{1}{4}$th to $\frac{1}{3}$rd grain. Nitro-glycerine may be combined with the morphine. The nitrites and chloroform are not of such value when there is no decided arterial spasm as in cases in which it is present. Where there is cyanosis or asthma, oxygen inhalations may be tried, particularly when morphine is found necessary.

If the drugs enumerated are not at hand, hot drinks, water containing whisky, brandy, capsicum or spirits of chloroform, or a carminative mixture, may do good by the relief of flatulence.

Pseudo-angina

Definition.—The term pseudo-angina is used by some writers to denote a paroxysmal attack of pain in the region of the heart, independent of cardio-vascular lesions. While, however, this is the case, it should be remembered that it may be met with in individuals who are the subjects of valvular disease.

Ætiology.—The malady is much more frequent in females than in males, and while it is found more particularly between the ages of 25 and 50, it may occur at any age. It is not infrequently associated with hysteria, neurasthenia, or toxic causes. While the exciting causes are the same as those of the true form of angina pectoris, physical exertion does not play such an important part; cold, emotional excitement, and perhaps dyspepsia, are, on the other hand, more important factors.

Symptoms.—The pain is usually less severe than in the true form of angina, and is usually accompanied by a feeling of distension instead of constriction. The patient may complain of shortness of breath, palpitation, and a feeling of faintness. The pulse is small, and its frequency is usually increased. The attack sometimes lasts for an hour or longer, and may be followed by the passage of abundant pale urine, the patient often complaining also of a sense of fatigue.

Pseudo-angina includes at least two groups of cases, namely—(1) the neurotic; and (2) the vasomotor or toxic. The first group includes the hysterical and neurasthenic cases, while the toxic group includes cases which are due to the excessive use of tobacco, and perhaps tea or coffee, and those which follow the acute infections—particularly influenza.

In the neurotic cases the attacks are not infrequently periodic and nocturnal, and induced by emotional excitement. Instead of becoming or remaining immobile, in a number of cases the patient moves about in an agitated manner, even rushing to the window for air. Associated nervous symptoms may be present; in hysterical subjects there may be points of hyperæsthesia and anæsthetic areas. The paroxysms show a tendency to recur for some hours, or even days, following the attack.

In the vasomotor or toxic variety, the individuals are not infrequently the subjects of vasomotor disturbances, such as numbness, coldness and pallor or lividity of the extremities; while in those cases associated with the excessive use of tobacco, symptoms of nicotine poisoning, such as tobacco amblyopia, may be present.

Diagnosis.—The differential diagnosis between true and pseudo-angina is, as a rule, not difficult. In its consideration, the age, the sex, the previous history, the presence or absence of evidence of cardio-vascular lesions, the exciting cause and character of the attack, its response to treatment, as well as the other distinguishing features already described, should all be taken into account.

Prognosis.—The prognosis with regard to life is good, the attack never proving fatal, and usually having little effect on the duration of life. Further, with suitable management and treatment, there is a good chance of complete cure; the neurotic forms, however, tend to recur. In those cases of toxic origin, it is essential that the causal factor should be removed. When abuse of tobacco is responsible, however, the complaint often persists for a long time.

Treatment.—Our first duty is to reassure the patient. We should review the ætiology of the malady, and measures appropriate to each case—as, for example, when the condition is associated with hysteria, neurasthenia, or the excessive use of tobacco—should be adopted. Further, all possible exciting causes should be prevented or treated. Anti-neuralgic therapeutical agencies are more likely to be efficacious than the use of vaso-dilators.

For the paroxysm, very hot water, sipped slowly, may be tried; while, if this be not successful, diffusible stimulants may be employed, although their frequent use is not to be encouraged. If these be of no avail, use may have to be made of morphine. It may be of service for the patient to carry about with him a carminative mixture, a dose of which may be taken when an attack is threatened.

FREDERICK W. PRICE.

CLINICAL ELECTRO-CARDIOGRAPHY [1]

By means of the electro-cardiograph we are able to obtain records of the movements of both the auricles and ventricles, to measure the function of conductivity of the auriculo-ventricular bundle not only above, but also below, its division into two branches—that is, after its entrance into the ventricular muscle, and to make out the time-relations of the contraction of the auricles and ventricles. In addition, it tells us the point of origin and path of conduction of the stimulus for contraction. It is the most precise means at our disposal of investigating the state of the myocardium.

It has been known for a considerable time that changes in electric potential take place in muscle when it contracts, and, further, that a record of these changes may be obtained by connecting the muscle with a sensitive galvanometer by means of electrodes.

A. D. Waller, in 1887, employed a capillary electrometer to register the changes in electric potential in the human heart during contraction. He demonstrated that these changes were distributed through the body, and he used the moist skin surfaces of the arms and legs as leads, connecting them with a galvanometer.

Einthoven employed the string galvanometer to register the changes

[1] Horizontal lines: 1 cm. = $\frac{1}{10}$ volt.
Vertical lines: thick = $\frac{1}{5}$th second, thin = $\frac{1}{25}$th second.
In most of the figures, the lead is marked in the upper left-hand corner.

in electric potential in the human heart. He modified this instrument, the Einthoven string galvanometer being now generally employed in physiological and clinical investigations.[1] In the Einthoven galvanometer there is an exceedingly fine silvered glass fibre, which is suspended in a box and placed vertically between the poles of a powerful electro-magnet. When a current passes through this fibre, minute movements of the fibre take place. The shadow of the oscillating fibre is magnified, and projected on to a photographic screen, and in this way a photograph of these movements is obtained. The sensitiveness of the fibre can be adjusted by altering the tension, the standard generally adopted being that of Einthoven, *i.e.* that when a difference of potential of one millivolt is passed through the fibre, this gives a deflection on the plate of 1 cm. in amplitude.

Following Einthoven, the common practice is to accept three leads and the following nomenclature, *i.e.* lead I, or the transverse, a lead from the right and left hands; lead II, or the axial, from the right hand and left foot; lead III, or the left lateral, from the left hand and left foot.

Oscillations may result from tremor of the somatic muscles, and may somewhat resemble those due to auricular fibrillation; the differential diagnosis will be discussed later.

The record of the changes in electric potential which take place in the heart during contraction is called an electro-cardiogram.

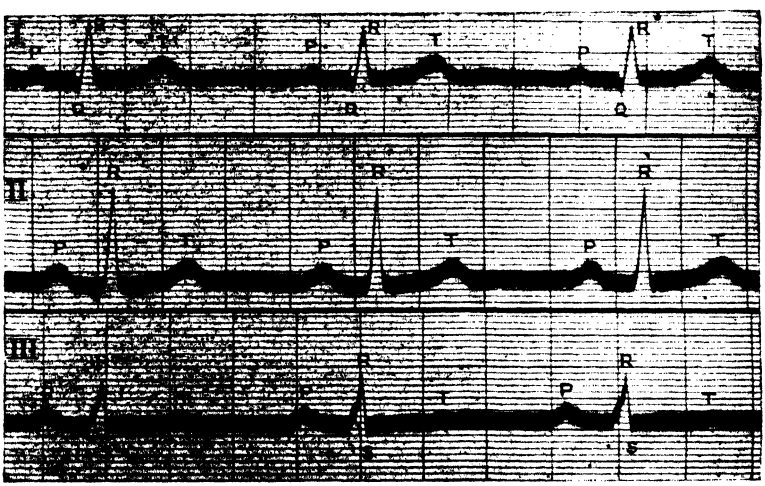


FIG. 68.—Electro-cardiogram of a normal subject. The first deflection, *P*, is due to the contraction of the auricles; the others are the result of the contraction of the ventricles, and are termed *Q*, *R*, *S*, and *T*. In normal subjects the amplitude of all the deflections is usually greatest in lead II, especially the deflection *R*.

If a normal electro-cardiogram be studied, certain upward and downward deflections are seen in each cardiac cycle, the former being the more important (Figs. 68 and 69). These deflections may exhibit considerable

[1] The electro-cardiograph supplied by the Cambridge Scientific Instrument Co. Ltd. is, in my opinion, the most satisfactory.

variations in amplitude and form. Following Einthoven, the deflections are called *P*, *Q*, *R*, *S*, and *T*, in some instances *T* being followed by *U* during the early part of diastole. That portion of the electro-cardiogram from the beginning of *P* to the commencement of *Q* is called the auricular complex,

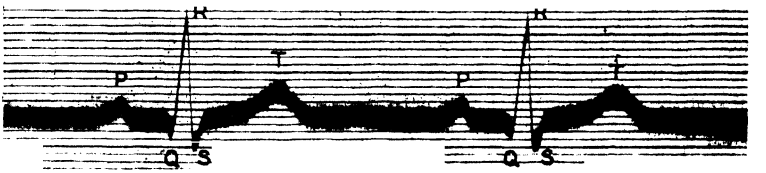


FIG. 69.—A normal electro-cardiogram.

and that portion between the commencement of *Q* to the end of *T* is called the ventricular complex. The interval between *T* and the following *P* represents diastole.

The first deflection, *P*, is due to the contraction of the auricles. *Q*, *R*, *S* and *T* are due to the contraction of the ventricles. *P* is a small, blunt and rounded, upward deflection. Following *P* the string either remains at zero,

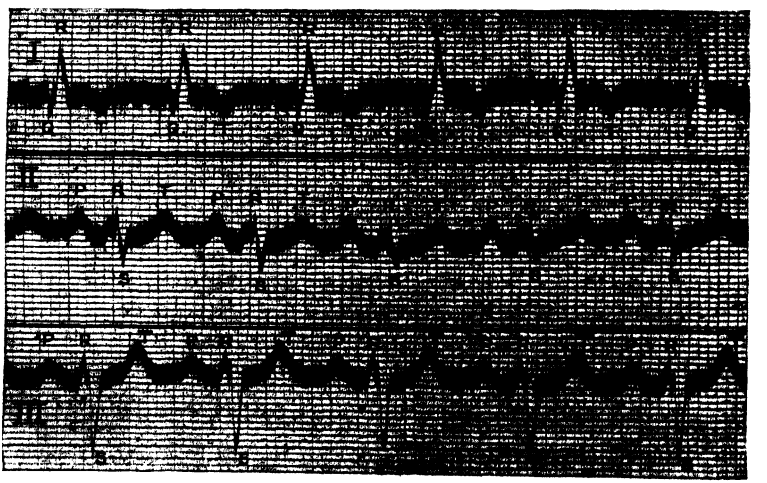


FIG. 70.—Electro-cardiogram showing inversion of *T* in lead I. There is also left-sided preponderance.

or descends somewhat. *Q* and *S* are downward, steep deflections, usually of small amplitude. *Q* passes at once into *R*, which is an upward sharp spike, and of greater amplitude than any of the other deflections. *S* follows immediately upon *R*. During the interval between *S* and *T* the string remains

at zero. *T* is a prominent, broad, blunt deflection. It is an upward deflection in lead II; it is almost always an upward deflection, but may be inverted in lead I (Fig. 70); and is not infrequently inverted in lead III

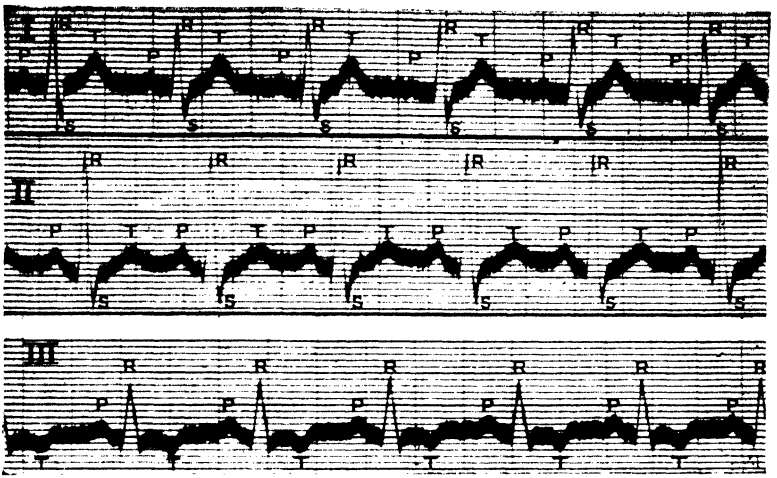


Fig. 71. Electro-cardiogram showing inversion of *T* in lead III.

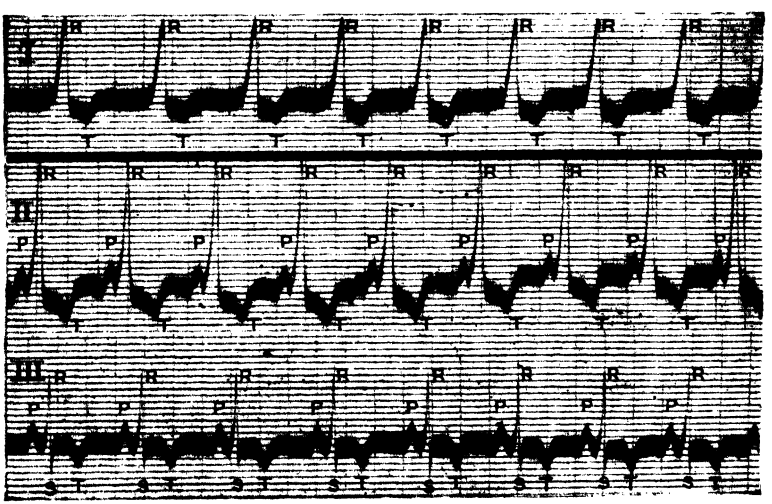


Fig. 72.—Electro-cardiogram showing inversion of *T* in all the leads.

(Fig. 71). It is said that inversion of *T* in lead II is always pathological, and in lead I nearly always so. If *P* (Fig. 73) or *R* be a downward deflection in lead I, II or III it is abnormal. Bifurcation of *R* (Figs. 74, 75 and 76) and

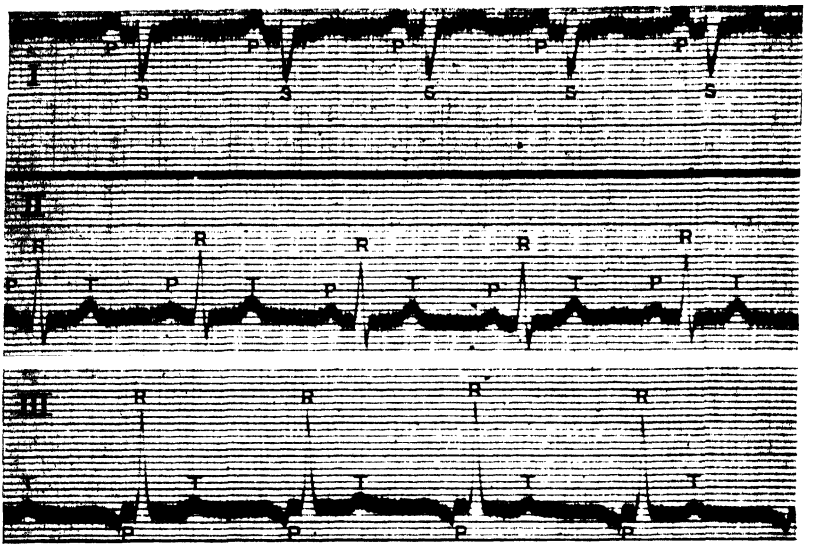
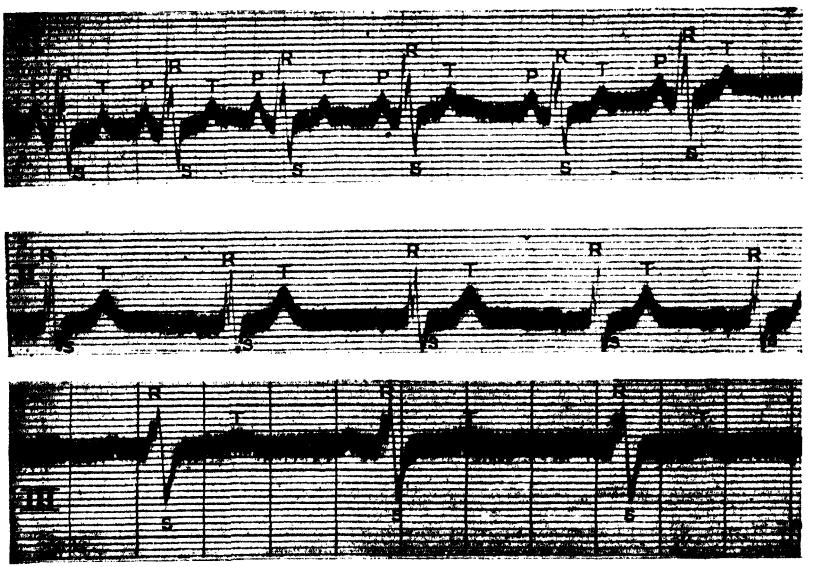


FIG. 73.—Electro-cardiogram showing inversion of *P* in lead III. There is also right-sided preponderance.



FIGS. 74, 75 and 76.—Electro-cardiograms from three different subjects, showing bifurcation of R

S is occasionally found in normal individuals, and of *P* (Fig. 77) more rarely. Bizarre types of the *Q*, *R*, *S* group of deflections are occasionally to be noted (Figs. 78, 79 and 80).

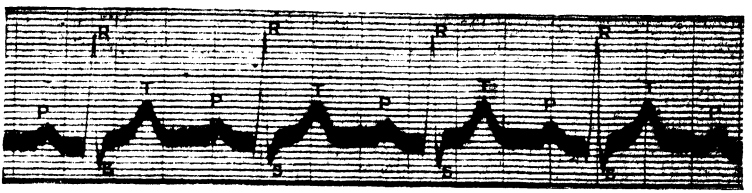
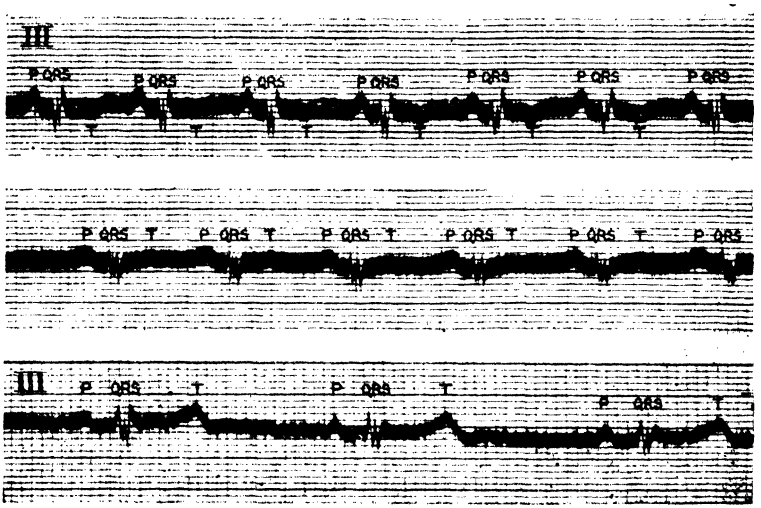


FIG. 77. Electro-cardiogram showing bifurcation of *P*.

R and *T* are the most constant deflections, the former more especially so; *Q* and *S* are not infrequently absent; while the *U* deflection is of very uncommon occurrence.

In normal subjects the amplitude of all the deflections is usually greater in lead II, especially the deflection R, while the deflections in lead III are not infrequently of small amplitude.

The time-distance between the beginning of *P* and the commencement of *Q*, or between *P* and *R*, as the case may be, is an index of the *As-Vs* interval,



FIGS. 78, 79 and 80.—Electro-cardiograms from three different subjects, showing bizarre types of *QRS* group of deflections.

that is, the interval separating the commencement of auricular and ventricular contraction, and is a measure of the function of conductivity of the auriculo-ventricular bundle above its division into two branches; it is called the *P–Q* or *P–R* interval. The rule is to employ the *P–R* interval, on account

of the frequent absence of the *Q* deflection. In normally acting hearts this interval does not measure more than 0·18 second (Figs. 68 and 69). If it exceeds this (Fig. 99), we may conclude that there is delay in the conduction of the stimulus from auricle to ventricle; this means that the function of conductivity is depressed, and that probably there is some affection of the auriculo-ventricular bundle. The *P–R* interval is a more reliable indication of the rate of conduction of the stimulus for contraction than the *a c* interval in a polygraphic tracing, because the presphygmic interval and the period between the opening of the aortic valves and the carotid pulse are not included. The period of time occupied by the ventricular complex is approximately that of the ventricular systole. The initial group of ventricular deflections (*Q*, *R*, *S*) corresponds to the initial events of ventricular systole—in other words, to the spread of the wave of excitation in the ventricular muscle. The period of time occupied by this group is of great importance, being a measure of the time during which the various parts of the ventricular muscle are passing into activity. It is normally not more than one-tenth second. If it is increased, it indicates a delay in the conduction of the wave of excitation through the ventricular muscle. The period of time between the *S* and *T* corresponds with the time during which the mass of the ventricular

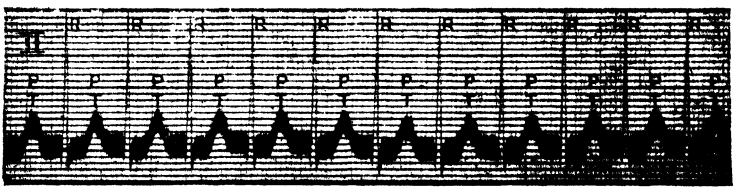


FIG. 81.—Electro-cardiogram in which *P* and *T* coincide and superimpose.

muscle is in contraction. The *Q T*, or *R T*, interval occupies about 0·32 second. When the cardiac rate is unusually frequent the duration of the diastolic interval is shortened, so that the deflection *T* approaches more and more to the following *P*, and *P* and *T* may even coincide and superimpose (Fig. 81).

The form of electro-cardiographic curves depends upon the point of origin and paths of conduction of the stimulus for contraction; any departure from the normal in respect of either of these will, therefore, result in a corresponding alteration in the form of the electro-cardiogram. A normal *P* signifies that the stimulus for contraction arises in the remains of the sinus venosus at the orifices of the great veins, and that from this point the stimulus spreads over the whole of the auricles along the normal paths. When *P* is abnormal, as, for instance, inverted, it is believed that the stimulus for contraction arises at some site other than the sino-auricular node, or that the paths of conduction are abnormal. Similarly, a normal ventricular complex signifies that the ventricles have contracted in response to a stimulus which has arisen above the level of the division of the auriculo-ventricular bundle into its two main branches, and that from this point the stimulus proceeds along the normal paths; and an abnormal ventricular complex signifies either that the stimulus for contraction has arisen at some point below

the level of the division of the auriculo-ventricular bundle, or that, when supra-ventricular in origin, the paths of conduction are abnormal.

Electro-cardiograms of a number of healthy persons all present different features, but the curve in each case will present individual characteristics which are constant. The form of electro-cardiogram is modified by age, and by displacement of the heart from whatever cause. Diminution in the amplitude of *T* occurs with advancing age.

CARDIAC HYPERTROPHY.—It has been previously pointed out that in cardiac hypertrophy, while both ventricles are more often affected than one alone, one ventricle is frequently involved to a greater degree than the other. This predominant hypertrophy or preponderance of either ventricle is revealed by the electro-cardiograph. If in cardiac hypertrophy an electro-cardiogram does not indicate either right- or left-sided preponderance, we

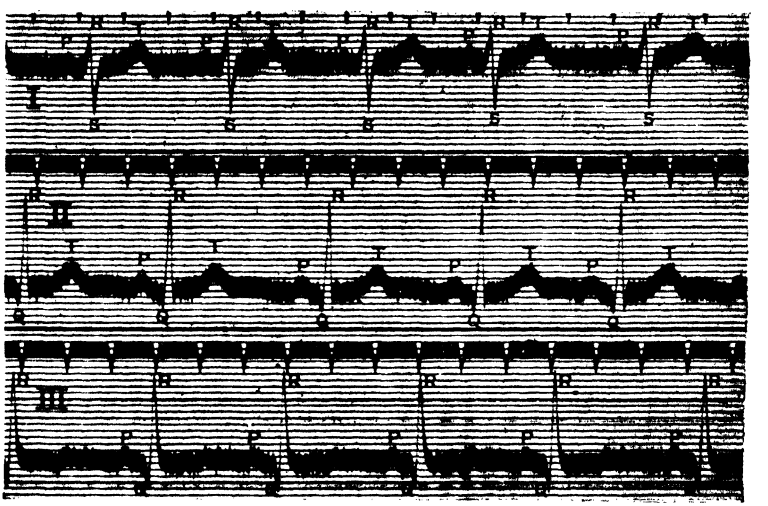


FIG. 82.—Electro-cardiogram showing predominant hypertrophy of the right ventricle.

may assume that the hypertrophy involves both ventricles approximately equally. Displacement of the heart should be excluded.

In predominant hypertrophy of the right ventricle, in lead I, *R* is small or absent, and *S* is large and may be very large; in lead III, *R* is large and may be very large, and *S* is small or absent; and *Q* is most pronounced in lead III (Fig. 82). The deflections of greatest amplitude in leads I and III, therefore, point towards each other. In predominant hypertrophy of the left ventricle, the electro-cardiogram is the reverse of that of the right ventricle. In lead I, *R* is large and may be very large, and S is small or absent; in lead III, *R* is small or absent, and *S* is large and may be very large; and *Q* is most pronounced in lead I (Fig. 83). The deflections of greatest amplitude in leads I and III, therefore, point away from each other. In extreme preponderance of either ventricle, the period of time occupied by the *Q*, *R*, *S* group of deflections may be increased, exceeding one-tenth of a

second. It is necessary to distinguish between predominant hypertrophy of the right or left ventricle and a lesion of the left or right main branch of the auriculo-ventricular bundle respectively. This will be referred to later.

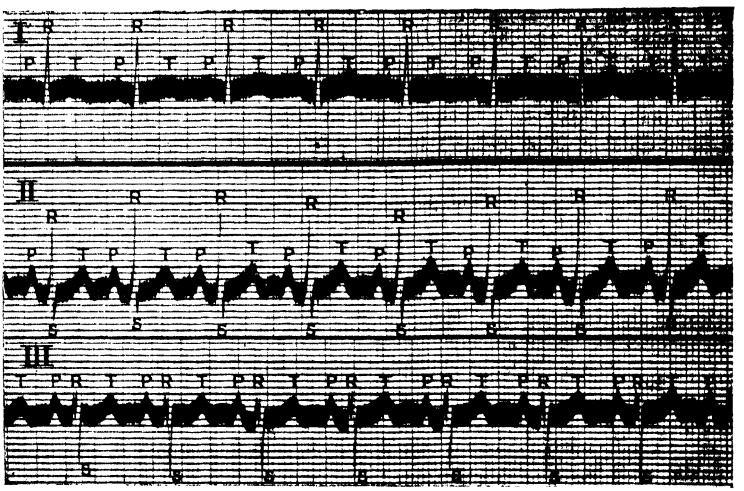
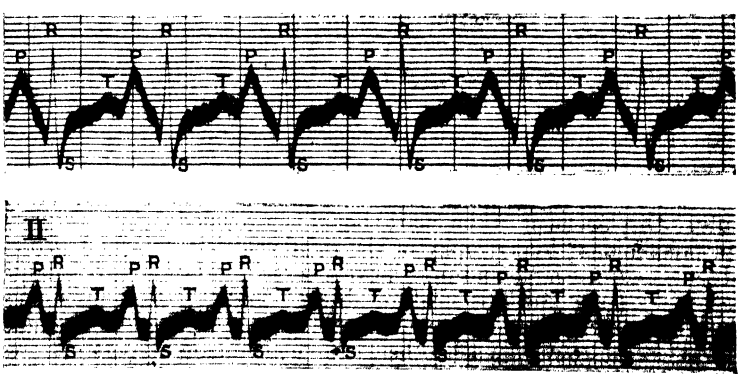


FIG. 83.—Electro-cardiogram showing predominant hypertrophy of the left ventricle.

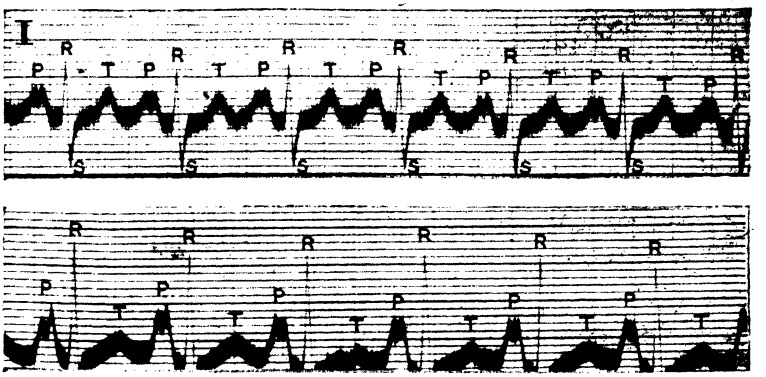
It is said that the amplitude of *P* is increased (Figs. 84 and 85), or even doubled, in hypertrophy of the auricles. Some writers, however, state that this is occasionally to be met with in normal hearts.



FIGS. 84 and 85.—Electro-cardiograms from two different subjects, showing increased amplitude of the deflection *P*.

CHRONIC VALVULAR DISEASE.—In many cases of aortic incompetence the ventricular complexes are the same as those of predominant hypertrophy of the left ventricle. In mitral stenosis the amplitude of the deflection *P* is often markedly increased, and not infrequently it is also broad, has a flat

top, and is bifurcate (Figs. 86 and 87). These features, when present, are of diagnostic value. While a marked increase in the amplitude of the deflection *P* is especially found in mitral stenosis in which there is hypertrophy



FIGS. 86 and 87.—Electro-cardiograms from two different cases of mitral stenosis. The deflection *P* is increased in amplitude, and is also broad, has a flat top, and is bifurcate.

of the auricles, in my opinion it is not justifiable to diagnose the lesion from this alone. In many cases of mitral stenosis the ventricular complexes are the same as those of predominant hypertrophy of the right ventricle. When auricular fibrillation supervenes in mitral stenosis, the curves will present

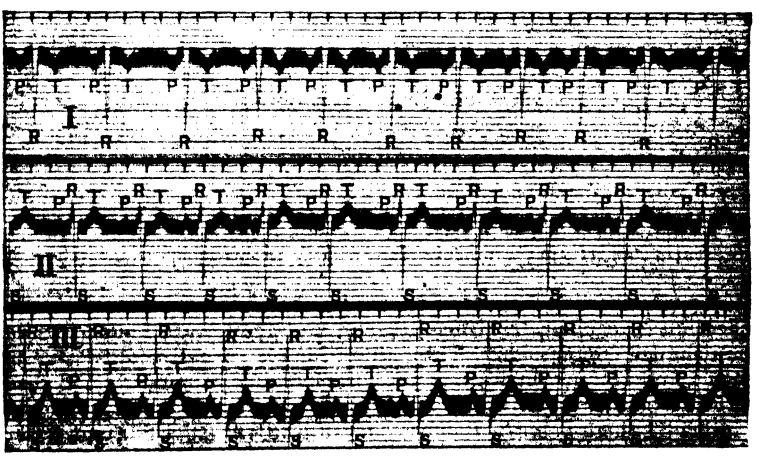


FIG. 88. Electro-cardiogram from a case of transposition of the heart. All the deflections in lead I are inverted.

features characteristic of that condition. In many cases of aortic incompetence, the ventricular complexes are the same as those of predominant hypertrophy of the left ventricle.

CONGENITAL HEART DISEASE.—It is said that an increase in the amplitude of the deflections is often found in congenital heart disease.

TRANSPOSITION OF THE HEART.—In this condition all the deflections of a curve from lead I are inverted (Fig. 88). It is believed that this form of electro-cardiogram is found in no other condition.

INFARCTION OF THE HEART.—As stated on page 861, electro-cardiograms of this morbid affection are usually characteristic, and are of great diagnostic value. They were first described by Pardee and others, and later in greater detail by Parkinson and Bedford,[1] and are as follows: There is usually an alteration in the *R–T* interval or in the *S–T* interval. This portion of the curve commences from the *R* or *S* deflection either above or below the zero

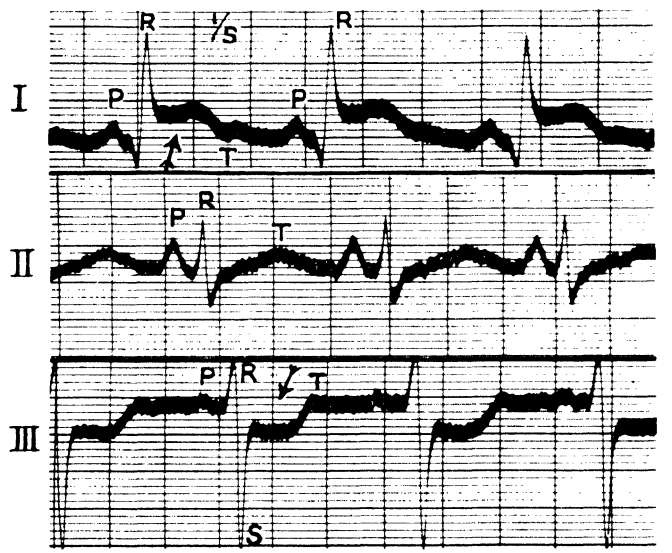


FIG. 89.—After Parkinson and Bedford (*The Lancet*). Electro-cardiogram from a case of infarction of the heart. Taken four days after the onset of symptoms. The *R–T* interval in lead I is in the form of a plateau-shaped elevation, and the *S–T* interval in lead III is in the form of a plateau-shaped depression, as indicated by arrows.

level, and afterwards proceeds in a more or less horizontal direction until the *T* deflection is reached, resulting either in a plateau-shaped elevation or in a plateau-shaped depression. This alteration is usually most noticeable in leads I and III, in which event the corresponding portions of the curves in these leads point away from each other—thus, when there is an *R–T* elevation in lead I there is an *S–T* depression in lead III (Fig. 89), and *vice versa*. Sometimes, however, it is best observed in leads I and II, or in leads II and III, and in either case the corresponding portions of the curves point in the same direction; or the alteration may be present in one lead only. The foregoing features are perhaps pathognomonic of the condition. From a few days to a few weeks later, the *R–T* or the *S–T* portion of the curve returns

[1] *Heart*, 1988, vol. xiv. No. 3.

to the zero level. Usually characteristic changes in the *T* deflections in one or more leads, generally the latter, are also to be noted (Figs. 90 and 91). If more than one lead is implicated, perhaps most frequently leads III and II, and next most commonly leads I and II; while if only one lead, either lead III or I. The *T* deflections become inverted, their form is usually that of a sharp spike, and their amplitude is often large. The *T* deflections point in the opposite direction to that of the previous deviation of the *R–T* or the *S–T* intervals respectively. The *R–T*, or the *S–T*, interval preceding an

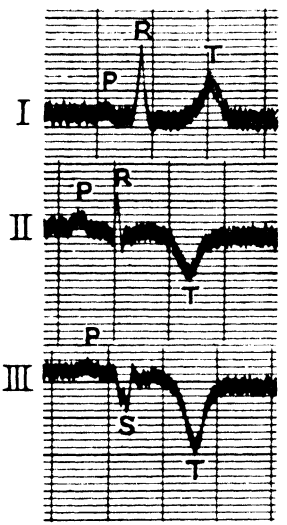


FIG. 90. After Parkinson and Bedford (*The Lancet*). Electro-cardiogram from a case of infarction of the heart. Taken two and a half weeks after the onset of symptoms. The *T* deflections in all leads are spiked and of large amplitude, and those in leads II and III are also inverted.

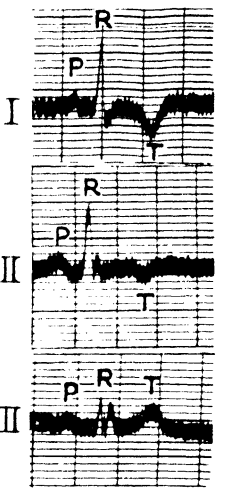
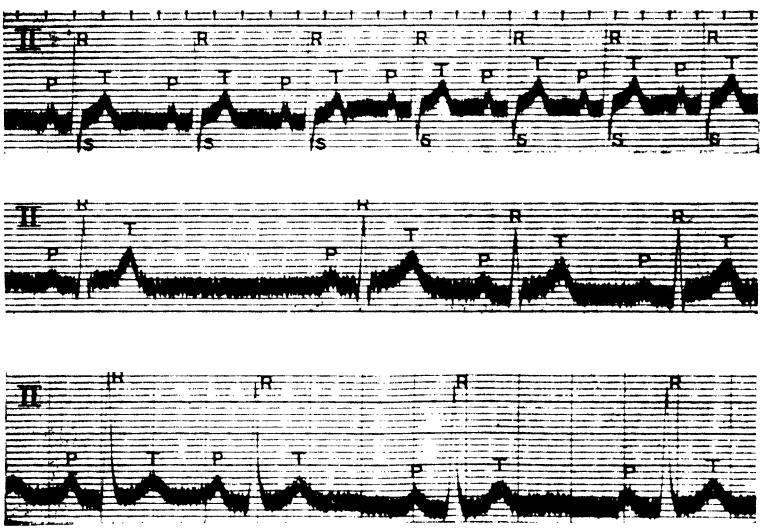


FIG. 91. After Parkinson and Bedford (*The Lancet*). Electro-cardiograms from a case of infarction of the heart. Taken three weeks after the onset of symptoms. The *T* deflections in lead I are inverted; their form is that of a sharp spike, and their amplitude is rather large. The *T* deflections in lead II are inverted.

inverted *T* deflection often exhibits upward convexity. These features are not so characteristic as are those of the first stage, but taken together with the clinical features, they afford strong corroborative evidence of the disease. In both the foregoing stages, the initial group of ventricular deflections (*Q*, *R*, *S*) usually exhibits diminished amplitude, the period of time occupied by the complex is often increased, and the latter is usually associated with notching or splintering. Some changes in the *T* deflections towards the normal generally supervene within a few weeks or months, and ultimately the *T* deflections in all leads may become normal, but sometimes those in one lead remain inverted and sharply spiked, and even these changes are very suspicious.

SINUS IRREGULARITY.—The electro-cardiogram of this rhythm may readily be identified (Figs. 92, 93 and 94). As the stimulus for contraction takes its origin at the physiological site, and from this point pursues a normal course, the auricular and ventricular complexes are of normal form, and the ventricular complexes follow the *P* deflections after a normal interval. As, however, there is a variation in the length of the diastolic intervals, variations are found in the length of the interval between *T* and *P*.



FIGS. 92, 93 and 94.—Electro-cardiograms from three different subjects, showing sinus irregularity. The auricular and ventricular deflections are of normal form, but there are variations in the length of the interval between *T* and *P*.

EXTRA-SYSTOLES.—Extra-systoles may be readily recognised by means of the electro-cardiograph, and usually their site of origin.

In the ventricular variety (Figs. 95 and 96) the auricle maintains its usual rhythm and contracts as the result of the normal stimulus from the sinus. When an extra-systole occurs, the ventricular complex occurs earlier than the anticipated time, and, as the point of origin of the stimulus for contraction is below the division of the auriculo-ventricular bundle into its two branches, it is abnormal in form; it is of larger amplitude and is diphasic. It is of the same duration as that of the rhythmic ventricular contraction. The corresponding *P* deflection appears at the anticipated time, and is normal in form; but it is usually embedded in the diphasic variation, although it may be detected in this part of the electro-cardiographic curve in some cases, and occasionally is nearly separate.

There are two main varieties of ventricular extra-systoles, and it is possible to differentiate between them by means of the electro-cardiograph. One variety has its origin in the basal or right portion of the ventricle, in which case the ventricular complex consists of an upward, tall, and pointed

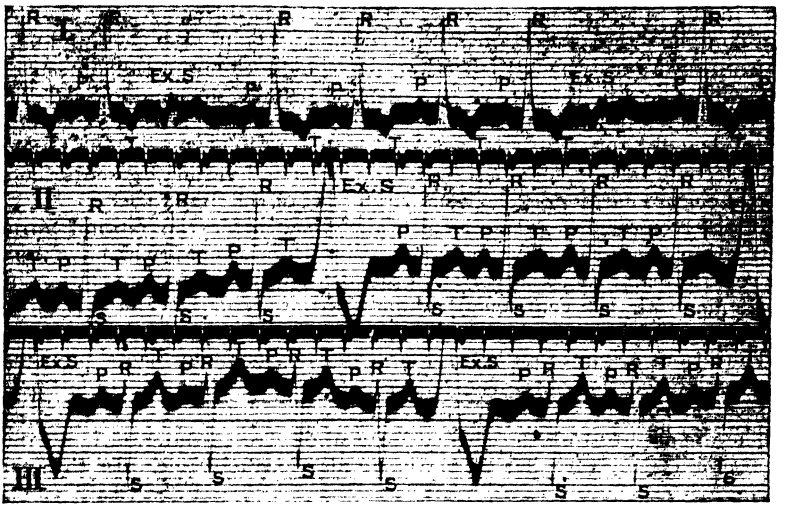


FIG. 95.—Electro-cardiogram showing extra-systoles, marked *Ex.S*, which arise in the right or basal portion of the ventricle. The direction of the deflections is the same in leads II and III, but is reversed in lead I. The corresponding *P* deflections are embedded in the diphasic variations. There is also inversion of *T* in lead I, and left-sided preponderance.

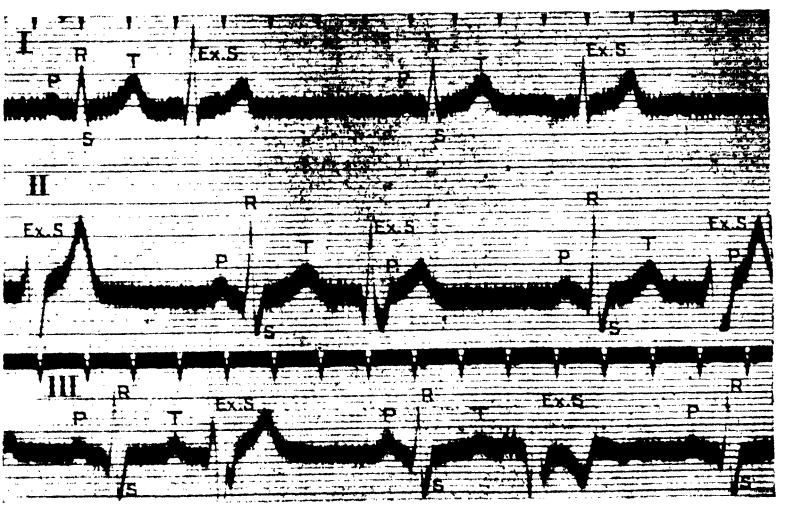


FIG. 96.—Electro-cardiogram showing ventricular extra-systoles. The first and third in lead II and the first in lead III arise in the left or apical portion of the ventricle. The second in lead II, the second in lead III, and those in lead I arise in the right or basal portion of the ventricle, probably high up near the auriculo-ventricular node.

deflection, and then of a downward and broader deflection; and in the other in the apical or left portion of the ventricle, in which case the ventricular complex consists of a downward, deep, and pointed deflection, and then of an upward and broader deflection. It should be noted that in any given case, while the direction of the deflections is usually the same in leads II and III, it is generally reversed in lead I; this means that lead I of the first variety usually gives the same form of electro-cardiogram as leads II and III of the second variety, and that lead I of the second variety presents the same form of electro-cardiogram as leads II and III of the first variety.

If the ventricular extra-systole take place after the normal auricular contraction, and the wave of contraction from the auricle have reached the ventricle and met that of the premature ventricular contraction in the ventricular wall, the ventricular complex of the premature contraction of the ventricle will present both normal and abnormal features.

The site of origin of an extra-systole may occasionally be at one time the basal or right portion of the ventricle, and at another the apical or left portion, in the same subject.

The departure from the normal form of electro-cardiogram is not nearly so pronounced in auricular as in ventricular extra-systole. In this variety

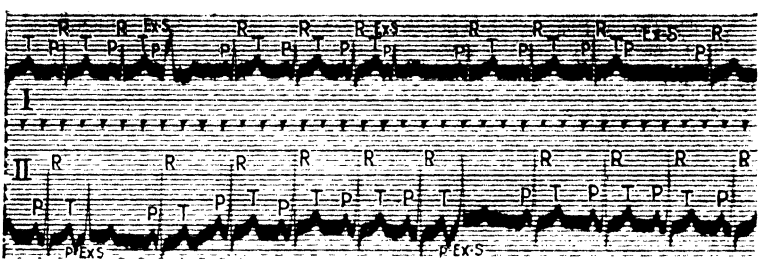


FIG. 97.—Electro-cardiogram showing auricular extra-systoles, marked *Ex.S.* The premature *P* deflections are of normal form in lead I, and of abnormal form—being inverted—in lead II. The premature ventricular complexes are of abnormal form. The third extra-systole in lead I is blocked.

(Fig. 97), when an extra-systole occurs, the *P* deflection takes place before the anticipated time. As the point of origin of the stimulus for contraction is abnormal, it is usually abnormal in form, often being inverted (lead II). Sometimes, however, the premature *P* deflection is of normal form (lead I). The *P* deflection is usually followed by a premature ventricular complex. This is usually of normal form, since the stimulus for contraction is supra-ventricular in origin and thence travels along the usual paths. Sometimes, however, the premature ventricular complex is of abnormal form (Fig. 97), due to the stimulus for contraction from the premature contraction of the auricle not reaching the various portions of the ventricular muscle in the normal manner. It may be even diagnosed as arising below the division of the auriculo-ventricular bundle into two branches. Abnormal ventricular complexes are almost always found only when there is diminished conduction along the auriculo-ventricular junctional tissues; and in some cases the

stimulus for contraction does not reach the ventricle at all, in which case the premature contraction of the auricle is not followed by a premature contraction of the ventricle—"blocked auricular extra-systole" (third extra-systole in lead I of Fig. 97). In auricular extra-systole, the premature contraction of the auricle may take place so early as to coincide with the ventricular contraction of the preceding cycle, in which case *P* and *T* superimpose.

In the auriculo-ventricular variety (Fig. 98), when an extra-systole occurs, there is prematurity of the *P* deflection, and also of the ventricular complex. The ventricular complex is of normal form, as its stimulus for

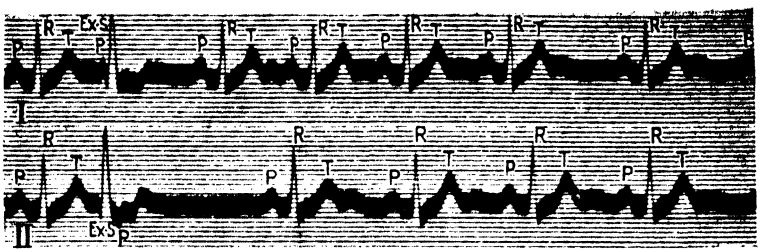


FIG. 98.—Electro-cardiogram showing auriculo-ventricular extra-systoles, marked *Ex.S.* In that of lead I the premature *P* deflection occurs before that of the ventricular complex, while that in lead II is embedded in the ventricular complex.

contraction is supra-ventricular in origin and thence travels along the normal paths. In cases in which the premature contraction of the chambers is absolutely synchronous, the *P* deflection is embedded in the ventricular complex (in lead II). When, on the other hand, the auricular contraction occurs before that of the ventricle, the *P* deflection is of abnormal form, often being inverted, and the *P*–*R* interval is diminished (in lead I).

Occasionally the beat immediately following an extra-systole arises from the same site as that of the premature contraction.

SINO-AURICULAR BLOCK.—In this condition there is an absence of both the auricular and ventricular complexes during the abnormally long pause.

AURICULO-VENTRICULAR BLOCK.—In the first degree of depressed conductivity (leads I and III of Fig. 99) there is merely an increase of the *P*–*R* interval, it exceeding 0·18 second. In the second degree, the *P* deflections are found at regular intervals and are normal in form, but more frequent than the ventricular complexes—even twice (lead II of Fig. 99), three times or more, according to the degree of block; in other words, sometimes the *P* deflections are not followed by ventricular complexes. But, unlike complete heart-block, on each occasion the ventricular complex is preceded by a *P* deflection. In complete heart-block (Fig. 100), the *P* deflections are found at regular intervals and are normal in form, and besides being more frequent than the ventricular complexes, the time-relation between the *P* deflections and the ventricular complexes is a constantly varying one—the *P* deflection at one time preceding, at another following, and sometimes again coinciding with the ventricular complexes. The ventricular complexes are of normal

form, as the point of origin of the stimulus for contraction is above the division of the auriculo-ventricular bundle into its two branches.

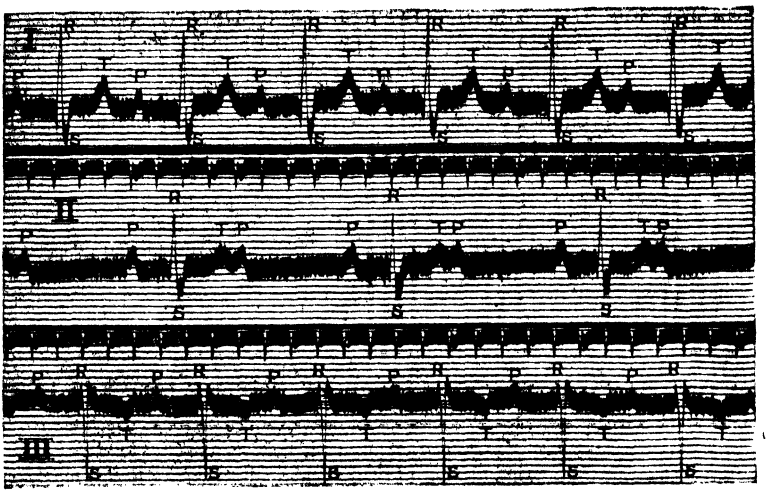


FIG. 99.—Electro-cardiogram showing partial heart-block. In each lead there is an increase of the *P–R* interval, and in lead II there is also continuous 2 : 1 rhythm, every other stimulus from the auricle failing to reach the ventricle. There is also inversion of *T* in lead III and left-sided preponderance.

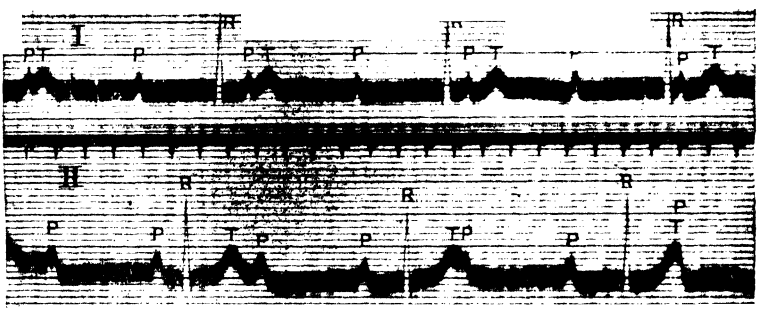


FIG. 100.—Electro-cardiogram of leads I and II, showing complete heart-block, or dissociation of the auriculo-ventricular rhythm, the auricles and ventricles beating independently of each other.

BUNDLE-BRANCH BLOCK.—A lesion of either the right or the left main branch of the auriculo-ventricular bundle may be recognised by means of the electro-cardiograph. When the right branch is involved, the stimulus for contraction from the auricle travels to both ventricles along the left branch alone ; and when the left branch is involved, the stimulus travels along the right branch alone. Each ventricular complex is preceded by a

P deflection of normal form, but the ventricular complexes are abnormal. The ventricular complex is of increased amplitude and is diphasic. The

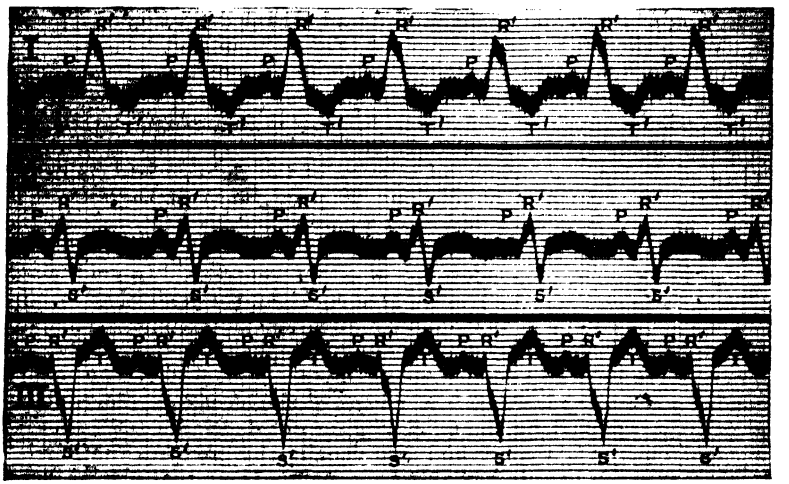


FIG. 101. — Electro-cardiogram showing a lesion of the right main branch of the auriculo-ventricular bundle.

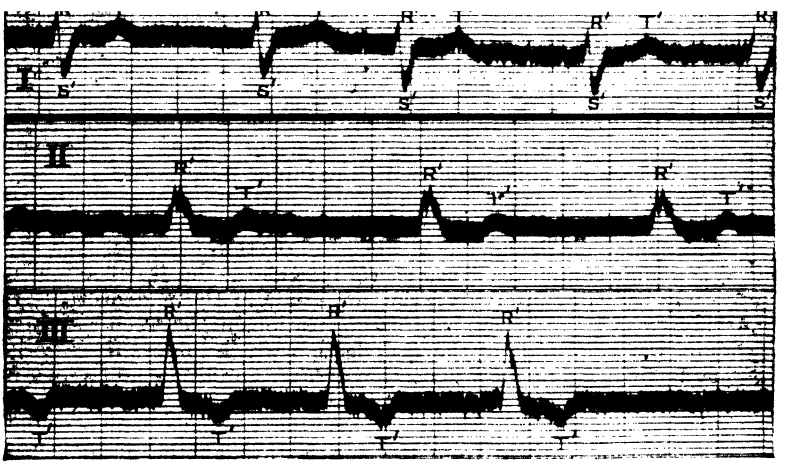


FIG. 102. — Electro-cardiogram showing a lesion of left main branch of the auriculo-ventricular bundle. There is also auricular fibrillation.

initial part is formed by the *Q*, *R*, *S* group, and the terminal part by *T*. The period of time occupied by the *Q*, *R*, *S* group is increased, exceeding one-tenth of a second, and usually more than a third of that of the whole ventricular complex. The terminal part, *T'*, points in the opposite direction to the

initial part in the same lead. The diphasic form of the ventricular complex is most evident in leads I and III, and the amplitude of the deflection *P* is increased in lead II. When the right branch is involved (Fig. 101), in lead I the deflection *R'* is tall and broad, and in lead III the deflection *S'* is deep and broad. When the left branch is involved (Fig. 102), in lead I the deflexion *S'* is deep and broad, and in lead III the deflection *R'* is tall and broad. It will thus be seen that when the right branch in involved the deflections of largest amplitude point away from each other, whereas in the case of the left branch the opposite holds good. As already stated, it is necessary to distinguish between the electro-cardiograms of a lesion of the right or left main branch of the auriculo-ventricular bundle and preponderance of the left or right ventricle respectively. In a lesion of a main branch, the period of time occupied by the *Q*, *R*, *S* group of deflections is always increased. This may occur also in extreme preponderance of either ventricle. In such event, a differential diagnosis may be readily arrived at by the facts that in bundle-branch block *T'* points in the opposite direction to the initial part of the ventricular complex in the same lead, and its amplitude is increased.

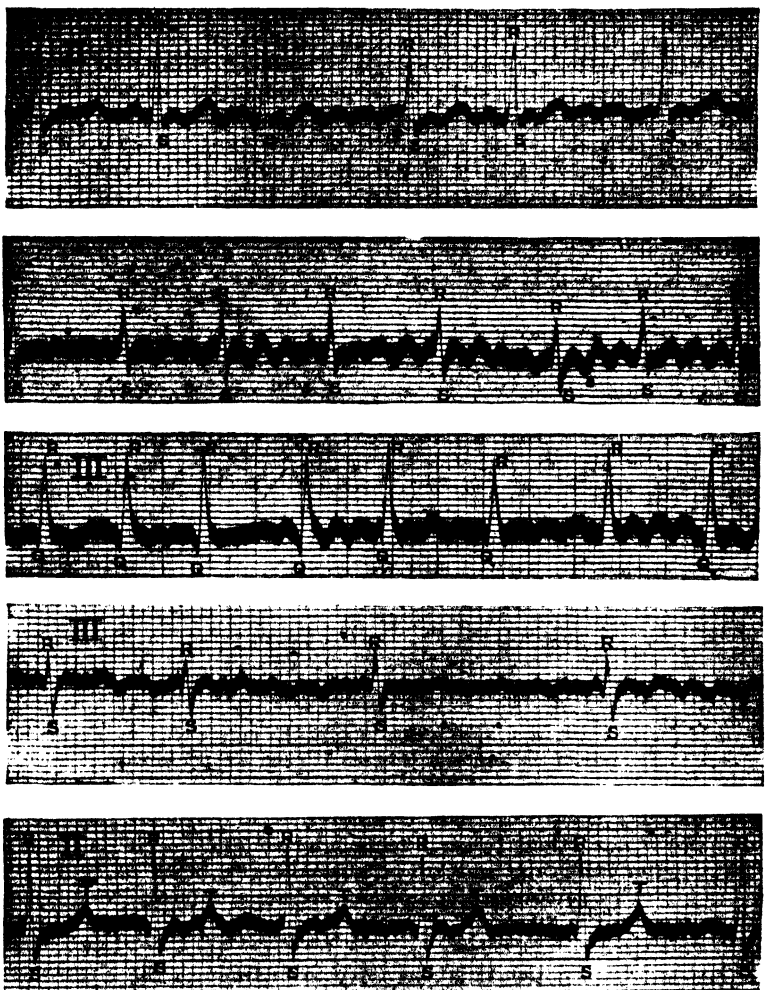
Intra-ventricular (Arborisation) Block.—It is believed by some that this condition may be recognised by means of the electro-cardiograph. The period of time occupied by the *Q*, *R*, *S* group of deflection is increased, exceeding one-tenth of a second, and also usually the group exhibits irregular notching or splintering. It has just been pointed out that the former may be found also in extreme preponderance of either ventricle.

Alternation of the Heart.—**This may be sometimes recognised by** means of the electro-cardiograph, by an alternation in the amplitude of the deflections due to the contraction of the ventricle (Fig. 111). Both the *R* and *T* waves may be affected, or one more than the other. It should be noted that alternation of the heart is sometimes shown in a sphygmogram without any corresponding evidence in an electro-cardiogram, while rarely the opposite holds good. It should be further noted that the alternation in a sphygmogram and electro-cardiogram do not always correspond ; *i.e.* the smaller ventricular deflections correspond with the larger pulse-wave.

Auricular Fibrillation.—In auricular fibrillation the electro-cardiogram is characteristic (Figs. 103–107). Apart from the very rare cases of complete auriculo-ventricular block, when the rhythm is regular, the rhythm of the ventricular complexes is *completely* irregular ; the *R* deflections occur at irregularly irregular intervals ; the amplitude of the *R* deflections varies from cycle to cycle ; and there is often no relationship between the length of a pause and the amplitude of the *R* deflection which follows it—*i.e.* a short pause may be followed by an *R* deflection of large amplitude and a long pause by one of small amplitude. When the ventricular rate is slow or very rapid, the irregularity may be only slight. When the ventricle contracts only in response to stimuli received from the auricle through the normal channel, all the ventricular complexes are of normal form. Such, however, is not the case when there are superadded ventricular extra-systoles, or when there is also a lesion of either main branch of the auriculo-ventricular bundle (Fig. 102).

There is an absence of *P* deflections ; these cannot be present because the auricle does not contract. There are, on the other hand, oscillations during diastole caused by the fibrillating auricle, occurring at the rate of about 450 per minute, and irregular in time and form. These are most evident in

cases of slow cardiac action, whereas if the action be frequent it is often difficult to detect them. Their size varies, being sometimes very minute and sometimes of considerable size. They may coincide with the *T* deflections, in which case the outline of the latter is altered.



FIGS. 103–107.—Electro-cardiograms from cases of auricular fibrillation.

These oscillations should be distinguished from those which occur as a result of tremor of the somatic muscles. These are of frequent occurrence in the subjects of Graves' disease, and may be of considerable size. Oscillations due to auricular fibrillation may be distinguished from those re-

sulting from tremor of the somatic muscles by the fact that in the latter case they are of more frequent occurrence—about 50 per second—and occur at regular intervals, the deflection *P* or some indication of it may be noted, and the ventricular complexes do not occur at irregularly irregular intervals.

It is further necessary to distinguish electro-cardiograms of auricular fibrillation from those of auricular flutter. This will be referred to later.

AURICULAR FLUTTER.—In this condition it is of especial importance to analyse the three leads (Figs. 108–110). The *P* deflections may range from 180 to 380, perhaps being usually between 280 and 300 per minute. In all leads they occur at regular intervals, and are of abnormal form, often being inverted, and in each lead of any given case they are almost invariably of constant form. In lead I their amplitude is comparatively small, while in

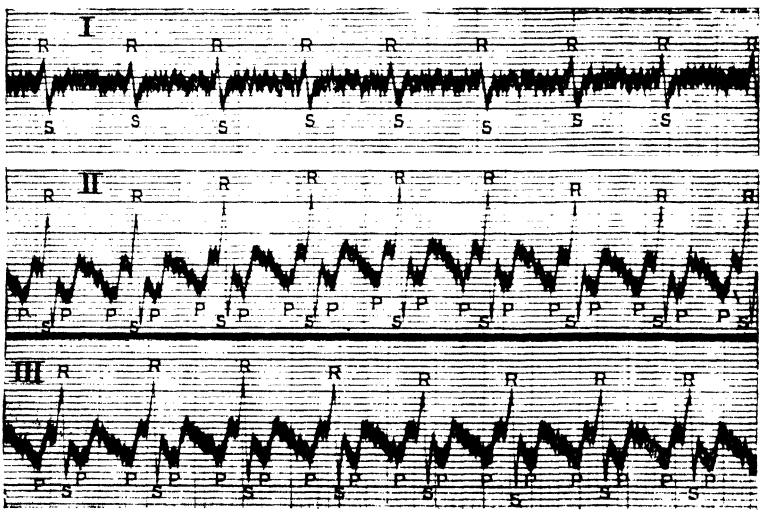


FIG. 108.—Electro-cardiogram from a case of auricular flutter, with 2 : 1 heart-block. The rate of the auricle is between 320 and 330 per minute.

leads II and III their amplitude is greater. Almost invariably there are two or more *P* deflections to each ventricular complex. The latter usually occur at regular intervals, and are of normal form, being of supra-ventricular origin. The ventricular complexes are superimposed, modifying the outline of some, or very rarely all, of the *P* deflections. In some instances *T* may be detected.

As has just been noted, it is necessary to distinguish the electro-cardiograms of auricular flutter from those of auricular fibrillation. In the case of the latter, the *R* deflections occur at irregularly irregular intervals; the amplitude of the *R* deflections varies from cycle to cycle; and there is often no relation between the length of a pause and the amplitude of the deflection *R* which follows it, *i.e.* a short pause may be followed by an *R* deflection of large amplitude, and a long pause by one of small amplitude. In the case of auricular flutter, it will be found that these features are not present, even

though the ventricular rhythm is markedly irregular. Further, the deflections due to auricular systole in cases of auricular flutter may be distinguished from the oscillations found in auricular fibrillation. In the case of the former,

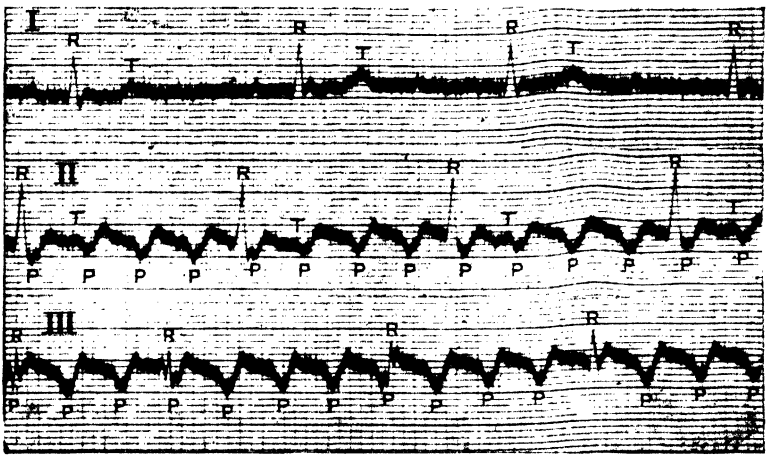


FIG. 109.—Electro-cardiogram from a case of auricular flutter, with 4 : 1 heart-block.

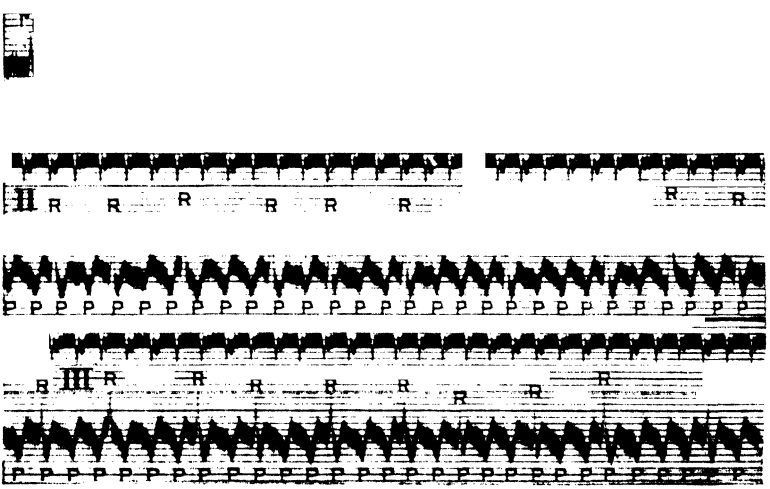


FIG. 110.—Electro-cardiogram from a case of auricular flutter. The auriculo-ventricular ratio is sometimes 2 : 1, at others 3 : 1, and at others again 4 : 1. The response of the ventricle to auricular contraction being at irregular intervals, there is irregularity of the ventricular rhythm.

they are less frequent, rhythmic, and almost invariably of constant form; whereas in the latter they are more numerous, irregular in rhythm, and inconstant in form.

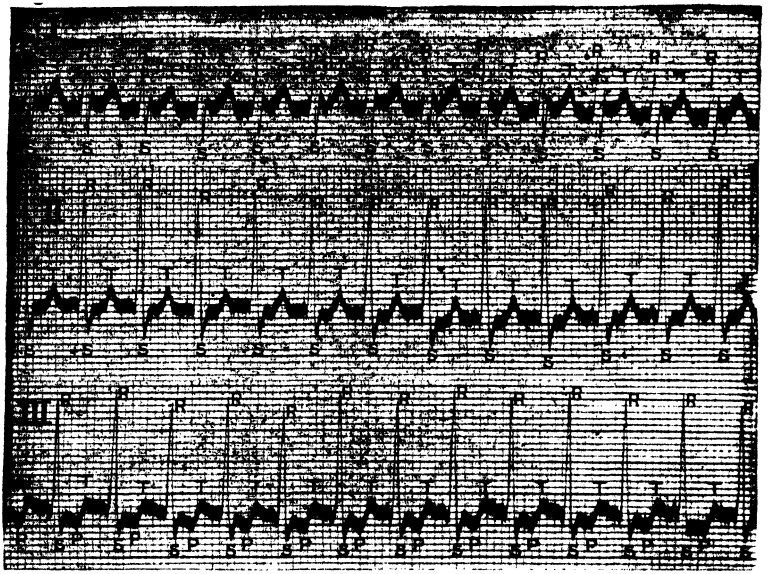


FIG. 111.—Electro-cardiogram from a case of paroxysmal tachycardia. The point of origin of the new rhythm is situated in the auricle. The *P* deflection is inverted, and coincides with the ventricular contraction of the preceding cardiac cycle. It might be regarded as auricular flutter, in which the ventricle responds to each auricular contraction. The rate is between 190 and 200 per minute. There is alternation in the amplitude of the *R* deflections.

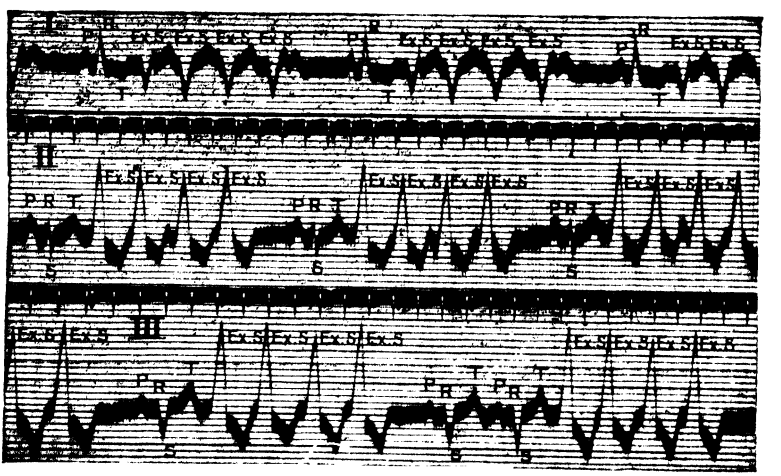


FIG. 112.—Electro-cardiogram showing short paroxysms of extra-systoles, which arise in the right or basal portion of the ventricle. The direction of the deflections is reversed in lead I. There is also inversion of *T* in lead I and left-sided preponderance.

NODAL RHYTHM.—In this condition the ventricular complex is of normal form, as it is supra-ventricular in origin. In cases in which the premature contraction of the chambers is absolutely synchronous, the *P* and *R* superimpose. When, on the other hand, the auricular contraction occurs before that of the ventricle, the *P* deflection is of abnormal form, often being inverted, and the *P–R* interval is diminished.

PAROXYSMAL TACHYCARDIA.—As might be inferred from what has been stated on pages 815 and 816, electro-cardiograms present different features, according to the point of origin and paths of conduction of the stimulus for contraction; for example, they may indicate auricular flutter, paroxysms of auricular systoles, auricular fibrillation, nodal rhythm, or paroxysms of ventricular extra-systoles (Fig. 112).

FREDERICK W. PRICE.

DISEASES OF THE BLOOD VESSELS

Disease of the arteries should be classified from the pathological standpoint. Much confusion has arisen from the use of the term arterio-sclerosis, which means arterial hardening. This term has been applied to at least four distinct pathological arterial conditions:

(*a*) It has been applied to arteries which have become hardened as the result of inflammation. Chronic inflammation of arteries, or chronic arteritis, is usually the result of syphilis, but may be caused by other infections.

(*b*) In the degeneration of the intima of the arteries, which is known as atheroma, calcification may take place and the artery become hardened. Marchand has given the name athero-sclerosis to this form of arterial hardening.

(*c*) Degeneration of the middle coat of the artery is also termed arterio-sclerosis. This form of hardening is especially marked in those arteries which are affected by Mönckeberg's degeneration. This form of degeneration is accompanied by a deposition of lime-salt in the middle coat. The lime-salt is deposited, more or less symmetrically, in rings round the artery.

(*d*) The term arterio-sclerosis has also been applied to hypertrophied arteries. Here the artery is increased in size, owing to an increase in its muscular elements, which are found mainly in the middle coat, and, to a less degree, in both layers of the intima. Muscular hypertrophy is the essential change in high arterial pressure.

It is therefore clear that the term arterio-sclerosis should not be used in describing arterial disease, and this will be classified as follows:

(1) Arterial inflammation.

(2) Arterial degeneration: (*a*) degeneration of the intima or atheroma; and (*b*) degeneration of the media.

(3) Arterial hypertrophy.

(4) Arterial infiltration, of which the chief example is amyloid infiltration.

ARTERIAL INFLAMMATION

The arteries may be infected from their intima, either by micro-organisms settling on the surface, or by the arrest of an infective embolus within the lumen. They may also be infected by micro-organisms reaching the media

or adventitia through the vasa vasorum, or by direct inward spread of inflammation from the surrounding tissues.

Acute Arteritis

Acute arteritis was formerly described as a common event in many diseases, the old authorities mistaking staining of the intima for inflammation. Acute inflammation of the arteries is, however, a rare disease, and is usually met with as a complication in the acute infections. The intima of the aorta may be infected in cases of septicæmia and pyæmia. This occurs most commonly in cases of progressive infective endocarditis, and the organisms usually found are streptococci. Vegetations may be seen upon the intima, and the inflammation rapidly involves the subjacent coats. Occasionally the aorta may be infected in a septicæmia or pyæmia, through embolism of the vasa vasorum, or the ascending aorta may be infected by spread through the vessel wall from a pericarditis. The wall of the aorta may rupture, or an aneurysm be formed. Acute multiple arteritis is most frequently seen as a sequel of typhoid fever, but cases have been observed after small-pox, scarlet fever, influenza and pneumonia. In many cases the organisms of the disease have been found in the vessel wall.

Symptoms.—The symptoms depend upon the vessels affected. In the case of the femoral artery, there may be severe pain in the course of the vessel with sometimes redness and swelling in the part affected. The pulse below is obliterated. The limb becomes pale and cold, and then livid. Gangrene may or may not follow; it depends upon the rapidity with which the vessel is blocked. In some cases where the onset is severe, and the symptoms suggest that gangrene will follow, the circulation improves and colour returns to the limb. In other cases, several of the arteries may be infected at the same time, with high fever and symptoms of an acute infection.

Prognosis and Treatment.—In acute arteritis treatment is of little avail, the infection always being a very severe one. Every effort should, however, be made to avoid infectious gangrene, and in some cases a surprising return of circulation may be observed.

Chronic Arteritis

Ætiology.—Acquired syphilis is by far the most common cause of chronic arteritis, which may, however, follow congenital syphilis. Tuberculous endarteritis is not uncommon in the small pulmonary arteries and in the arteries of the brain in tubercular meningitis. Endarteritis obliterans may also be caused by infection with pyogenic organisms of a subacute or chronic type. Moreover, changes in the adventitia of the small arteries are also found in polio-encephalo-myelitis and in encephalitis lethargica.

Pathology.—Chronic arteritis affects the arterioles. The aorta and other large elastic arteries are, however, affected secondarily, through the vasa vasorum and their terminations in the external and middle coats. The large muscular arteries are but rarely affected by syphilis. Chronic inflammation of the arteries has been divided into—(1) Endarteritis, where the intima is affected; and (2) periarteritis, where the external coat is involved. In the great majority of cases of inflammation of the arterioles all coats are involved. The muscular and elastic fibres tend to be destroyed, and this may result in

direct rupture. The changes in the intima are very conspicuous. Its layers become very much thickened by inflammatory infiltration and proliferation. In the early stages round cells are seen, and later spindle-shaped fibro-blasts appear, definite granulation being thus formed, while in cases of syphilis plasma cells and eosinophil leucocytes are often present. The result of this great thickening is markedly to narrow the vessel, and the condition is often termed endarteritis obliterans. The lumen of the vessel may finally become completely blocked, leading in the brain to cerebral softening, and in other tissues to fibrosis. The adventitia is also greatly thickened in chronic syphilitic arteritis and consists of inflamed tissue infiltrated by lymphocytes, plasma cells and occasional eosinophil leucocytes.

Syphilis of the aorta or syphilitic mesaortitis is due to inflammation of the vasa vasorum, shown microscopically by perivascular infiltration and by intimal proliferation. They become thickened and may show endarteritis obliterans. In the aorta the inflammation is mainly confined to the adventitia and media. Small-celled inflammation in the areas supplied by the diseased vasa vasorum is to be observed microscopically. The thickening of the vasa vasorum results in necrosis in the inflamed areas of the media, in which giant cells may sometimes be seen. The elastic fibres are broken up and destroyed by the infiltration or necrosis in the media, and consequently the artery becomes very much weakened in the area affected. In rare cases the degenerated areas in the media look like tiny miliary gummata, which in fact they are, and the syphilitic nature of this mesaortitis has been proved by the detection of *Sp. pallida* in the lesions. The intima of the aorta is usually thickened over the areas of inflammation, and this thickening has been in the past confused with the degeneration of the intima which we know as atheroma. The inflammatory thickening of the intima due to syphilis can be distinguished by the naked eye from atheromatous thickenings by its greater latitude and prominence, its pearly colour, its rubber-like consistency, crenated outline, pitted surface and freedom from fatty degeneration. The weakening of the vessel wall on account of the replacement of the middle coat frequently results in dilatations, varying in size from minute stellate patches to large aneurysms. The scarring and pitting are due to fibrous tissue replacing the inflamed media and are characteristic of the condition. It should be added that in the later stages atheroma usually occurs in the thickened intima over the areas of inflammation; also that syphilitic mesaortitis and primary atheroma may co-exist, especially in later life.

The heart is often found affected in these cases. Owing to the mesaortitis of the ascending aorta, the orifices of the coronary arteries become narrowed or blocked. Patches of syphilitic myocarditis are also found in the heart muscle and in the neighbourhood of these, endarteritis obliterans of the terminal branches of the coronary arteries may be found. The result of this is to produce areas of necrosis in the heart muscle, and fibrous patches are found in the myocardium. The heart is, therefore, not uncommonly enlarged. In addition, frequently we find that the aortic valves have become involved by the adjacent syphilitic mesaortitis, and aortic regurgitation is a common sequel. The brain and spinal cord are frequently affected. Thrombosis results from the endarteritis obliterans and softening of the nerve tissue occurs. The kidneys are but rarely affected, though occasionally gummata are found. The eyes are not infrequently affected, and a condition of syphilitic

choroido-retinitis may be seen on ophthalmoscopic examination. In other organs, such as the liver and testicle, gummatous necrosis, followed by fibrous changes, is found.

Symptoms.—The symptoms that result from syphilitic vascular disease depend upon the organ affected.

In the aorta, the symptoms of aneurysm are a common result from syphilis. Occasionally a dissecting aneurysm may result from a tear of the intima, the blood being forced into the media and splitting the wall into two layers. Aortic regurgitation, with its usual effect on the heart, is also common. The symptoms of fibrosis of the myocardium are severe anginal pains, often resulting in sudden death. Occasionally the heart muscle may give way and the heart dilate, with the usual signs of chronic cardiac failure. If the brain is affected by arterial thrombosis, the symptoms depend upon the area affected : hemiplegia, aphasia and hemianopia may all result. Albuminuria is quite uncommon in syphilitic vascular disease. Iritis may be present, but the usual condition found in the fundi is choroiditis. White patches surrounded by pigmented areas give a striking appearance to the fundus oculi in these cases. The optic disc is often white and atrophied. In gummatous meningitis, œdema of the optic papilla is often present. The radial artery is practically always normal to the touch in cases of syphilitic vascular disease.

Course.—The course of syphilitic arterial disease is extraordinarily variable. The symptoms are generally present in the acute secondary stage, from 2 to 5 years from the date of infection, but the vascular disease may exist with exacerbations all through life.

Prognosis.—The prognosis in syphilitic vascular disease is on the whole good, if the condition be taken early enough and treated properly. It has to be remembered, however, that vascular syphilis is often complicated by parenchymatous syphilis, where the spirochætes are not only found in the walls of the vessels, but also in the cerebro-spinal tissues themselves, and this complication certainly increases the gravity of the condition.

Treatment.—Prophylaxis is of the greatest importance in syphilitic vascular disease. With regard to treatment, in the acute stages of syphilitic vascular disease it cannot be too strongly urged that mercury is the best drug to use. Mercurial inunctions or soluble intramuscular mercurial injections should be given for 2 or 3 weeks before any intravenous injections are prescribed. Moreover, iodides should be given by the mouth, to absorb as far as possible the inflammatory products in the intima of the vessels and to decrease the viscosity of the blood. There is no doubt that the indiscriminate use of salvarsan and neo-salvarsan in the acute stages of syphilitic vascular disease has been followed by most disastrous results. The administration of these strong anti-syphilitic remedies causes further swelling of the intima and further blocking and thrombosis of the small vessels. After mercury and iodides have been given for 2 or 3 weeks, neo-salvarsan may be administered cautiously in small doses and gradually increased.

Thrombo-Angiitis Obliterans

This name was suggested by Buerger in 1908 for a disease characterised by acute inflammation of the deep arteries and veins, and sometimes a

migratory inflammation of the superficial veins in the extremities. Thrombosis develops, and the vessels become occluded.

Ætiology.—The malady is found almost exclusively in middle-aged male Hebrews. The cause is unknown, but the pathological changes suggest that it is due to an infection. Syphilis is usually not present, the Wassermann reaction being negative. Excessive tobacco smoking has been suggested as a predisposing factor.

Pathology.—The deep vessels of the arms and legs, especially the latter, show an acute inflammatory process in all their coats. In about a quarter of the cases this is associated with a migratory phlebitis in the superficial veins of the limbs. The vessels become occluded by organised thrombus, which does not contain elastic tissue, thus differentiating the process from obliterative endarteritis of syphilitic origin.

Symptoms.—The onset is gradual with pains in the feet and toes. The patient is unable to walk for more than a few minutes without severe cramp-like pain in the legs (intermittent claudication, see page 945). The thrombi in the superficial veins, when they occur, are also very tender. Redness of the extremity, especially when in a dependent position, is often noted, while blanching occurs when the limb is raised. Diminution or loss of pulsation in the arteries, such as the radial or dorsalis pedis, is often present. In the later stages, the cramp-like pain becomes intense, and the disability in walking often leads to marked mental depression. Trophic changes in the skin, with gangrene, appear, and fissures and ulcers may occur.

Diagnosis.—(1) Raynaud's disease more often attacks females; the upper extremities are most affected; and X-rays show marked atrophy of the bones of the hands. This is not present in Buerger's disease. (2) In erythromelalgia the limbs become red and flushed, but the arteries pulsate forcibly. Gangrene does not occur. (3) In gangrene due to Mönckeberg's degeneration, the calcified arteries may be well seen by means of the X-rays.

Prognosis.—The course of the disease varies. Some cases progress rapidly, while others last for years. Gangrene may require high amputation of the limb.

Treatment.—As the cause is not known, there is no specific treatment. With regard to drugs, iodides and nitroglycerine are used. Gentle massage and passive exercises are useful. Ultra-violet therapy has been tried. Pain is relieved by rest in the recumbent position, and heat applied to the painful limb by electric pads or electric light baths is also useful. Ulcers of the legs should be treated surgically.

Periarteritis Nodosa

Periarteritis nodosa is a rare complaint characterised by prolonged fever and the occurrence of nodular swellings, and in some cases aneurysms of the medium-sized arteries.

Ætiology.—Young adults are most commonly affected, and males more often than females. The cause is unknown. The Wassermann reaction is negative, but the pathological changes and course of the disease suggest an infectious agent.

Morbid Anatomy.—The medium-sized arteries are usually affected, especially those of the heart, kidneys and intestines. There are inflammatory

changes in all the coats of the arteries, and within the lumen are often found thrombi, which may become organised. White or yellowish-white nodules, from the size of a pin's head to that of a pea, can be seen on the arteries. Owing to the alteration in the lumen of the vessels, necrosis and infarcts occur in the organs supplied.

Symptoms.—The disease may commence with bronchial catarrh, or with epigastric pain. There is tachycardia and irregular fever, with marked prostration. Acute abdominal pain may be caused by disease of the mesenteric arteries—indeed, even perforation of the intestine and peritonitis have followed. If the arteries of the heart are involved, evidence of myocardial disease will be present; and when the kidneys are affected, blood and casts appear in the urine. Occasionally bronchial asthma, cough and haemoptysis have been noted. Later, in a small proportion of cases, nodular swellings, varying in size up to a pea, may be felt in the subcutaneous tissues of the abdomen, thorax and limbs. Examination of the blood shows anaemia and a moderate leucocytosis. Blood cultures are sterile.

Diagnosis.—This is extremely difficult, owing to the variable symptoms displayed. In most cases, a pyrexial infection, of unknown origin, has its nature revealed only at the post-mortem. Rarely, however, where a node was felt in the subcutaneous tissues and excised during life, the diagnosis has been made before death.

Prognosis.—In the great majority of cases death occurs within a few weeks to a few months after the onset of symptoms.

Treatment.—This is the same as that of any acute infection. Arsenic, mercury and quinidine should all be tried, though the results up to now have not been encouraging.

ARTERIAL DEGENERATION

Degeneration of the Intima; Atheroma

Definition.—Atheroma is a variety of arterial degeneration which affects and is almost confined to the intima. It is characterised by the accumulation of débris, which is at first fatty and later becomes impregnated with lime-salts. The Greek word was used by Galen to signify a swelling full of gruel-like material.

Ætiology.—There is no doubt that atheroma tends to increase with advancing age. Long life is a question of the blood vessels, and it has been well said that a man is only as old as his arteries. Occasionally the quality of the arterial tissue that the individual has inherited is poor, and a tendency to atheroma is often seen in all the members of certain families, thus showing the influence of heredity in the production of the condition. Much more commonly, however, atheroma results from the amount of wear-and-tear to which the vessels have been subjected. Hypertension is undoubtedly often a factor; probably because atheroma affects hypertrophied areas of intima much more frequently than the normal intima. The affection is much more common in the male sex than in the female, and in subjects who have prolonged and laborious physical work. Moreover, it is much more common in the aorta than in the pulmonary artery, and when it does occur in the

latter it is nearly always associated with high pulmonary tension, *e.g.*, in mitral stenosis and in pulmonary fibrosis. The severity of the disease increases with the length of time during which the high blood-pressure has existed. Over-eating and stress and strain of modern life are probably factors in the ætiology of the condition. The most important cause of atheroma is chronic poisoning. Acute atheromatous degeneration of the media has been found after typhoid fever in young people. Atheroma has been caused experimentally by the injection of bacterial toxins. Chronic lead poisoning and gout are also ætiological factors. On the other hand, syphilis has no connection with atheroma, though the condition of the aorta known as syphilitic mesaortitis was for a long time confused with the chronic intimal degeneration we now know as atheroma. Disease of the kidneys probably has no direct relation with atheroma, though the high blood-pressure of chronic interstitial renal fibrosis and of secondary contracted kidney is an important factor in producing atheroma in the large elastic arteries.

Pathology.—Atheroma occurs in the large elastic and muscular arteries. The condition is usually most marked in the aorta. The radial and temporal arteries are frequently affected. The condition may attack the retinal arteries. In the slighter degrees, minute yellow flecks or patches on the aorta may be observed by the naked eye. In the later stages, yellow plaques or buttons are conspicuous, and under the microscope masses of large fatty crystals, with a covering layer of fibrous tissue, are to be noted. Atheromatous plaques may ulcerate and the contents be discharged into the aorta, and thrombi are often deposited on the surface of these atheromatous ulcers. As the atheroma may be associated with degeneration of the media, a diffuse dilatation of the aorta is very common. On the other hand, saccular aneurysm does not occur in simple atheroma. The aortic valves are frequently affected by atheromatous degeneration, and aortic stenosis or aortic regurgitation may result. A yellow atheromatous patch is commonly seen on the anterior flap of the mitral valve. Atheroma often causes great narrowing of the lumen of the vessels, and eventually a thrombosis may form and complete occlusion result; this is the most dangerous result of atheroma; it frequently occurs in the large divisions of the coronary arteries, especially in the anterior interventricular branch of the left, and is not uncommon in the vessels of the brain. With regard to the heart, atheroma has a most profound influence, owing to the fact that it is one of the commonest causes of fibrosis of the myocardium; but the chief danger is a sudden blockage of one of the coronary arteries, generally the anterior ventricular branch of the left coronary. In these cases, if death does not follow immediately, a sudden softening of the heart muscle (myomalacia cordis) may occur, and an aneurysm of the heart may result, and in certain rare cases actual rupture of the heart wall has followed—a broken heart. In the brain, atheroma results in cerebral thrombosis, and is the commonest cause of this condition in old people who have not had syphilis. Very commonly, however, especially in those cases of atheroma where the blood-pressure is moderately raised, hæmorrhage may occur. In most cases of atheroma the kidneys are not involved, though occasionally atheromatous plaques may be found on the branches of the renal artery. Should, however, one of these plaques be large enough to cause thrombosis of an interlobular artery, a wedge-shaped

red area of fibrosis in the distribution of the artery will occur. The renal changes, however, are relatively unimportant, and they rarely lead to symptoms during life.

Symptoms.—The blood-pressure is either normal or only moderately raised. In the aorta a diffuse dilatation, with pulsation in the supra-manubrial notch, may be present. The radial and temporal arteries are frequently irregularly thickened and tortuous, and can often be seen pulsating beneath the skin. Atheroma of the coronary arteries frequently gives rise to cardiac failure, and angina pectoris may occur; and sudden death is not uncommon, owing to a sudden thrombosis of a large branch. In the brain, hemiplegia usually results from hæmorrhage and more rarely from thrombosis. Ocular symptoms are rare in atheroma of the retinal arteries, which may be seen with the ophthalmoscope to be irregularly swollen and tortuous, but swelling of the optic disc and retinitis are not present.

Prognosis.—The course and prognosis are extremely uncertain. Circulation through the diseased vessels may proceed fairly satisfactorily for a long time, but thrombosis may occur with alarming suddenness, and with the direst results, if a cerebral or cardiac artery is affected.

Treatment.—The treatment of atheroma is unsatisfactory. Prophylaxis exists in the removal of the cause when possible. Great attention should be paid to diet, and repletion should be studiously avoided. Alcohol and tobacco should be taken with greatest moderation, and attention should be paid to regular exercise, and the action of the skin should be assisted by warm baths. It is doubtful if drugs are of value in the treatment of atheroma; possibly small doses of iodide of potassium may be of some use in absorbing the degenerative products and assisting in the circulation of the blood through the obstructed areas.

Degeneration of the Media

There are two forms of degeneration of the media, namely—(1) That which is known as Mönckeberg's degeneration or ring calcification; and (2) fatty degeneration, the latter being the more common.

Mönckeberg's Degeneration.—This form of degeneration is accompanied by a deposition of lime-salts in the middle coat.

Ætiology and Pathology.—The cause is undoubtedly a senile degeneration of the elastic tissue and the muscle of the large muscular arteries, and a deposition of masses of lime-salts in the dying tissue. It has no relation to syphilis, and also it is very doubtful whether toxins have any share in its cause, though the disease is not uncommonly found in the later stages of diabetes in old people. The lime-salt is deposited, more or less symmetrically, in rings round the artery. The affection is very common in the arteries of the leg below the bifurcation of the femoral; occasionally the radial and ulnar arteries are affected; rarely the aorta.

Symptoms.—The symptoms are coldness and œdema of the legs, as the result of defective circulation through them, and finally, and not uncommonly, gangrene results, this form of degeneration being usually present in senile cases and in cases associated with diabetes. The arteries feel like pipe-stems, and sometimes crackle when rolled beneath the finger. They can be well seen by means of the X-rays.

Prognosis.—This depends partly upon the amount of gangrene present and partly upon the associated conditions.

Treatment.—It is clear that if amputation is undertaken a local amputation is of little value, and the limb should be amputated above the knee, as the arterial degeneration almost always extends to the bifurcation of the femoral artery.

FATTY DEGENERATION OF THE MEDIA.—Fatty degeneration of the media occurs very commonly in all arteries. *It certainly tends to occur in cases of high blood-pressure, and is consequently a common and important secondary complication of medial hypertrophy.* It is probably the result of toxins or lack of nourishment, and is frequently present in cases of severe anæmia. It also occurs in old age, and is associated with cardio-vascular hypertrophy. The muscle fibres become lost, being replaced by fibrous tissue. The vessel wall usually becomes weakened and is liable to rupture.

ARTERIAL HYPERTROPHY

Increase in the muscular layer of the small and medium-sized arteries is invariably associated with persistent elevation of the blood-pressure. It is also so frequently associated with hypertrophy of the heart, especially of the left ventricle, that the condition may be termed cardio-vascular myo-hypertrophy.

Ætiology.—Arterial hypertrophy is common in late middle age, and is by no means a senile change. In rare cases associated with chronic interstitial nephritis, it may occur in young children. It is more common in males than in females. Syphilis has no part in the causation of this condition, though, of course, it may be present in syphilitic cases; supernormal blood-pressure and cardio-vascular hypertrophy are comparatively uncommon in syphilitic vascular disease. Arterial hypertrophy is the result of the circulation of poisons, which act as pressor substances and cause persistent contraction of the arteries and of the heart. The question as to whether it is the arteries or the heart which hypertrophy first has given rise to much controversy. It is probable, however, that they both hypertrophy simultaneously. These circulatory poisons may be enumerated as follows: (1) They may result from repletion due to over-eating and insufficient exercise, in which case they are absorbed from the intestines. It has been shown that certain diamines, the result of protein putrefaction, act as powerful pressor substances when introduced into the circulation. (2) They may arise from focal sepsis, *e.g.*, in the teeth, the tonsils, the nasal sinuses and the genito-urinary tract. In some cases the removal of these foci of sepsis will permanently lower a persistent supernormal blood-pressure. (3) Poisons may be introduced from without the body. Excessive smoking, chronic alcoholic excess and lead poisoning are frequent causes of arterial hypertrophy. (4) Prolonged mental strain and anxiety are also well known to lead to the condition, which has thus become much more common under the stress of modern civilisation. The isolation of adrenalin and its effect in raising the blood-pressure may supply the clue to the circulating substance in these cases. It has been shown that acute mental strain and fear result in an over secretion of adrenalin, and when this is persistent and prolonged

it may result in suprarenal hyperplasia. In many cases of arterial hypertrophy the suprarenal bodies are found to be hypertrophied at post-mortem examination. (5) Pressor substances are also to be found circulating in the blood stream in renal disease. Here the kidneys fail to perform their function of eliminating poisons from the blood stream. Thus in gout, where defective renal function is an important feature, arterial hypertrophy is common. It is also found well marked in chronic interstitial nephritis, in secondary contracted kidney, and in the later stages of congenital polycystic disease of the kidneys. In all these conditions the diseased kidneys fail to eliminate from the blood stream certain metabolic poisons, which act as pressor substances.

Relationship of Cardio-Vascular Hypertrophy to Renal Disease.—This may be summarised as follows: (1) Cardio-vascular hypertrophy may exist with little or no clinical evidence of renal lesion, which condition has been named hyperpiesia by the late Sir Clifford Allbutt. On post-mortem examination, however, slight changes in the kidneys are usually to be noted. (2) In other cases, cardio-vascular hypertrophy is sooner or later followed by morbid changes in the kidneys (see Hyperpietic Kidney, p. 1211). When this condition has become well marked, evidence of renal deficiency appears, and the failure of the kidneys to eliminate metabolic poisons results in a vicious circle by which the arterial hypertrophy is still further increased. (3) Cardio-vascular hypertrophy may also be a sequel to chronic interstitial nephritis, or to secondary contracted kidney. With regard to the latter, it begins to appear when secondary contraction of the kidney follows chronic parenchymatous nephritis (see p. 1203). It is also well seen in the later stages of congenital polycystic kidneys. As in the course of years the kidneys gradually enlarge, owing to the increase in fluid in the cysts, the kidney substance between them gradually becomes destroyed by pressure, and as the kidneys fail to eliminate metabolic poisons, arterial hypertrophy develops.

Pathology.—As Sir George Johnson described in the year 1852, the condition is a true muscular hypertrophy. This increase in muscle fibres occurs in the heart (mainly in the left ventricle), and in the media of the muscular arteries. In the later stages of the malady, there is also an increase in the musculo-elastic layer of the intima. In the course of time, this being earlier in older people, there is a tendency to fatty degeneration in the hypertrophied muscular tissue. This results in a weakening of the walls of the vessels, which in the case of the arterioles frequently rupture, so that hæmorrhage is the most common complication of cardio-vascular hypertrophy. It also results in ischæmic fibrosis of the organs. According to this view, the cardio-vascular hypertrophy is antecedent to the degenerative changes in the vessel wall, the clinical manifestations of the former, such as supernormal blood-pressure, preceding those of the latter. The muscular arteries are those chiefly affected. The radial and temporal arteries, and the arterioles of most of the organs of the body, are involved. In the case of the cerebral arteries, the perforating branches of the middle cerebral are most frequently affected, especially the lenticulo-striate branch. Hæmorrhage may also take place from the kidneys, the stomach, the intestines and the nasal mucous membrane. While the kidneys may be almost normal in cases of simple hyperpiesia, secondary fatty degeneration of the arterioles tends to appear rapidly, and this leads to ischæmic fibrosis (see Hyperpietic Kidney).

In cases where the cardio-vascular hypertrophy is the sequel either of chronic interstitial nephritis or of secondary contracted kidney, the changes in the kidneys are those described under these diseases respectively. In the heart the most striking change is the muscular hypertrophy, the left side being very much more involved than the right; the left ventricle may be even two or three times thicker than normal. In the aorta there may be little or no change, but patches of atheroma are not uncommon. The aortic valves are rarely affected.

Symptoms.—In cardio-vascular hypertrophy the vessel wall is felt to be uniformly thickened—the so-called "whip-cord" artery. The degree of hardening of the arteries is found on palpation to vary at different times. The artery feels hardest when the vessel is most contracted and consequently smallest. As the muscular arteries are those chiefly affected, the radial and temporal arteries are frequently found to be involved. The systolic blood-pressure in cases of simple hyperpiesia varies from 170–200 mm.; in cases associated with chronic interstitial nephritis it may reach even 300 mm. or more; and in secondary contracted kidney and in polycystic disease of the kidneys it varies between 160 and 220 mm. Symptoms of cardiac hypertrophy are common in the early stages. In some cases cardiac hypertrophy is followed by dilatation, with its attendant symptoms. Headache, of a throbbing and bursting character and generally in the occipital region, is an early symptom of arterial hypertrophy, and giddiness and fullness in the head are frequently complained of. Transient paralysis may occasionally be met with, and this has been attributed to spasm of the hypertrophied arteries. Later on, cerebral hæmorrhage, with the production of hemiplegia, may occur. Albuminuria and casts in the urine may be found, while profuse renal hæmorrhage may occur. Uræmic symptoms are uncommon. Gastro-intestinal symptoms are often present. The patient may first complain of dyspepsia. A chronic diarrhœa without obvious cause in an elderly man should lead to a careful examination of the arteries and kidneys. Bronchitis and emphysema may mask a cardio-vascular hypertrophy, and the enlargement of the heart may be overlooked; it is only by careful examination of the blood-pressure and urine that the underlying conditions can be recognised. The changes in the fundi are numerous and characteristic. The retinal arteries are thickened, and on ophthalmoscopic examination often show a glistening light along their course—the so-called "silver wire" arteries, due to the reflection of light from the thickened artery. If one of the thickened arteries is examined in the neighbourhood of the optic disc, it may be seen to cross a retinal vein and in so doing obstruct the flow of blood through it, leading to distension of the peripheral part of the vein. Retinal hæmorrhages, which are often flame-shaped, are occasionally to be noted, due to fatty degeneration in the hypertrophied muscular tissue. If the cardio-vascular hypertrophy is due either to chronic interstitial nephritis or to secondary contracted kidney, hæmorrhages are much more common, and also further changes in the fundi, due to either of these affections respectively—described elsewhere—are to be noted.

Intermittent lameness or claudication is not uncommon in these cases. The patient is unable to walk for more than a few minutes without severe cramp-like pain in the legs, the pain and the loss of power in the muscles being due to the spasm of the thickened arteries. Pulsation may be absent

in the dorsalis pedis, and in the dependent position the feet and legs may become deeply congested and swollen.

Prognosis.—The prognosis depends very largely on the degree of renal involvement. In hyperpiesia the condition may last for many years and only be terminated by hæmorrhage into the brain. When, however, the kidneys are affected, as shown by persistent albuminuria with casts in the urine and a blood-pressure well over 200 mm. Hg, the condition is grave; and when well-marked albuminuric retinitis is present death usually occurs within six months, though very rare cases have been recorded where a certain amount of ocular change has persisted for years.

Treatment.—The first indication is to remove the cause of the condition as far as possible. Thus, gouty tendencies should be corrected by the administration of alkalis and intestinal antiseptics, such as sodium benzoate or dimol. All sources of focal sepsis, whether in tonsils, teeth, nasal sinuses or genito-urinary tract, should be carefully sought for and, if found, removed. Moderation in food and drink, with regular exercise and care in promoting diaphoresis, is essential. Turkish and vapour baths may be given cautiously. The administration of a brisk purgative pill once a week, and the use of a mild saline purgative each morning are indicated. Nitroglycerine and the nitrites are useful in moderate degrees of increased blood-pressure, though where the blood-pressure is very high they rarely produce any permanent benefit. In these latter cases the administration of thyroid extract has been successful in reducing the pressure to a more reasonable level; while in acute crises the abstraction of one pint of blood from the arm has often saved life.

ARTERIAL INFILTRATION

The commonest form of infiltration is amyloid infiltration.

Ætiology.—Amyloid or lardaceous disease occurs in cases of long suppuration due to pyogenic organisms, and is frequently associated with the secondary pyogenic infections which occur in tuberculosis of the bones and joints, in chronic syphilitic ulceration, and in actinomycosis.

Pathology.—The amyloid substance is extracellular and is deposited first of all in the middle coat of the small arterioles. The affected organs are firm to the touch and have a waxy appearance. The amyloid substance can be demonstrated macroscopically by pouring tincture of iodine on the affected organ, the waxy material being stained a deep mahogany colour. Microscopically, an iodine staining may be used, or a methyl-violet stain, which colours the amyloid substance pink and the parenchymatous cells blue. In the kidney, the small arterioles in the glomeruli, those around the convoluted tubules and those in the medulla, are first attacked. In the intestine, the arterioles in the villi stand out clearly. There are two forms of amyloid infiltration of the spleen: the diffuse waxy spleen, where the venous sinuses are outlined and the central artery of the Malpighian capsule is affected; and the sago spleen, where the Malpighian capsule is greatly enlarged by the amyloid infiltration—its central artery is untouched, but its branches into the capsule are greatly swollen by the waxy material. In all these organs the parenchymatous cells are unaffected directly by the amyloid infiltration,

but in the later stages become compressed and atrophied by the pressure of the waxy substance upon them.

Symptoms.—The patient is pale, but often has a waxy complexion with a bright colour in the cheeks. Chronic, profuse and painless diarrhœa is common. The urine contains a large quantity of albumin, and is usually fair in amount and of low specific gravity. The liver and spleen are enlarged, and ascites and œdema of the legs are often present.

Prognosis.—If the chronic suppuration can be cured, the condition may sometimes disappear; but in the majority of cases this is not possible, as the septic condition is engrafted on to a chronic tubercular or other granulomatous condition, which is almost always impossible to eradicate.

Treatment.—This consists in trying to remove the cause.

ANEURYSM

Definition.—The word aneurysm is derived from the Greek to widen or dilate, and may be said to include any dilatation of an artery.

Aneurysms are generally divided into—

1. TRUE ANEURYSMS, in which the walls of the dilatation are formed by the coats of the artery. These may again be divided into—

(*a*) *Dilatation aneurysm.* (i.) A dilatation limited to a certain portion of the vessel, known as a fusiform aneurysm. This variety is frequently seen in the arch of the aorta. (ii.) A tortuous dilatation extending over the whole of an artery and its branches, the so-called cirsoid aneurysm.

(*b*) *Circumscribed saccular aneurysm*, occurring commonly in the aorta.

(*c*) *Dissecting aneurysm*, caused by the splitting of the coats of the artery, the blood having passed through the lumen into the wall of the artery, separating one coat from another.

(*d*) *Arterio-venous aneurysm*, in which there is a communication between an artery and a vein. There are two varieties in this group—(1) aneurysmal varix, and (2) varicose aneurysm.

2. FALSE ANEURYSMS are those following a wound or rupture of an artery, with the formation of a diffuse or circumscribed hæmatoma, and are bounded by tissues external to the wall of the artery.

A true aneurysm frequently ruptures and gives rise to a false aneurysm and the resulting structure is known as a mixed aneurysm.

Ætiology and Pathology.—The two main factors in the causation of aneurysm are—(1) degenerative changes in the wall of the artery; (2) strain. The latter may be brought about by either high arterial tension or by repeated and prolonged muscular effort. The importance of strain as a causal factor is borne out by the fact that aneurysm is much more frequent in men than women—about five to one—and occurs more frequently in the fourth decade of life than at any other period. It also occurs much more frequently in hard manual workers, such as dock labourers, soldiers and sailors. *By far the most common cause producing weakening of the large elastic arteries is syphilitic inflammation. In cases of persons dying of aneurysm, examination of the aorta in the neighbourhood of the aneurysm will, in a large majority of cases, reveal mesaortitis* (see page 937). Aneurysm may also result from erosion of the walls of the

arteries in cases of malignant endocarditis—the so-called mycotic aneurysm. Frequently these aneurysms are multiple. Extensive growth of streptococci and septic granulations may be seen in the neighbourhood of the dilatations.

Aneurysm may also be the result of congenital deformity of the wall of the vessel, which is very commonly seen about the circle of Willis, at the junction of the anterior communicating artery with the anterior cerebral. The aneurysms are about the size of a pin's head to that of a pea, and not infrequently their rupture gives rise to a diffuse subarachnoid hæmorrhage, the origin of which is often overlooked unless careful search is made for the aneurysm. Congenital aneurysm has also been described in the aorta, at the point of insertion of the ductus Botalli, and in cases of coarctation of the aorta, in which condition there is great narrowing of the aorta just below the origin of the left subclavian artery.

Loss of support by surrounding tissues also appears to lead to the production of aneurysm, *e.g.* at the base of a gastric ulcer a small aneurysm often projects as a nodule and is liable to rupture. Peptic erosion may also be a cause of weakening the walls of such arteries. In the cavities of the lungs, occurring as the result of pulmonary tuberculosis, it is quite common to find an aneurysm on the walls of the arteries lying in such cavities.

It is very doubtful whether trauma alone is ever the cause of true aneurysm. Atheroma itself does not lead to sacculated aneurysm, but if combined with fatty degeneration of the media, as it so often is, a diffuse dilatation of the aorta not uncommonly results. Continued high blood-pressure, as in other forms of aneurysm, is an important contributory factor in the formation of a diffuse dilatation of the aorta.

One of the most striking appearances in an aneurysm is the coagulation of blood in the sac itself. This does not occur in diffuse dilatation of the aorta, but in those cases of sacculated aneurysm where the wall has become roughened. The sac becomes lined with fibrinous deposits, and occasionally an aneurysm may be cured by the deposition of successive layers of fibrin, so that the sac becomes almost completely filled. On the other hand, in many fatal cases of aneurysm rupture and hæmorrhage have taken place, the deposition of fibrin having failed to prevent the blood reaching the surface. Rupture may take place externally, or into any of the hollow viscera or the serous cavities. Rupture into the pleura is common, as also is rupture into the trachea or into the œsophagus. In these cases, death is usually sudden, though oozing may have taken place some time before the final rupture. When the hæmorrhage forces itself into the connective tissues or muscles, it takes place much more slowly, and in the cases of the limbs may allow time for treatment. An aneurysm often exercises pressure on the other organs and structures in its neighbourhood. The heart is displaced away from the aneurysm, and the blood vessels are often narrowed so that circulation through them is impeded. The trachea, the bronchus, the œsophagus and the nerves passing near the aneurysm also suffer. When the aneurysm meets bony tissues, absorption of the bone takes place and the vertebræ are frequently eroded in this way, the bone being absorbed more rapidly than the intervertebral cartilage. When the aneurysm presses against the anterior surface of the chest, the ribs and sternum are pushed forward and finally are absorbed and perforated.

I. ANEURYSM OF THE THORACIC AORTA AND ITS BRANCHES

These are two types—(1) The diffuse dilatation which occurs in degeneration of the aorta; and (2) the saccular aneurysm, the result of inflammation, usually syphilitic.

Dilated Aorta

Symptoms.—In diffuse dilatation of the aorta the enlargement is gradual and never reaches a very great size. The symptoms of this form of dilated aorta are generally due to atheroma and the medial degeneration which accompanies it. Very often there is interference with the coronary circulation, and this leads to diminution of the circulation of blood through the heart and consequently to cardiac pain. The aorta may sometimes be felt pulsating in the supra-manubrial notch, and the X-ray photograph will show general dilatation of the aortic arch. When the aortic ring is not stretched, the dilatation of the aorta beyond it may lead to the formation of a systolic murmur. If the part adjacent to the aortic valves is affected, the aortic ring may be dilated and aortic regurgitation will take place. There will then be hypertrophy and dilatation of the left ventricle, with an aortic diastolic murmur, and the symptoms will be those of aortic regurgitation. Occasionally these patients die suddenly, on account of thrombosis of a branch of a coronary artery. Provided there is no aortic regurgitation or coexisting coronary disease, patients with dilated aorta may live for many years without serious discomfort.

Saccular Aneurysm

Symptoms and Diagnosis.—Aneurysm of the Ascending Part of the Arch of the Aorta.—An aneurysm of the ascending part of the arch tends to grow forward and outwards, and to produce a pulsating tumour which is palpable and audible at the level of the second or third interspace, and is hence often called the *aneurysm of physical signs*. It often erodes the ribs and sternum. The tumour is tender and is often the seat of pain, which may be constant but is increased by exertion. A soft systolic murmur may be heard over it.

The pressure effects produced by an aneurysm of the ascending aorta are as follows: The heart is displaced downwards and to the left. The superior vena cava is pressed upon. This may result in cyanosis of the head and neck, and œdema of the arms, and enlarged veins may frequently be seen coursing over the front of the thorax. Occasionally the aneurysm may rupture into the superior vena cava, in which case the symptoms noted may come on quite suddenly and are very marked. There is often a systolic thrill, and on auscultation a continuous murmur, which is increased during systole, is of great diagnostic value. The aneurysm may press upon the right bronchus, causing a chronic cough, due to irritation of the bronchus and stasis of its contents, and deficient or absent breath sounds over the upper lobe of the right lung. The aneurysm may occasionally press upon the pulmonary artery and in rare cases actually open into it, causing great dilatation of the right ventricle and auricle. Such aneurysms may present

themselves to the left of the sternum rather than in the usual place, the right. In rare cases aneurysm of the ascending aorta has perforated the right ventricle, the right or left auricle, and the pericardium. When the aneurysm comes forward it may irritate the pleura; and in some cases a loud pleuritic rub, audible over the aortic area, may be one of the early signs. Not uncommonly this form of aneurysm may rupture into the pleura and occasionally it ruptures externally.

ANEURYSM OF THE TRANSVERSE ARCH OF THE AORTA.—As the arch of the aorta passes from right to left it also passes from before backwards, and consequently aneurysms arising from the transverse and descending parts of the aortic arch are situated more deeply in the chest than those arising from the ascending portion. Aneurysms of the transverse and descending parts of the aortic arch have been called by Broadbent *aneurysms of symptoms*, because their presence has often to be inferred by the pressure symptoms which they produce, while a pulsating tumour is only present in the very late stages and may never appear at all during the whole course of the disease.

1. *Pain.*—Pain is one of the most common and earliest symptoms of aneurysm. It may often be anginal in character; that is to say, it may occur in the cardiac region or across the back and pass down the left arm and be very severe. This form of pain occurs when the aortic valve is affected and when the ascending aorta is distended. When, however, the transverse arch is affected the pain is sometimes felt on the left side of the neck and even in the occipital region. It is probable that this pain in the neck is a reflected pain from the spinal cord, resulting from the abnormal afferent impulses reaching the cervical spinal cord as a result of the distension of the transverse arch. A boring, persistent pain in the chest is probably the result of direct pressure of the aneurysm.

2. *Respiratory symptoms.*—Dyspnœa is common in aneurysm, and is usually caused by pressure upon a bronchus. There is often stridor, which in this case is heard both in inspiration and in expiration. Hæmorrhage also occurs as a result of leaking of an aneurysm through the bronchus. It may at first be slight, but often a huge gush of blood supervenes, causing death. It is said that reflex irritation of the vagi will occasionally cause bilateral adductor spasm of the vocal cords and marked dyspnœa. In this case the stridor is only heard with inspiration and disappears if a little chloroform is inhaled. Patients with aneurysm often have a ringing, rough, brassy cough. If the pressure on the bronchus has been gradual, secondary changes occur in the lung. Dr. Newton Pitt has brought forward evidence to show that compression of the left bronchus in the early stages produces over-distension of the left lung with diminished or absent breath sounds. This may be so great as to lead to a suspicion of pneumo-thorax; later on bronchitis occurs with dilatation of the bronchus with expectoration of purulent phlegm. Pressure on the trachea may occasionally be observed in cases of aneurysm of the aortic arch, the larynx being drawn downwards and backwards with each cardiac pulsation. A very important physical sign was described by Surgeon-Major Oliver and is known as *tracheal tugging*. The patient should be placed in the erect position, and directed to close his mouth and elevate his chin. The cricoid cartilage should be grasped between the finger and thumb and gentle steady upward pressure be made upon it.

If aortic dilatation or aneurysm exist, the pulsation of the aorta will be distinctly felt transmitted through the trachea to the hand. This is a valuable sign, and often occurs in aneurysm before other symptoms are evident. Occasionally a systolic murmur may be heard in the mouth when the patient compresses his chest with his mouth wide open. Dr. Sansom has pointed out this tracheal whiff may be rendered distinctly audible with a binaural stethoscope when the end is placed in the mouth with the lips closed over it. It is either the aortic systolic murmur produced at the mouth of the sac, or the result of driving the air out of the windpipe during systole by the pressure of the aneurysm.

3. *Pressure on nerves.*—(*a*) The left recurrent laryngeal nerve.—This nerve courses round the arch of the aorta and passes up behind it, and is consequently often involved in aneurysm of the transverse arch. The abductor fibres of the recurrent laryngeal nerves succumb to the effect of pressure before the adductor fibres and consequently the vocal cord is at first in the position of adduction. During respiration, the right vocal cord moves up to and meets the adducted left vocal cord and respiration is unaffected. During phonation, the right vocal cord again comes up to and meets the left vocal cord, and the voice may be quite normal. It is therefore clear that a laryngoscopical examination may reveal the early stage of pressure on the left vocal cord before there has been any alteration in the voice. As the pressure increases, the adductor muscles are affected and the left vocal cord remains motionless in the cadaveric position half-way between full inspiration and full expiration. The voice is now hoarse, and it not uncommonly happens that hoarseness is the first symptom for which the patient presents himself. (*b*) Pressure on the sympathetic nerve.—Pressure upon the sympathetic nerve causes first of all irritation and later on a paralysis of the cervical sympathetic fibres. When the sympathetic is irritated, the pupil on the same side is dilated, and this is accompanied by slight protrusion of the eyeball, slight retraction of the upper eyelid, together with sweating and flushing of the same side of the face and ear. When the cervical sympathetic is paralysed, the pupil is smaller than on the opposite side, the eyeball is sunken into the orbit, and there is a slight degree of ptosis. Unequal pupils in aneurysm are, however, frequently found without any of the other symptoms of sympathetic irritation or paralysis, and in these cases another explanation must be found. Doctors Wall and Walker suggest that the difference in the pupils is due to pressure of the aneurysm upon the arteries passing to the neck. They have shown that in a condition of low blood-pressure the pupils are dilated, whilst in a condition of high blood-pressure they are contracted, and that pressure upon one common carotid will cause dilatation of the pupil on the same side. They point out that under these conditions the dilated pupil is constantly on the same side as the smaller temporal pulse, and they consider that the dilated pupil and the small pulse are due to the same cause, namely, pressure upon the arteries supplying that side of the neck. Unequal pupils also occur as the result of syphilitic disease of the nervous system. We may get bilateral pin-point pupils, or the pupils may be unequal and irregular in outline. In both cases the reaction to light is lost, while the reaction to accommodation remains. I have seen a case where a syphilitic aneurysm occurred coincidently with a syphilitic paralysis of one third nerve, and in

this case the pupil was dilated and the other symptoms of paralysis of the third nerve were present. (*c*) Pressure upon the intercostal nerves occasionally results from an aneurysm which presses backwards and erodes the vertebræ and posterior portions of the ribs. In these cases the pain is very severe along the affected nerves. In the distribution of the nerve itself the skin may be anæsthetic—the so-called *anæsthesia dolorosa*. (*d*) In some cases the aneurysm presses upon the brachial plexus, shooting pain occurring in the head and neck and down the right arm.

4. *Pressure upon the branches springing from the aorta is not uncommon.*—This may result in the absence of one radial or temporal pulse, or inequality between the two pulses. If the innominate artery is pressed upon, the right radial and temporal arteries may be small and imperceptible, while in an aneurysm of the transverse arch of the aorta, the left subclavian artery is compressed, in which case the left radial pulse may be affected. A sphygmographic tracing is often of value in demonstrating the difference between the two pulses, and a forced expiration, by increasing the intrathoracic pressure, will often accentuate the difference between the two sides. When the pulses are markedly unequal, the blood-pressure is also diminished on the side of the feebler pulse ; a difference of pressure of over 30 mm. between the two sides is strongly in favour of aneurysm.

5. *Pressure on the œsophagus may result in slight difficulty in swallowing, but the dysphagia is very rarely complete.*—Occasionally the aneurysm may ulcerate into the œsophagus, until at last death takes place from a sudden rupture.

ANEURYSM OF THE DESCENDING PORTION OF THE ARCH.—In these cases the sac frequently projects backwards and erodes the vertebræ from the third to sixth thoracic, causing great pain and occasionally compression of the spinal cord, resulting in paraplegia. Dysphagia is common, and sometimes a tumour appears in the region between the scapula and the spine, and may attain a very large size.

ANEURYSM OF THE DESCENDING THORACIC AORTA may occur close to the diaphragm. Aneurysm of this form is frequently overlooked, pain in the back being the most prominent early symptom.

ANEURYSM OF THE INNOMINATE ARTERY.—This is not uncommon. It forms a pulsating tumour, which can sometimes be felt above the right clavicle, and nearly always produces marked diminution in the right radial and temporal arteries. In this form of aneurysm, paralysis of the right recurrent laryngeal nerve occurs not infrequently, the right vocal cord being paralysed instead of the left.

Inspection.—This is most essential. Abnormal pulsation should be looked for in the thorax, and can often be seen when the patient is looked at obliquely in a good light. Posterior pulsation is generally observed to the left of the spine. Enlarged veins over the chest, suffusion of the face, and alteration in the pupil may be noted. The apex-beat is often dislocated from its normal position, especially when the sac is large, this being due to pressure of the aneurysm on the thorax ; the heart itself is seldom hypertrophied, unless there is a leakage through the aortic valves.

Palpation.—Palpation may reveal the area and degree of the abnormal pulsation. There may only be a diffuse impulse, but if the sac has perforated the chest-wall, a forcible heaving and expansile impulse may be felt. Occasionally a diastolic shock is to be noted. This has been thought by some to be

due to the forcible closure of the aortic valves producing an effect within the aneurysmal sac; another explanation is that the contraction of the heart draws in the ribs during systole at the point where they are adherent to the aneurysm and the diastolic shock is produced by the elastic recoil of the ribs and costal cartilages. Occasionally a systolic thrill may be felt.

Percussion.—A dull area may in some cases be made out in the second right interspace in cases of aneurysm of the ascending aorta. Much more rarely an aneurysm of the arch may press forwards and to the left, and produce dullness below the left clavicle. Pressure upon a bronchus may at one period result in hyper-resonance from lung distension, and later, owing to absorption of air in the lung, the percussion note may become dull.

Auscultation.—There may be no murmur, even in a large aneurysm, but a systolic murmur is not uncommonly present. When both systolic and diastolic murmurs are heard, aortic regurgitation is present in addition to the aneurysm. Accentuation of the aortic second sound is the most reliable auscultatory sign of aneurysm.

Reference has already been made to alteration in the radial and temporal pulses. Occasionally in a large aneurysm of the descending aorta there may be absence of pulsation in the abdominal aorta and peripheral arteries of the legs, the dilatation of the thoracic aorta being sufficient to convert the intermittent into a continuous stream.

Tracheal tugging is another very valuable physical sign of aortic aneurysm, especially in the differential diagnosis of aneurysm from tumour.

Examination by the Röntgen rays is most important in every case where aneurysm is suspected. The chest should be examined from the anterior, the posterior and the right oblique positions. In the last position, most valuable information as to the state of the aortic arch can be obtained. With the fluoroscope the pulsation of the tumour and its relation to the aorta may actually be seen, but photographs should always be taken, both in the anterior-posterior and oblique positions, as much information is obtained from the density of the shadow cast by the aneurysm. If the latter is very dense, it can be reasonably inferred that deposition of the laminated clot has taken place within the sac.

Complications and Sequelæ.—The main complication, bringing about a fatal termination, is rupture, which may take place either externally, into the pericardium, into the pleura, into the œsophagus, into the bronchus, or into the lung tissue itself. Pressure on the trachea, causing stridor and respiratory obstruction, is a very distressing complication. Bronchitis may occur during the course of the illness, and may be recovered from more than once. Broncho-pneumonia and gangrene of the lung not infrequently occur when there is pressure upon a bronchus, and empyema may also result. Tuberculosis of the lung may coexist with aneurysm, but death from hæmoptysis, the result of perforation of a deep-seated aneurysm into the bronchus, has often been mistaken for the profuse hæmorrhage of tuberculosis. Cardiac failure is responsible for a large number of deaths. This may be the result of exhaustion, or of displacement of the heart, or of interference with the circulation through the coronary arteries; in other cases it is due to the aortic regurgitation. Cerebral embolism sometimes occurs in cases of aortic aneurysm, a portion of the clot within the artery becoming displaced and passed up to the brain.

Course.—Most cases live from 2 to 3 years from the time when the first symptoms have appeared. Occasionally life may be prolonged for several years by treatment. In rare cases spontaneous cure may be obtained by deposition of laminated clots within the cavity of the aneurysm, but this result is comparatively rare.

Diagnosis.—Intrathoracic aneurysm is often difficult to diagnose from intrathoracic new-growth. In both there may be an externally projecting tumour, but in aneurysm the pulsation may be seen to be expansile. The diastolic shock present in aneurysm is absent in a case of new-growth. Systolic murmurs may occur in both conditions, but the ringing aortic second sound is of great importance, and is rarely heard in tumours. Tracheal tugging is in favour of aneurysm, while progressive wasting and enlargement of glands in the neck are in favour of new-growth. Aneurysm, as a rule, occurs in apparently healthy men under 55 years of age, whereas malignant growth in the chest occurs either in early life or advanced years, and is associated with emaciation and pallor. In aneurysm there is a greater likelihood of the pupils and pulses being unequal, while in new-growth œdema of the upper extremities and chest-wall is not uncommon. In all doubtful cases an X-ray examination should be made, and will nearly always clear up the diagnosis between the two conditions. Clinical evidence of infection by syphilis and a positive Wassermann reaction are important in diagnosis.

A violently pulsating thoracic aorta, either in association with aortic regurgitation or with violent throbbing of the heart, may lead to the unfounded suspicion of an aneurysm.

In cases where an empyema is pointing on the left side in the region of the heart, the tumour may pulsate. The throbbing is usually diffuse and widespread, and there is a coexistence of a pleural effusion. Exploration with a fine needle will usually settle the diagnosis. It must, however, be remembered that occasionally an empyema may be the result of extension of septic trouble from a bronchus which has become compressed by an aneurysm.

Prognosis.—In aneurysm this is always difficult. Complete cure is very unlikely, although pain and other unpleasant symptoms and physical signs may give way to treatment. The presence of aortic regurgitation is unfavourable, while an aneurysm progresses much more slowly in people of a placid disposition and those who lead a quiet life. Even in cases where treatment has apparently been most successful and pain and dyspnœa have been apparently relieved, sudden death not uncommonly occurs from rupture of the sac.

Treatment.—The recognition of the fact that the main cause of aneurysm is the weakening of the wall by syphilitic mesaortitis has brought anti-syphilitic treatment into the forefront of modern treatment of aneurysm of the thoracic aorta. Mercurial inunctions and injections have been but little tried, but in many cases a good deal of benefit has been observed. The iodides have been given in aneurysm for many years—long before syphilis had been recognised as a cause of the condition. The most striking effect of iodide is the relief of pain, and this may be obtained by even small doses, such as 5 grains three times a day. In all cases, however, large doses, such as 20 grains three times a day, should be given a trial. Dr. de Haviland Hall, in his lectures on intrathoracic aneurysm, states that *it is inadvisable to give salvarsan; but I have given this drug intravenously in*

several cases with marked success. In two cases where the patients appeared to be almost moribund from respiratory complications, owing to pressure, the administration of salvarsan was followed by distinct improvement, and both these patients have remained comparatively well, one for 3 and the other for 4 years.

Efforts to produce clotting within the sac should be tried in early cases of aneurysm. Of these the best known is Tufnell's method—that of a complete rest and restricted diet. The patient must lie in a perfectly quiet and secluded room, and the treatment should be pursued for several months. He should not consume more than 10 ounces of solid food and 8 ounces of fluid per diem. Iodide of potassium should not be given during this period, as it increases thirst and makes it impossible to limit the amount of fluid. Few patients put up with such a rigid diet and rest, but an endeavour should be made in an early case to attempt this method. Secondly, the administration of lime-salts, such as the chloride or lactate of calcium, should also be tried, in an endeavour to promote clotting within the sac. Twenty grains of calcium lactate three times a day may be given for the first 3 days of a week, and be omitted for the remaining 4 days. Normal horse serum may be given in conjunction with the calcium lactate, either by the mouth, per rectum or hypodermically. The gelatin treatment, introduced by Lancereaux, consists in the hypodermic administration of 50 c.c. of a 2 per cent. solution. Unfortunately several deaths have occurred, owing to the gelatin solution having become infected by the tetanus bacillus. It is very doubtful whether the treatment has had much success. It has been suggested that the effect on the blood may be due to the amount of calcium the gelatin contains.

Many patients with intrathoracic aneurysm do better if they are allowed to follow their general avocations, provided their work be not too strenuous for body or mind. Patients should be cautioned to take things as easily as possible, to avoid alcohol, eat with great moderation, and avoid any sudden exertion. A certain amount of tobacco may be smoked.

Special symptoms may have to be treated. For severe pain, cyanosis and dyspnœa, venesection will often give marked relief. Amyl nitrite and iodide of potassium are of great service in relieving the anginal pain of aneurysm. Severe paroxysmal dyspnœa is nearly always due to direct pressure on the trachea; both inspiratory and expiratory stridor are present. The inhalation of chloroform does not give relief, and tracheotomy is quite useless. It has been stated that in some cases there is a bilateral abductor spasm of the vocal cords, due to irritation of the vagi—a very rare condition. If present, relief will probably be obtained by chloroform. Intubation of the larynx is generally preferable to tracheotomy; in fact, the latter operation should never be performed to relieve the dyspnœa of aneurysm.

Surgical Treatment.—This may be considered under four heads—(1) ligature of the vessels arising from the arch of the aorta; (2) the passage of wire into the sac with or without galvanism; (3) needling the sac; and (4) ligature of the neck of the sac.

Ligature of vessels has been of little service in the case of aneurysm of the aorta. In aneurysm of the innominate artery, combined simultaneous ligature of the right common carotid and subclavian arteries may be tried, but even this may be insufficient to prevent the flow of blood through the sac. Moore's method of introducing silver or zinc wire into the sac through a

cannula has been used, but the best results have been in cases of abdominal rather than intrathoracic aneurysm. Puncture of the aneurysm and scratching its wall with the point of a needle, as advocated by Sir William McEwen, has been partially successful in several cases. Ligature of the neck of the sac may be undertaken when it appears to be small, but suitable cases are very rare.

SUBCLAVIAN ANEURYSM is nearly as frequent as carotid aneurysm.

ANEURYSM OF THE PERIPHERAL ARTERIES is mainly of surgical interest. It most commonly occurs in the common carotid, and is relatively frequent in women. It has been suggested that the carotid is likely to be strained or overstretched during parturition. Syphilis is found in all cases.

II. ANEURYSM OF THE ABDOMINAL AORTA AND ITS BRANCHES

Aneurysm may occur in any part of the abdominal aorta, but it is a comparatively rare disease. A forcible dynamic pulsation of the vessel is often mistaken for aneurysm, and no case should be diagnosed as aneurysm unless a tumour can be grasped between the fingers. In true aneurysm there is evidence of syphilis and the Wassermann reaction is positive. A systolic thrill can sometimes be felt, and a systolic murmur is, as a rule, audible. The complications in abdominal aneurysm are many. Death may result from complete obliteration of the lumen by clots, by erosion of the vertebræ, and compression of the spinal cord, resulting in paraplegia. Occasionally the superior mesenteric artery may become blocked by a clot and acute intestinal obstruction result. The commonest complication is rupture, which generally takes place into the retro-peritoneal tissues, with the formation of a large rapidly-growing tumour in the flank. More rarely death takes place from rupture into the peritoneum or duodenum.

Treatment.—The treatment of abdominal aneurysm is the same as that of thoracic aneurysm. In cases where medical treatment is unsuccessful after a fair trial, surgical measures should be undertaken.

ANEURYSM OF THE SPLENIC ARTERY is occasionally met with. A tumour can be felt near the spleen and it may perforate into the colon. If the diagnosis can be made, removal of the aneurysm and of the spleen should be undertaken.

ANEURYSM OF THE MESENTERIC ARTERY generally results in plugging of the vessel or its branches, with the result that acute intestinal obstruction takes place and death occurs from this cause.

ANEURYSM OF THE HEPATIC ARTERY is very rare.

ANEURYSM OF THE RENAL ARTERY has occasionally been noted, and in some cases successfully removed.

ANEURYSM OF THE FEMORAL ARTERY also occurs.

ANEURYSM OF THE POPLITEAL ARTERY is one of the most common of the peripheral aneurysms. It has been suggested that this is due to the fact of the exposure to stress and strain to which the popliteal region is subjected during violent lifting efforts.

In all cases of peripheral aneurysm a syphilitic basis must be investigated; but as in these cases the sac-wall rapidly changes from a true to a false or mixed aneurysm, anti-syphilitic treatment is of little avail and the treatment is mainly surgical. Distal or peripheral ligature and excision have all been

tried, but a great advance has recently been made in the treatment of aneurysm by Matas. After rendering the limb exsanguine, he freely opens the arterial sac and by a process of suturing reconstructs a channel between the afferent and efferent artery of the sac. He terms this procedure *Reconstructive Endoaneurysmorrhaphy*.

III. DISSECTING ANEURYSM

This may originate in an atheromatous ulcer. Very often the dissection of the coat is small, especially when the blood-pressure is not high. When, however, there is a very high blood-pressure and much fatty degeneration of the media, an extensive dissecting aneurysm may occur. The fatty degeneration of the media may cause a small split in the intima and the dissection separates the intima from the media, so that in some cases there may be a double tube instead of a single aorta. Extensive dissection frequently causes sudden death, but in other cases the patient may live on, and the association of a rapidly beating heart and a feeble pulse in the lower limbs has been suggested as a clinical sign by which the condition may be recognised. Turnbull has shown that in five cases of extensive dissecting aneurysm of the aorta, vascular hypertrophy was well marked, and consequently the blood-pressure was high during life.

IV. CIRSOID ANEURYSM

Cirsoid aneurysm is a condition in which an artery and its branches are dilated and tortuous. The affection is usually met with in the scalp—the superficial temporal, the posterior auricular, and the occipital arteries being affected. In very rare cases it has been found in the perineum, in the orbit, and in the limbs. Occasionally it follows an injury, but in other cases it seems to be of the nature of an angioma, and has been given the name of serpentine angioma. It is most common between puberty and 30 years of age.

Pathology.—The arteries are dilated, thinned and very tortuous, and the disease tends to spread towards the capillaries and also along the arteries which feed the aneurysm. The skin over the aneurysm is often atrophied and may become ulcerated, leading to very dangerous hæmorrhage.

Symptoms.—There is an ill-defined pulsating tumour on the scalp, in which the tortuous vessels may be felt. In rare cases the tumour may be slow in its growth, but this is generally rapid and the skin over it ulcerates, leading to hæmorrhage.

Treatment.—This is very difficult. In limited cases the tumour may be excised. Generally, however, ligature of the peripheral arteries of the growth is more satisfactory. Electrolysis and injections of perchloride of iron into the mass have been tried, with some success.

V. ARTERIO-VENOUS ANEURYSM

Arterio-venous aneurysm is the name given to the condition in which an artery and a vein communicate, and consists of two kinds—(1) aneurysmal varix, where the two vessels anastomose directly; and (2) varicose aneurysm, where the sac separates the connecting vessels.

(1) ANEURYSMAL VARIX.—The condition is usually traumatic in origin and generally occurs at the elbow, as the result of venesection. The artery is wounded at the same time as the vein and they become connected, the result being that the vein becomes markedly dilated and tortuous.

The varix forms a soft, compressible, ill-defined tumour, which pulsates. Pain in the tumour is not uncommon. A marked thrill can often be felt and a loud bruit may be heard over the tumour. If the limb is raised the tumour shrinks, while it becomes large and congested if the limb is held downwards. The limb below the tumour is often œdematous.

In some cases the condition remainsstationary, and all that is required is an elastic support. If, however, the aneurysm tends to increase in size, the artery should be ligatured above and below its communication with the vein.

An intrathoracic aneurysm may become adherent to a vein and perforate into it. The most common case occurs when an aneurysm of the ascending arch of the aorta perforates the superior vena cava. The latter vessel becomes greatly distended and an arterio-venous aneurysm is formed. There is often a sudden onset when the lumen of the two vessels becomes connected; there is distinct congestion of the head and neck and upper limbs, great distension of the veins, and often œdema. On auscultation over the tumour, a continuous humming murmur is heard, with marked accentuation during systole.

(2) VARICOSE ANEURYSM.—This occurs when an artery and vein are simultaneously wounded. An aneurysmal sac is formed in the tissues which communicate both with the artery and vein. The symptoms are similar to those of an aneurysmal varix, but in addition there is a pulsating tumour, which can be distinguished from the dilated vein. This form of aneurysm should be excised by open operation.

ARTERIO-VENOUS ANEURYSM OF THE ORBIT OR PULSATING EXOPHTHALMOS.—This is a form of aneurysm by anastomosis, due to a communication having formed between the cavernous sinus and internal carotid artery as it passes through it. It is generally the result of a fracture of the base of the skull. The condition is usually unilateral, but may be bilateral, and the communication may take place immediately after the fracture, or evidence of the lesion may only appear days or weeks after the injury.

The main symptom is protrusion of the eyeball, the globe being displaced outwards and downwards. It may be seen to be visibly pulsating, but if not, slight pressure upon the globe of the eye will bring out pulsation. A loud bruit, either continuous or increased during systole, may be heard anywhere over the head; this roaring sound is generally very distressing to the patient. There is great dilatation of the veins around the eyelids, conjunctivæ and fundus. Headache is common.

The condition may last for years, and in a few cases spontaneous recovery has taken place.

The treatment of the condition is either compression or ligature of the carotid artery. The great danger in ligaturing the carotid artery is the occurrence of cerebral softening and hemiplegia. To avoid this, it is better to ligature the artery temporarily and see if any cerebral symptoms tend to develop; if they do, the ligature should be removed after 24 hours; but if they do not, the ligature may be tightened and the artery completely occluded.

PHLEBITIS

Phlebitis or inflammation of the veins may be sharply divided into two great classes—(1) non-suppurative or plastic phlebitis, and (2) the suppurative form. The terms endo- and peri-phlebitis have been used to indicate inflammation of the internal and external coats. Peri-phlebitis results from invasion of the veins by inflammatory processes outside it, or from injury. It may extend inwards towards the lumen of the vein, and result in endophlebitis and frequently clotting of the blood within the vein. Endophlebitis is usually the result of poisons or microbes circulating within the vein. Inflammatory changes occur in the endothelium, and a plastic inflammation results, and in consequence a clot or thrombus is set up within the vein. The clot may adhere to the vessel wall and completely obliterate it. Organisation of the clot by fibrous tissue may occur, the vein being transformed into a hard fibrous cord. In other cases the clot may become softened and broken down, and the circulation may be resumed through the vein. In certain cases changes in the composition of the blood may lead to clotting in a vein, and the presence of this clot itself may give rise to a plastic phlebitis; this is sometimes called *thrombo-phlebitis*. In other cases the vein and contained clot may become invaded by pyogenic organisms, and leucocytes will enter the clot and cause it to break down into a purulent fluid.

Plastic Phlebitis

Ætiology.—(1) Traumatic phlebitis; (2) the formation of a non-infective clot—thrombo-phlebitis; (3) gouty phlebitis may accompany an attack of gouty arthritis or may occur independently; (4) typhoid fever not infrequently causes phlebitis and thrombosis; (5) in pneumonia and influenza phlebitis is not an uncommon complication; (6) post-operative phlebitis is not at all uncommon in cases of operation on the lower abdomen and the bladder; and (7) puerperal phlebitis or phlegmasia alba dolens frequently follows parturition.

Phlebitis may attack any vein, but is most common in the lower limb, particularly in the saphena vein.

Symptoms.—Phlebitis is accompanied by pain and tenderness in the course of the affected vein. The vein can be felt as a hard cord. The skin may become reddened over the superficial veins, and the limb is often œdematous when thrombosis has taken place. There is usually more or less febrile disturbance. In gouty phlebitis, the pain is often severe, the areas of inflammation are often multiple, there is a great tendency for more than one vein to be attacked at once, and, in opposition to most forms of phlebitis, the disease may be symmetrical.

Complications and Sequelæ.—The complications and sequelæ of plastic phlebitis are those of the thrombosis which accompanies it, and will be described under thrombosis.

Prognosis.—This is always grave, unless treatment is very carefully carried out.

Treatment.—Patients with phlebitis should be put to bed, and the limbs elevated and wrapped in cotton wool. All sudden movement, friction or

handling should be avoided. The bowels should be freely opened, as chronic constipation and stasis in the colon may impede the circulation in the iliac veins. In gouty phlebitis, the diet should be restricted to fish and light farinaceous foods, but when patients are marasmic and anæmic, the diet should be as liberal as the patient's digestive powers will permit. In all cases of phlebitis foods containing much lime-salts, such as milk, should be avoided. Potassium or sodium citrate with carbonate of ammonia and liquor ammonii acetatis are of service. Glycerine and belladonna smeared over the inflamed vein appears to ease the pain.

Suppurative Phlebitis

Ætiology.—Suppurative phlebitis is the result of infection of the walls of the veins with pyogenic organisms. The micrococci may be in the circulating blood, as in some cases of puerperal phlebitis, or they may reach the veins from a focus of suppuration around it, as in facial carbuncle, middle-ear disease, or inflammation of the portal veins—suppurative pylephlebitis.

Pathology.—The coats of the vein are infiltrated with leucocytes, the clot which has formed within the vessel breaks down into yellow pus, and abscesses are not infrequently found along the course of the vein. Not uncommonly the septic inflammation spreads along a vein, splitting up the coats.

Symptoms.—There is a throbbing, smarting pain in the region of the affected vein, and the part drained by the vein is œdematous. Not infrequently the septic process spreads along a vessel. There is often fever, a rapid pulse, a dry tongue, and delirium, and in many cases a succession of rigors indicates the development of pyæmia.

Complications and Sequelæ.—These depend upon the situation of the vein and the occurrence of emboli, owing to breaking away of the softened clot. (See Thrombosis.) When the vein is superficial the diagnosis is easy, but when a deeply-seated small vein is affected the only symptoms may be those of the pyæmia to which it gives rise.

Treatment.—The prevention of this disease by aseptic and antiseptic methods is one of the greatest advances in modern surgery. As soon as the disease is recognised, a ligature should be placed upon the vein between the affected area and the heart, the inflamed vein should be thoroughly laid open, the septic clot removed and the cavity thoroughly cleansed. In some cases where numerous abscesses are formed, amputation is the only means of arresting the general infection.

Theodore Thompson.

THROMBOSIS AND EMBOLISM

Thrombosis is the name applied to the coagulation of blood within living vessels, whether in the heart, the veins or the arteries.

Embolism is the process whereby a portion of clot or other substance, such as parasites, fat globules, masses of bacteria or particles of tumour, is carried from one part of the circulation to another, and is impacted when it arrives at a vessel too narrow for its further progress. An infarct is the

degenerated or necrosed condition of the tissues due to interference with the circulation of blood within it, and can be caused by embolism, thrombosis, endarteritis, endophlebitis, or strangulation of veins. An infarct is generally wedge-shaped in outline, with the base towards the periphery of the organ affected. As seen post-mortem, it is either yellowish-white in colour (the white infarct), or blood red in colour (the hæmorrhagic infarct).

In the case of the white infarct the tissue deprived of its blood supply becomes permeated with lymph from the surrounding living tissue, and coagulative changes take place in it. In the case of the kidney or spleen, the coagulable material is sufficient to render the infarct hard. In the case of the brain, less coagulable lymph is poured out, and the area of the brain affected becomes softened. In the early stages there is often a zone of congested vessels around a white infarct; this is a reaction on the part of the surrounding living tissues to the presence of the dead material. Later the infarct becomes invaded by fibrous tissue and a scar results.

In hæmorrhagic infarct, coagulation and necrosis also take place, but to this is added hæmorrhage, by diapedesis of the red blood cells from vessels of the collateral circulation. An hæmorrhagic infarct is commonly seen in the lung; a cone-shaped area of lung tissue becomes hard and dark red in colour. Should the embolus, instead of being aseptic, contain living micro-organisms, a septic process is set up within the infarct and an abscess results. Such purulent abscesses are commonly seen in the lungs, as the result of septic phlebitis, and occasionally in the systemic system, as the result of septic endocarditis.

Thrombosis

Ætiology.—The causes of thrombosis are—(1) altered conditions of the blood or increase in its coagulability; (2) slowing of the current of the blood within the vessels; and (3) a lesion of the lining membranes of the vessel or cavity of the heart. Thus, thrombosis may occur in cases of chlorosis, where the blood is more coagulable than normal, in the appendages of the dilated auricles of the heart where the current of blood is feeble, and it may result from inflammation of the lining of the vessel or degenerative changes in its endothelium.

(1) Cardiac Thrombosis.—Cardiac thrombosis is one of the commonest forms of thrombosis and is very important. It occurs in the left auricle, when it has become extremely dilated, as the result of mitral stenosis, or more rarely of mitral regurgitation. The ante-mortem clot generally begins to form in the dilated appendix of the left auricle, but it may extend by the deposition of excessive layers of fibrin and invade the auricle itself and a large ball thrombosis be formed within the cavity. Portions of the ante-mortem clot may break away from the thrombus, and may be carried into the left ventricle and into the general circulation, and embolism may occur in the brain, spleen, kidneys, intestines and the main arteries of the limbs.

Ante-mortem clot is occasionally deposited among the meshes and cavities of the dilated left ventricle. In cases of cardiac fibrosis and myelomalacia cordis, the result of disease of the coronary arteries, the lining of the heart may become affected and fibrinous deposits occur within the ventricle. Lastly, in infective endocarditis, large vegetations, consisting of clot and masses of micro-organisms, may occur. Inflammation of the ventricle and

of the auricle may also be present, and ante-mortem clot may be deposited on these roughened surfaces. Portions of this clot may leave the ventricle and pass into the general arterial circulation, where the effect produced will depend upon whether the emboli are aseptic or contain micro-organisms.

Thrombosis in the right auricle occurs in many conditions where there is gradual cardiac failure and dilatation of the right side of the heart. Portions of ante-mortem clot form in the right auricular appendix, and parts may break away and pass into the lungs and an embolism of the pulmonary artery result. If the embolus is sufficiently large to cause blocking of the artery or of one of its main branches, sudden death ensues, but if only one of the smaller branches is affected, a pulmonary infarct results. Much more rarely ulcerative endocarditis occurs on the right side of the heart, and portions of the valves or affected clot reach the lungs in the same way.

Thrombosis of the coronary arteries is a very important condition, since it is a frequent cause of sudden death. The usual artery affected is the anterior interventricular branch of the coronary artery. Atheromatous plaques are constantly found within the thrombosed vessel, and sometimes atheroma has occluded the orifice of the artery. In cases where the circulation has been slowed and greatly diminished before the final clotting, changes in the wall of the left ventricle are very common. Syphilitic mesaortitis sometimes occludes the orifices of the coronary arteries.

(2) Venous Thrombosis. — *Thrombosis of the lateral sinus* occurs in disease of the middle ear. The mastoid cells become infected with pyogenic organisms and the disease spreads to the petrosal or sigmoid sinus. The clot in the vein becomes softened by pyogenic organisms, and particles break away and are conveyed to the lungs, in which pyogenic abscesses are formed.

The symptoms of septic thrombosis of the lateral sinus—and its continuation of the jugular vein—are infiltration of the tissues of the neck, with a cord-like induration of the vein itself, with some restriction of the movements of the head. There is a history of a chronic and often offensive discharge from the ear of the same side. A high temperature and rigors, due to flooding of the circulation by poison, occur when a portion of the septic clot is dislodged. In these circumstances the jugular vein should at once be ligatured below the clot, in order to prevent further portions of the clot gaining access to the blood stream. A radical mastoid operation should also be performed, the sinus opened and its septic contents removed.

Thrombosis of the longitudinal sinus of the brain occurs as the result of injuries and infected wounds of the skull. It is a common war injury, the vertex of the head having been injured by a bullet as the soldier passed along the trench. Thrombosis of the cranial sinuses also occurs in marasmic patients, but it is usually agonal.

In many of these cases, owing to the vertical position of the leg areas in the brain, a paraplegia is produced, while the arms are not affected. The condition should be treated by trephining and draining the cranial cavity. Occasionally the longitudinal sinus becomes thrombosed in septic conditions in children and also in chlorotic anæmia in adults.

Thrombosis of the cavernous sinus is not infrequently the result of the extension of a chronic suppurative process of the sphenoidal cells at the back of the nose. The cavernous sinus is also affected by septic processes on the face; a small boil on the nose or a mosquito sting on the face may produce

a septic thrombosis of the angular vein; this vein communicates with the ophthalmic vein, and the septic clot may extend along the latter into the cavernous sinus. As the venous plexuses of the pterygoid and zygomatic fossæ communicate through the foramina in the middle fossa and by the inferior ophthalmic vein, purulent inflammation of the jaw and of the teeth sockets is sometimes a cause of cavernous thrombosis. The result is that a marked degree of exophthalmos and swelling of the lids and œdema of the optic disc and extensive retinal hæmorrhages occur. Not infrequently the septic condition of one cavernous sinus spreads to that on the other side through the circular sinus, and the exophthalmos may be double. Death from pyæmia or meningitis results. Owing to the position of the sinus, operation is impossible.

Femoral thrombosis is perhaps the commonest form of thrombosis. It frequently occurs after parturition and in anæmic and marasmic states. It is met with after infectious fevers, especially after typhoid fever, more rarely after influenza and pneumonia. It also follows operations, especially if a septic condition has been dealt with, or results from the operation. The thrombosis generally occurs in the femoral vein, and there is often some rise of temperature and a slight rise in pulse-rate. The limb affected becomes œdematous, and a hard cord is found in the course of the vein.

In other cases thrombosis of the veins may also occur in marasmic conditions secondary to carcinoma, tuberculosis and tertiary syphilis.

Complications and Sequelæ.—Collateral circulation is usually satisfactorily accomplished in femoral thrombosis. In cases where the arteries as well as the veins are involved gangrene may occur. Occasionally the thrombosis may spread up into the iliac vein and into the inferior vena cava, in which case both legs may become swollen and œdematous. Even in cases where the inferior vena cava has become thrombosed, recovery may take place, collateral circulation being established by means of veins passing up from the legs into the axillæ. If, however, the clot reaches the entrance to the renal veins, death nearly always results from renal thrombosis. Embolism is not at all uncommon in femoral thrombosis, the clot passing into the right auricle, and then into the right ventricle and pulmonary artery.

Treatment.—Complete rest for 4 or 5 weeks, as a precaution against embolism, should be insisted upon. Avoidance of foods containing quantities of lime salts, such as milk, and the administration of citrates and salts of ammonia will materially help in the treatment of the case. The leg should be elevated and wrapped in cotton wool and kept warm.

Thrombosis of the portal vein is not uncommonly the result of septic conditions within the abdomen. The most common affection is suppuration in the region of the appendix. The condition is not always acute. Gastric and duodenal ulcers also lead to portal thrombosis, and tubercular glands along the course of the portal vein have been found to cause clotting within the lumen of the vessel. Dysenteric ulcers resulting from bacillary dysentery may also give rise to septic portal thrombosis, but typhoid ulceration very rarely does so.

The effect of portal thrombosis is to produce a portal pyæmia, portions of the clot passing into the liver and causing abscesses within the radicles of that organ. Occasionally the portal vein itself becomes converted into a

sac containing pus, and the liver is then riddled with abscesses along the course of the portal branches. This condition is known as *portal pylephlebitis*.

Symptoms.—The symptoms of septic portal thrombosis are the occurrence of fever and of rigors. The liver becomes enlarged and tender, and jaundice of a slight degree is quite common.

As the condition is such a generalised one, recovery very seldom takes place, even if treatment is adopted.

Treatment.—This consists in removing the cause and incising any liver abscesses.

(3) Arterial Thrombosis.—Arterial thrombosis is much rarer than venous thrombosis. It is generally due to arterial embolism, but is occasionally the result of trauma or disease of the arterial walls, such as atheroma or endarteritis.

Thrombosis of the coronary arteries of the heart has already been described (pp. 860 and 962). Thrombosis is very common in the small cerebral arteries, especially when they have become narrowed as the result of disease. In middle-aged people this narrowing is usually the result of syphilitic endarteritis, while in the elderly the arterial lumen is diminished by atheromatous changes in the wall of the vessel.

Thrombosis of the main artery of a limb usually results in gangrene: the limb becomes first white and pallid, later mottled in appearance, and finally black. If the patient survives the immediate shock and the disease to which the thrombus owes its origin, a line of demarcation will form between the vital and devitalised tissues, and the limb should be amputated well above this level.

Embolism

Embolism may occur in three main situations, namely—(1) In the systemic circulation; (2) in the pulmonary circulation; and (3) in the portal circulation.

Emboli in the systemic circulation are derived from ante-mortem clots in the left auricle and left ventricle. These clots are formed in cases of mitral stenosis and more rarely in mitral regurgitation, and also when the left ventricle is greatly dilated and hypertrophied. In these cases the emboli are aseptic. Systemic emboli also occur in infective endocarditis, when portions of the valve break away or masses of fibrin and micro-organisms pass into the general circulation. These emboli are septic, and when they reach their destination usually form abscesses.

Emboli in the pulmonary circulation usually have their origin in clots which form within the right auricle and right ventricle. More rarely they are the result of infective endocarditis of the tricuspid and pulmonary valves. They may also come from any part of the systemic venous system. A very important form of pulmonary embolism is met with after abdominal operations and after childbirth. About the tenth day after an apparently successful abdominal operation or an uneventful parturition, a pulmonary embolism may occur with appalling suddenness. Death may take place at once, or hæmoptysis and pleurisy supervene. The clot forms in the common iliac vein, at the junction of the internal and external iliacs. Not only may a clot pass along the veins, but we also get droplets of fat in fat embolism, air bubbles in air embolism, and masses of parasites in parasitic embolism.

In embolism in the portal circulation portions of clot in the radicles of the portal vein are finally arrested in the liver.

Symptoms.—1. *Embolism of the cerebral arteries.*—The onset is sudden, and the left side of the brain is rather more often affected than the right. Hemiplegia or aphasia is produced; consciousness is only lost for a few minutes during the attacks.

2. *Embolism of the splenic artery.*—The onset is sudden, with pain in the left side and sudden enlargement of the spleen, which is very tender. During the next few days, the spleen diminishes in size, but it often remains permanently enlarged.

3. *Embolism of the renal arteries.*—Sudden pain in the back is produced, and blood and a little albumin are present in the urine. The hæmaturia may last for a week or 10 days and then disappear.

4. *Embolism of the superior mesenteric artery.*—The patient is seized with sudden, violent abdominal pain and distension. The collateral circulation, in spite of the numerous vascular arteries that supply the intestine, fails, and gangrene of the small intestine results. There is a complete intestinal obstruction, and blood finds its way into the stools and into the peritoneal cavity. Operation should be at once undertaken, but owing to the large amount of bowel affected recovery is very rare.

5. *Embolism of the central artery of the retina.*—This is not an uncommon event in cases of mitral stenosis and in infective endocarditis of the aortic and mitral valves. The patient is seized with pain in the eye and becomes suddenly blind on one side. The optic disk becomes pale and the retinal vessels small. Occasionally only a single branch of the vessel is affected.

6. *Embolism of a large artery in a limb.*—This sometimes occurs. There is acute pain in the limb, followed by numbness and loss of power. The pulse is imperceptible below the seat of the embolism, and gangrene results.

7. *Air embolism.*—Air may enter the veins during operation on a large vein, or during intravenous injection of saline or other solutions, or after distension of the bladder and the urethra with air. It is said that occasionally air may enter the open uterine sinuses after parturition or miscarriages, but some of the cases are probably due to the invasion of the *Bacillus aerogenes capsulatus*. Air embolism is undoubtedly capable of causing death, but a small quantity may enter a vein without any effect whatever, or if some disturbance should arise without fatal termination. The exact way in which air embolism causes death is doubtful; it may be due to arrest of the pulmonary circulation or to cerebral anæmia.

The diagnosis is not difficult, the respiratory embarrassment, convulsions, the feeble pulse and the characteristic sound upon air entry into the veins are usually sufficient.

Treatment consists in immediately occluding the vein into which the air has entered. Stimulants should be administered hypodermically and nitrite of amyl inhaled. Venesection may be used to relieve the embarrassment of the heart.

8. *Fat embolism.*—Fat may reach the blood vessels in cases of fracture of bones and in cases of hæmorrhage into or rupture of the liver. The fracture is usually situated in the long bones, generally in the tibia or femur, and occasionally in the ribs. Fat embolism may occur within a few hours of fracture of the bones.

The fat droplets first lodge in the capillaries of the lungs. Occasionally they are forced on through the lungs into the general circulation, and the glomeruli of the kidney may be plugged with fat cells, and they may also lodge in the brain or spinal cord.

The patient becomes cyanosed, and crepitations from œdema of the lungs may be heard at the bases. The temperature remains normal. Cerebral complications, such as delirium, coma and rarely localised paralysis, may be found. The urine should always be examined, as oil drops have been detected by staining with osmic acid, and also the retinæ, as in one case the fat drops were recognised in the retinal vessels before death.

When fat embolism occurs within a few hours of fracture of the bones it has to be diagnosed from the general shock of the accident. It is doubtful whether fat embolism in the lungs can alone cause death. It is probable that a fatal termination is due to the disturbance of the kidneys or lesions of the brain.

The indication for treatment is to sustain and stimulate the heart. Nitrite of amyl is often useful, and inhalations of oxygen should be given to lessen cyanosis.

9. *Paradoxical Embolism.*—In certain cases of venous thrombosis, emboli occur not only in the lungs but also in the systemic arteries. It has been shown that in these cases the embolus has passed from the right auricle to the left auricle through a patent foramen ovale. These crossed or paradoxical emboli in many cases are preceded by pulmonary embolism. The latter causes a rise in pressure in the right auricle and a fall in pressure in the left auricle, and thus the embolus in the right auricle can pass to the left side of the heart.

ARTERIAL BLOOD-PRESSURE

By the blood-pressure is meant the pressure that the blood exerts against the wall of the vessel in which it is contained. The term, therefore, includes endocardial pressure, arterial pressure, capillary pressure and venous blood-pressure. We are here concerned only with arterial blood-pressure. This depends upon (1) the force of the contraction of the left ventricle; (2) the volume of blood which the left ventricle propels into the already full arteries; (3) the elasticity of the middle coats of the large arteries; and (4) the peripheral resistance.

The arterial pressure synchronous with the systole of the ventricle is called the *systolic blood-pressure*, that synchronous with the diastole is called the *diastolic blood-pressure*, while the difference between the two is called the *pulse-pressure*. The *mean arterial pressure* is the mathematical mean between the systolic and diastolic pressures.

The introduction of the sphygmomanometer has proved of great value in clinical medicine. The results obtained are more reliable, and, indeed, not infrequently the practitioner will detect cases of supernormal blood-pressure which might otherwise have been overlooked; further, the results can be expressed in terms of mathematical formulæ, which

can be kept for reference, and in this way the practitioner is enabled to compare the records while patients are undergoing treatment with the aim of reducing tension. A word of warning, however, is necessary: it should be remembered that the sphygmomanometer may exhibit fallacies and possesses limitations, and there is undoubtedly a danger of overestimating its value in clinical work, when we rely upon its readings alone as an indication of the patient's condition. Blood-pressure measurements should be considered in conjunction with other clinical data. The normal blood-pressure in all probability has a wider range of variation in different individuals than is generally supposed, and, if this be so, great caution should be exercised in arriving at the conclusion that a blood-pressure outside what is generally supposed to be the normal limit is necessarily indicative of a diseased state. At the same time it should be remembered that the detection of supernormal blood-pressure in its earliest stages is of great practical importance, because it is in these stages that therapeutic measures may be successful. In considering the question whether a rather high pressure reading is normal to the individual, or is indicative of a pathological departure, it is important that inquiries should be made with regard to four points—viz. (1) what was the patient's usual blood-pressure previously? (2) are there any symptoms other than a supposed abnormal blood-pressure, such as a sensation of fullness or throbbing in the head? (3) what is the condition of the heart, the arteries, and the kidneys? and (4) what is the result of treatment? If there be a fall in the pressure readings, together with a coincident improvement in the general health of the individual during treatment, it may be inferred that the higher pressure reading is pathological.

The following may be regarded as the normal standard of systolic blood-pressure, as measured in the brachial artery, while at rest. In children under 10, 100 mm.; in early manhood, from 100 to 120 mm.; in middle life, from 125 to 135 mm.; above 60 years of age, 145 to 150 mm. The suggestion that if the figure 1 is prefixed to the age of individuals of 15 years or upwards the result will give the normal systolic blood-pressure is inaccurate, especially in the case of older people. In the female, the systolic pressure is generally from 10 to 20 mm. lower than in the male. The range of diastolic blood-pressure, as estimated by the auscultatory method in healthy young adults is usually accepted as 70 to 90 mm.; but MacWilliam and Melvin found it when examined in the sitting position to be considerably lower, the figures being 50 to 80 mm. It is held by some that the diastolic pressure is about two-thirds that of the systolic, while others are of opinion that up to middle life this proportion is as high as three-fourths, and that afterwards it is less and may not exceed a half of the systolic pressure.

Variations in Blood-pressure under Physiological Conditions

There are variations in the blood-pressure under physiological conditions, among these being mental states, sensory stimulation, sleep, change of posture, meals and physical exertion.

Those of nervous, anxious temperament, as well as those whose mode of life necessitates considerable nervous strain, have a tendency to exhibit higher readings, especially in the later period of life; while in those of an equable and placid temperament, and those whose lives are less harassed, the

opposite is found. Sensory stimulation causes a rise in the arterial pressure, especially in the diastolic. The effect of pain varies in different individuals; in some it results in a rise of pressure, in others it results in a fall, while in others again there is no effect produced. In sleep there is a fall in the minimum blood-pressure, and probably a slight fall in the maximum pressure also. Opinions as to the effects of the digestion upon the systemic blood-pressure vary, some holding that there is a constant rise, others that there in a constant fall, while others again are of opinion that there is no alteration. In all probability the maximum and the pulse pressures are increased, and the minimum pressure may be also to a less extent. It is probable that the change in pressure commences within a quarter of an hour after a meal, the highest reading being reached in about an hour, after which it gradually returns to the normal, which is reached in about two hours. During exercise the maximum and minimum pressures of the systemic circulation are raised, and the pulse-rate is also increased. Immediately after exercise, the arterial pressure may be supernormal, normal, or even subnormal; in the first case, a lowering quickly supervenes, that of the diastolic pressure usually occurring before the systolic. The arterial pressure generally returns to the normal in about half an hour; it is, however, usually better to postpone taking a measurement for at least one hour after exercise. The blood-pressure readings of those who engage in arduous physical exertion while in training, when taken at rest appear to be somewhat below the normal.

Subnormal Arterial Pressure (Hypotension)

Ætiology and Pathology.—Subnormal blood-pressure may be met with in acute cardiac disease which is not accompanied by a pronounced degree of cyanosis, in most cases of chronic valvular disease—especially mitral disease, in most cases of fatty degeneration of the myocardium, in some cases of chronic interstitial myocarditis, in congenital deficiency of the vasomotor system, in Addison's disease, in the early stages of Graves' disease, acute infective diseases—particularly enteric fever, influenza, diphtheria, and pneumonia, in auto-intoxication—especially from the teeth, the tonsils, the accessory nasal sinuses, the colon, and the genito-urinary tract, in pulmonary tuberculosis, shock, and collapse, after severe bleeding, after severe vomiting, in gastric disorders, diarrhœa, dysentery, cholera, cancer, and other wasting diseases, cerebral thrombosis, neurasthenia, the excessive use of tobacco, in some cases in which there is an unduly slow pulse, and after prolonged rest in the recumbent posture.

The chief factors in the causation of subnormal arterial pressure are (1) a diminution of the ventricular output, and (2) lowering of the vasomotor tone, splanchnic stasis being usually associated with the latter. It should be noted that a subnormal blood-pressure is more often an indication of derangement of the vasomotor centre than of cardiac impairment. Some are of opinion that in subnormal arterial pressure due to lowering of the vasomotor tone, there is in the large majority of cases adrenal insufficiency, frequently thyroid insufficiency, and not rarely pituitary insufficiency, and that these are the cause of the condition; and, therefore, that in all cases of this group an endeavour should be made to ascertain whether there is endocrine insufficiency, and if so to what extent, with a view of remedying this, in the

belief that when once this is done the arterial pressure will be raised to normal and remain so, as long as these glands continue to functionate effectively. Adrenal insufficiency may be due to, among other things, inadequate development, lesions of the adrenals, and auto-intoxication.

Symptoms.—Among these are asthenia—especially myasthenia, premature exhaustion on maintaining the upright posture, giddiness and faintness—especially on change of posture, neurasthenia, mental depression, insomnia, irritability of temper, nervous instability, sensitiveness to cold, numbness, and pallor or lividity of the extremities, subnormal temperature, increase in the cardiac rate of more than 10 per minute when the individual assumes the upright posture after lying down, and splanchnic stasis. When giddiness and faintness are especially associated with change of posture, it is suggestive of vasomotor derangement, as is also an abnormal increase in the pulse-rate on assuming the upright posture after lying down. In splanchnic stasis, pressure on the abdomen by the hand while the patient is lying down is sometimes accompanied by distension of the jugular veins.

Treatment.—Our first duty is to review the ætiology of the condition, and in this connection a searching inquiry should be made for any possible source of auto-intoxication—from the teeth (including X-ray examination), the tonsils, the accessory nasal sinuses, the colon, and the genito-urinary tract, and if this is found to be present it should be adequately treated. In acute cases rest in bed may be advisable; and after the acute stage has passed, great care should be taken to avoid over-exertion, and an adequate amount of rest after exertion, and before and after meals, is indicated. In shock and collapse the patient should lie on his back, and the foot of the bed may with advantage be raised by 1 or 2 feet. Massage is helpful in certain cases. A tepid or cold sponge bath in the morning, followed by suitable exercises, and residence in a bracing climate are to be commended. The proportion of those articles of food which especially stimulate the cardio-vascular system, such as meat and meat-extractives, should be increased, roasted meat being of greater value than meat which has been boiled, while meat soups and gravies should also be given. Cod-liver oil, malt, glycerophosphates, phosphorus, iron, and arsenic may be tried. Digitalis, and to a less extent strophanthus, have gained a reputation in the treatment of subnormal blood-pressure; but my investigations have shown that, *judged by the methods in use for observing the blood-pressure clinically*, the internal administration of digitalis does not raise the blood-pressure in man. Strychnine also has a considerable reputation in the treatment of this condition, especially when present in diphtheria or other acute infective diseases. Among other remedies advocated are adrenalin, pituitary extract, and ergot. The wearing of an abdominal belt is very useful in some cases of subnormal blood-pressure.

Supernormal Arterial Pressure (Hypertension)

In pathological hypertension the blood-pressure is *persistently* above the normal of the individual; *temporary* supernormal blood-pressure is found, for example, in the nervous excitement incidental to medical examination. The late Sir Clifford Allbutt introduced the term *hyperpiesia* to denote a clinical

condition in which there is a persistently-raised blood-pressure independent of renal disease.

Ætiology and Pathology.—Hyperpiesia is common in late middle age and is by no means a senile change. In the case of women it often occurs at the time of the menopause. It is more common in males than in females. The condition may be met with in prolonged mental strain or anxiety, in individuals who habitually over-indulge in food or tobacco or alcohol, in auto-intoxication—especially from the teeth, the tonsils, the accessory nasal sinuses, the colon, and the genito-urinary tract, in gout and in lead poisoning. Other causes of supernormal blood-pressure are nephritis—more especially the chronic interstitial form, in the later stages of hyperthyroidism, often in the cyanosis of cardiac failure, and usually in polycythæmia. In rare cases associated with chronic interstitial nephritis, it may occur in young children. It will thus be seen that the ætiology of supernormal blood-pressure is similar to that of arterial hypertrophy (see pages 943–944).

In the course of time arterial hypertrophy and cardiac hypertrophy, more especially of the left ventricle, tend to develop; and still later fatty degeneration in the hypertrophied muscular tissue of the arteries, resulting in a weakening of the walls of the vessels, and it may be ischæmic fibrosis of the organs may occur. These morbid changes are fully described on pages 944–945. Supernormal blood-pressure is also often a factor in the causation of atheroma.

Symptoms. The patient is often plethoric and well nourished. There may be a complete absence of subjective symptoms for some years. The patient is, however, apt to suffer from a sensation of fullness and throbbing in the head, headache, usually in the occipital region, flushings, tinnitus aurium, flashes of light before the eyes, giddiness, insomnia and palpitation. The systolic blood-pressure in cases of simple hyperpiesia varies from 170 to 200 mm.; in cases associated with chronic interstitial nephritis it may reach even 300 mm. or more; and in secondary contracted kidney and in polycystic disease of the kidneys it varies between 160 and 220 mm. There is evidence of high-tension pulse. The vessel wall may be felt to be uniformly thickened —the so-called "whip-cord" artery. As the muscular arteries are those chiefly affected, the radial and temporal arteries are frequently found to be involved. There may be the physical signs of hypertrophy of the left ventricle, reduplication of the second sound over the septum ventriculorum and accentuation of the aortic second sound. Later on the history may show great diversity. This is fully dealt with in Arterial Hypertrophy (see pages 945–946). If atheroma supervenes, the radial and temporal arteries frequently become irregularly thickened and tortuous.

Diagnosis.—In cases of persistent hypertension and cardio-vascular hypertrophy it is necessary to distinguish between hyperpiesia and chronic interstitial nephritis, in which connection the following are among the points which should be noted. In hyperpiesia the patient is often plethoric, with a high colour and well-nourished body, there is absence of symptoms of toxæmia, and the urine is of good colour and of normal specific gravity—indeed, it differs from healthy urine only in the presence of a trace of albumin and occasional casts of granular or hyaline kind; while in chronic interstitial nephritis there is often a sallow tinge in the complexion and loss of weight, gastric disturbance is more often that of hypochlorhydria than is the dys-

pepsia of hyperpiesia, and the urine is of low specific gravity. Further points in the differential diagnosis of hyperpiesia will be found on pages 945–946.

Prognosis.—This is dealt with on page 946.

Treatment.—Treatment is mainly prophylactic, hygienic and dietetic, the actual specific treatment being of far less value.

It is important first of all to review the ætiology of the condition. I would especially urge the importance of a searching inquiry for auto-intoxication—especially from the teeth (including X-ray examination), the tonsils, the accessory nasal sinuses, the colon, and the genito-urinary tract.

The value of rest, both physical and mental, in the management of high blood-pressure is great, and is not sufficiently appreciated. It is sometimes necessary to keep the patient in bed, the period varying according to the nature of the case. Rest, especially when combined with hepatic stimulation and suitable purgatives, may be sufficient. Exercise, provided it be moderate and regulated, also ranks high as a therapeutic measure, and this applies with suitable discrimination to any period of life. A cardinal rule in all cases should be that exercise should not be carried to the point of inducing increased frequency of the pulse or respiration, or indications of cardiac distress. It is much better to abstain from exercise soon after a meal, when rest should be enjoined for a period of half an hour to an hour. Walking is an excellent form of exercise; quiet cycling, golf and horse-riding are useful in some cases; while special forms of exercises, such as the Swedish form, and slow breathing exercises, are not infrequently of value. Sudden exertion, hurry, straining at stool, and mental strain of every kind should be carefully avoided.

The quantity of fluid taken with meals should be diminished; but, on the other hand, it is advisable to take a quantity of fluid from 1 to 2 hours before meals. My usual custom is to order the patient to take 1 or 2 tumblers of hot water, preferably soft or distilled, before breakfast and also before the midday meal, and perhaps in addition a tumblerful before going to bed. A preference is given by some to the mildly alkaline waters.

Some writers lay great emphasis upon the necessity for drastic regulation of the diet, and many patients are in consequence rendered miserable by the deprivations to which they are subjected in this respect. Whilst I am of opinion that regulation of the diet may be too drastic, I believe that the value of a regulated diet of moderate latitude may be great, and it is very important for the patient to avoid dietary excesses of all kinds, both in regard to the quantity and character of the food. In choosing a diet, therefore, for a patient suffering from supernormal blood-pressure, we should see that the number and bulk of the meals are limited, and that those articles of food which especially stimulate the cardio-vascular system are proportionally reduced: thus, the quantity of beef and mutton should be diminished below the proportion ordinarily taken, while the allowance of white meat, such as chicken and fish, may be correspondingly increased. In cases of moderately increased arterial pressure, my usual custom is to recommend a fair helping of meat once daily on 4 or 5 days in the week, fish and chicken being substituted on the remaining days. When the increase in blood-pressure is severe, the amount of beef and mutton should be decreased still further. Some authorities go further than this and recommend a reduction also in the quantity of veal, poultry and fish. Meat which has been boiled, and is taken without the

broth, is preferable to roasted meat taken with the gravy. Meat extractives, such as meat soups and gravies, should certainly be largely diminished or totally excluded from the dietary. An adequate supply of carbohydrate foods may be allowed, while the proportion of green vegetables and the simpler fruits should be increased. Some physicians, and especially Continental physicians, attach great importance to the diminution or exclusion of chlorides from the diet. If this view be correct, we should remember that the deprivation of the salt usually added at table is not enough; food-stuffs which, before being cooked, have the smallest proportion of salt should, therefore, be chosen. The late Sir William Roberts recommended chloride of potassium in place of chloride of sodium as a table-salt, but some have found it disagreeable to the taste. An exclusively milk diet for a few days, combined with rest, is useful in some cases. Tea and coffee in strict moderation may be allowed in most cases. Strict moderation in the use of tobacco should be enjoined. With regard to alcohol, my view is that it is better left alone altogether. If, however, the increase in arterial pressure be not considerable, a moderate amount may be allowed; and even in cases in which the increase of pressure is of severe grade, if the patient be made unhappy by being deprived of all alcoholic beverages, it becomes a question whether a certain allowance of alcohol should not be made, preferably avoiding wines and liqueurs.

Purgatives are certainly useful in the treatment of supernormal arterial pressure, and it should be noted that a slight laxative action of the bowels each day is of greater value than an occasional purge. In choosing an aperient, saline purgatives, as they induce fluid motions, are the most suitable, and should be administered in hot water some time before breakfast. It is advisable also to administer some mercurial preparation once a week at bedtime. Some writers are of opinion that the administration of mercury results additionally in vascular relaxation, and, if this be the case, minute doses of calomel may advantageously be given two or three times a day for a few weeks occasionally. Sulphur is also supposed by some to reduce the blood-pressure, as well as to act on the bowels. The functions of the skin should be attended to, and in this connection a warm equable climate and woollen underclothing, especially in winter, are to be commended. Cold baths are to be avoided; but a warm bath, the temperature of which is gradually lowered, may be taken daily. A Turkish bath once or twice a week, perhaps followed by massage, or hot packs about thrice weekly, may be of service. A regular course of balneological treatment is sometimes beneficial, and different kinds of baths, among these being the Aix-les-Bains douche, are in fashion in this country, and especially on the Continent. Recently diathermy has been advocated by some physicians. Venesection undoubtedly reduces high blood-pressure, but in my investigations at the Mount Vernon Hospital I found that, while it certainly acts rapidly, its effects are only transient; at the same time, it is undoubtedly of great value as a temporary measure.

It is not right, even if it were possible, to lower supernormal blood-pressure by drugs which act by diminishing the force of the cardiac action. We must, therefore, resort to drugs which are supposed to cause dilatation of the blood vessels, especially of the peripheral vessels; among these are sodium nitrite, erythrol tetranitrate, mannitol nitrate, and nitro-glycerine. I must say, however, that in my investigations at the Mount

Vernon Hospital I had very disappointing results from the administration of drugs in severe degrees of supernormal blood-pressure, even with regard to their temporary results. If these drugs be used, we should see that those whose action is slowest and most prolonged are chosen, and administer them in increasing doses until the physiological effects are obtained, while they may be continued in rather smaller doses for considerable periods in suitable cases. Some authorities believe that the hippurates and benzoates are useful. The iodides have a great reputation in the treatment of arterial disease, but, in the investigations already mentioned, in no case was their administration followed by a reduction of blood-pressure. In some cases a single dose of 20 to 30 grains of one of the iodides at night-time is better than smaller doses three times a day. When the usual preparations cannot be borne, one of the iodine compounds may be tried. Some physicians advocate thyroid extract.

FREDERICK W. PRICE.

SECTION XIII

VASOMOTOR NEUROSES (ANGIO-NEUROSES)

UNDER this heading are described a group of conditions characterised by a predominance of symptoms of vasomotor disturbance and by the peculiarity of their distribution. Though the vasomotor changes are the prominent feature, sensory, secretory and trophic disturbances are associated. The symptoms of vasomotor neuroses are commonly regarded as due to disordered activity of the involuntary or vegetative nervous system. This hypothesis, however, is by no means equivalent to the theory that the involuntary nervous system is the starting-point of the condition. From this point of view, Raynaud's disease is regarded as an expression of vaso-constrictor spasm, erythromelalgia as the result of vaso-constrictor paralysis, and angio-neurotic œdema as an expression of vasomotor irritability. Variations in capillary permeability and tone are necessarily included in any conception of vasomotor neurosis. Vaso-dilator impulses must play their part in the production of these complexes, but they are not usefully included in any working hypothesis, so long as the anatomical distribution of the nerve fibres that carry these impulses remains in doubt.

The conditions to be described are called "neuroses," because a pathological lesion is not an essential part of their appearance and because they tend to occur in persons of an unstable nervous temperament. A hard-and-fast distinction is not to be drawn between these diseases occurring as neuroses and their occurrence in recognised pathological states, such as lesions of the spinal cord or brain (tabes dorsalis or hemiplegia), lesions of peripheral nerves (peripheral neuritis), and lesions of vascular channels, or local pressure effects, such as may result from a cervical rib: nor are they separated by any rigid line from slighter manifestations of vasomotor instability, such as are frequent in women at the climacteric, and in clinical disorders resembling exophthalmic goitre. They are undoubtedly akin to such common symptoms as flushings, cerebral hyperæmia, facial congestion, angio-spasm in all its varieties, tachycardia (in some of its forms), anginal attacks, migraine, vertigo, tinnitus aurium, universal or circumscribed hyperidrosis, and gastric disorders of certain functional types.

RAYNAUD'S DISEASE

Synonym.—Symmetrical Gangrene.

Definition.—A paroxysmal affection of the blood vessels of the extremities, frequently symmetrical, characterised by persistent ischæmia or a

passive hyperæmia, which leads to disturbance of function, or to a loss of vitality with necrosis.

Ætiology.—If the disease is regarded as an independent affection in which pathological changes in tissue structure are not responsible for the symptoms there is no actual cause. The affection is more common in women than in men, and occurs at any age, though most frequent in the second and third decades. It is chiefly due to a neuropathic diathesis; there may, therefore, be a congenital predisposition, or the affection may occur in more than one member of a family, and it is associated with hysteria, epilepsy and traumatic neuroses. Intestinal toxæmia is often a causative factor. Anæmia, exhaustion and congenital narrowness of the aorta (Oppenheim) predispose to it. It sometimes complicates diseases of the spinal cord, for example, tabes dorsalis, syringomyelia, disseminate sclerosis and tumours. A proportion of cases are due to syphilis, as was first suggested by Hutchinson; this may be congenital or acquired, and is said to be associated with syphilitic endarteritis in some cases. Cases due to malaria have been reported. Lead and tobacco are possible factors; with regard to the latter, its importance in thrombo-angitis obliterans, intermittent claudication and certain forms of angina is of interest. The condition has occasionally been observed after acute infections. Exposure to cold, mental emotion and trauma are exciting causes.

Pathology.—As an independent affection, a pure neurosis, it has no pathology. It is probably a vascular spasm, affecting arteries, capillaries and veins. Peripheral nerve changes have been observed and are probably secondary. Dehio observed endarteritis and endophlebitis. Vascular changes are not always present; also they may be secondary. When due to syphilis or disease of the nervous system, the pathology is that of the primary disease.

Symptoms.—The affection is characteristically paroxysmal. It may be preceded by great pain in the whole extremity, especially in its distal part, increasing with the onset, and becoming intense. The discomfort is not always limited to the extremity. The attack itself begins in the fingers or toes, with numbness and tingling, or pain. Later these parts are noticed to be white and cold, or waxen-white like dead fingers (*local syncope*); the vessels in this stage are contracted, so that no blood enters the part. After an interval of perhaps an hour or two, the fingers or toes become red and hot (*active hyperæmia*); the vessels dilate widely in this stage. More commonly there is an intervening period of *local asphyxia*, during which the affected part is deeply cyanosed—blue or blue-black—a condition which may persist, with variations, for days, weeks or months. It may be accompanied by swelling of the part. The process gradually subsides, or is followed by the stage of hyperæmia, and recovery occurs. Alternatively, gangrene develops, with the appearance of small black spots or vesicles filled with bloody fluid. These burst and a black scab forms, which gradually separates, leaving a scar, or an ulcer that heals slowly. In this way the pad of a finger may necrose, or the necrosis may involve the tip of the finger, the terminal phalanx, or the whole finger. More than one finger or toe may be lost in very severe cases. A line of demarcation gradually forms and the necrotic part separates. Movements of the affected part are stiff and slow, and their sensibility for all kinds of sensation is greatly diminished. In some cases the edges of

the ears, the tip of the nose, the chin, the lips and the eyelids are affected.

Mental depression accompanies a moderate or severe form of Raynaud's disease, and gastric disturbance; for example, anorexia and vomiting may precede or accompany an attack. Osler reported a case complicated with three attacks of aphasia with hemiplegia, ending in recovery. There may be affections of the special senses (hemiopia, deafness, tinnitus and affections of the sense of taste), and albuminuria, glycosuria and hæmoglobinuria have been observed. An associated multiple arthritis is sometimes seen. The chronic form may progress to scleroderma; occasionally true generalised scleroderma begins with features of Raynaud's disease.

A severe attack lasts from 2 to 4 months or even longer. There may be no further attack, or there may be a recurrence after an interval of a year or more.

Mild degrees of Raynaud's disease scarcely merit the title, and are relatively common. Only a part of a finger, or one finger, or the fingers alone, or the hand as far as the wrist (often also the toes), go numb and white in winter or when bathing, and with a warmer temperature there returns the stage of active hyperæmia—the so-called "beef-steak" hand. The circulation may return to normal without a marked stage of hyperæmia. Chilblains belong to this group of vasomotor manifestations, and severe chilblains may lead to superficial necrosis. Transition forms between erythromelalgia and Raynaud's disease have been described.

Diagnosis.—Raynaud's disease differs from frost-bite in that the sequence of events in the former is usually syncope, cyanosis, hyperæmia, while in the latter it is hyperæmia, cyanosis, syncope. In mild and more chronic forms of the disease, the differential diagnosis from acroparæsthesia may be required. The age of onset is different. In general, acroparæsthesia is a subjective complaint. The feeling of numbness and tingling is continuous, and sometimes painful, and in rare cases there is evident pallor of the finger-tips, but asphyxia and necrosis do not occur. The toes are rarely affected. Local gangrene of the toes occurs in senile and diabetic arterial disease. In both conditions arterial disease is a marked feature, and the pulse in the dorsalis pedis artery is generally imperceptible; the latter condition is obvious in the accompanying glycosuria. The differential diagnosis from thrombo-angitis obliterans is more difficult, since it occurs in the age period in which Raynaud's disease is most common, and in its early stages may closely resemble Raynaud's disease. The points of importance are its occurrence in male Jews of Polish extraction, excessive cigarette smoking, the asymmetrical distribution, and accompanying obliterative endarteritis and thrombosis of the vessels of the affected limb. As Osler remarks, necrosis in Raynaud's disease is a simple matter, as simple as if a string were tied tightly round a finger-tip. To this extent the possibility of self-mutilation requires mention. Leprosy is recognised by its specific characteristics. Erythromelalgia is not paroxysmal, is accompanied by swelling, does not involve local syncope, does not proceed to gangrene, and is aggravated by dependence of the part affected and by warmth.

Prognosis.—The prognosis to life is good, though in rare cases septic infection may cause death. Severe attacks are resistant to treatment. Relapses are common, but the attacks may subside as the patient gets older.

Treatment.—Syphilis, malaria, lead and tobacco, as potential factors, furnish, when present, direct indications for treatment. Measures to improve the general health, to strengthen the nervous system, and to protect the patient from worry and excitement should be employed. Careful investigation of the alimentary canal should be made for any cause of toxæmia, and any tendency to intestinal stasis should be corrected. In our opinion this factor is one of great importance in the causation of the disease. General hygienic measures, attention to clothing and choice of a suitable climate are matters for consideration. During an attack, physical and mental rest and warmth are urgently required. The affected limb should be elevated and wrapped in cotton wool. Great care should be taken to avoid slight injuries, such as might result from tight boots and the cutting of corns or nails. Gentle massage and dry warmth to the extremities may be of benefit. Electrical treatment is of definite benefit in the majority of cases. According to Cumberbatch, the galvanic current is the most effective method; he employs diathermy, however, as a preliminary measure in those cases in which there is gangrene, this to be followed by the use of the galvanic current after the necrosed portions have separated and the parts are completely healed. Treatment by the galvanic current lessens the frequency and severity of the attacks, and the patients note a feeling of well-being after each treatment. He applies the kathode to the spine over the cervical (or lumbar) enlargement of the cord. The hands (or feet) should be immersed in warm water and connected to the anode. A current of 20 to 25 milliamperes should be passed for 20 minutes. Treatment should be given thrice weekly. Thyroid extract is well worth a trial, but other drugs are of little value, though calcium lactate in 15-grain doses, given three or four times daily, has proved useful in some cases. The drug sometimes relieves chilblains. Chloral or morphine may be given for the relief of severe pain.

ACROPARÆSTHESIA

Definition.—A vasomotor neurosis, characterised by paræsthesiæ of the hands, especially affecting the finger-tips.

Ætiology.—The condition is usually observed in women, especially at the climacteric. It rarely occurs before the age of 30. It is frequently associated with a neuropathic diathesis and a lowered vitality due to any cause. General causes include such conditions as inanition, cachexia, anæmia and pregnancy. Local causes are exposure to cold, particularly cold water, or to alternate hot and cold water as experienced by washerwomen.

Symptoms.—The onset is insidious and the symptoms are almost entirely subjective. The affection is often limited to one hand or certain fingers, the toes rarely being affected. The patient complains of numbness, tingling, formication of the fingers or tenderness of the finger-tips. There may be slight loss of sensibility in the finger-tips and occasionally evident pallor.

Diagnosis.—The condition is readily distinguished from Raynaud's disease by the absence of local asphyxia. It is important to exclude any affections of the spinal cord, such as tabes dorsalis.

Prognosis.—The complaint tends to be continuous and persistent. The

outlook regarding recovery is not good, unless the condition is due to a recognisable and removable cause. There are, however, no complications.

Treatment.—This is directed to the removal of the cause, and improvement of the general health and of the local circulation. Salicylate of soda and bromides are often helpful, and radiant heat and massage are of value.

ANGIO-NEUROTIC ŒDEMA

Synonym.—Quincke's Disease.

Definition.—A paroxysmal affection, characterised by the appearance of circumscribed œdematous swellings of the skin and subcutaneous tissues of transient duration. The mucous membranes are sometimes affected.

Ætiology.—Heredity is an important factor. Osler reported the case of a family in which five generations had been affected, involving 22 members. The condition is more common in men than in women, and generally affects the young. Those attacked are usually of a nervous disposition. Neurasthenia, hysteria and rarely exophthalmic goitre are associated conditions. Garrod has reported a case in which each recurrence of periodic hydrarthrosis was attended by circumscribed œdema, either of the lips or eyelids. The attacks may coincide with menstruation. The exciting cause is generally difficult to determine. It may be mental emotion, exposure to cold, or trauma. Local trauma sometimes determines not only the onset but the site of an attack, as in a case recently reported in which riding provoked an attack on the inner aspect of the thighs and knees.

Pathology.—In the absence of a known pathology various theories have been advanced to explain the condition. Local venous spasm, a direct nervous influence on capillary walls, as a result of which the permeability of the vessels is increased, and, more recently, the local action of a circulating toxin on the capillary walls, are theories which have obtained support. With regard to the last named, Garrod has drawn attention to the joint swellings that frequently accompany erythematous and urticarial rashes resulting from known toxic causes. Such conditions form a part of the clinical picture of serum sickness, or may occur after taking certain articles of diet, or as the result of stings of insects or nettles. This thesis illustrates the present view of angio-neurotic œdema as being a local expression of the presence of a circulating toxin, prone to occur in persons of nervous temperament, rather than a disease *sui generis*. The patients often show other signs of vagotonia, especially in their sensitiveness to foreign proteins.

Symptoms.—The complaint takes the form of acute circumscribed swellings of the skin and subcutaneous tissues, 1 to 4 inches in diameter. The swellings are rounded, painless, rarely itch, and are generally pale or sometimes redder than the surrounding skin, from which they stand out prominently. They may develop simultaneously in different parts of the body, and disappear in a short time. They may recur repeatedly, or only after a period of years; the recurrence is occasionally periodic. They occur most commonly in the eyelids, lips, cheeks and backs of the hands, and are asymmetrical. The whole side of the face, one side of the scrotum, the penis, a whole limb, or in fact any part of the skin, may be involved. The pharynx, tongue and conjunctivæ may be implicated. Œdema of the glottis is very

rare, and has proved fatal. Swelling of mucous membranes may lead to symptoms of gastro-intestinal disturbance, such as nausea, vomiting and abdominal pain (colic). Cases in which hæmorrhage from mucous membranes, stomach, bronchi, bladder, etc., occurred have been reported. Hæmoglobinuria has been observed; in such a case a Wassermann test is indicated. The attacks are generally afebrile, and there is no constitutional disturbance, unless the stomach or intestine is involved.

Course.—This is variable. Recurrence is frequent, often at intervals of 3 to 4 weeks, but sometimes after long intervals. It is rarely periodic.

Diagnosis.—The complaint is so characteristic, in the sudden onset and rapid subsidence of asymmetrical rounded swellings, that it is hardly likely to be confused with other affections. The condition is nearly allied to urticaria, from which it is distinguished by the circumscribed and deep-seated nature of the swellings and the absence of itching. No distinction is made between angio-neurotic œdema and giant urticaria.

Treatment.—The general health must receive first attention, and a saline purge is indicated. Both arsenic and quinine have been warmly advocated. It is advisable to avoid any particular protein in the food which is found to excite attacks. When the attacks occur after a particular meal of the day, a capsule containing 1 to 2 grains of peptone half an hour before that meal appears to have an effect in temporarily desensitising the body against foreign protein. This, combined with 5 to 7½ minims of the tincture of belladonna and 10 to 15 grains of calcium lactate after meals, has prevented recurrences in several cases. The former drug diminishes the vagal hypersensitiveness, and the latter increases the viscosity of the blood. On of the most useful forms of treatment for the relief of the paroxysm is a subcutaneous injection of 3 to 7 minims of liquor adrenalin. hydrochlorid. This excites the antagonistic action of the sympathetic. When the tongue is involved the patient should be given one or two of Armour's suprarenal tablets to suck. Pituitrin injections have also been recommended. Bromide is often helpful as an additional measure when the symptoms are marked. In severe cases the intravenous injection of small doses of peptone might be considered. Autohæmotherapy has proved useful in some cases.

Intermittent Hydrarthrosis, which is described fully under "Diseases of the Joints" (p. 1256), presents some interesting affinities with the vasomotor neuroses, particularly in its association with angio-neurotic œdema.

ERYTHROMELALGIA

Definition.—A rare condition characterised by pain and redness of the skin at the distal parts of the feet, and less often of the hands.

Ætiology.—Little is known of the ætiology of the disease. Men are more frequently affected than women. The condition may occur in the course of a disease of the central nervous system, such as hemiplegia, disease of the cauda equina, and disseminate sclerosis. Exposure to cold is the important exciting cause.

Pathology.—Disease of the peripheral arteries—a chronic endarteritis—has been described in three cases by Batty Shaw. Changes in the peripheral

nerves have been held responsible, and Weir Mitchell found marked degeneration of the fine nerve branches in one case. Others regard the malady as an angio-neurosis, the antithesis of acroparæsthesia and Raynaud's disease, and possibly a primary involvement of the vaso-dilators. The suggestion has also been put forward that it is due to a spinal disease, involving the lateral grey matter of the cord.

Symptoms.—The first case was described by Weir Mitchell, and was that of a sailor, aged 40, whose first complaint, following an African fever, was of "dull, heavy pains at first in the left, and soon after in the right foot. There was no swelling at first. When at rest he was comfortable, and the feet were not painful; after walking the feet were swollen. They scarcely pitted on pressure, but were purple with congestion; the veins were everywhere singularly enlarged, and the arteries were throbbing visibly. The whole foot was said to be aching and burning, but above the ankle there was neither swelling, pain . . . nor flushing."

Pain is generally the first symptom, rapidly followed by redness and swelling, most marked in the terminal phalanges of the toes or fingers. The pain is generally severe; at first it occurs only in the evening, but later it becomes chronic or remittent and may be agonising. The redness may increase to cyanosis. The swelling is more marked in the latter part of the day, and is aggravated by standing, walking, dependence of the limb and by heat. These symptoms are relieved by cold and recumbency. Hyperidrosis of the affected part is not uncommon. The condition may be complicated by general weakness, vertigo, headache, palpitations and tachycardia. Its complication with erythræmia has been described.

Prognosis.—The complaint is intractable, and tends to persist, with exacerbations and remissions, for many years.

Treatment.—Faradism and cold have been recommended. Analgesics are required for the relief of pain, which may even necessitate amputation (Shaw). Excision of the nerve supplying the affected parts has been followed by relief (Dehio, Weir Mitchell); gangrene has, however, resulted from this operation.

MILROY'S DISEASE

Synonym.—Hereditary Œdema.

Definition.—In 1892 Milroy described a persistent œdema of the legs, occurring in the absence of any of the known causes of œdema, affecting members of the same family in successive generations.

Ætiology.—The disease has occurred in six generations of the same family, but the percentage of incidence in the families has varied greatly. It is apt to appear in neurotic families. Both sexes are affected about equally, and the œdema may either appear soon after birth, or its onset may be delayed even to adult life.

Pathology.—Nothing is known of the pathology of the condition. There is no evidence of venous or lymphatic obstruction.

Symptoms.—Only the legs are affected, and these to a variable extent. Thus the swelling may be limited to the ankles; it usually does not extend beyond the knees, but may reach the thighs in long-standing cases. Gradually

the affected part becomes hard and brawny. The swelling increases in the standing posture, and, once established, it is permanent. There is no pain or redness, the veins are not enlarged, and the general health is not affected.

In some cases there are acute attacks accompanied by fever and pain.

Diagnosis.—This is made on the familial incidence, and the absence of all other recognised causes of œdema.

Prognosis.—The affection does not tend to shorten life.

Treatment.—The affected parts should always be kept bandaged with crêpe, as by this means the swelling can be kept under control, and the patient remains capable of strenuous exertion; but if such measures be not employed the œdema gradually extends. Acute attacks may require opium internally, and evaporating lotions locally.

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Geoffrey Evans.

SECTION XIV

DISEASES OF THE RESPIRATORY SYSTEM

THE PHYSICAL SIGNS IN THE CHEST IN HEALTH AND DISEASE

ACCURATE diagnosis in diseases of the air-passages and lungs depends very largely upon careful observation and record of physical signs, especially in their relation to subjective symptoms. Unfortunately, there is no strict uniformity in regard to the nomenclature of physical signs. It is, therefore, desirable to define explicitly the sense in which the various technical terms used in this section are employed. At the outset, it is well to emphasise the importance of a careful and methodical examination in every case. The magistral sequence of inspection, palpation, percussion, auscultation and mensuration has more than the sanction of tradition to commend it. Unless confined to bed, the patient should be examined both in the erect and recumbent positions in all cases of difficulty.

Inspection.—The patient being placed in a good light, the configuration of the chest, the range and character of the respiratory movements, and the position of the cardiac pulsations should be carefully noted. Most of the terms used in this connection, such as flattening, retraction, recession of intercostal spaces and diminished movement are self-explanatory.

The respiration may be unduly slow or rapid. Quickening of the rate is referred to as hyperpnœa, and if associated with distress—as dyspnœa.

Dyspnœa may be inspiratory, expiratory, or spasmodic. A peculiar periodic disturbance of the respiratory rhythm is that referred to as Cheyne-Stokes breathing. In this condition, the respiratory movements wax and wane in short periods of dyspnœa, each followed by an interval of apnœa or cessation of respiration lasting up to 30 or 40 seconds. It is due to deficient aeration of the blood and is met with in respiratory, cardiac and renal disease, and also in cerebral lesions and after some poisons.

A variety of grouped breathing is Biot's breathing, sometimes seen in tuberculous meningitis. The hyperpnœic period consists of a few breaths, deep or of increasing depth, followed by apnœa without the waning.

Certain abnormal forms of chest configuration are described: The *alar, phthinoid* or pterygoid type of chest is long, narrow and flat, with winging of the scapulæ, the subcostal angle is narrow and the upper interspaces are wide. The *emphysematous* or barrel-shaped chest is broad and rounded, the angle of Ludovici is prominent, the subcostal angle is wide, and the movements are restricted. The *pigeon breast* is characterised by prominence of the sternum, with sloping anterior thoracic walls. The *funnel breast* is

the converse of this, with depression of the lower end of the sternum and of the cartilages attached to it.

Palpation.—Vocal fremitus or tactile fremitus is the vibration felt over the lung when the hand is placed flat upon the chest-wall without pressure and the patient says "ninety-nine" or some other resonant syllables. Vocal fremitus may be increased, decreased or absent in disease.

Tussive fremitus.—The similar vibration felt during cough.

Rhonchal fremitus.—The vibrations communicated to the chest-wall by sonorous rhonchi and felt by the hand in bronchitis.

Friction fremitus or pleural fremitus.—A rubbing sensation communicated to the palpating hand in certain cases of dry pleurisy. A similar fremitus is occasionally felt in pericarditis.

Percussion.—This consists in tapping the chest-wall over the lung and observing the note produced and the sense of resistance felt. Percussion may be *direct* on to the chest-wall or *mediate*, when the tap is made on to a finger or an instrument placed on the chest. The applied finger or instrument is called the pleximeter, the tapping finger or instrument, the plessor. Percussion should always be light, except over very muscular parts of the chest.

Normal resonance is the note obtained over healthy lung tissue.

Hyper-resonance is an increased resonance, with diminished sense of resistance obtained over emphysematous lung tissue.

Dullness is diminution or loss of resonance, with increase in the sense of resistance. Various degrees of dullness are described, such as impaired percussion, slight dullness, flat, wooden or stony note.

Tympanitic resonance—a hollow drum-like note.

Skodaic resonance—a clear, high-pitched note intermediate in character between the hyper-resonant and tympanitic notes.

Cracked-pot sound—or *bruit de pot fêlé*—a hollow note with a slight jingle added to it, obtained by smart percussion over a fair-sized cavity. It is also heard on percussion of a crying baby.

Auscultation.—The breath sounds should be listened to first, then the adventitious or added sounds, and lastly the vocal resonance.

Breath Sounds.—The following varieties of breath sounds may be differentiated:

Vesicular breathing.—The normal respiratory murmur or faint rustling sound audible during inspiration and expiration, the former phase being two or three times as long as the latter. The pause between inspiration and expiration is short.

Cog-wheel, jerky or interrupted breathing is a form of vesicular breathing in which inspiration waxes and wanes, or is divided into two or more parts.

Harsh, exaggerated or puerile breathing.—An intense form of vesicular breathing heard in children and in some forms of emphysema.

Vesicular breathing with prolonged expiration.—There is no alteration in the intensity or pitch of inspiration, but expiration is more prolonged and often harsher.

Absent, diminished, weak and suppressed breathing are self-explanatory.

Bronchial breathing.—The pitch of both inspiration and expiration is raised. Expiration is as long as inspiration and is separated from it by a distinct pause.

Broncho-vesicular and vesiculo-bronchial breathing are incomplete forms of bronchial breathing in which inspiration or expiration respectively assume the bronchial type.

Tubular breathing is a peculiar form of high-pitched bronchial breathing of whiffing character, sounding as if produced close under the stethoscope. This term is often used as if synonymous with bronchial breathing, but should be restricted to breathing of the type just described, which is only heard in consolidation from lobar pneumonia and broncho-pneumonia and in collapse of the lung, including that form associated with pleural effusion.

Cavernous breathing is bronchial in type, but both inspiration and expiration have a peculiar hollow character. Expiration is hollower and more prolonged than inspiration.

Broncho-cavernous breathing is incomplete cavernous breathing, inspiration being bronchial, while expiration is cavernous.

Amphoric breathing.—An intense form of cavernous breathing, often having a very hollow metallic sound.

ADVENTITIOUS SOUNDS.—These were formerly divided into dry and moist. The former are now called rhonchi, the latter râles.

Rhonchi are musical sounds produced by the passage of air over mucus or muco-pus in the bronchi. Those arising in the larger tubes are called sonorous rhonchi, those in the smaller tubes sibilant or whistling rhonchi.

Râles are bubbling or crackling sounds produced in the bronchi or alveoli by the passage of air through fluid exudate or secretion. They are usually divided into bubbling and crackling râles. **Bubbling râles** are heard when the lung tissue is still spongy. **Crackling or crepitant râles** are produced in consolidated or softening areas of lung. Both varieties are arbitrarily subdivided into fine, medium and coarse râles. Crepitant râles are sometimes referred to as "creps"; this practice may lead to confusion with crepitation and is better avoided. Crepitant râles were formerly called consonating, bubbling râles non-consonating. **Gurgling râles** are coarse, low-pitched râles, usually heard over a cavity, especially after cough.

Crepitations are fine "hair-like" crackling sounds. They may be produced either in the pleura or in the lung. In the latter they occur only in pneumonia, broncho-pneumonia, collapse and œdema. They are heard chiefly with inspiration and may be increased in number and intensity by coughing. A coarse variety heard in resolving pneumonic lung is called **redux crepitation**.

Pleural crepitations are fine sounds of similar character occurring in the early or dry stage of pleurisy. They are heard rather towards the end of inspiration and are usually unaffected by cough.

Friction is a coarse rubbing, creaking or grating sound heard in pleurisy when there is rough exudate on the pleural surfaces. It may occur with either inspiration or expiration or with both.

Stridor is a loud, coarse sound, heard chiefly during inspiration in cases of obstruction of the larynx, trachea or main bronchi. It is louder and lower pitched than a rhonchus.

Post-tussive suction is a hissing sound, audible directly after cough. It is heard only over a cavity, and is caused by the influx of air to replace that expelled by cough.

Veiled puff of Skoda or Laennec is a puffing sound heard towards the end of inspiration. It is said to indicate small and sacculated bronchiectatic dilatations.

Metallic tinkling and amphoric echo are terms used to describe the quality of certain sounds produced near a very large cavity or a pneumothorax, in breathing or coughing, or by the heart's action. The latter is practically a low-pitched variety of the former.

Succussion splash is a splashing sound produced in a hydro- or pyopneumothorax by shaking the patient, or getting him to shake his thorax. If a gastric splash can be excluded, it is pathognomonic of a pleural or subphrenic hydro- or pyopneumo-thorax.

Bell sound or *bruit d'airain*.—A ringing sound heard on auscultation over a pneumothorax or any large cavity when a coin placed flat on the chest-wall over the air-containing space is tapped by a second coin. A similar sound is often audible on flicking with the finger and thumb over the chest-wall under similar conditions.

Voice Sounds or Voice Conduction.

Vocal resonance is the muffled sound on listening over normal lung when the patient articulates " ninety-nine " or some other resonant syllables.

Bronchophony is an increase in the intensity of the normal vocal resonance.

Pectoriloquy is conduction of the articulate voice sounds which are clearly heard as if spoken into the stethoscope. It is best appreciated by auscultating the whispered voice, and is then called whispering pectoriloquy.

Ægophony denotes a peculiar bleating or nasal modification of the voice sounds, sometimes present on listening to them through fluid in the pleural cavity.

Physical examination of the chest includes mensuration, estimation of vital capacity and examination by the X-rays when these are necessary.

Vital capacity is determined by a spirometer, which measures the amount of air which can be expired by a full expiration after the deepest possible inspiration. The average for an adult man is about 3600 c.c. The vital capacity is diminished in many diseases of the respiratory system, notably in acute pneumonia, pulmonary tuberculosis and in attacks of asthma.

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DISEASES OF THE NOSE

ACUTE CATARRHAL RHINITIS

Ætiology.—This affection is part of a coryza or " cold " and is produced not by one specific bacillus, but by various organisms, some of which are present in the throat in health. Among those which are known to be causative are Friedländer's bacillus, *Micrococcus catarrhalis*, *Bacillus septus*, *B. influenzæ*, pneumococcus, and probably the pyogenic staphylococci and streptococci. Its ætiology is, therefore, largely a matter of the relative susceptibility of the subject and virulence of the invading organism; this virulence is increased by passage through a susceptible person who often

imports colds into a household, and then infects the less susceptible members. Chilling of the body lowers the resistance, and, of all things, a draught in a hot ill-ventilated room most predisposes to infection; but an open-air life is the best safeguard against catching cold. Acute rhinitis is also a symptom of the infectious fevers, especially of measles and influenza.

Symptoms.—At first there is a feeling of dryness and discomfort in the nose or naso-pharynx, with malaise and with or without fever, followed by nasal obstruction, watery discharge and often lachrymation and sneezing. Later, the discharge becomes muco-purulent. The entire attack usually extends over a period of 2 weeks, but a chronic rhinitis may be set up and persist indefinitely. Vasomotor rhinorrhœa closely resembles the acute stage of a coryza, but is much more variable and transient.

Complications.—In simple cases, but more often in those due to the infectious fevers, acute inflammation of the accessory nasal sinuses, or of the ears, may occur. In some cases the inflammation regularly extends down the throat and causes laryngitis, tracheitis or bronchitis.

Treatment.—This is often disappointing and few persons will take the trouble to treat a cold efficiently, but singers and other professional voice-users, as well as patients subject to bronchitis, should submit to treatment. In the earliest stage, it is possible to abort a cold by obtaining free diaphoresis; the patient should be warmly wrapped up in bed and take hot drinks, with or without alcohol; quinine, 5 grains every 2 hours for 3 or 4 doses, or 10 grains of Dover's powder; the essential oils of the odoriferous plants are excreted by the respiratory tract, and are much used in this connection; onions are a household remedy, cinnamon is efficacious in large doses, 1 drachm of the essence in hot milk several times a day, and menthol and eucalyptol may be used in an atomiser. Especially after the early stage is passed, spraying or syringing the nares with warm normal saline, or with Dobell's solution, relieves discomfort and tends to prevent the discharge from becoming purulent.

The frequency and severity of attacks may often be diminished in highly susceptible persons by inoculations with an autogenous vaccine prepared from organisms derived from the patient's nasal secretion or by a "stock" vaccine containing the usual causative germs.

CHRONIC CATARRHAL RHINITIS

Ætiology.—Simple chronic rhinitis appears to result from frequently occurring attacks of coryza, or even from the persistence of a single acute attack. Predisposing causes of this persistence are deficient resistance, local irritation, auto-intoxication from the gastro-intestinal tract, and reflex vasomotor disturbance. Thus we find chronic catarrh associated with anæmia, stuffy and over-heated rooms, occupations involving inhalation of irritating dust or vapour, excessive smoking, snuff-taking (a commoner habit than is generally realised among shop-assistants and clerks who are prevented from smoking during working hours), dyspepsia and constipation, alcoholism, sexual excess and masturbation. Nasal obstruction is an important factor in keeping up chronic catarrh by preventing ventilation of the passages, allowing mucus to collect and encouraging the growth of micro-

organisms; in children the presence of adenoids is the commonest cause of catarrh.

Symptoms.—The symptoms are excessive secretion, which may be watery or muco-purulent, and may come forwards to the nostrils or pass backwards into the throat ("post-nasal catarrh"), and nasal obstruction. Secondary results, from the extension of the inflammation, include catarrhal and suppurative otitis media, pharyngitis, laryngitis and bronchitis.

The nasal mucosa may be reddened, but often has a pale, sodden appearance. The turbinals are swollen and are at first quite soft, but later, when definite thickening has occurred, they feel firmer, and no longer shrink after the application of cocaine or adrenalin. At this stage the condition may be called "hypertrophic rhinitis," and the mucosal thickening, most marked over the two ends of the inferior turbinals and over the lower margin of the middle turbinal, may form large lobulated masses.

Diagnosis.—The diagnosis, in cases of hypersecretion, can only be made after excluding by rhinoscopic examination all other causes, such as a foreign body, mucous polypus, syphilitic, tuberculous and lupoid ulceration, and, more especially, suppuration in any of the accessory sinuses; in the latter, the discharge is not scattered over the nasal passages, but emerges in a localised stream from one or other of the ostia and reappears in the same situation after being removed. The discharge of chronic rhinitis is bilateral, and, though often muco-purulent, is never true pus. The diagnosis from vasomotor rhinorrhœa is often difficult; the symptoms of the latter come and go with great suddenness, often as a result of definite causes such as going into a hot room, and there is complete absence of symptoms between the attacks; a bacteriological examination is often helpful.

Treatment.—General treatment, directed to the predisposing causes mentioned above, is necessary if a good result is to be obtained. Next, nasal obstruction must be removed, and operative treatment is called for if the cause be adenoids, deviation of the septum, or great hypertrophy of the extremities of the inferior turbinal bodies. For details, the reader is referred to surgical works; but it must be emphasised that the valuable secreting surface of the nasal mucosa must not be recklessly sacrificed, and that large portions of inferior turbinal must on no account be removed, nor should every slight deviation of the septum be submitted to operation, for it is rarely quite straight. When the turbinal enlargement is soft and shrinks after the applications of cocaine, the galvano-cautery should be used under local anæsthesia to draw one or two lines along the length of the inferior turbinal, the result of which is to produce a scar binding the mucosa to the bone. When the case has not gone on to definite hypertrophy, the most valuable form of local treatment is cleansing of the nasal passages. The lotion must be warm, about 90° F., and quite unirritating; for this reason it should have approximately the same specific gravity as serum, and normal saline solution does very well. A mildly antiseptic and alkaline lotion is usually to be preferred, of which Dobell's solution is the type, such as sodium bicarbonate, grs. iij; sodium chloride, grs. iij; carbolic acid, gr. i; glycerine, ℥ xlv; water, ℥i. A convenient instrument for the purpose is a small rubber ball of a capacity of 2 oz. with a blunt nozzle moulded in one piece, which is slowly emptied into the nostril, while the patient breathes deeply through the mouth and inclines the head forward over a basin; in this way

the palate is raised and the lotion passes through the naso-pharynx and out by the other nostril. The nose must not be violently blown afterwards, nor must any force be used during syringing, or fluid may be injected into the Eustachian tubes. Occasionally syringing causes headache, in which case the lotion may be used in a coarse spray-producer. Chronic nasal catarrh is, however, in certain cases notoriously resistant to treatment, especially under the conditions of civilised town life; indeed, many sufferers found themselves better in the wet and exposure of life in the trenches. Vaccine therapy is uncertain in its effect, but gives good results in a proportion of cases; an autogenous vaccine should be prepared from the patient's nasal secretion.

RHINITIS SICCA

This is a condition which results from failure of the nasal mucosa to secrete enough fluid to saturate the inspired air without itself becoming dry, and is frequently accompanied by dryness of the pharynx and larynx.

Ætiology.—The cause is found in any constitutional disturbance which interferes with free nasal circulation and secretion, such as anæmia, dyspepsia or alcoholism, and in breathing unusually hot dry air, as by cooks or stokers. As a temporary disturbance it is a usual accompaniment of any febrile condition.

Symptoms.—Small dark scabs of dry mucus are found especially where the current of air most impinges, on the front end of the middle turbinal and more particularly on the anterior inferior portion of the septum. In the latter situation the scabs are removed by blowing or picking and leave a small erosion, which is the commonest source of epistaxis. Sometimes the septal cartilage is completely perforated; this, the so-called "idiopathic perforation," is smooth and round and always limited to the cartilage, which serves to distinguish it from syphilitic perforation which usually involves the bony septum; the perforation due to lupus is, like the idiopathic variety, limited to the cartilage, but can be distinguished, in the active stage, by the characteristic nodules and by coexisting lesions elsewhere.

Treatment.—This consists in dealing with the anæmia, constipation, etc., avoidance of dust and excessive alcohol or tobacco, and the use of an emollient spray, such as menthol, grs. x, paraffinum liquidum, ℥i; or for erosions on the front of the septum an ointment, *e.g.*, ung. hydrarg. nitrat., ℥i, vaseline, ad ℥i.

ATROPHIC RHINITIS

Ætiology.—Cases usually first come under treatment between the ages of 15 and 18, but its insidious beginnings date from an earlier age, and a history of nasal discharge through childhood is often obtainable. It affects females at least three times as often as males. A peculiar physiognomy is to be noticed in nearly half the cases; the skull is brachycephalic, the nose wide and flat, and the nostrils broad, and so directed forwards as to be more than usually conspicuous. The affection is sometimes unilateral, in which case the septum is deflected, and the disease occurs on the wider side. Occasion-

ally it is found among several members of a family, which might be the result of contagion, but it is also inherited in circumstances where contagion cannot apply, and this may be due to inheritance of the disease or merely of the predisposing physiognomy. Of the many bacteria found in association with the affection, the most important are the Klebs-Loeffler bacillus, the *Cocco-bacillus fœtidus* of Perez, and the *Cocco-bacillus mucosus* of Beeritz, but the consensus of opinion is that they are secondary and, though helping to produce the fœtor, are not the primary cause of the disease. The condition occurs at too early an age to be the final stage of hypertrophic rhinitis, nor is it usually due to accessory-sinus disease, which can be excluded in the majority of cases. It is probably the sequel of prolonged purulent rhinitis in childhood, which results in the replacement of the ciliated by squamous epithelium, and thus destroys the principal agent for the removal of secretion; the undue width of the nasal passages promotes this retention by diminishing the force of the expulsive current of air, by drying the secretions and by unduly admitting dust and micro-organisms. In this way crusts of dried mucus are formed and decompose, and the resulting inflammation prevents the development of the turbinals and further increases the width of the nasal fossæ.

Pathology.—There is a chronic inflammation resulting in sclerosis and atrophy of the mucosa; the ciliated epithelium is replaced by squamous, the mucous glands are degenerated and the venous sinuses have disappeared. These changes are most marked over the inferior turbinals, and the middle turbinals are frequently large and œdematous. The discharge is not pus, but mucus precipitated by evaporation, mixed with shed epithelial cells and teeming with micro-organisms. This collects and dries into large greenish-black crusts which give rise to the peculiar sweetish and horribly offensive odour. There is never true ulceration or necrosis of bone.

Symptoms.—The symptoms are chiefly those of the nasal discharge and the offensive stench; the latter is rarely perceptible to the patient, who usually, in established cases, has complete anosmia. There are also obstruction from the crusts, dryness of the throat and cough, and often some degree of ill-health from toxic absorption.

The inside of the nose is full of crusts; the inferior turbinals are reduced to mere ridges, the mucosa is pale and thin, and through the widened nasal passages the body of the sphenoid and the wall of the pharynx are plainly visible.

Complications.—Infection of an accessory sinus may result by extension from the septic nasal cavities, but is not very common; conversely suppuration of the sphenoidal or a posterior ethmoidal cell is a possible, and has been considered by some authorities as the usual, cause of the affection. The lymphoid tissue of the throat is conspicuously absent; there is often a dry pharyngitis and laryngitis, and sometimes the crusting extends to these parts, or even down the trachea. Catarrhal and suppurative otitis are common, and the disease is thought by many to predispose to pulmonary phthisis.

Prognosis.—As the ciliated epithelium can never be replaced, the affection is not truly curable, though regular treatment can keep it in an inoffensive condition, and it is common to see a suggestive degree of atrophy of the turbinals in young people with rhinitis completely disappear under treatment.

Also, the crusting tends to become less troublesome as time goes on and ultimately to cease, a state of things which is difficult of explanation.

Treatment.—The nose must be kept clean by regular syringing with a mild alkaline antiseptic lotion, of which a large quantity should be used with a Higginson syringe provided with a fine nozzle which cannot block the nares. An oily, stimulating or emollient application, such as oleum eucalypti 15 minims to 1 ounce of paraffinum liquidum, or a 25 per cent. solution of glucose in glycerine, may be painted or sprayed into the nose. The crusting can be prevented by excluding the air, and when syringing is insufficient, this should be done by introducing a plug of gauze or cotton wool loosely into the anterior nares. After some weeks of treatment the packing may be omitted, but resumed in the event of a relapse. On removal of the plug the discharge is seen to be a clear mucus; if pus is found, it must be traced to its source in an accessory sinus. Paraffin wax may be injected under the mucosa, to narrow the nasal passages, but it is liable to slough out, and a piece of costal cartilage has been implanted with the same object. Recently a plastic operation has been devised to shift the antro-nasal wall inwards and has given encouraging results. The treatment of anæmia is important: good food and an open-air life, especially at the seaside, are beneficial.

MEMBRANOUS OR FIBRINOUS RHINITIS

The Klebs-Loeffler bacillus produces in the nares two very different clinical conditions: a true nasal diphtheria which is then usually of a severe type, and a purely local affection known as fibrinous rhinitis. This latter occurs in children and is not associated with any marked constitutional disturbance nor followed by paralysis; it appears to be slightly infectious, as such, but not to give rise to true diphtheria, and therefore does not require notification.

Treatment.—The treatment consists in cleansing the nares with the usual mild alkaline lotion, and a spray of liquid paraffin; strong antiseptics and forcible removal of the membrane only do harm, and antitoxin is useless.

EPISTAXIS

Ætiology.—The causes of epistaxis may be classified as follows:

Local causes.—Traumatism, including blows on the nose, fracture of the base of the skull, surgical operations, foreign bodies; the small septal erosion of rhinitis sicca, which is the commonest of all causes; malignant disease; angio-fibroma, or "bleeding polypus," of the septum; multiple telangiectasis, a curious hereditary affection characterised by numerous minute dilatations of the capillaries on the face and mucous membranes of the nose, mouth and throat; the general congestion caused by adenoids; and syphilis, lupus and the rarer granulomata, though in these the bleeding is usually an insignificant symptom.

General causes.—High blood-pressure, as in arterial disease, chronic nephritis, cirrhosis of the liver, violent exertion, extremes of heat and cold, congestion at the menstrual period, or "vicarious menstruation"; venous congestion, as in mitral stenois, tumours in the thorax or root of the neck,

emphysema, bronchitis and whooping-cough; toxic blood conditions, as pernicious anæmia, leukæmia, purpura, scurvy, and all the acute infectious fevers, especially in the prodromal stage. To these may be added rarefaction of the air, as in aeroplane ascents and mountaineering, and poisoning by some drugs, especially salicylates and quinine.

The *source of the bleeding* is, in the large majority of cases, a small spot, called Little's or Kisselbach's area, situated on the front and lower part of the septum just beyond the vestibule.

Treatment.—Epistaxis, of sufficient severity to call for the attention of the doctor, should always be treated, though it is of course of comparatively little importance in healthy young people; in older patients with high blood-pressure the loss of blood may be beneficial, but the occurrence is so distressing and alarming to the patient that other means to lower the pressure should be adopted.

The source of the bleeding is so far forward that a pledget of wool introduced for less than an inch into the naris, and held by compressing the nostrils, will generally control it temporarily. To arrest it and prevent recurrence, the bleeding spot must be found, started if necessary with a probe, controlled by application of cocaine and adrenalin on a plug of wool, and sealed by the galvano-cautery at dull-red heat. The use of an emollient ointment during the separation of the scab is advisable. In obstinate cases the bleeding may recur from another spot or from the opposite naris, when the treatment must be repeated. As in other forms of hæmorrhage, a rapid excited heart's action, associated with restlessness and fright, is often present, and an injection of morphine is of great value. Calcium lactate is often recommended and may be given in 20-grain doses three times a day for 2 or 3 days; or colloidal calcium may be injected subcutaneously. If the bleeding is from the usual situation, formal plugging of the nose is seldom called for; but sometimes the bleeding proceeds from farther back in the nose, or is so profuse that its situation cannot at first be determined. In such cases the naris should be evenly packed with ribbon-gauze introduced on forceps under inspection. The older method of plugging the posterior nares is seldom or never required. Nasal plugs quickly become septic, and should ordinarily be removed in 24 hours; but they may be kept sweet for several days, should it be necessary to retain them, by moistening them frequently with peroxide of hydrogen.

MUCOUS POLYPUS

Ætiology and Pathology.—Nasal polypi are rare before puberty and are somewhat commoner in men than in women. They never grow from the septum, inferior meatus or inferior turbinal, but only from the ethmoidal region. They are not neoplasms, but are essentially due to a local œdema of the mucous membrane; the swelling thus produced is acted upon by the expulsive forces of the nose, and, being so pulled down and elongated, the return flow of its blood vessels and lymphatics is further impeded and a greater degree of œdema results. All stages of polypus formation may be found, ranging from an œdematous fringe along the border of the middle turbinal to enormous pedunculated masses which block the nose and expand its bony walls. In the great majority of cases the œdema is due to inflam-

matory infiltration of the muco-periosteum of the ethmoidal labyrinth and is often associated with suppuration in the ethmoidal cells ; sometimes, however, the cause is vasomotor disturbance, for polypi are found in cases of hay fever and paroxysmal rhinorrhœa. There is also another form, the so-called "choanal polypus," in which a large single polypus hangs into the naso-pharynx from a long pedicle attached within the antrum and passing through the ostium into the nose.

Symptoms.—The cardinal symptoms are nasal obstruction and discharge, which is profuse and watery. The symptoms are worse in damp weather. Cough, headache and asthma are not infrequent, and a loss of the power of mental concentration often occurs.

Polypi are smooth, shiny, white, translucent bodies, pedunculated and extremely soft and movable to the probe ; their appearance is so characteristic that they cannot properly be mistaken for anything else. If they project into the nostril they become pinker and more opaque.

Treatment.—The best method of removal is in most cases with a wire snare, a process which can be rendered quite painless with skilful manipulation and the application of cocaine. Any polypoid mucosa in the neighbourhood should be removed with punch-forceps, but the application of caustics or the cautery only does harm. Recurrence is common, but becomes less rapid if the new polypi are removed at regular intervals before they have grown large. Suppuration in the ethmoidal cells and other sinuses must, of course, receive treatment. In the worst cases, the polypi are so numerous and return so rapidly that the snare cannot deal with them adequately ; in such they should be removed with a ring-knife or suitable forceps under general anæsthesia, together with the softened ethmoidal tissue, and any suppurating sinuses be opened at the same time.

PAROXYSMAL OR VASOMOTOR RHINORRHŒA

In this condition fits of sneezing are associated with a profuse watery nasal discharge, irritation of the nasal and conjunctival mucosa, nasal obstruction, and often marked depression and prostration. The discomfort is usually worse in the morning, in overheated rooms, or on going out into the cold. The rapidity with which the attacks come and go are sufficient to distinguish them from an ordinary coryza. The affection usually shows itself in early adolescence and tends to improve with advancing age ; it is distinctly hereditary and may be associated, either in the patient or in his relations, with asthma, urticaria or chilblains. Males and females are equally affected, and it is most frequent among the cultivated classes ; a mental shock is sometimes the starting-point of the attacks.

Of these cases, *hay fever* is the best known and most marked variety, and is due to specific susceptibility to a proteid substance contained in the pollen of certain grasses ; in this country, attacks begin about the end of May and terminate in August. Hay-fever subjects are affected by very minute quantities of this toxin, whereas ordinary people are completely immune. Other individuals are susceptible to the pollen, seedlets or scent of other plants and flowers, and others again to the emanations from horses, cats, dogs and other animals ; and recent researches show that asthma, urticaria

or rhinorrhœa may be variously produced by many kinds of proteid substances, including common and uncommon articles of diet, such as eggs or lobsters, in certain people who are specifically susceptible to these substances.

Treatment.—The determining factors, which should receive attention, are heightened irritability of the nervous system, occasionally some intranasal abnormality which increases the sensitiveness, and the specific irritant. Nervine tonics, strychnine, arsenic and valerian, are indicated, and attention to the general health. Hay-fever patients are better in a locality as free as possible from pollen; some remain comparatively well at the seaside, others only on board ship, while some have to spend the best days of the year in a darkened room. Occasionally great good results from the removal of some nasal abnormality, a polypus or a sharp spur impinging on the turbinal, but the result of operative treatment is uncertain. In most cases the nares are normal, and in many of these a light cauterisation of the most sensitive areas is very helpful; the sites usually chosen are on the upper anterior part of the septum, and on the anterior part of the inferior turbinal. True hay-fever patients may have their susceptibility to pollen lessened by inoculation with diluted extract of pollen; the use of these extracts, standardised under the name of *pollaccin*, gives excellent results in a large proportion of cases, and, more recently, the attempt has been made to test susceptibility to, and to immunise against, other proteid poisons.

ACCESSORY-SINUS SUPPURATION

Ætiology.—In the large majority of cases infection reaches the accessory sinuses from the nasal cavity, and may result from a simple coryza or from one of the acute infectious fevers. Influenza is especially liable to produce disease of the sinuses, which may also be caused by measles, scarlet fever, erysipelas, enteric, pneumonia or small-pox. In addition, antral suppuration is caused by infection from the teeth, particularly the second bicuspid and first two molars, whose sockets are in closest proximity to the antral floor. The discharge from one sinus readily enters and infects another, so that disease of several cavities often coexists.

Symptoms and Diagnosis.—If the ostium of a suppurating sinus be occluded the pus is secreted under pressure, and the local symptoms are severe, whereas if the secretion can escape freely there may be no symptoms except discharge. The former class of case has been called "closed" and the latter "open" empyema. The difference between the two is, however, only relative, and many cases are alternating, the severe symptoms being relieved by periodical discharge. As the pressure of the pus in the cavity depends on the rapidity of its secretion, and the degree of occlusion of the ostium by inflammatory swelling, it follows that the closed and open cases correspond generally to acute and chronic suppuration; acute suppuration is usually fairly obvious, but some chronic cases with scanty secretion are only to be detected after very careful examination and may be for long the undiscovered cause of post-nasal catarrh, pharyngitis or chronic toxæmia.

The symptoms, then, are swelling, pain, tenderness and discharge, together with the secondary effects of the suppuration. Swelling is rare; the

bony walls are not bulged by an empyema, and this is a point of distinction between it and a tumour or cyst, but occasionally spread of the inflammation causes periostitis outside the cavity, or a fistula is formed leading to an abscess. Thus, in frontal sinusitis a swelling may appear at the junction of the inner and upper walls of the orbit, displacing the eye downwards and outwards, or an abscess may form here and, after opening, leave a fistula. Similarly, ethmoidal disease may produce a swelling farther back on the inner wall of the orbit, displacing the eyeball outwards. In antral empyema, a little œdema of the cheek, or slight swelling in the canine fossa, may be found, but a swollen cheek is more likely to be due to dental periostitis, while any definite bulging of its bony walls is an indication of a tumour. Pain is often severe in acute cases, and in chronic suppuration there may be considerable neuralgic pain. Pain of an intermittent character, relieved by a sudden gush of discharge from the nose, is highly characteristic of sinus disease. The pain may be of a local inflammatory character, or may be referred to various parts, and of a neuralgic type. In antral suppuration it is over the cheek, or may be referred to the supra-orbital region or to the teeth. The pain of frontal sinusitis is over the cavity or along the supra-orbital nerve; that of ethmoidal disease is over the nasal bridge, behind the eye or in the temple, and in sphenoidal suppuration, in the middle of the head, behind the eye, on the vertex or in the occipital region. Tenderness can usually be elicited in frontal empyema by percussion over the anterior wall, and especially by pressing upwards against the floor of the cavity; it is less marked in antral disease, in the canine fossa. Discharge into the nose is the most important, and often the only, symptom. A localised stream of pus in the nose, which reappears after removal, is, in the absence of a foreign body, conclusive evidence of suppuration in an accessory sinus. The differentiation of the affected sinus is made by following the pus to its source with a probe and, in the case of the antrum, by tapping with a trocar and cannula. The antrum, frontal and anterior ethmoidal cells open into the middle meatus, and the posterior ethmoidal and sphenoidal into the superior meatus. Further assistance is afforded by transillumination and skiagraphy. Fœtor, both subjective and objective, is often present, and a serious degree of anæmia and ill-health frequently results.

Complications.—These include pharyngitis, laryngitis, bronchitis, and otitis media; the swallowed pus causes various forms of gastric and intestinal disorders, including appendicitis. Acute septicæmia and pyæmia are rare, but symptoms of chronic poisoning, such as arthritis and fibrositis, are common. A very important series of complications results from extension of the inflammation to surrounding parts: orbital abscess or cellulitis, osteomyelitis of the frontal bone, cerebral abscess, thrombosis of the cavernous sinus, paralysis of the oculo-motor nerves and, from the sphenoidal sinus, papillœdema and atrophy.

Treatment.—This, in acute cases, consists in rest in bed, hot fomentations to the affected part, aperients, a light diet, and a few doses of aspirin. Inhalations of mentholised steam at frequent intervals are of value, and may be prepared by adding 10 drops of 25 per cent. solution of menthol in spirit to a pint of steaming water in an inhaler. In recent cases of antral suppuration, the cavity should be tapped with trocar and cannula and washed out with a warm saline lotion; this should be repeated daily or every

other day, and will effect a cure in a proportion of cases in an early stage. Frontal sinusitis has a greater tendency to spontaneous cure; the anterior end of the middle turbinal should be amputated and occasionally a cannula can be passed and the cavity washed out. Cases which fail to recover under such treatment, and those of chronic suppuration, must be submitted to operation.

SYPHILIS

Congenital Syphilis

The *early form* appears at any time within 3 months after birth, usually within the first few weeks. The symptoms, frequently called "the snuffles," are those of nasal discharge and obstruction; the former may be thin and ichorous, or purulent and bloodstained, and is often associated with cracks and excoriations about the nostrils, upper lip and angles of the mouth; the obstruction may cause attacks of choking and frequently prevents the baby from taking the breast, and so produces wasting and malnutrition. These symptoms are not pathognomonic of syphilis, but may also be caused by catarrhal and purulent rhinitis, therefore the diagnosis must be established by the concomitant lesions.

The *late form* appears usually about the period of puberty, but may occur at any time after the age of about 5 years. It is characterised by a slow destructive gummatous infiltration and ulceration, and the symptoms are those of nasal catarrh and obstruction, frequently with fœtor and crusting; this chronic rhinitis destroys the ciliated epithelium, and may thus cause a true atrophic rhinitis which persists after the syphilis has become quiescent or cured. Congenital syphilis is apt to produce a very characteristic "saddle-back" flattening of the bridge of the nose.

Acquired Syphilis

Primary chancre is sometimes seen on the ala of the nose, and is accompanied by bubo of the submaxillary and pre-auricular glands, and by much induration and swelling.

Secondary syphilis does not produce noticeable symptoms in the nose; there may be rhinorrhœa and obstruction associated with hyperæmia of the mucosa.

Tertiary syphilis occurs usually in the form of a diffuse gummatous infiltration and ulceration, which may proceed to necrosis of any of the bony or cartilaginous walls of the nose; there is profuse purulent discharge, often bloodstained, which tends to dry into greenish-black crusts, the odour of which is extremely offensive. A localised gumma may occur on the septum, where it forms a smooth round swelling projecting into both nostrils which, by its contraction after healing, produces a steep depression of the bridge just below the nasal bones. Syphilitic ulceration sometimes attacks the external parts of the nose, causing perforation of the ala or destruction of the columella, with a characteristic depression of the nasal tip.

Diagnosis.—This seldom presents much difficulty; the form with crusting and ozæna imitates atrophic rhinitis, but in the latter there is never

necrosis or decided ulceration—indeed intranasal necrosis may be considered pathognomonic of syphilis. A septal gumma has an appearance identical with that of a hæmatoma, but without the sudden onset and history of traumatism. Syphilitic perforations nearly always involve the bone, whereas those due to rhinitis sicca or lupus never do. Some cases of diffuse infiltration resemble lupus; but in the latter there is no necrosis or offensive odour, the characteristic nodules are usually to be seen at the edges of the lesion, and other patches of lupus may be found on the skin or in the fauces. The chief difficulty of diagnosis lies between severe syphilitic infiltration and malignant disease, but it can usually be determined by the clinical appearance, especially by the characteristic edge of the syphilitic ulcer, by the examination of an excised portion, by the Wassermann reaction, and by the results of anti-syphilitic treatment.

Treatment.—General treatment must be very prompt and energetic to prevent irremediable deformity, and should ordinarily be begun with the injection of salvarsan or of one of its congeners. Of local treatment, the lesions should be kept clean by frequent syringing with a saline lotion, to which sanitas, lysol or listerine may be added when the odour is offensive, and any necrosed bone must be removed as soon as it is loose.

LUPUS AND TUBERCULOSIS

Ætiology.—With the exception of the rare occurrence of tuberculous ulceration as a terminal infection in advanced phthisis, the lesions produced in the nose by lupus and by tuberculosis are indistinguishable; it appears that the tubercle bacillus finds in the nasal mucosa a medium unsuitable for its development, its virulence is diminished, and it can only produce the modified lesions known as lupus. It is possible, also, that this modification of the bacillus by its sojourn in the nose is the ordinary cause of lupus; at any rate it is frequently primary in the nares, whence it spreads to the fauces and larynx and on to the face and hands. The disease begins most frequently between the ages of 15 and 30, is twice as common in females as in males, and is usually seen in badly nourished people of the poorer classes.

Symptoms.—The early lesions are found on the antero-inferior part of the septum, the nasal floor and the front end of the inferior turbinal, within reach of the finger-nail, which probably conveys the infection. The characteristic "apple-jelly" nodules are seen, with or without ulceration, the latter with rounded slightly raised margins, and tending to spread in some directions and cicatrise in others. The lesions are covered by small adherent scabs, and perforation of the septal cartilage is common. The alæ often become involved with destruction of the margin or with perforation, and the nostrils may be much narrowed and deformed by scarring, while the lachrymal duct is frequently involved. The progress of the disease is extremely slow and may continue over many years. The subjective symptoms are nasal obstruction with a slight sticky discharge.

Diagnosis.—The nares should be examined in all cases of cutaneous lupus, for, if the disease remain unhealed in the nose, relapses will continually occur. In the majority of cases of nasal lupus the diagnosis is cleared up

by the presence of lesions or scars on the face, fauces or larynx. The difficulties of diagnosis are from rhinitis sicca with perforation, and from syphilis. The typical brownish nodules are pathognomonic and can always be found by careful examination when the lesions are progressing; they can be made more conspicuous by blanching the mucosa with adrenalin. The scabbing of rhinitis sicca quickly clears up under simple emollient treatment, while the lesions of syphilis are more rapidly progressive and tend to involve bone.

Treatment.—The affected areas are defined by the application of adrenalin and thoroughly and carefully scraped away with a sharp spoon, a general anæsthetic being employed if the lesions are at all extensive; small lesions and recurrences are destroyed with the galvano-cautery. Nascent iodine by Pfannenstiel's method may be employed; sodium iodide is given in 7-grain doses six times a day, while the nose is packed with gauze kept moist with peroxide of hydrogen, 10 volume strength, with 5 per cent. of acetic acid added; when a marked reaction has been obtained this solution should be diluted to half its strength, the iodide being continued as before; the treatment may have to be persisted in for several months. Radium is still under trial, and tuberculin has not established its value in this affection.

Of general treatment, arsenic in full doses, fresh air, cod-liver oil and fattening foods are of value. Lupus does not show the same tendency to spontaneous cure in the nose as in the larynx; it is easy to obtain improvement, but complete cure is very difficult.

TUMOURS

Papilloma occurs on the skin lining the vestibule and differs in no respect from cutaneous warts elsewhere. On the nasal mucosa it is excessively rare, occurs usually on the septum, has a narrow pedicle, a rough red or greyish surface, and bleeds readily when touched; occasionally the growths are multiple, and, when large, are difficult to diagnose from a malignant growth, but they do not erode the bones; they tend to recur locally after removal.

Fibroma, similar to the naso-pharyngeal fibromata, occurs, though very rarely, as a smooth pink growth attached to the posterior region of the nares. It bleeds readily and spontaneously and demands great caution in removal.

Angio-fibroma, or "bleeding polypus of the septum," is less uncommon. It varies from the size of a pin's head to that of a filbert, is red or purple, smooth or finely lobulated, sessile or pedunculated, and grows from the anterior part of the septum. The prominent symptom is epistaxis, for the tumour bleeds freely and spontaneously. When pedunculated, it may be removed with the snare and the base cauterised; when sessile, it should be stripped off the underlying cartilage with an elevator. Recurrence is common.

Osteoma and *enchondroma* are extremely rare, and usually grow from the ethmoid region and produce obstruction and deformity.

Cysts.—Mucous polypi are occasionally cystic; the so-called "ethmoidal cyst" is an enlarged cell in the anterior part of the middle turbinal pressing

on the septum and causing obstruction and headache. True cysts are sometimes seen on the anterior part of the nasal floor, and arise from the roots of incisor teeth. When small, they may be treated by intranasal removal of part of the wall; when large, they should be dissected out from the gingival fold.

Malignant tumours, also, are somewhat uncommon in the nose; sarcomata and endotheliomata are more often found than carcinoma. Though they sometimes appear on the septum or nasal floor, the usual site of origin is the ethmoidal region. They tend to expand the bones of the face, producing a characteristic frog-like deformity, and they frequently invade the antrum and expand its walls, constituting a common variety of tumour of the upper jaw. The facial, palatine and orbital walls of the antrum may each be bulged outwards, the latter with displacement of the eyeball, and egg-shell crackling can sometimes be elicited. Sanious discharge and free spontaneous hæmorrhage are prominent symptoms and important for diagnosis. Access to the deep parts of the nose for the removal of these tumours is obtained by lateral rhinotomy, or Moure's operation, by which an incision is made in the line of junction between the nose and face and the nasal process of the superior maxilla removed. Good access to the lower part of the nose without scarring is attained by Rouge's operation, in which an incision is made in the gingivo-labial fold from the molar teeth of one side to the other and the soft parts raised. A formal excision of the upper jaw rarely fits the case. A small proportion of cases have remained free from recurrence over long periods; in a much larger number the relief of nasal obstruction and pain has made the operation well worth while, and the whole area being thrown into one large cavity by removal of bony partitions enables it to be kept clean and diminishes pressure-pain. The implantation of radium needles has given encouraging results.

HAROLD S. BARWELL.

DISEASES OF THE NASO-PHARYNX

ADENOIDS

Ætiology.—By this term is implied a chronic enlargement of the lymphoid tissue of the naso-pharynx, the "pharyngeal tonsil." This normally is present in childhood and disappears by the age of 20 or thereabouts, but if chronically enlarged may remain up to any age. The precise stage at which the enlargement becomes pathological can only be determined by the symptoms which it produces; these usually become manifest between the ages of 3 and 8, but occasionally show themselves at or soon after birth. The incidence of adenoids is universal, but they are most common in damp temperate climates, and there is no doubt that chronic or repeated attacks of nasal catarrh are the principal factor in the causation; the infectious fevers, particularly measles, scarlet fever and diphtheria, are also a frequent cause of the hypertrophy.

Pathology.—The adenoid, as it should really be called, or enlarged pharyngeal tonsil, is a mass of lymphoid tissue of definite anatomical shape; it is thickest above and tapers away below, and presents a series of ridges which

radiate from below upwards and slightly outwards. In older patients the mass is firmer and more fibrous, and the ridges are often adherent in places, leaving deep clefts and furrows in which secretion can collect and decompose.

Symptoms.—The symptoms of adenoids are many and various and include those due to nasal obstruction, those caused by infection and by the extension of inflammation, and reflex processes attributable to irritation and lowered vitality. In infants the nasal obstruction interferes with sucking and a serious degree of malnutrition will result unless the baby be carefully spoon-fed. Older children snore at night, breathe heavily in the day, and either bolt their food or eat very slowly owing to the necessity of breathing through the mouth. Owing to lack of oxygen the patients sleep restlessly wake unrefreshed and often suffer from a peculiar inability to concentrate the attention sometimes called "aprosexia." Persistent nasal obstruction during the period of growth mechanically produces permanent deformities of the jaws and face which narrow the nasal passages, prevent the mouth from closing naturally and thus perpetuate mouth-breathing. When the mouth is habitually held open, the alæ nasi are pulled downwards with the cheeks, and become narrow and slit-like and fall in like valves with each inspiration; this "alar collapse" is an important cause of obstruction in neglected cases of adenoids. The palate is narrow and highly arched; the dental arch is narrow and V-shaped, so that the upper incisors, crowded and prominent, look outwards rather than forwards, and are not covered by the short upper lip; the lower jaw retains its infantile obtuse angle, and the lower incisors lie behind the upper; the chin is receding and, in the worst cases, when the molar teeth come into contact on biting, the incisors cannot meet. Only a proportion of cases of adenoids show these deformities, and undue softness of the bones, such as occurs in rickets, is doubtless an additional factor in their causation, as also in that of the malformations of the chest which result from the obstruction to the entry of air. The long narrow unexpanded chest with acute costal angle and prominent scapulæ is the commonest deformity. Harrison's sulcus, a transverse depression corresponding to the attachment of the diaphragm; pigeon-breast, a prominent sternum with depressed costal cartilages; and funnel-breast, a sharp depression at the lower end of the sternum, are also encountered.

Various infective processes result from the spread of inflammation and, if the naso-pharynx be large, are not necessarily associated with nasal obstruction. The terribly common catarrhal and suppurative affections of the ear in children are, in an overwhelming majority of cases, the result of adenoids. Blepharitis and phlyctenular conjunctivitis are also associated with adenoid vegetations. Feverish attacks, often with tender enlargement of the cervical glands, are caused by infection of the pharyngeal and faucial tonsils, and tuberculous disease of the glands is usually due to passage of the bacilli through these portals; in such cases the tonsils and adenoids may remain unaffected or may themselves show tubercles under the microscope. Chronic or recurrent bronchitis frequently results from the infection spreading to the lower air-passages. The mucus secreted by the adenoids is swallowed in large quantities, and produces derangements of stomach and intestines with failure of growth and general health. Finally, mouth-breathing undoubtedly predisposes to dental caries. The irritation of these vegetations,

and their effect on respiration and the general health, account for numerous reflex and nervous disturbances. Among them may be enumerated laryngitis with spasm called "laryngitis stridula," spasm of the glottis without laryngitis or "laryngismus stridulus," stammering, reflex cough, asthma, night terrors and nocturnal enuresis; it should be stated that the latter disorder is by no means always to be cured by removal of the concomitant adenoids, and that in general too much stress must not be laid upon the presence of adenoids as the causative factor in these reflex disturbances.

Diagnosis.—In the majority of tractable children a view of the naso-pharynx can with patience be obtained with a good light and a very small rhinoscopic mirror, when the upper part of the septum and the concavity above it are seen to be occupied by an irregular convex mass. Where this is impossible a rapid digital examination may be required; this is extremely unpleasant to the little patient, and may be postponed, in those cases where the tonsils are sufficiently large to call for removal, until the child is anæsthetised. Similarly, in very frightened intractable children, if the symptoms point strongly to adenoids it is wiser to give an anæsthetic for examination, being prepared to remove the vegetations if present. In the Mongolian type of idiocy the tongue is large and the mouth persistently open, and in microcephaly the extremely undeveloped naso-pharynx causes nasal obstruction; cases of both these types of maldevelopment are often brought to the doctor in the hope that removal of their adenoids will cure their "backwardness," and care should be taken not to fall into the error of performing a useless operation, though if a well-marked adenoid be present it should be removed under a guarded prognosis On the other hand, adenoids can be present and produce serious secondary effects without causing nasal obstruction or any appearance of the typical "adenoid facies."

Treatment.—The normal naso-pharyngeal tonsil becomes swollen during a coryza and such temporary swelling should not be diagnosed as "adenoids," by which term chronic hypertrophy is understood, and does not call for removal provided that it subsides promptly, does not frequently recur and is not associated with otitis media or other important complications. In such cases, and when the only symptom is a mild catarrh, the regular use of a simple warm saline lotion with a rubber ball-syringe (see p. 987) will often effect a cure; in children below the age of 5 or 6 syringing is apt to be difficult and the lotion may be used in a spray, while in infants it is best to drop it into the nostrils from a small pipette like the filler of a fountain-pen. This treatment should be combined with open air—if possible a change to the seaside or a bracing country district—cod-liver oil, iodide of iron or arsenic. Breathing exercises are of great value in these slight catarrhal cases, but only do harm where there is marked obstruction.

When the enlargement frequently recurs or has gone on to chronic hypertrophy, operative removal is the only treatment, and this is especially called for when any aural symptoms supervene, or when cervical adenitis is present. After operation the general treatment referred to above is valuable, but the nose should on no account be syringed until healing is complete, as this encourages aural complications. If the alæ nasi are collapsing, or the chest narrow, breathing exercises are of use, but healthy open-air occupations are more useful still. In patients in their teens, or upwards, turbinal hypertrophy has not infrequently resulted; the surgeon should be prepared to snare off

enlarged posterior ends of the inferior turbinals at the time of the operation, and intranasal cauterisation may be required later.

TUMOURS

Innocent tumours in the naso-pharynx are exceedingly rare; the so-called "choanal polypus" is a variety of nasal mucous polypus which hangs into the naso-pharynx from a long pedicle attached within the naris.

Fibroma of the naso-pharynx, or naso-pharyngeal polypus, occurs usually in males between the ages of 10 and 25, grows by a broad pedicle from the periosteum of any part of the walls of the naso-pharynx, usually from the basi-sphenoid, and forms a smooth, rounded, pink mass which fills the naso-pharynx and sends prolongations into the nasal cavities. The palate is pushed downwards, the bones of the face expanded, and the eyeballs separated and displaced, producing the "frog-face" deformity. The cardinal symptoms are nasal obstruction and discharge, with headache and severe epistaxis; aural complications may follow, or the eyes may be involved with diplopia, exophthalmos and compression of the optic nerve; and, finally, death results from exhaustion, hæmorrhage, sepsis or cerebral invasion. Histologically the tumour is composed of fibrous tissue containing numerous thin-walled blood vessels and a variable admixture of round or fusiform cells, so that in some cases it might be described as a fibro-sarcoma; but it is not truly malignant, for it neither involves the glands nor becomes disseminated, though there is a tendency to local recurrence after removal.

During surgical removal the bleeding is terrific, but quickly ceases when once the pedicle has been detached; rapid operation is therefore important. The tumour must be removed by separating the pedicle from its attachment with special stout elevators, and may be reached through the mouth, or through the nose after lateral rhinotomy has been performed, according to its site of origin. It cannot be approached satisfactorily through the anterior nares and, on the other hand, division of the soft palate is unnecessary. A preliminary laryngotomy is advisable. Radium has proved of considerable value in reducing the size and vascularity of these growths, as a preliminary to operation.

Dermoid tumours occur as pathological curiosities in the naso-pharynx.

Malignant tumours are not common in the naso-pharynx, but epithelioma, sarcoma and endothelioma all occur. The early symptoms are chiefly pains of a neuralgic character and those produced by Eustachian obstruction; later, epistaxis, nasal obstruction, secondary involvement of glands and affections of the eye and cranial cavity may appear. Removal by operation is rarely feasible, but occasionally a growth of limited size may be attacked through the lateral rhinotomy route. Sarcomata and endotheliomata in this region sometimes yield remarkably to treatment by radium.

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DISEASES OF THE LARYNX

ACUTE CATARRHAL LARYNGITIS

Ætiology.—The affection ordinarily occurs as part of a coryza, or cold, the inflammation spreading downwards from the nose or naso-pharynx. It is also caused by over-use of the voice, especially with faulty voice-production, and frequently a slight catarrh is made worse by using the voice during a cold. It occurs in many infectious fevers, *e.g.*, influenza, measles, scarlet fever, typhoid and small-pox, and it is occasionally a result of traumatism, instrumentation, or the inhalation of irritating fumes in chemical works or of the gases used in warfare. Predisposing causes are chiefly those factors which favour attacks of coryza, such as nasal obstruction or discharge, sedentary occupations and overheated rooms; apart from local tuberculous lesions, consumptives are very subject to laryngeal catarrh.

Symptoms.—The symptoms consist of hoarseness or aphonia, local discomfort varying from dryness or tickling to a burning sensation or actual pain, and sometimes an irritable cough. There is little expectoration, unless the trachea is involved. At the onset there may be slight feverishness and malaise. The degree of hoarseness is by no means proportionate to the objective appearances; the voice may be quite good in cases of decided hyperæmia, and may be completely lost when little abnormal is to be seen. This depends largely on the neuro-muscular tone; a muscular man will retain a strong voice with a degree of inflammation which would render a weakly woman completely aphonic, indeed, some women lose the voice with every slight cold, so that it becomes difficult to differentiate between laryngeal catarrh and "functional aphonia." On the other hand, in some voice-users redness of the cords appears to be the normal condition and causes no interference with function. This variable effect on the voice is to be observed in all forms of laryngeal disease. In children, acute laryngitis is a serious affection. They show a far greater tendency to œdema and to spasm, and as the glottis is not only absolutely but relatively smaller than in adults, a dangerous dyspnœa may ensue with great rapidity. The larynx is reddened, and this is most obvious on the parts usually pale—the epiglottis and vocal cords, the vessels on the former being unduly prominent. The cords may be red, pink, yellowish, or merely have lost their bright pearly lustre. A small amount of mucous secretion is generally present, but no large accumulations of strings of mucus, such as are seen in chronic laryngitis; a minute globule of mucus may sometimes be seen standing on the centre of the cord during phonation, and resembles a little nodule. There is often a little swelling of the cords so that, on phonation, their edges come into contact at the centre; this explains how singers' nodules are caused by use of the voice during a laryngitis.

Treatment.—People suffering from the slighter degrees of laryngitis rarely apply for treatment, unless they are professional voice-users. The patient should remain in a warm (65° F.), well-ventilated room, preferably in bed, and must not attempt to use the voice. The coryza, if present, should be treated at the same time. Steam inhalations are of value and may be used from an inhaler or from a jug round the mouth of which a towel

has been wrapped in the shape of a cone. The water should be at a temperature of 130° to 140° F., and one of the following medicaments may be added in the proportion of one drachm to the pint: Compound tincture of benzoin (Friar's balsam) ʒi, with or without menthol, grs. x–xv; or benzoic acid, grs. iij, kaolin, grs. xij, tincture of tolu, ℥ xviij, and water to ʒi, these being sedative, while oleum pini sylvestris, ℥ xl, magnesii carb. levis, grs. xx, water to ʒi is mildly stimulating. Steam inhalations should only be ordered when the patient can remain in a warm room; when he is not confined to the house, or in a later stage, an oily solution from an atomiser is preferable, such as menthol, grs. vij, camphor, grs. iij, chloretone, grs. v, liquid paraffin, ʒi. Internally, expectorants are indicated; vinum ipecacuanhæ, ℥ x, or vinum antimoniale, ℥ v, potassium iodide, grs. ij or iij—singly or in combination—or ammonium chloride, grs. v, or oil of cubebs, ℥ v in syrup, every 4 or 6 hours. If cough is severe it should be restrained; a lozenge of morphine and ipecacuanha is useful, or a linctus containing heroin hydrochloride, gr. $\frac{1}{12}$, or liquor morphinæ, ℥ ij to iv.

The acute laryngitis of children calls for prompt treatment. One or two grains of calomel may be given every 3 hours until the bowels have acted freely, after which it may be continued in ½ gr. doses three times a day. Hot fomentations to the neck and a steam-kettle are advisable, and in acute febrile cases, 1 minim each of tincture of aconite and vinum antimoniale every 3 hours. If dyspnœa occurs, an emetic dose of ipecacuanha often gives prompt relief; 1 drm. of the vinum followed by ½-drm. doses every half-hour until vomiting occurs: in very young or weakly children, 15 minims every quarter-hour may be preferred.

SPASMODIC LARYNGITIS (LARYNGITIS STRIDULA)

This is simply catarrhal laryngitis with spasm of the glottis as a marked feature. It is a disease of childhood and is predisposed to by general ill-health, rickets and adenoids. The onset is that of an ordinary cold, with slight feverishness, hoarseness and a frequent cough, and during the evening or night the respiration becomes embarrassed. There is inspiratory stridor, recession of the epigastrium and lower ribs and, in some cases, an alarming degree of asphyxia. The symptoms tend to subside towards morning and, though they may recur on the next few nights, it is usually with diminishing severity. The condition should be distinguished from laryngismus stridulus, a purely spasmodic affection, with no hoarseness or other symptoms between the attacks. The evanescence of the symptoms serves to distinguish it from œdematous laryngitis and from diphtheria, in which the attacks become increasingly severe. The general health requires attention, and adenoids, if present, must be removed after recovery takes place.

ŒDEMATOUS LARYNGITIS

Ætiology.—Œdema of the larynx is not a disease but a pathological condition due to a variety of causes. Non-inflammatory œdema may be mentioned here for the sake of completeness; it occurs, though rarely, as part of the general anasarca of renal and cardiac disease. Angio-neurotic œdema sometimes occurs in the larynx, in which event it produces rapid and

severe dyspnœa (see p. 978). The swelling which occasionally results from administration of potassium iodide in susceptible subjects may be placed in the same category.

Inflammatory œdema seldom results in adults from a simple catarrh, but it may do so in children ; it more often occurs as part of an acute septic pharyngitis, and is often associated with "angina Ludovici." Œdema may follow various forms of traumatism, the drinking of corrosive poisons in attempted suicide, inhalation of irritating vapours, such as the poison gases of the Great War, the lodgment of foreign bodies, or rough or unduly prolonged bronchoscopy. Scalding, from attempts to drink from a kettle-spout, is a common cause among children. In other cases it is a sequela of typhoid fever, pneumonia, scarlet fever or small-pox, and is a local complication of syphilitic, tuberculous, cancerous or traumatic ulceration.

Symptoms.—If part of a septic pharyngo-laryngitis, the general symptoms are severe. The chief local symptom is dyspnœa with inspiratory stridor and the associated symptoms of asphyxiation ; there is hoarseness or aphonia, local discomfort and tenderness, and sometimes dysphagia. The arytenoepiglottidean folds are enormously swollen, appearing as pale or purple translucent flask-shaped masses ; if the epiglottis be œdematous it forms a sausage-shaped swelling of the same appearance. The mucosa of the vocal cords is too adherent to permit much swelling, and "œdema of the glottis" is therefore a misnomer. The subglottic region is lax and may become swollen ; indeed, the œdema may be confined to this region and then appears as a red swelling below each vocal cord. In children œdema may be inferred from the steadily increasing dyspnœa without the rapid increase and decrease typical of spasmodic laryngitis.

Angio-neurotic œdema is a very rapid condition and has proved fatal.

Treatment.—In slight cases, the swelling may be reduced by sucking ice and by the application of an ice-bag to the neck ; the latter is inadmissible in young children. A spray of adrenalin, 1 in 1000, may be used. Hypodermic injections of pilocarpine, gr. $\frac{1}{8}$, are recommended and, for the œdema produced by iodides, large doses of bicarbonate of soda. Free scarification of the œdematous tissues at the upper aperture should be practised without undue delay ; in adults this should be done with a laryngeal lancet under guidance of the mirror, but in children it is best performed with a curved bistoury guarded to near the point with strapping and passed down along the left forefinger as a guide. If this does not give quick relief, or if the dyspnœa be severe, tracheotomy should be performed without delay, in adults under local anæsthesia. Intubation is not suitable for cases of œdema of the upper aperture of the larynx, though it may be employed for subglottic cases, provided that skilled attention be immediately available should the tube be coughed out. Angio-neurotic œdema should be treated by a spray of adrenalin, and the same drug may be injected hypodermically ; tracheotomy may here also be required.

MEMBRANOUS LARYNGITIS

The formation of false membrane in the larynx is nearly always part of an attack of diphtheria, which is discussed elsewhere, but by the term "mem-

branous laryngitis " is implied a formation of membrane of non-diphtheritic origin. Apart from traumatic cases, in which the membrane is due to irritating chemicals and scalds, inflammation of the larynx accompanied by membrane may be caused by a variety of streptococci and staphylococci. The affection occurs especially in children between the ages of 2 and 8 years. The first symptom is hoarseness, soon followed by a brassy cough and the signs of dyspnœa; the patient is restless and the temperature rises rapidly to 103° or 104°. In some cases, however, the disease takes a subacute form, the attacks of dyspnœa being worse at night and abating towards morning. The diagnosis from diphtheria is only possible by bacteriological examination, and pending the report the case should be treated with antitoxin; but it may be noted that the pharynx is nearly always involved in diphtheria, whereas in membranous laryngitis the disease is often primary in the larynx. The prognosis is grave, worse than that of diphtheria since the introduction of antitoxin. An emetic dose of ipecacuanha should be given, and a steam-tent and hot fomentations to the neck are advisable. Calomel treatment is recommended; 1 or 2 grains every 3 hours until the bowels have acted freely and subsequently 1 grain three or four times a day. Tracheotomy or intubation must not be delayed when there is serious dyspnœa.

PERICHONDRITIS

Ætiology.—This, an inflammatory exudation beneath the perichondrium of one of the laryngeal cartilages, usually going on to suppuration, is most frequently the result of infection with pyogenic organisms in the course of tuberculous, syphilitic or malignant disease of the larynx. It is found as a complication of typhoid fever, small-pox, or other infectious fevers, or of septic laryngitis; and it is also caused by traumatism from without or by a foreign body within, by the rough passage of the stomach tube, or by the introduction of a tracheotomy tube through the larynx.

Symptoms.—In acute cases there are the usual general feverish symptoms. Locally, there is pain and tenderness, with a variable degree of hoarseness, dysphagia or dyspnœa, depending on the site and severity of the inflammation. External swelling and abscess formation occur when the thyroid or cricoid cartilages are attacked.

Arytenoid perichondritis appears as a unilateral rounded swelling of this region; the infection generally enters at the vocal process, where the mucosa is thin and adherent and, when pus forms, the abscess ruptures here. When necrosis occurs, the entire cartilage may be exposed in a deep triangular cavity, which opens on its inner aspect. This form is a common complication of tuberculous laryngitis. Epiglottic perichondritis produces a rounded red swelling, accompanied by severe dysphagia. In thyroid perichondritis, there is diffused swelling of the lateral wall of the larynx and ventricular band of the affected side, with early fixation of the vocal cord and hoarseness. Externally there is a tender swelling over the ala. The abscess may rupture into the larynx or ramify widely in the neck. Cricoid perichondritis usually affects the posterior plate, causing a swelling of the posterior laryngeal wall, frequently with subglottic œdema and severe dyspnœa.

Treatment.—This depends largely on the cause. Abscesses should be

opened when they form, either internally or externally, and necrosed cartilage removed when possible. Dyspnœa may call for tracheotomy and, later, cicatricial stenosis may demand treatment. When pain is present, aspirin and small doses of opium are required; insufflations of orthoform, 3 grains, or of orthoform and anæsthesin in equal parts, 15 minutes before meals, are helpful in relieving the pain of swallowing.

CHRONIC LARYNGITIS

Ætiology.—The causation is similar to that of acute catarrhal laryngitis; indeed, chronic laryngitis is often the result of recurrent or persistent acute catarrh. The principal factors which predispose to chronicity are nasal obstructions and discharges, dusty occupations and lack of fresh air, over-use of the voice and faulty voice-production, and the abuse of alcohol or tobacco; consumptives are particularly liable to non-specific catarrhal laryngitis, and oral sepsis must not be omitted. Almost any cause of general ill-health may be included among the predisposing causes, such as gout, rheumatism, anæmia, and gastro-intestinal, cardiac and hepatic disorders.

Symptoms.—The only constant symptom is impairment of the voice, which is hoarse, easily tired or even, though rarely, completely aphonic; it is sometimes weakest when tired in the evening, but is often at its worst on rising in the morning or after a rest. There is frequently a sensation of aching, dryness, tickling or of a lump in the throat, and there is usually some cough, but little expectoration, unless the trachea and bronchi are involved.

The objective appearances vary with the severity of the affection. The larynx generally is of a deeper red than usual, and the vocal cords have lost their normal pearly lustre and are pink or grey; they are usually somewhat thickened at the edges, and enlarged vessels may be visible on their surface; the vocal processes are often prominent and may be reddened or show up white against the hyperæmic cord. Strings of sticky secretion may stretch between the cords, or a little globule of mucus may form on the centre of the cord during phonation; adduction is frequently imperfect. When the epiglottis is reddened, its yellow edge stands out clearly and enlarged vessels are seen on the surface; the ventricular bands are often swollen so as to hide the outer part of the cords. The mucous membrane in the interarytenoid space, thickened and relaxed, is seen to be thrown into folds on adduction of the cords, and may form a mass large enough to prevent their approximation.

Atrophic rhinitis usually produces a form of inflammation, *laryngitis sicca*, in which small brown scabs adhere to the cords and posterior commissure, but occasionally the disease itself spreads to the larynx, which is covered by large greenish or brownish-black fœtid crusts; more rarely still the crusts extend into the trachea and cause severe dyspnœa, which may prove fatal.

Pachydermia laryngis is a somewhat rare variety of chronic laryngitis, occurring principally in middle-aged men. It is frequently ascribed to alcoholism, perhaps on insufficient grounds, to syphilis and to tubercle; the diagnosis between pachydermia and these two diseases is, however,

often a matter of difficulty. The characteristic epithelial thickenings are probably of the nature of corns, resulting from frequent cough and continued irritation. There is hoarseness of a rough raucous character, but no particular discomfort. The epithelial thickening is pink or whitish and occupies the posterior or cartilaginous region of the glottis from the vocal processes backwards to the posterior commissure. A circumscribed swelling appears on each vocal process, with a small cup or depression at the apex; the approximation of the cords is better than would be expected, because the prominence on one vocal process fits into the depression at the other. The epithelium of the inter-arytenoid space is thrown into ridges, which fill up the angles between the arytenoid and the posterior commissure, but leave a depression in the middle line. These firm opaque symmetrical swellings, without ulceration, are distinguishable from the soft irregular granulations of a tuberculous lesion; and the even cup-shaped swelling on the vocal process, even when more marked on one side, should not be mistaken for an early epithelioma.

Treatment.—The detection and correction of the ætiological factors are the most important part of treatment. Any constitutional disturbance, such as anæmia, rheumatism, gout or dyspepsia, should receive attention. Over-indulgence in tobacco, or alcohol, lack of ventilation and exposure to dust must be considered, and with teachers the black-board chalk is a common source of irritation.

Incorrect voice-production is a factor of great importance especially, but by no means exclusively, among those who use the voice largely in their occupations; in such, a course of lessons in voice-production often works wonders. In a large proportion of cases the primary cause of the laryngitis is to be found in the nose, therefore any source of nasal obstruction, catarrh or suppuration must be carefully looked for and treated; any concomitant pharyngitis should also receive attention.

Locally, treatment must begin with rest of the voice, which should be absolute in the case of professional voice-users. Where there is much secretion a saline lotion may be used in a spray—sodium bicarbonate, sodium biborate, sodium chloride, 10 grains of each, thymol water, 2 drms., glycerine, 1 drm., water to 1 ounce. Oily solutions are usually preferred, such as menthol, 5 grains, camphor, 2 grains, chloretone, 5 grains, or oil of eucalyptus, pine or gaultheria in similar proportions to an ounce of liquid paraffin. The direct application of pigments is not often called for, and is to be recommended only when pachydermatous changes are present; in such cases the cautious application of a solution of nitrate of silver on a cotton-wool mop once a week may be tried, beginning with 5 grains to the ounce and increasing the strength gradually to 50 or more grains; Dundas Grant advises an alcoholic solution of salicylic acid, beginning with 1 per cent. and increasing to 6 or 8 per cent.

Internally, small doses of potassium iodide, 2 or 3 grains, or the yellow proto-iodide of mercury, $\frac{1}{6}$ grain, three times a day over long periods, are of value.

CONGENITAL LARYNGEAL STRIDOR

In this condition there is an exaggeration of the infantile shape of the upper aperture of the larynx; the epiglottis is sharply folded laterally, the

ary-epiglottic folds are almost in contact, and the opening is thus reduced to a narrow vertical slit. As these parts are very flaccid in infancy, they become sucked together during inspiration and, by their vibration, produce the characteristic stridor. This stridor is noticed very soon after birth, it is inspiratory, of a peculiar purring or even musical character, and is most marked during active breathing and crying. The voice is unaffected, and there is remarkably little sign of dyspnœa or distress. These characteristics distinguish the condition from other forms of obstruction found in infants, such as laryngeal webs or papillomata, or "thymic asthma." It tends to disappear during the second year of life, but the prognosis must be guarded in early infancy, for an attack of bronchitis is more than ordinarily dangerous and even kills a proportion of these patients.

SYPHILIS

Congenital Syphilis

The early, or secondary, form appears in the first few months of life and is rarely recognised, but it may be suspected when the cry is hoarse in an infant with active syphilitic lesions.

Tertiary lesions are rare, and usually make their appearance about puberty, less often during the second dentition. The disease takes the form of diffuse infiltration with or without ulceration; the swelling may produce obstruction or, later, cicatricial stenosis may ensue. The symptoms are stridor with hoarseness, and tracheotomy may be required.

Acquired Syphilis

Symptoms.—Secondary lesions are superficial, cause no symptoms but hoarseness, and seldom come under observation. The commonest manifestation is an erythema which differs from that of catarrhal laryngitis by being more uneven and patchy in its distribution, and may affect one cord, leaving the other normal. Mucous patches are occasionally found on the cords or on any part of the larynx, appearing as superficial erosions with a smooth greyish base and a sharply defined hyperæmic margin. The fauces are nearly always affected at the same time.

Of tertiary lesions, the superficial serpiginous ulcer is occasionally seen with the same characters with which it more commonly appears on the fauces. Diffuse infiltration may attack any part of the larynx, but chiefly, in contra-distinction to tuberculosis, the anterior regions, such as the epiglottis and the front parts of the vocal cords. Subglottic infiltration is fairly frequent and abduction of the cords often limited, so that stenosis is much commoner than in tuberculous disease. The typical circumscribed gumma is distinctly rare; it is single, unilateral, and attacks especially the epiglottis and arytenoids, and usually breaks down rapidly to form a deep excavated ulcer, which may result in perichondritis, exfoliation of cartilage, and, ultimately, in severe cicatricial stenosis. The subjective symptoms are hoarseness, of a peculiar rough, "raucous" character, and sometimes dyspnœa with stridor; pain is in general not a prominent symptom, but a gumma on the upper aperture may cause severe dysphagia.

Diagnosis.—From tuberculous disease the diagnosis is discussed under that heading (see p. 1010). From epithelioma a gumma is distinguished by its more rapid evolution; the edge of an epithelioma is thick and everted and its base nodular, whereas these characters are less marked in syphilitic ulceration, the margin of which is hyperæmic and frequently sharply cut; while other parts of the larynx or fauces often show syphilitic lesions. The hard infiltration of secondarily involved glands is characteristic of malignant disease.

Treatment.—General treatment is urgently called for to prevent perichondritis and stenosis. Local treatment is not often required. Tracheotomy should be performed when decided dyspnœa is present; it seems to aid the recovery of the larynx, and the tube can often be omitted in a short time, when anti-syphilitic medication has removed the obstructing lesion. Necrosed pieces of cartilage must be removed by internal or external operations, and insufflations of orthoform are indicated when dysphagia is present.

LUPUS

Lupus in the larynx is comparatively rare, and is probably always secondary to the disease in the nasal passages.

Symptoms.—The lesions begin on the epiglottis and slowly spread along the aryteno-epiglottic folds; the interior of the larynx is less often attacked and the cords usually escape. The infiltration is composed of tiny red nodules, which develop the typical "apple-jelly" centre and break down to form multiple coalescent shallow ulcers, the smooth base covered by a scanty secretion and with indefinite uninflamed margins. Cicatricial contraction goes on during the progress of the affection, and the epiglottis, if not destroyed, is usually much deformed; but the scars are less thick, and the contraction less severe than in syphilis, and marked stenosis is uncommon.

Treatment.—The disease shows a decided tendency to spontaneous cure, and in many cases of cutaneous lupus the scars of healed disease can be seen in the larynx. Open-air treatment, as carried out in a sanatorium, with good food, moderate exercise, and cod-liver oil suffice to cure most cases. Arsenic, in large doses, appears to have a specific effect, starting with 5 minims of liquor arsenicalis 3 times a day and increasing the dose gradually to 15 or more minims. Local treatment should be reserved for those cases which general measures fail to cure. If the lesions are confined to the epiglottis, this may be removed; for more diffuse infiltration repeated galvanocautery puncture gives the best results, but over-zealous application will promote stenosis. Good results have recently been reported from the use of radium, applied externally to the neck in the form of plates.

TUBERCULOSIS

Ætiology.—Primary tuberculosis of the larynx is so rare as to be of no practical importance; in the overwhelming majority of cases the disease is secondary to pulmonary tuberculosis, of which it is a common and important complication. It is probably caused by infection from the sputum,

is two or three times commoner in men than in women, and is most frequent between the ages of 20 and 40. St. Clair Thomson finds that the difference in sex-incidence is occupational, and that women working in office and factory are as susceptible as men.

Symptoms.—The disease attacks, in order of frequency, the vocal cords, arytenoid region, inter-arytenoid space, ventricular bands and epiglottis; in general the lumen is invaded before the upper aperture, and the posterior rather than the anterior parts of the larynx. The typical infiltration is finely nodular, pallid and soft in appearance; ulcers are shallow, with a smooth speckly base and pale ill-defined margin. On the vocal cord the disease chiefly attacks the posterior half and especially the vocal process, where ulceration readily reaches the underlying cartilage and may produce a deep triangular excavation. Thickening in the inter-arytenoid region is common; infiltration of the arytenoids results in typical pale semi-translucent flask-shaped swellings, while the epiglottis appears as a firmer red sausage-shaped mass.

Of subjective symptoms, the hoarseness is very characteristic, being weak and effortless and very different from the raucous voice of syphilis. Cough and expectoration are mostly due to the pulmonary disease and not in any considerable degree to the larynx. Pain on swallowing is common and often very intense; there may also be actual obstruction to deglutition and, in a late stage, entry of food into the larynx. Dyspnœa is rare.

Diagnosis.—Although signs of pulmonary tuberculosis are helpful in diagnosis, it is obvious that any kind of laryngeal disease may occur in a consumptive patient.

From simple laryngitis.—In the earliest stage of invasion tuberculous laryngitis may exactly resemble catarrh, but redness of one cord only is certainly not due to catarrh, and the latter quickly improves under treatment. The swollen arytenoids of œdematous laryngitis are less pale and more transparent, while the affection is acute and the entire larynx inflamed. Inter-arytenoid infiltration somewhat resembles pachydermia, but the latter is opaquely white, firm and symmetrical.

From lupus, typical tuberculosis differs completely. The former is painless, affects first the epiglottis and upper aperture, is never accompanied by œdema, and tends to cicatrisation. But there is a chronic "lupoid" form of tuberculous laryngitis which attacks the epiglottis and is very similar to lupus.

From syphilis.—The tuberculous ulcer has an ill-defined margin without surrounding hyperæmia; the base has a yellow speckled appearance, and on healing there is little scarring or contraction. The superficial syphilitic ulcer has a well-defined hyperæmic margin, with a smooth, flat base; the deep ulcer is "crateriform," with thickened punched-out edge, and, on healing, leaves a dense scar and marked deformity. In general, syphilitic lesions attack the anterior half of the larynx, tuberculous the posterior; the former look firm and dense, the latter soft, translucent and ill-defined.

From neoplasms.—Only the rare tuberculomata resemble innocent tumours. Occasionally tuberculosis attacks one vocal cord in an elderly patient and may then easily be mistaken for epithelioma (see p. 1014).

Prognosis.—Any tuberculous lesion of the larynx renders the prognosis of a case of pulmonary tuberculosis much more serious. A considerable

number of the superficial lesions become healed; but it is doubtful if any cases of extensive infiltration recover, with the exception of a few rare instances where it is confined to the epiglottis and can be entirely removed.

Treatment.—Tuberculous laryngitis is but a complication of pulmonary tuberculosis, and by far the most important part of the treatment is that of the general infection. For the laryngeal lesions the most valuable remedy is complete silence, but it is a severe and depressing measure and should not be insisted on unless there is a prospect of cure; the pain and irritation in advanced cases are, however, often relieved by vocal rest. Any concomitant catarrh should receive attention; an oily spray containing menthol and chloretone (7 grains of each in an ounce of liquid paraffin) is valuable, and irritable cough should be relieved by a simple lozenge, or, if severe, by heroin, $\frac{1}{2}$ gr. or less in a lozenge or linctus. Attempts to cure by active local treatment must only be made when the pulmonary lesions are quiescent or progressing towards arrest, the general health good, and the local lesions not very extensive. Of these methods the galvano-cautery is the most generally useful, and may be employed to the surface of superficial ulcers, or as multiple puncture of infiltrated areas. Chemical caustics may be applied to ulcerated surfaces, especially on the cords and posterior commissure; lactic acid, 50 to 80 per cent., may be used, or Lake's mixture of lactic acid 50 per cent., formalin 7 per cent., and phenol 10 per cent. Ulcers covered with sprouting granulations may be curetted, and occasionally infiltration of the epiglottis or arytenoid may be removed with punch-forceps.

In advanced cases the dysphagia is so distressing that its relief is of great importance. For this purpose the most valuable drug is orthoform, which may be combined in equal proportions with anæsthesin; it is an insoluble non-toxic powder and is used as an insufflation in doses of 3 to 5 grains, 30 to 60 minutes before meals; patients readily learn to inhale it into the throat through a glass tube. Cocaine and morphine should be reserved to the last stages. When the dysphagia is due to a greatly swollen epiglottis, the greatest relief is afforded by its removal under cocaine with special punch-forceps; and when the pain is caused by a tense swollen arytenoid, the removal of a piece with punch-forceps relieves tension and gives similar relief. Injection of alcohol into the superior laryngeal nerve is a useful method of alleviating pain in cases of extensive disease. Tracheotomy is seldom required, and tuberculous infection of the wound is common after this operation.

TUMOURS

Innocent Tumours

Singer's nodules are inflammatory epithelial thickenings, and may be considered as a form of pachydermia. They are found in teachers and speakers, rather than in singers, and are caused by faulty voice-production and, especially, by forcing the voice when the cords are inflamed. The appearance is that of a minute pink or whitish nodule on the edge or upper surface of the vocal cord, surrounded by a varying amount of injection; there is usually a nodule symmetrically placed on each cord, but it is frequently

larger on one side than on the other. The place where the growth occurs, and which is also the "seat of election" for other innocent tumours, is at the junction of the anterior and middle thirds of the glottis, that is, in the centre of the true vocal cord, for the posterior third of the glottis is cartilaginous. It is here that the maximum vibration occurs, and here that the cord, if swollen, comes into contact with its fellow on phonation.

Fibromata occur usually on the vocal cord on the same site as the singer's nodule, of which they are in some cases probably a development, or at the anterior commissure. They are pedunculated, smooth and round, white, pink or brown from extravasation of blood, and vary from the size of a pin's head to that of a bean. These growths not infrequently become œdematous, when they appear translucent like a nasal polypus and have been incorrectly described as *myxomata*.

Papillomata are reddish, papillary, pedunculated growths, and occur anywhere on the larynx, but, when single, generally occupy the "seat of election" on the vocal cord, and are seldom found on the posterior half of the glottis. Multiple papillomata occur in childhood and, as they present special characteristics, will be considered separately later.

Cysts.—A fibroma may degenerate with the formation of a cystic space in its interior. Apart from this, cysts, which may reach a large size, are found as a rarity on the upper aperture of the larynx, especially on the anterior surface of the epiglottis. They are thin-walled and translucent, with ramifying vessels running over the surface.

Angiomata occur, though rarely, on any part of the larynx either as a flat patch or a raised purple mass resembling a blackberry.

All innocent neoplasms are uncommon; in addition to those already mentioned, *lipomata*, *chondromata* and *thyroid-gland tumours* have been observed.

Symptoms.—A tiny growth situated on the vocal cords, or in such a situation as to prevent their approximation, causes hoarseness and a variable amount of aching and discomfort, but even a large tumour elsewhere may cause no symptoms to attract attention. Dyspnœa results in rare cases when a neoplasm is large enough to block the air-way, but it is astonishing how slight a disturbance may be produced by a large tumour if it has grown slowly; inspiration is more difficult than expiration, except when the tumour lies below the glottis. Angiomata cause hæmorrhage, which may be slight or very severe.

Diagnosis.—This is usually easy on inspection, but a growth in the anterior commissure, or one that drops down below the cords, may be readily overlooked. The rare tuberculoma may so exactly imitate an innocent neoplasm as to be only recognisable under the microscope. The important matter of diagnosis from a malignant neoplasm will be referred to under the latter disease.

Treatment.—Tumours situated away from the glottis and causing no symptoms should be left alone. Cysts are best treated by making a large hole with punch-forceps or the cautery, for they refill after simple incision. Angiomata, especially if diffuse, are best left untouched, unless bleeding calls for interference, in which case it can usually be checked by the cautery at dull-red heat; diathermy puncture with a fine terminal through a direct laryngeal spatula, or by suspension-laryngoscopy, is a preferable method;

if repeated hæmorrhage becomes a danger, it can be excised by an external operation, but is usually more widely spread than appears on laryngoscopic examination. Singer's nodules, if quite small and sessile, frequently disappear under prolonged rest of the voice; the smaller nodules may be lightly touched with the galvano-cautery; larger ones should be removed with forceps. Fibromata and papillomata are removed with forceps; it causes far less disturbance to the patient if this be done under cocaine anæsthesia by the "indirect method," *i.e.* under guidance with the laryngeal mirror, provided that the operator has acquired the necessary skill, but since the introduction of the "direct method" they are often removed through the tube-spatula. After the little operation, absolute rest of the voice should be enjoined for a few days; in cases of singer's nodule a longer rest is necessary, with training in voice-production and avoidance of dust and conditions of vocal strain.

Multiple papillomata.—This rare but serious condition occurs almost exclusively in children and generally attracts attention between the ages of 2 and 4. The warts may be very numerous, fill the lumen with a cauliflower-like mass, and extend to the subglottic region, down the trachea and even on to the pharynx. The first symptom is hoarseness, and long-continued hoarseness in a child should suggest the possibility of papilloma; dyspnœa ensues later and becomes gradually more severe until tracheotomy is necessary. The growths may disappear after tracheotomy, or spontaneously, or after an acute illness, and tend to vanish or cease to recur about puberty. The modern treatment is to remove the growths through the tube-spatula, or by suspension-laryngoscopy, under general anæsthesia; a preliminary tracheotomy is advisable if there is much dyspnœa; several sittings may be required, and the operation must be repeated as often as the growth recurs.

Malignant Tumours

Ætiology and Pathology.—Epithelioma is by far the commonest malignant growth in the larynx, but spheroidal-cell carcinoma and sarcoma also occur. Malignant disease of the larynx proper is rare below the age of 40, and is seldom seen in women; but there is a post-cricoid epithelioma, which of course originates on the mucous membrane of the pharynx, which is relatively common in women, and at such an early age as 23 or even younger. Secondary or metastatic growths are practically unknown in the larynx; on the other hand, owing to the fact that the laryngeal lymphatics do not anastomose freely with other systems, cancers confined to the lumen of the larynx rarely become disseminated and do not readily infect the glands. Therefore, Krishaber's classification into *intrinsic* and *extrinsic* is valuable for treatment and prognosis; the former are those situated within the cavity of the larynx, while the latter affect the upper aperture, epiglottis and arytenoids, and the outer walls, such as the posterior surface of the cricord plate.

Symptoms.—Unfortunately, intrinsic malignant tumours do not cause severe symptoms at an early stage and, particularly in hospital practice, frequently do not present themselves for treatment until they have become extrinsic by extension; hence the importance of a laryngeal examination in all patients over 40 with hoarseness which does not rapidly yield to treat-

ment. Hoarseness is the most general, and usually the only early, symptom; owing to the deep infiltration characteristic of malignant disease, it is often more marked than the size of the tumour would appear to warrant. Cough is not a common symptom. Pain is absent in the early stages of intrinsic cancer, but is severe in the later stages and in the extrinsic forms; it radiates to the ear and side of the head, and is made worse by swallowing, speaking, and coughing. The later symptoms include involvement of the glands, fœtor of the breath, salivation, hæmorrhage, dyspnœa, dysphagia and general cachexia; often the patient dies of septic pneumonia.

On a vocal cord, epithelioma may appear as a definite tumour resembling a papilloma or angioma, or it may begin as a diffuse infiltration, or even as a mere area of thickening and congestion. On the ventricular band or posterior commissure it usually shows itself as an irregular papillary dusky-red swelling; cancer of the epiglottis ulcerates early and appears as a dirty-white or reddish tumefaction. Often the only sign of a post-cricoid growth is a swollen and fixed arytenoid; sometimes the upper edge of the growth is visible, but it is frequently necessary to pass a tube-spatula or to pull the larynx forward with a probe passed down to the glottis before it can be inspected.

Diagnosis.—In the earliest stage the diagnosis obviously is a matter of extreme importance and sometimes one of great difficulty. The unilateral character of the infiltration is ordinarily sufficient to exclude a simple inflammatory lesion; though pachydermia may be more marked on one side, the smooth cup-shaped swelling on the vocal process is characteristic. The difficulties of diagnosis are generally between an innocent neoplasm on the one hand, and a tuberculous or syphilitic infiltration on the other. A papilloma or a fibroma on a vocal cord should be regarded with suspicion in a man over 40, and especially if, after removal, the site fails to heal promptly. An innocent neoplasm has a fine pedicle, moves freely in the air-current on phonation, there is no tumefaction at its site of origin, and it is found at or in front of the middle of the vocal cord. A malignant growth may occur in any situation; it is less movable and pedunculated, the cord in the neighbourhood is frequently swollen and may show a leash of tiny vessels running to the tumour; a white spiky appearance of the papillæ is suggestive of malignancy; a sluggish delayed movement of the cord is an important sign, insisted on by Semon, but its absence by no means excludes malignancy, for it only occurs when somewhat deep infiltration has occurred, and is absent in a considerable proportion of early cases. Epithelioma beginning as a flat infiltration may resemble a tuberculous or syphilitic lesion, but usually other signs of these diseases are present to aid the diagnosis; in the latter the Wassermann reaction and, still more, the results of vigorous anti-syphilitic treatment will clear up the doubt. There is a form of senile tuberculosis in which infiltration of one vocal cord may closely imitate epithelioma, more especially as the pulmonary signs are merely those of bronchitis and tubercle bacilli are very scanty in the sputum. Sometimes a piece may be removed for examination, but frequently the growth is too sessile to permit it; the piece removed must not be very small, and a negative finding is of little value, for the tip of a malignant growth cannot always be distinguished microscopically from a papilloma. This removal should never be performed in inoperable cases, for it only stimulates the growth and does harm.

Extrinsic epithelioma is most likely to be mistaken for tertiary syphilitic ulceration. A gumma grows and ulcerates more quickly, its edge is smoother and sharper, and its base often covered by a yellow slough. Pain has little diagnostic value, for a gumma of the upper aperture may cause severe dysphagia. Palpation with the finger is of great service, for the firm hard feel of an epithelioma is very characteristic.

Treatment.—Malignant disease cannot be removed with certainty by the natural passages. Thyrotomy, or laryngo-fissure, is the operation of choice for removal of intrinsic cancer; it consists essentially in wide removal of the disease from the interior of the larynx after splitting the thyroid cartilage in the middle line. The results in suitable cases are probably better than those of removal of malignant disease in any other part of the body; there is now practically no immediate mortality in skilled hands, statistics show from 70 to 80 per cent. of permanent cures, and a useful husky voice remains. When, however, the growth has spread at all extensively to the arytenoid, or to the subglottic region, or across the anterior commissure to the opposite cord, laryngo-fissure is no longer possible and a very different picture is presented. Hemi-laryngectomy is performed in some cases in which the cancer is limited to one side, but it is impossible to protect the lungs from septic discharges and the mortality is very high. In most cases, too advanced for removal by thyrotomy, if operation is feasible, a total laryngectomy is preferable, for the trachea is sutured to the skin at the lower end of the neck and aspiration of sepsis thus avoided; in the last few years the mortality has been much reduced and the results, as regards freedom from recurrence, greatly improved. The operation leaves the patient in a condition very different from that after thyrotomy; as he breathes through the tracheal opening in the neck he cannot cough or strain and has no natural voice. Nevertheless he can often produce a faintly audible whisper by means of the air in the pharynx, or with the aid of a tube leading from the tracheotomy wound into the mouth or nose, and a number of cases succeed in passing a surprisingly happy and useful existence. Subhyoid pharyngotomy and, more recently, lateral pharyngotomy are operations designed to obtain access to cancers at the upper aperture of the larynx; the latter operation gives very good results in strictly limited tumours of this region. The technique of therapy by means of X-rays and radium has now been put on a reliable basis by determination of the appropriate dosage and by adequate screening; in many cases of malignant tumours of the larynx, great improvement can now be obtained by both these agencies, and a considerable proportion of cures has been effected. Radium, or its emanation, is enclosed in needles or small seeds of platinum and buried, accurately spaced, in and close to the tumour; or plates containing radium are embedded in wax and applied as a collar to the neck: the two methods may be combined in the treatment of any particular case. Great care and judgment are required in the selection of cases for these various operations, and very many come under observation too late. In these much can be done by palliative treatment; careful attention to the hygiene of the mouth and teeth is of great importance, together with mild antiseptic laryngeal sprays containing hydrogen peroxide, listerine, sanitas or carbolic acid. For dysphagia, insufflations of powdered orthoform, with or without anæsthesin, is the most reliable remedy; cocaine is disappointing, for its effect is very transient and

the resulting numbness interferes with swallowing; the judicious administration of morphine or heroin is eventually necessary, but the local application of these drugs is useless. Palliative tracheotomy or gastrostomy may be called for, and partial removal or curettage gives relief in some cases of cancer at the upper aperture.

PARALYSIS

Paralysis of a vocal cord is a frequent symptom of various diseases of the thorax and of the nervous system, and the laryngoscope is therefore of great value to the physician as an aid to diagnosis; this is more especially the case in that the common early form, abductor paralysis, causes no symptoms, and can only be recognised by laryngoscopic examination.

The larynx has two more or less antagonistic functions; that of respiration, aided by abduction, and that of phonation, associated with adduction of the vocal cords. Of the two, the latter is the more recently acquired and, being directly controlled by the will, has a definite cortical centre situated bilaterally in the lower part of each ascending frontal convolution. On the other hand, the respiratory function is more vital, less under conscious control and is mainly represented in the medulla. Accordingly, functional disturbances always paralyse the adductors, while organic lesions affect first the abductor muscle.

Organic Paralysis

In paralysis of the superior laryngeal nerve the affected cord remains slack and wavy and sags up and down with respiration. Owing to the short course of these nerves, isolated paralysis of the crico-thyroid is extremely rare; it results from surgical or suicidal wounds, or by pressure from glands, but most often occurs after diphtheria. In lesions of the vagus above the origin of this branch the signs of this paralysis are obscured by that of the other muscles of the cord. The recurrent laryngeal nerves supply all the other muscles. In any progressive lesion of the nerve-path the muscles become paralysed in a definite order, the enunciation of which is known as Semon's law; the abductors are first affected, then the tensors or thyro-arytenoidei, and finally the adductors.

In *abductor paralysis* the affected cord lies in the middle line; during phonation the sound cord adducts to meet it and the larynx appears normal, but on inspiration it is drawn outwards and backwards and appears longer than its paralysed fellow, which remains unmoved. As would be expected from the course of the recurrent nerves, the left cord is far more often affected than the right. The voice is unaltered, but, although the glottic aperture is reduced by half, there is usually dyspnœa only on exertion, except in children, in whom the narrowing of the naturally small glottis may produce sufficient obstruction to necessitate a tracheotomy.

When the thyro-arytenoid fails, the edge of the cord is concave on phonation, the cord appears narrower than its fellow, and the voice gradually becomes husky. Finally, when *total recurrent paralysis* has occurred, the cord assumes the "cadaveric position" between the middle line and the normal position of rest. On phonation, the healthy arytenoid crosses the middle line and pushes the paralysed cartilage aside; sometimes the latter

drops forward and exposes its broad posterior surface, which may be mistaken for a swelling. As the cords are still able to approximate, the voice is not necessarily lost, but is hoarse and easily tired, with a characteristic breathy quality, from waste of air, or a diphonic character, due to unequal vibration of the two cords.

In cases of *bilateral abductor paralysis* the cords lie together near the middle line. The voice is good, but the inability to take a full breath gives the speech a peculiar character; dyspnœa is a marked symptom accompanied by inspiratory stridor and severe paroxysmal exacerbations. When the disease progresses to complete *bilateral recurrent paralysis*, both cords remain in the cadaveric position, the dyspnœa passes off and the voice is reduced to a whisper.

Diagnosis.—The diagnosis is almost entirely a matter of accurate inspection. Obliquity of the laryngoscopic image, due to faulty position of the mirror, may cause confusion. In nervous subjects the cords are sometimes adducted on inspiration, but they will abduct naturally during the involuntary inspiration which follows a prolonged phonation. The only condition which really imitates paralysis is the fixation of the arytenoid cartilage which results from disease in or around the joint; its complete immobility with the presence of swelling or scarring often aids the diagnosis, but in old-standing cases of paralysis secondary fixation frequently occurs.

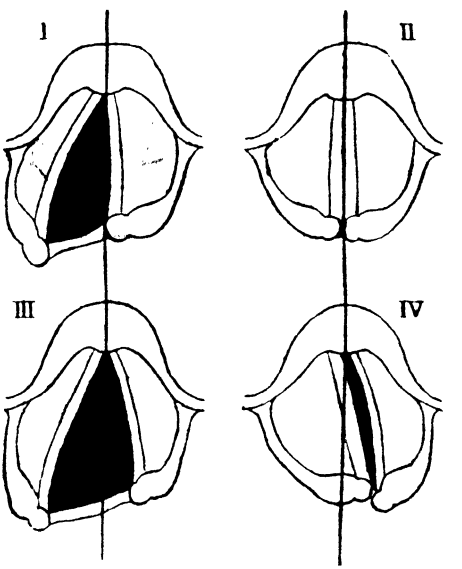

FIG. 113.—Organic Paralysis: I. Abduction paralysis of left cord on inspiration; II. Abduction paralysis of left cord on phonation; III. Total paralysis of left cord on inspiration; IV. Total paralysis of left cord on phonation. (*Lancet.*)

Ætiology.—The ætiology is of some importance, for it is on our knowledge of their causation that the diagnostic value of these lesions depends. The movements of the cords are represented bilaterally in the cortex cerebri, and stimulation of either centre produces movement (adduction) of both cords, from which it follows that no unilateral lesion above the bulbar nuclei can paralyse the larynx, and clinically we find that it is never affected in cases of hemiplegia. The bulbar centres lie in the floor of the fourth ventricle, and here a lesion of one centre causes paralysis of the cord at the same side which, in a gradually progressive lesion, attacks first the abductor muscle. Thence the nerve fibres pass in the roots of the bulbar-accessory to the vagus and recurrent laryngeal nerve; the cause of the paralysis may, therefore, be situated (1) in the medulla, (2) at the base of the skull, (3) in the vagus, or (4) in the recurrent laryngeal nerve.

Paralyses of bulbar origin are often, but by no means always, bilateral. In lesions here and at the base of the skull neighbouring nerves are liable to be involved; thus, paralysis of a cord and of the same side of the palate may coexist (syndrome of Avellis), or paralysis of cord, palate, trapezius and sterno-mastoid from involvement of the spinal accessory roots, or persistent frequency of the pulse due to damage of the cardio-inhibitory centre or nerves. Tabes dorsalis is the most frequent cause of paralysis of central origin; it may affect one or both cords and may be associated with anæsthesia, paræsthesia or the spasmodic attacks called "laryngeal crises." In general paralysis of the insane laryngeal palsy is not uncommon. It is the rule in bulbar paralysis, and is usually bilateral, but appears late in the disease. Syphilitic nuclear disease, pachymeningitis and gummata at the base of the brain are frequent causes, and here the ocular muscles, especially the external rectus, are often attacked.

Peripheral causes usually act by compression of the recurrent nerve, the most frequent causes being aneurysm, enlarged glands, usually tuberculous, and cancer of the œsophagus. Other causes are thyroid tumours, usually but not necessarily malignant, mediastinal tumours, cancer of the lung, pleurisy, and pulmonary tuberculosis in which the nerve, usually the right, may be involved in a lesion at the apex of the lung, or by tuberculous bronchial or tracheal glands. Neuritis is a cause of laryngeal paralysis; it may be produced by the toxins of the infectious fevers, usually diphtheria, or by organic poisons, especially lead, and more rarely arsenic and alcohol. Finally, the condition is sometimes the result of traumatism, more especially surgical operations on the thyroid gland and œsophagus.

Prognosis.—Paralysis of one cord is not in itself dangerous to life; but when the cause is undiscovered the prognosis must be guarded, for this paralysis may be for a long time the only sign of serious disease; on the other hand, the recurrent nerve may be involved in some non-progressive lesion, such as a fibrotic bronchial gland, and such cases of paralysed cord have been under observation for 20 or 30 years without change.

Treatment.—This depends on the cause. In most cases it is but a symptom of disease elsewhere and does not call for special treatment. In traumatic cases, however, the nerve may sometimes be found and sutured; afterwards, and in cases due to neuritis, strychnine and the local application of the faradic current by means of an intra-laryngeal electrode are indicated. Tracheotomy is advisable in bilateral abductor paralysis, but a plug may usually be worn in the tube, and removed at night and whenever dyspnœa threatens.

Functional Paralysis (Functional Aphonia)

Ætiology.—Functional aphonia is a common manifestation of hysteria, and has been a very frequent symptom of war-neurosis or "shell-shock," but it should be clearly stated that the majority of cases are not purely hysterical. Anything which increases the effort of phonation, such as debility or laryngeal catarrh, predisposes to this affection, which is characteristic rather of feeble neuro-muscular tone than of hysteria; this explains how some women lose the voice completely with every slight cold, while other patients can produce a loud if hoarse voice with severe laryngeal disease.

Symptoms.—Paralysis of the adductors presents a totally different clinical picture from the organic paralysis. It is always bilateral; the larynx appears normal while at rest, but, on attempts at phonation, it is seen that the cords do not adduct into the position necessary for the production of the voice. Very commonly the thyro-arytenoidei are the only muscles which fail to act; the cartilaginous glottis is then properly closed, but an elliptical chink is left between the cords. If the crico-arytenoidei are paretic, the entire glottis remains open to a variable extent, and, very rarely, the arytenoideus is affected alone, when a triangular aperture is left behind the vocal processes. The paralysis is hardly ever complete; indeed a considerable amount of movement is usually seen, though insufficient to produce phonation. In purely hysterical cases the onset and recovery are sudden, the cough is usually not aphonic and the voice when regained is not hoarse. In some hysterical patients there is also inability to whisper.

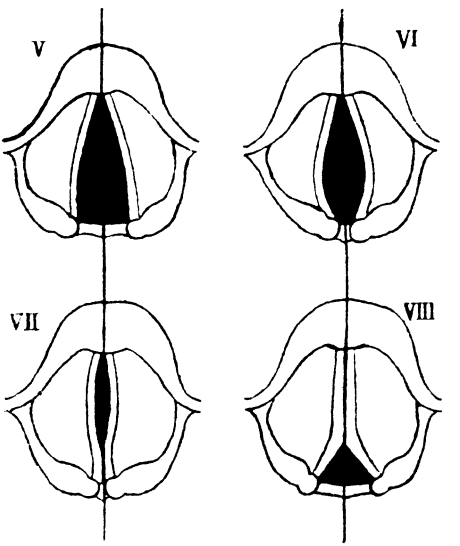

FIG. 114.—Functional Paralysis; all during attempted phonation: V. Paresis of all the adductors; VI. Arytenoideus still active; VII. Paresis of internal tensors; VIII. Paresis of interarytenoideus. (*Lancet.*)

Treatment.—In patients suffering from debility the cause should be found and treated; chronic phthisis is such a common cause of functional aphonia that it should always be thought of in this connection. There is frequently a slight degree of laryngitis and in some the failure of adduction is "myopathic," or due to inflammation of the muscles; in these the local condition must receive appropriate treatment. When the larynx is normal the voice can nearly always be temporarily restored by any powerful local stimulation, such as the intra-laryngeal application of chloride of zinc, or any similar drug, or of the faradic current; but the aphonia usually recurs again, and succeeding applications are less effective, so that the most difficult cases to cure are those who have had much local treatment. Far better results are obtained by moral suasion, explaining to the patient that there is no serious disease; but that he is not using his muscles correctly, and that he can produce a good voice quite easily when the laryngeal mirror or tongue-depressor is in position. With a little elementary instruction in voice-production this is usually successful, the patient's confidence is restored and the voice does not again fail; in obstinate cases some perseverance in lessons on production is required. These methods have been extraordinarily successful with gassed and shell-shocked soldiers, but it must be confessed that such certain and rapid results are not always obtainable in hysterical women.

SPASMODIC AFFECTIONS

Glottic Spasm

Spasm of the laryngeal muscles produces adduction of the cords, for, though the abductors are probably affected, they are overpowered by the stronger adductor muscles.

Ætiology.—(1) In the majority of cases the spasm is a reflex set up by local irritation: foreign bodies, including the laryngoscopic mirror, irritating gases; inflammation, ulceration or tumours in or near the larynx, children being much more liable than adults to spasm from local irritation. (2) Spasm is also caused by irritation of the recurrent laryngeal nerves by enlarged glands, mediastinal tumours and, especially, by aneurysm. (3) Central nervous lesions, especially tabes. (4) Functional disturbances, frequently hysterical, often associated with globus hystericus, and sometimes excited by sexual disturbances.

Symptoms.—The attacks vary much in different subjects in severity and duration. The patient is usually aware of its onset, and clutches some support or rushes to the window. The respirations are rapid and shallow, with loud inspiratory stridor, and, in the height of a severe attack, are completely arrested with all the signs of asphyxia. The subjective sensations include a horrible feeling of anxiety, but consciousness is not lost. Many cases are less acute but persist longer, even for several hours.

Prognosis.—The attacks are practically never fatal, unless a foreign body or tumour be present.

Treatment.—During the attack amyl nitrite or chloroform may be inhaled, and ampoules of these drugs should be kept on hand. Between the attacks sources of irritation should be sought for and removed, the upper air-passages brought to a healthy condition, and the general health and mode of life should receive attention. Administration of bromides may be required when the attacks recur frequently.

Laryngismus Stridulus

Ætiology.—This is a condition, clinically similar to glottic spasm, occurring in children. It is far commoner than the spasm of adults, and it has been suggested that the asphyxial attacks of laryngismus are caused by collapse of the soft and yielding cartilaginous framework of the larynx. It is commonest between the ages of 6 months and 2 years, but may persist later; it occurs in ill-nourished, unhealthy children, usually in association with rickets, and practically always in association with adenoids.

Symptoms.—The onset is sudden and usually at night. The child wakes gasping for breath, and a series of short noisy inspirations are followed by complete cessation of breathing and terminated by a long, crowing inspiration. There are retraction of the lower ribs and epigastrium, cyanosis and great terror and distress, and in severe cases, carpo-pedal contractions, convulsions and evacuation of urine and fæces. When the attack is over the child is perfectly normal and there is no hoarseness. Slighter and less typical attacks often occur.

Diagnosis.—This is easy if the symptoms are carefully noted; the sudden attack of dyspnœa, with complete absence of symptoms in the intervals, is quite distinctive.

Prognosis.—The prognosis is somewhat grave in severe cases; an infant rarely dies in an attack, but is often worn out and succumbs to collapse of the lungs.

Treatment.—During the attacks the face and chest may be freely sponged with cold water, and the inhalation of amyl nitrite from a capsule broken in a handkerchief may be tried. The quickest relief can usually be obtained by drawing the tongue forward with a finger passed into the mouth to its base, a manœuvre easily performed by the mother or nurse. The attacks are so short and sharp that there is no time for a hot bath or the administration of bromides frequently recommended.

Prevention involves general tonic treatment, fresh air, wholesome food and correction of digestive disturbances. The removal of adenoids is of great importance, even if not large enough to be definitely obstructive, as is the treatment of naso-pharyngeal catarrh with the usual saline lotion which, in small children, may be dropped into the nostrils from a pipette. Bromides are to be avoided if possible as depressing, but 10 to 30 drops of liquid extract of grindelia may be given 3 or 4 times a day in milk or sweetened water as recommended by Eustace Smith.

CICATRICIAL STENOSIS

Ætiology.—Suicidal and other wounds, gunshot injuries and scalds frequently produce cicatricial narrowing of the lumen of the glottis. After thyrotomy a web may form across the anterior commissure. In the haste of an emergency tracheotomy, the wound has often been made too high and the cricoid cartilage cut through; in these cases it generally happens that, after the subsidence of the acute condition, dyspnœa follows every attempt to remove the tube, and a stenosis is found to have resulted from swelling and narrowing in the subglottic region. Similarly, a proportion of cases intubated for diphtheria are unable to breathe without the tube, by reason of a subglottic stenosis. Lupus and tuberculosis of the larynx can produce cicatricial stenosis, but extensive cases of the latter disease rarely progress far enough towards healing for this to occur. Syphilis is the most fruitful cause of this condition, and the great difficulty of obtaining a cure at this stage is a powerful reason for early and thorough treatment of syphilis of the larynx. Leprosy and scleroma cause stenosis, but are rarely seen in this country. The perichondritis which is an occasional complication of enteric fever, small-pox and diphtheria, commonly ends in severe stenosis.

Symptoms and Diagnosis.—The principal symptom is naturally dyspnœa, but in chronic cases it is remarkable how great may be the narrowing before dyspnœa becomes severe. The obstruction and the stridor are most marked on inspiration, in contra-distinction to tracheal stenosis where the stridor is both inspiratory and expiratory. The larynx moves downwards with each inspiration; this "respiratory excursion" of the larynx is a further diagnostic sign of laryngeal obstruction, but is not always present. The patient sits upright, with the head thrown back; whereas in tracheal obstruction he bends forward to relax the trachea.

Treatment.—In all cases with decided dyspnœa tracheotomy should be first performed, and in syphilitic cases it is important that all active disease should be arrested by thorough treatment before any attempt at dilatation be begun, and the stenosis itself will often be greatly improved by such treatment. The administration of iodides is dangerous in these cases, for the increased secretion is pent up behind the stenosis and may overwhelm the lungs. Difficulty in dispensing with the tube after tracheotomy is sometimes due to nervousness on the part of the child, and can then be surmounted by using a fenestrated tube which is plugged occasionally and by encouraging the patient to breathe through it by blowing soap-bubbles or sounding a whistle. When the tracheotomy wound is too high, a low tracheotomy should be performed and the original wound allowed to close; this is often sufficient to overcome the difficulty.

The successful treatment of severe cicatricial stenosis demands the greatest skill and perseverance on the part of the surgeon as well as the patient co-operation of the sufferer. The whole circumstances of the case should be carefully considered before advising difficult and prolonged treatment. Adult patients can live active lives with a permanent tracheotomy opening. If the stenosis be not too extreme, a fenestrated tube may be worn which can be kept plugged during the day, so that the patient may have the use of speech and respiration by the natural passages. In children and young people a permanent tracheotomy is more harmful, and the prospect of cure by dilatation is better. The best method of dilatation is by the use of intubation tubes: under anæsthesia increasing sizes are passed until the stricture is dilated as far as possible, when the largest is left in position. This must have an especially large swell to prevent its being coughed out, or, better, is fixed by a special clamp passed through the tracheotomy fistula. In this way safety is assured, and the tube in these cases may be retained for 3 or 4 months without becoming foul; at the end of this time it is replaced, if necessary, by one of a larger size until dilatation is complete.

HAROLD S. BARWELL.

DISEASES OF THE TRACHEA

INFLAMMATION OR TRACHEITIS

ACUTE TRACHEITIS

Acute tracheitis may occur from any condition leading to irritation of the mucous membrane of the trachea. When it occurs as a result of bacterial or chemical agency, the whole of the upper air-passages are usually involved in greater or less degree, and the clinical manifestations are not confined to the trachea. In some cases, however, the stress of the resultant reaction falls upon this tube, and the condition therefore requires separate consideration.

Ætiology.—1. *Microbic invasion.*—This is the commonest cause. The bacteria usually found associated with tracheitis are the so-called catarrhal organisms, such as the *Micrococcus catarrhalis*, the pneumococcus, the Friedländer pneumo-bacillus and Pfeiffer's *Bacillus influenzæ*. Less frequently

a member of the streptococcus group may be found, either alone or in association with one or more of those just mentioned. As with catarrhal inflammation of other parts of the upper air-passages, damp, cold or foggy climatic conditions predispose to tracheitis. It is more common in young and middle-aged adults than in infancy or in old age. Mouth-breathers are more liable to this condition. Exposure to sudden changes of temperature may be a factor in its onset.

Tracheitis may also occur as part of the clinical picture in some of the acute specific diseases, such as enteric fever, diphtheria, whooping-cough and measles. It is often a troublesome and distressing association or sequel of true influenza.

2. *Chemical agencies.*—Irritating or poisonous fumes and vapours may lead to a very acute form of tracheitis. It may, therefore, occur in certain occupations, unless adequate precautions are taken. The use of "poison gases" in warfare has drawn widespread attention to this form of the condition, since tracheitis was an almost constant result of certain forms of "gassing." The chief chemical irritants used in the Great War were chlorine, phosgene and yperite, or dichlorethyl sulphide, commonly known as yellow cross or mustard gas. Of these the latter was perhaps the most irritant to the trachea, and fatal cases invariably showed tracheal lesions. Direct inhalation of steam may also induce an acute tracheitis.

3. *Mechanical causes.*—The presence of a foreign body, or the invasion of the trachea by extension from malignant growth in adjacent structures may lead to a local or even to a general tracheitis. It is noteworthy, however, that the trachea is frequently spared in occupations involving the respiration of dusty air, which lead to deposits in the lungs and bronchial glands with resulting pneumonokonioses. Although a coal miner's lungs are black, yet his trachea may be practically normal.

Pathology.—The changes found in the trachea vary from simple catarrhal inflammation to intense destructive changes with ulceration, and in some cases croupous or membranous exudate. In the catarrhal forms, the mucous membrane shows changes similar to those in bronchitis. It is at first swollen, red and dry, the vessels running across the trachea being engorged and clearly visible. Then, owing to increased activity of the mucous glands, excessive mucoid secretion occurs and the mucous membrane becomes moist, after which resolution may take place, or the process may proceed to a mucopurulent stage, when the fluid on the membrane coheres to form yellowish or green tenacious pellets. Occasionally numerous red blood cells are extruded and the tracheal exudate becomes streaked, tinged or uniformly pinkish.

In some inflammations, such as those induced by poison gases or inhaled steam, the mucous membrane may be intensely engorged and actual destruction may occur, involving even the deeper structures and the cartilages, so that greyish yellow sloughs result, which on separation leave ulcers. In diphtheria the characteristic false membrane composed of necrosing fibrin, leucocytes and bacilli may be found loosely attached to the mucous membrane, as in other localisations of this process. It may be primary or secondary to faucial or laryngeal diphtheria, either by direct extension or through diphtheritic infection of a tracheotomy wound.

In influenza the pink appearance of the trachea is of such constancy in fatal cases that it has come to be regarded as one of the most characteristic

post-mortem changes found in this disease. The bright injection generally involves the lower half of the trachea, but it may occur along the whole length of this tube.

In whooping-cough the inflammatory reaction is usually less acute.

In typhoid fever small ulcers may occasionally be found in the trachea similar to those occurring more commonly in the larynx.

Symptoms.—Acute catarrhal tracheitis usually begins more or less acutely, like the common "cold," of which it is to be regarded as one form, with malaise, slight headache, and a mild degree of fever, the temperature being usually between 99° and 100° F., rarely 101° F. The patient soon experiences a sensation of irritation behind the sternum, rapidly leading to a harsh, dry cough of noisy character. The cough aggravates the retrosternal discomfort, which develops into a sensation of rawness or soreness, making the cough very painful and distressing. If the larynx is involved at the same time, the voice becomes hoarse and sometimes lost, or reduced to a raucous whisper. In tracheitis alone the voice is usually unaffected. After from 12 to 24 hours the condition passes into the mucoid stage. The cough becomes looser and less painful, and small pellets of tenacious mucus are coughed up, usually greyish or black in town-dwellers, whitish in those in rural conditions; in either case, the mucus may be streaked with blood or even tinged a uniform pink colour; in the more acute forms, it sometimes becomes yellow and more purulent. In the mucoid stage, the retrosternal soreness becomes less, the constitutional symptoms abate, while the temperature subsides and becomes subnormal. The patient often feels weak and out of health for some days, and is sometimes left with a noisy morning cough and tracheal irritation which may last for days or weeks. The aspect of the patient shows nothing characteristic. There is the general appearance of fever, malaise and discomfort. The rise of temperature and increase in pulse-rate are usually moderate. In the early stages physical examination of the chest shows no abnormality, but when exudation occurs a coarse wheeze may be audible over the trachea, particularly when the patient takes a deep breath or just before a cough occurs.

Diagnosis.—The association of catarrhal symptoms with a dry, harsh cough and retrosternal soreness, without signs of bronchitis, is almost pathognomonic. In some cases the diagnosis can be established with the laryngoscope or by endoscopy, but in most the discomfort which these examinations entail is unnecessary.

Prognosis.—This is almost invariably good, except in debilitated subjects or in those with cardiac or renal disease, in whom the process may spread to the larynx, bronchi or lungs. The usual course is from 2 days to a week, though cough and expectoration may persist for days or weeks. The condition may become chronic. To some extent the prognosis depends upon the care and treatment in the initial stage. Cases that are neglected are liable to become chronic.

Treatment.—The prophylactic and remedial treatment of acute tracheitis is practically identical with that of acute bronchitis of the larger tubes. Even in mild cases the patient should go to bed, though this may be necessary only for 1 or 2 days; but he should keep to his room till his temperature has become normal. There may be less need for expectorants than in bronchitis, and a simple saline diaphoretic mixture, with the addition later of vin. ipecac.

and tinct. camphoræ co., may be all that is necessary. Sedative inhalations, such as vapor benzoini, are specially useful, and counter-irritation to the sternal region is comforting and grateful to the patient. When a chronic noisy cough develops, a mixture containing small doses of apomorphine and tinct. chloroform. et morphin. co. often gives relief.

When tracheitis occurs as part of some specific disease, such as diphtheria or influenza, the treatment should be that appropriate to the primary disease.

In "gassing," every effort should be made to relieve the distressing and painful symptoms, and for this purpose morphine, either alone or in combination with atropine and strychnine, may be required. Various inhalations may be tried, and useless cough should be checked by sedative mixtures or by a linctus of heroin, morphine or codeine.

Chronic Tracheitis

Ætiology.—Chronic tracheitis may follow an acute attack, or it may develop insidiously in patients suffering from chronic laryngitis or bronchitis. Inhalation of cigarette smoke is a not infrequent cause. It is also sometimes a sequel of chronic rhinitis, especially with the atrophic form or ozæna. A certain degree of chronic tracheitis accompanies the specific lesions of syphilis and tuberculosis, which are described below.

Pathology.—Various degrees of chronic inflammatory lesions may be found. In chronic catarrhal tracheitis, the vessels are distended or engorged, and the mucous membrane of the trachea becomes thickened and more or less covered with mucoid or muco-purulent secretion, the histological changes being those of chronic catarrhal inflammation, namely, shedding of the ciliated epithelial cells, overactivity of the mucous glands, and sometimes thickening and induration of the submucous tissues from proliferative changes. A condition of perichondritis of the tracheal cartilages may, in this case, be observed, and this may result in a mammillated appearance in the internal aspect of the trachea. In ozæna, crusts similar to those in the nose and pharynx may form on the tracheal mucosa.

Symptoms.—The symptoms of chronic tracheitis are similar to those of the acute form. There is a sense of discomfort and irritation about the trachea and a chronic, almost dry cough, often worse in the morning. There is generally some scanty, sticky expectoration, mucoid or muco-purulent, darkened by carbon particles and occasionally blood-tinged.

There are practically no physical signs of this condition, except that the tracheal changes can be observed by the laryngoscope or by endoscopy of the trachea.

Diagnosis.—This is concerned chiefly with its differentiation from chronic changes in the trachea due to syphilis, tuberculosis or leprosy and to the effects of new growths. It must largely be made by endoscopic examination.

Prognosis.—The prognosis depends upon the cause. When this can be removed, as by treatment of predisposing conditions in the nose and throat, the outlook is good. When the tracheitis is due to other conditions, such as syphilis and tuberculosis, it depends upon the situation and extent of the other lesions and upon the treatment adopted.

Treatment.—This is, in its main features, similar to that of acute tracheitis, but climatic treatment may be of great importance. The patient may perhaps

spend the winter months in a warm or equable and clear climate with great advantage. Vaccine treatment may also yield good results. When other conditions are concerned, such as ozæna, syphilis or tuberculosis, the treatment appropriate to them should be employed as well.

CYSTS AND TUMOURS

These are rare conditions, but require careful consideration.

Cysts

Owing to weakening of the wall of the trachea, local bulging may occur, giving rise to a cystic, air-containing swelling in the neck, in direct communication with the lumen of the trachea. Such cysts are known as "tracheoceles" or "aeroceles." They are resonant to percussion and can often be temporarily reduced by pressure.

Small retention cysts may occur in the posterior wall of the trachea, from obstruction of the ducts of the mucous glands as they pass through the trachealis muscle. They are of pathological interest only, and do not give rise to symptoms.

Simple Tumours

The most important is papilloma. It occurs chiefly in children and is usually pedunculated. When it grows in polypoid form it may lead to obstruction of the trachea low down, in which case tracheotomy may fail to give relief, and death results.

Other innocent tumours occur, but are rare. They include enchondrosis from localised overgrowth of cartilage, multiple enchondroma, and osteoma from ossification of a pre-existing enchondroma. Lipoma and aberrant thyroid tumours may occur, but are very rare.

Symptoms.—These tumours produce varying degrees of tracheal obstruction, and can usually only be recognised by endoscopy. Treatment is considered under that of tracheal obstruction.

Malignant Tumours

A few cases of primary carcinoma of the trachea have been recorded. Secondary growths are not common, but the trachea is often involved and infiltrated by primary carcinoma in adjacent structures, such as the œsophagus, the thyroid, the larynx, or by the extension of secondary deposits in the cervical or mediastinal glands.

Primary sarcoma of the trachea is also very rare. The growth is usually smooth and not pedunculated. Secondary deposits of sarcoma in the trachea may occur from sarcoma of distant organs, such as the kidney; or it may be invaded directly by sarcoma originating in the thymus or other mediastinal structures, and especially by lympho-sarcoma of the mediastinal glands.

Symptoms.—The tracheal symptoms and signs are usually those of ob-

struction, accompanied by pain. When the primary growth is in the œsophagus, antecedent dysphagia and sometimes laryngeal paralysis reveal the origin of the tracheal symptoms when they occur. In this case, copious frothy mucoid expectoration is frequent, and when ulceration develops, food particles may enter the trachea, excite cough and soon lead to inhalation broncho-pneumonia or gangrene. When the growth is near the bifurcation, urgent dyspnœa is the rule, and spasmodic attacks may occur, causing the most extreme distress. In most cases of tracheal growth the characteristic clanging brassy cough (gander cough) of tracheal obstruction can be heard. The trachea may be pushed to one side and its lumen distorted and obstructed by growth in the cervical glands. In mediastinal new-growth invading the trachea, the pressure signs and symptoms characteristic of that disease usually render the explanation of the tracheal symptoms apparent.

Course.—This is generally rapidly progressive.

Diagnosis.—Intratracheal growths have to be differentiated from other causes of tracheal obstruction and the diagnosis is considered in detail under that condition. Endoscopy would afford valuable confirmation if it is practicable or desirable. In œsophageal and mediastinal new-growths invading the trachea, X-ray examination may assist in diagnosis.

Prognosis.—This is hopeless, death occurring from asphyxia or from some complication or by asthenia.

Treatment.—Treatment can be palliative and symptomatic only. In obstruction, it may be possible in rare cases to give temporary relief by a low tracheotomy, but as a rule this is impossible, owing to the presence of obstruction below any point where the trachea is accessible.

THE INFECTIVE GRANULOMATA

Syphilis

The trachea may be affected in both the congenital and acquired forms.

In congenital syphilis, a progressive cicatrisation may occur, leading to stenosis. In acquired syphilis, during the secondary stage, the mucous membrane of the trachea may become generally hyperæmic, or small raised mucous patches may develop locally. In the tertiary period, gummata may occur in the trachea, the commonest site being towards the lower end. Degenerative processes, leading to necrosis and softening, eventually result in ulceration, sometimes with local sloughing of parts of the tracheal rings. In the process of cicatrisation a progressive stenosis may develop.

Symptoms.—Symptoms are those of chronic tracheitis and tracheal irritation in both the secondary and tertiary manifestations, but in the latter, signs of tracheal stenosis may develop when scarring and healing are in progress. Laryngeal involvement occurring at the same time tends to distract attention from the tracheal lesions or to obscure them.

Diagnosis.—The diagnosis of syphilis of the trachea depends upon a careful study of the history of the case, indications of tracheal irritation, laryngoscopic or endoscopic examination, the coexistence of other manifestations of syphilis, and in their absence, a positive Wassermann reaction.

Prognosis.—If the condition is recognised early, excellent results may

be obtained by treatment, but it is obvious that where deep destructive changes have resulted, medicinal measures can only palliate.

Treatment.—Anti-syphilitic treatment should be administered vigorously, and after a course of neo-salvarsan or novarsenobillon, mercury should be given. Inunction seems sometimes of special value in such cases. In cases of stenosis of the trachea from cicatrisation, dilatation of the stricture by means of bougies introduced through an endoscope may be practicable and afford useful help.

Tuberculosis

Tuberculosis of the trachea is occasionally found post mortem in advanced cases of pulmonary tuberculosis, usually in those with extensive laryngeal involvement. Primary tracheal tuberculosis is unknown. The rarity even of secondary lesions in this tube is probably to be explained by the ciliated epithelium preventing lodgment of the bacilli.

Pathology.—Tuberculous lesions may occur at any part of the trachea, but they are more frequent in the lower part and on the posterior wall. When they occur they are usually numerous. There may be some general hyperæmia, or small tubercles, varying in size from a pin's head to a split pea, may be visible. Later, superficial ulceration occurs, forming irregular punched-out ulcers. Occasionally, the process may extend deeper, and erosion of the cartilages may occur, with the formation of sinuses and even fistulous communication with the œsophagus.

Symptoms.—Since tracheal tuberculosis is usually a late manifestation of advanced disease, its clinical indications are slight and are usually obscured by the more obvious laryngeal and pulmonary symptoms and signs, though if the process extends deeply and produces sinuses and fistulous tracks, it may become apparent. The actual tracheal symptoms are those of cough and retrosternal soreness.

Diagnosis.—This condition has to be distinguished from other chronic tracheal lesions, and a diagnosis can only be made from a careful review of the history, the general evidence of tuberculous disease and by the tracheal involvement which may be visible by endoscopy.

Treatment.—This must, from the nature of things, be largely palliative, and is in effect practically identical with that of laryngeal tuberculosis, notably intratracheal insufflation with orthoform and anæsthesin.

Leprosy

In some cases of this disease, granulomatous lesions occur in the trachea, and these may eventually give rise to tracheal stenosis, owing to the contraction of new-formed fibrous tissue. The diagnosis can only be made from the occurrence of tracheal symptoms in a case with established lesions of leprosy in other parts.

The treatment is symptomatic.

Scleroma

Although in most cases this condition affects the nose only, scleromatous lesions may be found in the trachea as a pathological curiosity. The disease

in any form is rare in England, and occurs chiefly in Poland and Austria. The nodules of granulomatous tissue in the trachea may cause partial obstruction mechanically, or, on contraction, lead to actual stenosis.

TRACHEAL OBSTRUCTION

Obstruction to the lumen of the trachea may be produced by foreign bodies, by conditions originating in the trachea, and by pressure from without.

Foreign Bodies in the Trachea

The commonest route by which foreign bodies enter the trachea is through the mouth and larynx, in the acts of breathing, laughing, yawning, sighing, or before and after coughing, when food or some foreign substance is in the mouth. A piece of bone, a stud, button, false teeth, chewing gum, peas, articles of food, nuts, grains of wheat, beads or blades of grass are among the substances which may gain entrance to the trachea in this manner. Surgical operations in the mouth and throat may lead to the inhalation of a tooth, a piece of tonsil or a mass of adenoid tissue. Material vomited from the stomach, such as food, blood clot or intestinal worms, may be inhaled into the trachea. A large blood clot in hæmoptysis may temporarily obstruct it. Foreign bodies may also gain access through the tracheal wall, such as small projectiles in wounds of the neck, a piece of new growth or tuberculous glands by ulceration through the wall.

Unless it becomes impacted, or is too large to enter one of the two main bronchi, a foreign body rarely remains long in the trachea. It either causes death with dramatic rapidity, is coughed out again, or passes down into one or other of the large bronchi or their secondary divisions, where it produces results which are described in the section on diseases of the bronchi.

Symptoms.—These depend upon the mode of entry, the size of the foreign body, and the degree of obstruction to the air current which it induces, but in general the tracheal symptoms are less urgent than those of laryngeal obstruction, and less serious than those of obstruction of one or other main bronchus. There may be intense dyspnœa, with great discomfort and alarm during the actual passage through the larynx of a small foreign body, especially if it is temporarily arrested there; but when it enters the trachea there is an almost instantaneous cessation of the acute distress, though some degree of dyspnœa may persist. The type of dyspnœa is inspiratory in the main, though a minor degree of expiratory difficulty may be apparent if the foreign body is of considerable size. There may be a definite stridor with both phases of respiration, but it is more pronounced in inspiration. If the foreign body remains loose in the trachea, which may occur if it is rounded and too large to engage in one of the main bronchial divisions, a sound of vibratory character may be heard on auscultation of the trachea, sometimes described as the *bruit de grelottement*. This may be produced by friction of the foreign body against the tracheal wall, or more commonly by the air passing over it during respiration. A paroxysmal cough may occur, caused by the foreign body irritating the sensitive posterior wall of the trachea, and during such an attack the foreign body may be forced up to the larynx,

obstruct it, or cause reflex spasm with intense dyspnœa and cyanosis and a risk of suffocation, unless it drops back, is coughed out, or removed. When sudden rupture of caseous material into the trachea occurs, the lumen may be blocked and death take place rapidly.

Course.—A foreign body impacted in the trachea may give rise to septic inflammation of its walls, with subsequent cicatrisation after removal, or it may lead to secondary infective processes in the lungs, such as purulent bronchitis and broncho-pneumonia.

Diagnosis.—The history of disappearance of some object from the mouth during coughing, breathing or laughing should give rise to suspicion of an inhaled foreign body, and this may be confirmed by seeing the object directly by endoscopy, or indirectly by means of the X-rays.

Prognosis.—This depends in the main on the nature of the foreign body, and the time elapsing before its removal. An irregular, rough or soft foreign body is more likely to induce septic complications than a smooth, hard substance. Apart from rapidly fatal results, the prognosis is better with intratracheal foreign bodies than with those reaching the bronchi. If removal is effected within 24 to 36 hours, recovery is usually rapid and complete.

Treatment.—Treatment consists in rapid removal with as little damage to the trachea and larynx as possible. This may be effected by means of forceps passed through a Killian's bronchoscope, either by the mouth or through a tracheotomy wound, a method requiring expert manipulation, or by tracheotomy alone, when the foreign body may be coughed out through the opening or be easily removed by forceps. The tracheotomy wound should be kept open by means of a dilator instead of the usual tracheotomy tube. Inversion of the patient in the hope that gravity may assist the expiratory efforts of cough is dangerous and should only be attempted after tracheotomy has been performed. Where rupture of a caseous gland or softening new-growth occurs into the trachea, an immediate tracheotomy may be necessary.

Obstruction from Cicatrisation of the Tracheal Walls

Ætiology.—This may result from any condition leading to ulceration of the tracheal walls, with subsequent healing, such as a syphilitic gumma, or less commonly other granulomata, such as tubercle, leprosy or scleroma. Another cause is cicatrisation from wounds of the trachea, accidental, suicidal or after tracheotomy, when the incision has been made too near the cricoid, or when the wound has become infected or the tube left in too long. Scarring from damage to the trachea by the inhalation of boiling or caustic liquids or even by inhaled gases may lead to stenosis.

Pathology.—The deformity of the trachea and the obstruction of its lumen depend upon the situation and the extent of the cicatricial contraction of its walls. It may be local, producing an hour-glass constriction, or involve a long extent of the tube. Occasionally, especially in syphilitic lesions, stenosis may occur at two different levels.

Symptoms.—These depend upon the degree of stenosis, the rapidity with which it develops, and the condition of the larynx, bronchi and lungs. When the stenosis is produced gradually, as in cicatrisation, a degree of obstruction may result, greater than would be compatible with life if suddenly

induced. In the early stages of a progressive stenosis, slight dyspnœa may be present on exertion, and during sleep a faint stridor may be audible, disappearing when the patient is awake. As the contraction progresses, the dyspnœa becomes more marked, and a definite and persistent stridor develops, at first inspiratory only, though expiration may become both noisy and obstructed. The patient may experience a sensation of obstruction referred to the neck or under the sternum, accompanied by pain and irritation, leading to cough, which may be dry, noisy and metallic, or accompanied by more or less frothy sputum, if the primary condition is associated with widespread tracheitis. The voice may lose tone and volume, and the patient talk more quietly than normal and with some evident effort. In advancing stenosis, sudden and alarming attacks of dyspnœa may occur, leading to cyanosis and threatening suffocation. These attacks are usually due to an accumulation of mucus at the site of the stenosis. The patient in advancing degrees of obstruction cannot lie down, and generally sits leaning forward with chin depressed. It may be noted that the extraordinary muscles of respiration contract forcibly, and yet the laryngeal excursions may be small or hardly noticeable, in contrast with those of laryngeal obstruction in which they are maximal. This distinguishing sign was first pointed out by Gerhardt, and is of value, but unfortunately it is not absolute and cannot, therefore, be regarded as pathognomonic. On auscultation over the trachea, a noisy roar may be audible, of maximum intensity near to the obstruction, whereas the breath sounds over both lungs may be deficient, although the stridor may be conducted bilaterally.

Course.—The course of cicatricial stenosis is usually progressive, unless arrested by treatment, and the dyspnœic attacks become more frequent and alarming.

Diagnosis.—Tracheal obstruction from cicatrisation has to be distinguished from laryngeal obstruction, in which the symptoms are usually more acute and more urgent. Gerhardt's sign described above may also be suggestive. It must also be differentiated from obstruction due to pressure from without (*vide infra*). The only reliable method of distinction is by direct inspection with the bronchoscope.

Prognosis.—Early syphilitic stenosis may be arrested by appropriate anti-syphilitic treatment. Obstruction due to other granulomatous conditions varies with the severity and extent of the primary lesions. Caseous material or degenerated growth ulcerating into the trachea is usually immediately fatal, or leads to death within a few days from pulmonary complications.

Treatment.—Rest, avoidance of exertion, smoking and alcohol should be advised. The patient's fears should be allayed and symptomatic treatment ordered, such as sedative inhalations or a linctus to check useless cough. In syphilitic stenosis vigorous anti-syphilitic treatment with salvarsan [1] should be given. A low tracheotomy may be necessary for an intractable stricture high up in the trachea. In some cases where an ordinary tracheotomy cannot be performed below the stricture, it may be possible to insert Koenig's long tracheotomy tube through an opening in the trachea made above it. In

[1] According to Mr. Harold Barwell, administration of potassium iodide is very dangerous, as it increases the secretion which is pent up behind the stenosis. It may be given in combination with belladonna, but it is better withheld until the severity of the condition has been relieved by salvarsan.

other cases, dilatation of a fibrous stricture by bougies passed through an endoscope may be feasible.

Obstruction from External Pressure

Pressure on the trachea may occur in the neck or in the mediastinum.

Causes of pressure in the neck.—Strangulation, throttling or garotting leads to death by occlusion of the trachea and suffocation. Enlargement of both lobes of the thyroid body may cause lateral compression of the trachea, until eventually its lumen is reduced to a narrow slit—the so-called "scabbard trachea." Irregular or unilateral enlargements on the other hand cause deviation of the trachea, with kinking of its lumen. Other less common causes of compression of the trachea are enlargement of the cervical glands from tuberculosis, malignant disease, Hodgkin's disease or leukæmia. The trachea may be pressed on from behind by a foreign body impacted in the œsophagus, or by a bony tumour arising from the vertebræ.

Causes of pressure in the mediastinum.—An aneurysm of the aortic arch may press directly upon the trachea at, or near, the bifurcation and cause obstruction. Similarly deep pressure may be caused by a retrosternal goitre, a persistent and enlarged thymus, or a thymic abscess, mediastinal glands enlarged from any cause, usually malignant disease, a dermoid cyst or a bony tumour originating in the sternum.

Symptoms.—The symptoms are in the main identical with those of stenosis of the trachea from intrinsic causes, with the special symptoms due to the primary external condition superadded.

Diagnosis.—This may be simple and obvious, as in those cases due to pressure from tumours in the neck, whereas, in those due to mediastinal pressure, it is usually only possible after a careful survey of all the symptoms, and is in brief identical with that of aneurysm or mediastinal new-growth, to which reference should be made. In some cases X-ray examination may give valuable information.

Prognosis.—This is good in obstruction due to causes in the neck other than malignant disease, but it is almost uniformly bad, indeed hopeless, in obstruction due to mediastinal causes, with the exception of abscess and some thymic conditions.

Treatment.—The treatment is that of the primary condition. In goitre and tuberculous glands, in simple tumours and some thymic conditions, operation may be possible and may effect complete cure. In those due to mediastinal pressure, especially from aneurysm or new-growth, treatment, in most cases, can be only palliative or symptomatic, and directed to the relief of pain, dyspnœa, cough and distress.

INJURY

Direct violence to the trachea has been known to cause rupture when the chin is raised upwards and the trachea is, therefore, extended.

R. A. Young.
G. E. Beaumont.

DISEASES OF THE BRONCHI

BRONCHITIS

Inflammation of the bronchi, or bronchitis, is one of the commonest maladies and may be induced by a variety of causes. These, in the main, fall into three groups, bacterial, chemical and mechanical, similar to the causes of tracheitis, which is, indeed, in many cases, a concomitant or antecedent of bronchitis, so that tracheo-bronchitis would be a more accurate designation of the majority of cases. At the same time it should be recognised that the trachea may be alone or predominantly affected, while, on the other hand, in many cases of bronchitis of the smaller tubes, the trachea may escape, or be only slightly involved.

Bronchitis is so varied in its extent and in the form and severity of its manifestations that a satisfactory classification is somewhat difficult to formulate. Fowler's classification into (1) acute bronchitis, (*a*) of the larger tubes, and (*b*) of the smaller tubes; (2) chronic bronchitis; (3) secondary bronchitis; and (4) plastic or fibrinous bronchitis, is convenient as a combined clinical and pathological grouping, but fails to separate what appear to be clinically distinct entities. We propose to consider the clinical manifestations of bronchitis according to the following classification:

1. Acute Forms—(*a*) Catarrhal bronchitis, (1) of the larger tubes, (2) of the smaller tubes; (*b*) suppurative; (*c*) secondary bronchitis; (*d*) bronchitis due to mechanical and chemical agencies; (*e*) fibrinous.

2. Chronic Forms—(*a*) Catarrhal, (*b*) suppurative, (*c*) secondary, (*d*) due to mechanical agencies, and (*e*) fibrinous.

ACUTE BRONCHITIS

Acute Catarrhal Bronchitis of the Larger Tubes

Synonyms.—This condition is often called Bronchial Catarrh, or Acute Tracheo-bronchitis.

Ætiology.—*Predisposing causes.*—Climate and latitude undoubtedly play an important part. Catarrhal bronchitis is rare in polar and arctic regions and near the equator, but is very prevalent in damp and foggy climates. In England attacks are common in late autumn, winter and early spring. It is probable that some degree of hereditary predisposition occurs, since "weakness of the chest" is common in some families. Owing chiefly to greater exposure, the disease occurs more frequently in men than in women. It is most common at the extremes of life, infancy and old age, but it is not infrequent at any age. Fatigue and privation play their part, and exposure to cold, wet or fog so frequently seems to initiate the attack that it is often regarded as the exciting cause. Scoliosis, kypho-scoliosis and other malformations or deformities of the chest predispose to bronchitis, and some of them are induced or aggravated by bronchitis early in life. Chronic cardiac and renal disease both render their subjects more liable to bronchitis, as do also conditions of the nose and pharynx which lead to mouth-breathing, in consequence of the inhalation of air which is unwarmed and

unfiltered by the nose. In childhood, dentition seems to be a frequent predisposing condition.

The exciting cause is usually one of the catarrh-producing organisms, and one or more of the following may be found in the sputum: the pneumococcus, Friedländer's pneumo-bacillus, streptococci, *Micrococcus catarrhalis*, staphylococci, *M. tetragenus*, and occasionally *Bacillus coli communis*. It may also be caused by the *Spirochæta bronchialis* (see p. 189). In health, the bronchial mucosa is in all probability sterile, though this has been disputed, and it is possible that a "carrier" condition may occur here as in the upper air-passages.

Pathology.—The changes induced in the bronchi are similar to those in the nasal mucosa in coryza and in the trachea in tracheitis. Three stages may be described: An initial dry stage, when there is active hyperæmia of the bronchial mucosa, with exudation into the submucous layer, causing temporary diminution of the bronchial secretion from occlusion of the mucous ducts. The second or mucoid stage is associated with copious discharge of mucoid secretion, owing to increased activity of the mucous glands, this secretion being mixed with shed ciliated epithelial cells and scanty leucocytes. Sometimes in acute cases a few red blood corpuscles are present. The third stage is that of resolution, though not infrequently a muco-purulent stage occurs, when the sputum becomes less copious and greenish in colour from large numbers of pus cells.

In fatal cases the lung tissue may appear slightly distended and red, while the bases may be sodden from œdema. On section, the bronchi appear injected and the mucosa is swollen. On squeezing the lung, beads of mucoid fluid or muco-pus exude from the cut ends of the bronchi. There is no consolidation and the lung tissue floats in water.

Symptoms.—An attack of acute bronchitis generally begins suddenly, with malaise, aching in the limbs, and a sense of oppression in the chest. If the trachea is also involved, there is the characteristic feeling of rawness under the sternum. The temperature rises, varying from 99° to 100° F. in mild cases to 103° F. in more severe ones. The cough is at first dry, irritating and ineffective, but in a few hours it becomes looser. The sputum in the early stage is scanty, tenacious and sometimes streaked with blood; it then becomes copious, mucoid and frothy in character, and is found to contain mucus, shed epithelial cells, leucocytes and red blood corpuscles; later it lessens in quantity and may become thick, yellow and muco-purulent. With the onset of expectoration there is generally an abatement in the symptoms, the rawness under the sternum disappears, and the feeling of pain or soreness about the pectoral muscles and the costal attachments of the diaphragm lessens. The febrile reaction may last only 3 or 4 days, but the cough and expectoration may go on for 10 days or longer, gradually diminishing, until they are present only night and morning, and then cease completely.

In the early stage the patient is flushed and the breathing may be slightly increased in rate, but it is rarely or never laboured, unless emphysema co-exists. Vocal fremitus is unaltered, but rhonchal fremitus may sometimes be felt over one lung or both. The chief physical signs are discovered only on auscultation. The breath sounds may be harsher and higher-pitched, particularly in infants and children, but they remain vesicular, and expira-

tion may be prolonged. The voice conduction is unaltered. As a rule rhonchi, either sonorous or sibilant, according to the size of the bronchus in which they are produced, are audible over both lungs and during the mucoid stage bubbling râles may be heard, especially at the bases.

Complications and Sequelæ.—Bronchitis may go on to broncho-pneumonia or may be followed by lobar pneumonia, fibroid induration or bronchiectasis. It may lead to chronic bronchitis, or be followed by active tuberculosis. Occasionally acute interstitial emphysema may result from violent coughing.

Course.—This is variable. The patient may be convalescent in from 7 to 14 days, but cough, expectoration and a condition of debility may continue for several weeks, though, in this case, the possibility of pulmonary tuberculosis should always be considered.

Diagnosis.—The diagnosis of bronchitis is usually easy, owing to the characteristic rhonchi, but it is important to differentiate primary bronchitis from bronchitis occurring as a secondary condition in acute specific fevers and other diseases.

Prognosis.—Bronchitis of the larger tubes is rarely fatal, except when it occurs in infants or the aged, or as a complication of advanced cardiac or renal disease.

Treatment.—*Prophylactic.*—This consists in the avoidance of stuffy, ill-ventilated rooms and places of entertainment when catarrhal infections are rife. In mouth-breathers, steps should be taken to deal with the conditions of the naso-pharynx inducing this habit, and instruction in normal breathing given. In dusty occupations, suitable measures should be taken to minimise the irritant particles in the air, as is now done in most factories and workshops. Where poisonous gases have to be encountered the excellent form of gas-mask evolved during the war should be utilised.

Prophylactic inoculation by vaccines, either from stock mixtures such as are now available, or from autogenous cultures, are now being extensively used, and with some success. Detoxicated vaccines are also used for this purpose, so that larger doses can be administered. An autogenous vaccine is usually to be preferred, if possible. The dose given depends upon the organism and varies from 1 to 50 or 100 millions. Two or three doses at intervals of 7 to 10 to 14 days are usually given in the case of the stock vaccines, whereas with the autogenous a course of 6 to 12 gradually increasing doses is given at intervals of about a week.

General.—No matter how mild the attack may be at the onset, the patient should be kept in bed. This may only be necessary for 1 or 2 days, but he should keep to his room till his temperature has returned to normal. The Turkish bath taken by some patients at the first onset is unwise and should be discouraged. The room temperature should be kept at 60° to 65° F. While the temperature is raised the diet should be the ordinary, simple, liquid diet suitable to febrile conditions, namely, milk, weak tea, cocoa and simple gruels, broths or one of the many invalid foods. The patient is often thirsty, and warm or hot demulcent drinks, such as toast and water, fruit juices in hot water, and linseed tea sometimes afford great comfort. The air of the bedroom may be moistened by means of a steam kettle in the dry stage, but the use of a steam tent is to be avoided. Local applications over the sternum, acting as counter-irritants, seem to give some relief to the

distressing soreness so often complained of. A mustard leaf or one of the medicated wools is the most easy to apply, but a linseed poultice, antiphlogistine or a liniment, such as camphorated oil or the acetic turpentine liniment, may be ordered. Some patients find a cold or hot compress to the neck comforting. Medicated inhalations may be used, either in a special inhaler or in a domestic substitute, such as a jug. At first vapor benzoini —1 drachm to the pint—is the most comforting, but in later stages vapor olei pini sylvestris or a dry inhalation of creosote, terebene and spirits of chloroform may be useful. It is often wise to start treatment with an aperient, unless this is contra-indicated. In the dry stage, a simple saline diaphoretic mixture may be given, with vin. ipecacuanhæ or vin. antimoniale in small doses. One-drop doses of tincture of aconite are also sometimes given. When expectoration starts it may be encouraged by saline and stimulating expectorants, such as ammonium chloride and carbonate, combined with squills and flavoured with syrup of tolu or of Virginian prune. For the first night it may be well to give 10 grains of Dover's powder to relieve discomfort and secure sleep.

During convalescence the patient should take care to avoid chill and should be given a more liberal diet. A mixture of strychnine and phosphoric acid may be given for a few days, and a linctus or lozenge containing small doses of heroin or other sedative, to lessen the ineffective cough, which not infrequently occurs. Convalescence is usually shortened by a few days' stay at the coast, especially the south.

When bronchitis occurs as a part of some specific disease, such as diphtheria or influenza, the treatment should be that appropriate to the particular disease.

Catarrhal Bronchitis of the Smaller Tubes

Synonym.—Capillary Bronchitis.

It is open to question whether this condition exists as a separate entity. When the finer bronchi and bronchioles are inflamed the alveoli invariably become involved, since very little swelling of the bronchiolar walls is sufficient to occlude the lumen of the tube, with the inevitable production of an area of lobular collapse. The transition from this condition to actual lobular pneumonia is a very small one. In any case, the causes, the symptoms and the treatment of capillary bronchitis and broncho-pneumonia are identical. (See Secondary Broncho-pneumonia.)

Acute Suppurative Bronchitis

Synonyms.—Sometimes called Acute Purulent Bronchitis, or Suffocative Catarrh.

This condition was brought into prominence during the recent Great War. In 1916 and 1917 it appeared in epidemic form amongst the British troops in England and France. Although it was then regarded by some observers as a new disease, it is more probable that it was, in reality, an epidemic form of a condition usually rare and sporadic and previously termed "suffocative catarrh." That name has unfortunately been applied loosely to a number of conditions associated with acute dyspnœa.

Ætiology.—*Predisposing causes.*—The exceptionally severe winter of 1916-17, together with conditions of overcrowding in huts and billets, were undoubtedly concerned in the epidemic just mentioned. The condition affects young adults chiefly, and is much more common in men. Over-exertion, fatigue and debility predispose to it, but the disease may occur in robust and healthy persons. A history of chill may be given, but often no obvious cause can be discovered.

Exciting cause.—The organisms usually found are the pneumoccocus and Pfeiffer's ***Bacillus influenzæ***, the latter being reported in 90 per cent. in some series of cases. The ***Micrococcus catarrhalis*** is also sometimes present.

Pathology.—A very intense inflammation occurs in the medium-sized and small bronchi, leading to an exudate rich in leucocytes. The inflammatory process may extend to the alveoli, which then contain a fibrinous fluid, with entangled red cells. The condition occurs in both lungs and is usually almost universal, no portion being spared. Post mortem the lungs are heavy and red in colour. On section the bronchi are found to contain a thick yellow purulent fluid. Small areas of collapse and sometimes of broncho-pneumonic consolidation are seen, and there is usually œdema of the bases. Plastic pleurisy is not infrequent, and the glands at the root of the lung are enlarged.

Symptoms.—The onset is usually abrupt, often in young people apparently in robust health. A definite chill may occur, or only coryza and general malaise, with aching of the muscles. The temperature rises quickly and may reach 104° F. early in the disease. A cough soon develops and extreme dyspnœa is a characteristic feature. Expectoration starts early, often on the second or third day. At first it may be streaked with blood, but it soon becomes yellowish green and nummular; it consists of almost pure pus; there is often as much as 5 or 6 ounces in 24 hours. In most instances there is great prostration. In grave cases the patient becomes unconscious and loses control of the sphincters.

There is intense cyanosis, the face, lips and ears being purple. Respiration is rapid, 30 or 40 per minute, and the accessory muscles are often in full action. Palpation and percussion may not show any abnormality, though slight dullness is sometimes present at the bases. At first no signs may be discovered on auscultation, but soon the breath sounds become largely obscured by medium-sized bubbling râles, often audible from apex to base, both front and back. The pulse is frequent, the right heart may dilate and the heart-sounds become weak.

Complications and Sequelæ.—In severe cases recurrent bronchitis, broncho-pneumonia, fibroid disease or emphysema may follow.

Course.—In favourable cases complete restoration to health results. In severe cases the course is rapid, the patient becomes comatose from toxæmia, expectoration ceases and death occurs from exhaustion in 2 or 3 days from the onset. In other cases the disease may last for weeks and proceed to recovery or death.

Diagnosis.—The occurrence of marked dyspnœa and cyanosis early, the expectoration of copious pus, and the widespread râles without dullness are very suggestive of acute suppurative bronchitis. The disease must be differentiated from other conditions described as acute suffocative catarrh, that are associated with extreme dyspnœa and cyanosis.

Acute pulmonary œdema is usually afebrile, and the sputum is albuminous, frothy and copious. The condition leading to it, such as cardiac or renal disease, may be apparent.

Capillary bronchitis or broncho-pneumonia may give rise to difficulty, but in these conditions the sputum is scanty, tenacious, sometimes rusty, and but rarely purulent; moreover, cyanosis and dyspnœa develop late and depend upon the extent of the disease and the condition of the right side of the heart.

Pneumonia of the wandering type may simulate this condition, but the character of the signs, with dullness and tubular breathing, and the rusty sputum, usually render diagnosis easy.

Prognosis.—This is very grave. The mortality is high, often as much as 50 per cent. Cases extending to 3 weeks or more with swinging temperatures usually recover.

Treatment.—Cases of this disease should be isolated. If there are indications of an epidemic spread, prophylactic inoculations with a vaccine made from the special strain of pneumococci concerned may be useful in limiting it. When once the disease has set in, unfortunately little except symptomatic treatment is available. The steam tent and the inhalation of medicated vapours, such as vapor benzoini, may give a little relief to the dyspnœa. Oxygen has not been found beneficial, though it may be tried. Venesection may give temporary relief, but produces no lasting effect. Ammonium carbonate and potassium iodide are generally recommended. Stimulants, such as brandy and strychnine, should be given freely, and hypodermic injections of camphor in sterile oil up to 10 or 20 grains a day may be given. Vaccines have so far not proved of any curative value.

Secondary Bronchitis

Ætiology.—Bronchitis, usually of catarrhal type—indistinguishable as regards symptoms and signs from primary acute catarrhal bronchitis—occurs as a definite part of many acute infectious diseases and as a complication in others. Among these may be mentioned measles, whooping-cough, influenza, the enteric group, small-pox, diphtheria, malaria and plague. Acute nephritis of infective origin is often accompanied by acute bronchitis. Other conditions associated with bronchitis are pulmonary tuberculosis, glanders, secondary syphilis, pleurisy and gunshot wounds of the chest.

Diagnosis.—Bronchitis is easy to recognise, but it is important not to overlook the fact that it may not be the primary condition. In all cases of bronchitis in the early stages, the possibility of a primary acute specific infection should be borne in mind. The diagnosis is also of importance in regard to treatment—for example, in malaria, nephritis and syphilis, in which treatment directed to the primary condition may be more helpful than the ordinary treatment of catarrhal bronchitis.

Bronchitis due to Mechanical and Chemical Agencies

Ætiology.—*Mechanical.*—Attacks of acute bronchitis may be caused by the inhalation of dust-laden air. In occupations where the worker is liable to inspire fine particles of carbon, silica, steel, iron or kaolin, acute bronchitis

may result, but more often these conditions lead to chronic bronchitis and pneumokoniosis. Pressure on a bronchus by aneurysm or new-growth, or irritation by the presence of a foreign body, may induce local acute bronchitis. The symptoms and signs are practically identical with those of the catarrhal form and need no special description.

Chemical.—Acute bronchitis may follow the inhalation of chemical irritants, either as a result of occupation, accidents, attempts at suicide, or the use of poison gases in warfare. Special attention has been drawn to this subject by the large number of cases of "gassing" dealt with in the Great War. Death not infrequently occurred, much acute suffering was caused, and some permanent damage has resulted in many cases which recovered. "Mustard gas" produces its chief effects upon the skin, the eyes and the bronchi. A fibrinous exudate forms on the mucosa as a false membrane, which separates as a slough. The suffocative gases chlorine and phosgene affect the alveoli primarily and more intensely. Chlorine inhaled in a concentration of 1 in 10,000 causes a rapid alveolar flooding with a serous and highly albuminous fluid, and if the victim does not die at once he is liable to suffer from an acute bronchitis. A condition called bronchiolitis fibrosa obliterans has been described as a sequel.

Symptoms.—These are similar to those of acute catarrhal bronchitis, but there is great pain, distress and almost constant cough, often with copious expectoration.

The treatment is referred to under the heading of Tracheitis, and is, in the main, symptomatic and directed to the relief of pain, useless cough, and distress

Acute Fibrinous Bronchitis

Synonym.—Acute Plastic Bronchitis.

Definition.—A comparatively rare acute disease in which there is inflammation of the bronchi, with the formation of casts. These may be hollow or solid, and are coughed up in the expectoration.

Ætiology.—The cause of the disease is unknown. It is more common in males, and is met with both in children and in adults. It may begin as a primary catarrhal bronchitis, or develop as a complication of enteric fever, measles or pulmonary tuberculosis. Such organisms as the pneumococcus or a streptococcus may be found in the casts.

Pathology.—The casts may involve the main bronchi only, or more frequently the smaller ones and the bronchioles. They are greyish white, solid or tubular, and when large, bear the impress upon their exterior of the bronchial walls in which they have been enclosed. Thus, when a cast extends up to the lower portion of the trachea, the indentations made by the tracheal rings may be seen impressed upon it. The fine terminations generally show a spiral moulding. Chemically, they consist of fibrin or of fibrin and mucin. Post mortem, the casts may be seen in some places *in situ*; in other areas the bronchi from which they have been expelled may be recognised. The bronchial mucous membrane is at times acutely inflamed, red in colour, with the lining epithelial cells desquamating, or it may appear pale and unaffected. There is usually a certain degree of emphysema, and there may be collapse of lung tissue beyond the site of obstruction.

Symptoms.—The disease generally begins somewhat abruptly with a cough and malaise. In the course of a few days the patient becomes considerably worse, dyspnœa develops and a certain degree of pyrexia, but the temperature is often not more than 99° or 100° F. The dyspnœa becomes more intense, and is the prominent and all-important symptom. The face is seen to be cyanosed, the alæ nasi and the accessory respiratory muscles are in violent action, sometimes with retraction of the intercostal spaces. There may be diminished movement of the chest, either bilateral or unilateral. If there is unilateral pulmonary collapse the heart may be slightly displaced towards the same side. Vocal fremitus may be normal or locally diminished. The percussion note is somewhat hyper-resonant over the anterior chest-wall, but behind there may be some degree of dullness over one or other lobes. If the bronchi are unilaterally affected there may be dullness limited to one lower lobe, with diminution of air entry and no adventitious sounds. Vocal resonance over the affected area is lessened. There is usually some diffuse bronchitis, as indicated by the presence of rhonchi or râles. Marked stridor is sometimes heard with respiration. A special sign, the " bruit de drapeau," has been described when the cast lies free in the bronchial lumen. It is a dry clicking sound, caused by the flapping of the cast against the wall of the bronchus as the air passes over it. The ordinary sputum does not show any peculiarities. It may, however, show Curschmann's spirals, Charcot-Leyden crystals and eosinophile cells, and it may be absent until the crisis occurs. This consists in the expectoration of the cast after a violent fit of coughing. The cast may be stained with blood, or there is sometimes actual hæmoptysis. The peculiar nature of the expectoration often escapes notice, unless it is examined by floating in water, when a large intact cast is revealed. The dyspnœa ceases immediately after the cast has been expelled.

Complications and Sequelæ.—Emphysema may occur as the result of the violent coughing, or the disease may become chronic, recurring at intervals of varying duration. The most serious complication is laryngeal obstruction, caused by the cast becoming impacted between the vocal cords.

Course.—The disease is generally self-limited, terminating with the separation and expectoration of the cast. The acute stage does not, as a rule, continue for more than 12 to 24 hours.

Diagnosis.—The stridor and respiratory obstruction are suggestive of œdema of the glottis, but auscultation will show that the site of the lesion is lower down the respiratory tract. Asthma, and all causes of laryngeal and tracheal obstruction, must be excluded. The dyspnœa and the presence of signs localised to one lobe may suggest an active lobar collapse, or a lobar pneumonia, but the dyspnœa is more intense than is met with in either of these conditions. Casts are expectorated in diphtheria, pneumonia, chronic disease of the heart, pulmonary tuberculosis and hæmoptysis. The casts of acute fibrinous bronchitis are firmer than those found in these affections, and are expectorated in long pieces, showing the many branches and bifurcations of the bronchial tree.

Prognosis.—The immediate outlook is fair. Death may occur in the first attack, or recurrences may take place, which lead to an increasing degree of emphysema, with its usual results. The ultimate prognosis is, therefore, not good.

Treatment.—The patient should be kept in bed and treated as a case

of acute bronchitis. Inhalations of medicated vapours often afford relief. Potassium iodide is believed to expedite the separation of the cast. Intra-tracheal injections of olive oil or lime water have been recommended, as the casts tend to dissolve in the latter. Tracheotomy instruments should always be at hand in case of laryngeal impaction.

CHRONIC BRONCHITIS

Chronic bronchitis is perhaps even more difficult to classify than the acute varieties, each one of which may have its counterpart in chronic form, so that the same classification may be followed. At the same time it must be admitted that, especially in the catarrhal forms, the clinical manifestations are somewhat varied.

Chronic Catarrhal Bronchitis

Ætiology.—The causes are practically identical with those of the acute form, of which it is in most cases a sequel.

This affection may commence at any age, although it is more common in middle life and with advancing years. Men are more frequently affected than women. It seems also to have a special incidence in some families. It is more common in damp and foggy climates, and is favoured by urban conditions and by dusty occupations. It starts each winter with a more or less acute catarrhal attack, but each year the summer intermission becomes shorter, until the bronchitis persists throughout the year. It tends to produce emphysema and is aggravated in turn by this condition. It is especially favoured by cardio-vascular lesions, such as valvular defects and arterial disease; also by gout, chronic nephritis, syphilis and alcoholism. Conditions associated with chronic cough predispose to it, notably emphysema, asthma, arrested pulmonary tuberculosis, mouth-breathing and cigarette smoke inhaling.

The bacteria found are practically identical with those in acute bronchitis, the commonest being the pneumococcus, Friedländer's pneumobacillus, ***Micrococcus catarrhalis***, streptococci and staphylococci. Mixtures of two or more of these may be present. A rarer cause is bronchial spirochætosis, from infection with the *S. bronchialis* (see p. 189).

Pathology.—The bronchi show chronic inflammatory changes of a catarrhal nature. The walls are thickened from chronic hyperæmia and also from productive changes in the connective tissues. The mucous glands may be hypertrophied or atrophied, and there may be widespread desquamation of the ciliated epithelial lining of the bronchi. In long-standing cases there is usually some peribronchitis, leading to cylindrical bronchiectasis and distortion of the bronchi by fibrosis. There is almost invariably a greater or less degree of emphysema, which may be generalised or only marginal. Post mortem, the lungs are generally red and somewhat engorged, but if much emphysema has resulted they may be paler than normal. On squeezing the lung after section, pus or muco-pus exudes from the cut bronchi, and there is usually some evidence of œdema at the bases.

Symptoms.—A patient with chronic bronchitis complains of his "chest." By this he means that he suffers from cough, expectoration and shortness of

breath on exertion. The cough varies greatly in its severity. During the warm weather the patient may be completely free, and yet suffer for years from a winter cough. It may occur frequently throughout the day and in attacks at night, or only in the mornings and evenings.

The expectoration varies considerably in quality and quantity, so much so that the old classifications of chronic bronchitis were based on this factor. Thus, there may be practically no sputum or only small tenacious pellets, the "crachats perlés" of Laennec, which gave rise to the name "catarrhe sec": on the other hand, there may be a profuse expectoration resembling unboiled white of egg diluted with water, constituting the form described as "pituitous catarrh" or "bronchorrhœa serosa." Usually the sputum is mucous or muco-purulent and contains greyish-black particles mixed with a frothy fluid. The dyspnœa is largely due to the accompanying emphysema, and so indicates the degree of chronicity of the disease. At first the patient may only notice that he gets out of breath on going upstairs or on mounting slopes, but later even walking on the level causes dyspnœa.

Slight rises of temperature occur in the acute exacerbations of the catarrhal process. Slight cyanosis is frequently observed, especially after exercise, when the accessory respiratory muscles are called into play. Sometimes rhonchal fremitus is felt. Movement of the chest is restricted by emphysema, and the percussion note then becomes hyper-resonant. On auscultation, expiration is prolonged and sonorous or sibilant rhonchi are heard all over the lungs, with bubbling râles if there is thin secretion in the smaller bronchi. On the other hand, rhonchi may be scanty or only occasionally heard. Voice conduction is unaffected. The fingers may be slightly clubbed, and further evidence of venous obstruction apparent in the dilated venules on the cheeks or along the costal attachments of the diaphragm.

Complications and Sequelæ.—The following changes may occur in the lungs—peribronchial fibrosis, bronchiectasis and emphysema. Asthma or attacks of bronchial spasm sometimes form a complicating factor in chronic bronchitis, especially in the cases of so-called bronchorrhœa. The increased cardiac strain may lead to right-sided dilatation, with basal pulmonary congestion, ascites and œdema of the legs. Late in the disease, as the result of the cyanosis, a peculiar form of confusional delirium is met with, which is worse at night. Trophic lesions, such as dermatitis herpetiformis and pulmonary arthropathy, are occasionally seen.

Course.—The disease once firmly established, unless relieved by suitable climatic treatment, remains chronic and becomes progressively more severe as further damage is wrought in the lungs with each hibernal exacerbation. As the emphysema develops, a vicious circle is initiated, the aerating power of the lungs diminishes, and finally cardiac failure ensues.

Diagnosis.—Chronic bronchitis must be distinguished from pulmonary tuberculosis, bronchitis secondary to heart failure, and from bronchiectasis. In tuberculosis with bronchitis there is generally wasting, and often flattening of the chest-wall, owing to fibrosis of the lungs. In all cases where the summer intermission of the symptoms fails suddenly rather than lessens gradually, tuberculosis should be suspected. The diagnosis is clinched by the presence of tubercle bacilli in the sputum. In bronchitis secondary to heart failure, in addition to the cardiac signs, the râles in the lungs are chiefly basal and the rhonchi are not so universally distributed. In bronchiectasis

the signs are usually characteristic and limited to one lobe. The X-rays may afford useful aid in diagnosis.

Prognosis.—The immediate prognosis is good, the ultimate is bad. Much depends upon the patient's social condition and opportunities for treatment, especially in respect to climate. The expectation of life of a patient suffering from chronic bronchitis is considerably shortened.

Treatment.—Those subject to chronic bronchitis should live in a warm, equable and dry climate. In England the south-western districts are best, but it is advisable to winter farther afield if possible, either on the Riviera, the north coast of Africa, or in Madeira. High altitudes should be avoided if emphysema is present or if there are cardiac complications. Exposure to wet and chill is dangerous. The question of occupation is often difficult. Much time should be spent out of doors, provided that the patient is not exposed to the inclemencies of the elements; and, further, the work undertaken must not involve severe muscular efforts, or the inhalation of dusty or irritant particles.

In England it is difficult to find an outdoor occupation conforming with these desiderata, consequently light indoor work in a good atmosphere should be advised. Clothing should be warm but light, and afford special protection to the chest without overloading, as some patients are liable to do. Excesses in diet are to be avoided, also alcohol and heavy smoking. The general nutrition should be well maintained, and many patients, especially those of spare habit, seem to derive great benefit from cod-liver oil during the winter months.

If cough is troublesome and expectoration tenacious or scanty, various combinations of expectorant remedies are useful, such as ammonium carbonate or chloride, vin. ipecacuanhæ, preparations of squills or senega, with tolu, liquorice or Virginian prune as flavouring agents. A simple saline mixture, such as the "Mist. sodæ cum æthere chlorico"[1] of the Brompton Hospital Pharmacopœia, in the morning or at night, may help to "clear the tubes" and give the patient a spell of freedom from cough. In older patients the ether and ammonia mixture may be given, and in cases with bronchial spasm potassium iodide with anti-spasmodics, such as stramonium, lobelia, belladonna or grindelia, may be of great value. Various antiseptic drugs, such as turpentine ♏ x, terebene ♏ v–x, creosote ♏ iij in capsules or perles, have been recommended, and the elixir thymi et diamorphin. ℥i. Sedative lozenges, such as the compound liquorice, heroin or codeine, are often useful in checking useless cough. Intercurrent attacks of acute bronchitis must be treated on the principles described under that condition and the patient kept indoors or in bed, as may be necessary. When an advanced degree of emphysema coexists the treatment appropriate to that condition should be applied. Sometimes benefit may follow the use of the compressed air chamber. When failure of the right heart ensues, with visceral engorgement, the treatment must be modified suitably as described under emphysema. Liniments applied to the chest wall, especially those containing camphor, turpentine or belladonna, are soothing and afford relief. Care should be taken that any tendency to constipation is checked. In some cases, especially when the predominant organism is the ***Micrococcus catarrhalis*** or Friedländer's

[1] R. Sodii bicarb., grs. x; sodii chlorid., grs. iij; sp. chlorof., ♏ v; aquam anisi ad ℥i.

pneumo-bacillus, an autogenous vaccine prepared from the sputum ameliorates the symptoms. This should be considered especially in cases unable to undergo suitable climatic treatment.

Chronic Suppurative Bronchitis

Synonym.—Fœtid Bronchitis.

Ætiology.—This condition is not sharply defined and is not a specific and separate nosological entity, but it is a convenient group to include cases with fœtid purulent sputum. In some forms of chronic bronchitis the secretion may from time to time accumulate in the bronchi and prove offensive on expectoration. In some instances this condition becomes chronic and the expectoration is fœtid up to the time of death.

Pathology.—There is chronic inflammation of the bronchi, with marked peribronchial thickening. The bronchial secretion becomes purulent, and ulceration of the bronchial wall may occur. Post mortem, the lungs are soft, and on section some broncho-pneumonic areas, with œdema of the bases, may be seen. Pus of an offensive nature exudes from the cut ends of the bronchi.

Symptoms.—These resemble those found in chronic bronchitis, with, in addition, the unpleasant characteristics of the sputum. In the latter, Dittrich's plugs may be found. These are small, yellowish bodies, with an intensely offensive odour, composed of compact secretion.

Complications and Sequelæ.—Ulceration of the bronchial walls, abscess or gangrene of the lung, and areas of broncho-pneumonia may develop. As with bronchiectasis, pyæmia sometimes ensues, with the formation of secondary abscesses in the brain.

Course.—The disease is progressive, but in the early stages there may be long remissions in which the sputum is not offensive although the bronchitis persists.

Diagnosis.—The sputum is offensive in abscess and gangrene of the lung, bronchiectasis and interlobar empyema. X-ray examination of the chest is of great value in revealing these conditions, but they can generally also be recognised by their characteristic signs.

Prognosis.—As the disease becomes firmly established the patient's strength is gradually undermined from the absorption of toxins, and death ensues in the course of a few years, either from exhaustion, toxæmia or pyæmia.

Treatment.—An endeavour should be made to lessen or prevent the offensive character of the sputum. For this purpose creosote or garlic may be administered, as in bronchiectasis. Creosote vapour baths are also of great value. Apart from this, the treatment is as for chronic bronchitis.

Chronic Secondary Bronchitis

Chronic bronchitis is a common association of chronic cardiac and renal disease, and possibly also of gout. Its clinical characters do not need special description. It is only necessary to emphasise, as in the acute forms, the importance of recognising that the bronchitis is not the essential condition, and that treatment must be directed especially to the primary disease.

Chronic Bronchitis from Mechanical and Chemical Agencies

This usually proceeds to interstitial changes in the lung, and these results may be studied more conveniently under the heading of the pneumokonioses.

Chronic Fibrinous Bronchitis

Acute fibrinous bronchitis has been described above. In certain cases of chronic catarrhal bronchitis a fibrinous exudate may occur from time to time, with the formation of intrabronchial casts. There is then cough and dyspnœa, which abate with the expectoration of the cast. It therefore very closely resembles acute fibrinous bronchitis, and the treatment indicated is that described above.

TUMOURS OF THE BRONCHI

Tumours arising in the bronchi are somewhat uncommon. They may be (*a*) simple, or (*b*) malignant.

Simple tumours.—The following varieties occur: Adenoma, lipoma, myxoma, papilloma and chondroma. Any of these may lead to bronchial obstruction and, in consequence, to either collapse or bronchiectasis, but otherwise they rarely give rise to symptoms or physical signs, and they are for the most part only of pathological interest.

Malignant tumours.—Primary carcinoma or sarcoma may originate in the bronchi, but both are rare. In carcinoma the growth is usually of the columnar type, and presumably arises from the lining epithelium of the bronchi or from that in the mucous glands. In some instances secondary deposits of carcinoma may follow very closely the paths of the main bronchi.

Sarcoma may originate in the connective tissue of the bronchial walls. Even after death it may be difficult to establish the bronchial origin of an intrathoracic new growth. During life it is impossible to do so, since the symptoms and signs are indistinguishable from those of new growth of the lung, to which the reader is referred.

THE INFECTIVE GRANULOMATA

Syphilis.—During the secondary stage, a generalised hyperæmia of the bronchial mucous membrane may occur, giving rise to slight bronchial catarrh with the usual symptoms and signs, a condition that has been called syphilitic bronchitis. It is frequently beneficially influenced by anti-syphilitic treatment. In the tertiary stage, gummata may form in or near the large bronchi. They tend rather to fibrosis and contraction than to softening and ulceration, although the latter processes may occur. Contraction may lead to bronchial stenosis, with the symptoms and signs described below, or to extensive peribronchial inflammation and bronchiectasis. If the gummata extend into the lung, as may happen in rare instances, destructive lesions with cough, expectoration and hæmorrhage may result. This condition is more fully described in the section on pulmonary syphilis.

TUBERCULOSIS of the bronchi occurs as part of pulmonary tuberculosis and does not require separate description.

LEPROSY.—The bronchi may be involved in this disease, with the production of cellular infiltration and even nodule formation. At first, these lesions may produce bronchitis, but they are progressive and lead to cough, expectoration, wasting and asthenia. The general clinical picture may simulate chronic pulmonary tuberculosis, from which it is distinguished by the presence of leprous lesions elsewhere, and the absence of tubercle bacilli from the sputum.

BRONCHIAL STENOSIS AND OBSTRUCTION

Obstruction of the main bronchi or of their subdivisions within the lungs may arise from causes within the bronchi or from conditions outside them, and these require separate consideration. It is important to emphasise the fact that in both conditions the symptoms differ according to whether the obstruction is sudden and complete, in which case collapse of the corresponding lung is the rule, or whether it is partial and more gradual, when bronchiectasis usually results.

1. INTERNAL CAUSES

These are most conveniently considered in two groups—(*a*) Foreign bodies; (*b*) those due to cicatrisation of the bronchial walls.

(*a*) FOREIGN BODIES IN THE BRONCHI.—These usually gain access through the larynx and trachea by inhalation. Any inhaled foreign body that is small enough to pass down the trachea may reach a main bronchus, more commonly the right, or if it is small it may pass into one of the secondary bronchi. It may at once become impacted, or be moved by cough, but unless it is expelled in this way, it is sooner or later drawn into the smallest bronchus that will receive it, and there becomes impacted.

The recorded varieties of foreign body thus reaching the bronchi are very numerous, but among the more common are pieces of bone, beads, pins, coins, ear-rings, studs, pencils, fruit stones, grains, grasses, beans, nuts, teeth and pieces of tonsil or adenoid growths after tonsillectomy. Even a living fish has been inhaled into a bronchus. Foreign bodies may reach the bronchi through a tracheotomy wound, or a gland may ulcerate into the lumen of a bronchus. Broncholiths and pneumoliths, calcareous particles originating in the bronchi and lungs respectively, may be inhaled into a bronchus instead of being expectorated.

Pathology.—The pathological changes resulting from a foreign body in a bronchus depend upon the nature of the foreign body, the duration of its stay, the size of the bronchus obstructed by it, and the degree of obstruction induced. If the foreign body is smooth and comparatively little septic, and if it be removed within 24 hours or so, complete recovery after a very mild local inflammatory reaction may be expected. If, on the other hand, the foreign body is rough, or soft and laden with septic organisms, acute pneumonic processes, often septic in character, may develop very rapidly. A soft type of foreign body may swell and com-

pletely obstruct the bronchus it reaches, leading to complete collapse of the corresponding lung area, often the whole or half of the lower lobe. If the stay of any foreign body is prolonged to days, weeks, months or longer, irreparable damage almost invariably results. The forms this may take are numerous. Collapse and septic pneumonia have already been mentioned. If the obstruction is partial, septic bronchitis, with stagnation of the bronchial exudate and pus behind the obstruction, leads in turn to peribronchitis, bronchiectasis and fibroid induration of the corresponding lung area. In other cases gangrene of the lung results. Not infrequently an empyema may occur and the foreign body may be found in the empyema cavity. Suppuration round a foreign body may lead to localised intrapulmonary suppuration or abscess.

Symptoms.—During the passage of the foreign body through the larynx and trachea urgent symptoms may occur which leave no doubt as to what has happened; but this is not invariable, and the patient may not be sure whether he has inhaled or swallowed it. In any case, after a bronchus has been reached, there may be a latent period which engenders a sense of false security and leads to delay in treatment. In most cases pain, discomfort and cough develop rapidly. The cough may lead to the expulsion of the foreign body, or may cause dyspnœa if it forces it up to the larynx. The cough soon becomes noisy, often paroxysmal, and if local septic changes are set up expectoration occurs, sometimes mucoid and copious, at others muco-purulent. Pain may be absent, but is often severe. The temperature is generally normal for the first few hours, but soon rises, especially if bronchitis, pneumonia or broncho-pneumonia develop. The further symptoms are those of the reactive changes and complications which ensue.

The physical signs naturally depend upon the bronchus affected and upon the degree of obstruction. They are at first those of deficient air entry. The affected side may show less movement, and there may be some recession of the lower intercostal spaces in young people. If a large bronchus is involved and collapse results, there is some displacement of the heart to the affected side. Vocal fremitus may be diminished or absent, the percussion note impaired, and the breath-sounds and voice-sounds weak or absent over the whole or part of one lung, almost invariably the lower lobe. An "asthmatoid wheeze" has been described in America. This consists of a wheezing sound heard at the end of inspiration on listening close to the open mouth when the patient breathes deeply. When bronchiectasis, empyema or other conditions develop, their characteristic signs become apparent.

Complications and Sequelæ.—Many of these have been enumerated in describing the pathological results. Sometimes septic meningitis or cerebral abscess develops.

Course.—Spontaneous relief may occur in two ways, either by the foreign body being coughed up, as may happen within a few hours or days or after an interval of months or years, or the foreign body may track through the lungs and pleura, and be discharged in an abscess bursting through the chest wall. In both cases, if an interval of more than days occurs, irrecoverable damage may have resulted. Apart from these occurrences and from successful treatment the course is very variable. Death may occur quickly from some of the septic complications, or after a longer or shorter interval from bronchiectasis, gangrene or cerebral abscess.

Diagnosis.—The history of disappearance of some article from the mouth in the act of laughing, breathing, yawning or sighing, etc., should always arouse suspicion of an inhaled foreign body. If signs indicating bronchial obstruction are found, the diagnosis is almost certain. In every suspicious case radiograms of the chest should be taken in two different directions, in case the shadow may be merged in that of the scapula or of the ribs. The possibility of a foreign body should always be borne in mind in cases of unilateral basic bronchiectasis, especially if no obvious cause can be found. When such unilateral lung signs develop after an anæsthetic, or after operations on the mouth or naso-pharynx, the possibility of some inhaled material should always be remembered.

Prognosis.—This is grave unless the foreign body is removed within 36 hours, owing to the various dangerous complications that may ensue. Excluding the few cases in which cure occurs by spontaneous discharge of the foreign body, about 50 per cent. of cases left untreated die within 1 or 2 years.

Treatment.—This consists in removal, if practicable, as soon as possible after the diagnosis is established. If the foreign body is in a main bronchus or one of its principal divisions it can usually be removed by means of the bronchoscope and appropriate forceps. The operation requires very careful anæsthesia and expert manipulation. Where these are not available a tracheotomy may be done, when sometimes the foreign body is coughed out or can be extracted. If these methods fail the question of pneumotomy may have to be considered. If this is decided on, every effort must be made to localise the foreign body by X-ray examination. If intrapulmonary or pleural suppuration has occurred, this must be dealt with surgically, and sometimes the foreign body can be removed at the same time. The medical treatment of the cases consists in that of the various conditions resulting.

(*b*) Stenosis from Cicatrisation of the Bronchial Wall.—**Ætiology.**—The causes of this condition are those leading to ulceration of the bronchial wall, with subsequent healing, such as syphilitic processes in and around the bronchi, ulceration from injury produced by a foreign body or in its removal, or by the inhalation of severe irritants. The fibroid variety of tuberculosis may also produce it.

Pathology.—The stenosis may occur in one of the main bronchi, or in one passing to a lobe or to part of a lobe. At first partial, it may progress, until the lumen is almost completely occluded at one point. The changes occurring in the lung beyond the obstruction vary with its degree. At first there is retention of secretion in the bronchi, and air may be forced past the obstruction in inspiration, but not expelled during expiration, producing emphysema, with commencing bronchial dilatation. When the obstruction is more complete the air is absorbed, the lung tissue gradually becomes fibrotic, and the bronchi dilate further.

Symptoms.—Cough, not infrequently of paroxysmal character, is an early symptom and is usually a continuation of that caused by the primary condition. It may be dry or associated with mucoid sputum, sometimes blood-streaked. The expectoration may cause dyspnœa, by obstructing the narrowed bronchus. If bronchiectasis develops the sputum becomes fœtid.

The physical signs are those of collapse of a part of the lung and are progressive. Local limitation of movement and flattening, with displacement of the heart to the affected side, may be apparent on inspection. The

vocal fremitus is diminished, the percussion note, impaired at first, may progress to complete dullness when fibrosis develops. The breath-sounds are weak or even absent, and the voice-sounds diminished. In the early stages a bronchial stridor may be audible. Compensatory emphysema of the adjacent healthy lung tissue often develops.

Complications.—These are similar to those in stenosis from a foreign body, notably fibrosis and bronchiectasis.

Course.—Unless the primary condition causing the stenosis is one which can be arrested by treatment, the condition is progressive, and eventually the area of lung beyond the obstruction becomes permanently functionless.

Diagnosis.—Bronchial cicatrisation must be differentiated from obstruction due to extrabronchial causes, such as pressure from new-growths, aneurysm and the other mediastinal conditions mentioned in the section below. The history, the physical signs and examination by X-rays and possibly by the bronchoscope may help in distinguishing. The Wassermann reaction should be investigated in every case where the stenosis is proved to be of intrabronchial origin.

Prognosis.—This varies with the cause. It is most favourable in cases due to syphilis submitted to treatment at an early stage.

Treatment.—Vigorous anti-syphilitic treatment should be employed in cases due to syphilis. In other cases the treatment is to relieve symptoms by appropriate measures.

2. External Causes

These may be subdivided into—(*a*) *Mediastinal conditions*, chiefly enlargement of the bronchial or mediastinal glands from tuberculosis, Hodgkin's disease or malignant growth, aneurysm of the aorta, mediastinal abscess, pericardial effusion and œsophageal new-growths. (*b*) *Intrapulmonary causes*, generally primary or secondary new-growths.

Symptoms.—These are practically identical with those just described, but in addition there are those of the condition causing the pressure.

Diagnosis.—This has been discussed in the previous section. The bronchoscope should not be employed where there is any suspicion of an aneurysm.

Prognosis.—This is extremely unfavourable, except in cases due to tuberculous glands and pericardial effusion, and in some cases of mediastinal suppuration.

Treatment.—This can only be palliative in the majority of cases. Useless cough may be checked by a sedative linctus of heroin or morphine. Dyspnœa when due to spasm may be lessened by inhalations of creosote and spirits of chloroform, or by administration of oxygen. Pain may be relieved by aspirin or other analgesic drugs.

ASTHMA

The term asthma has been loosely employed to denote any form of dyspnœa of expiratory type occurring in paroxysms. For all conditions other than that now to be described some descriptive qualification should be employed to avoid confusion.

Asthma or true spasmodic asthma is a paroxysmal affection, occurring most frequently in patients of neuropathic inheritance. It manifests itself in attacks of severe expiratory dyspnœa due to excessive vagal discharges, set free by peripheral irritation, chemical agencies or cerebral influences.

Ætiology.—Probably no other disease shows such a varied and complex causation, but recent studies of idiosyncrasy and anaphylaxis have served to explain many of the obscurities.

Predisposing causes.—Age.—The first attack may occur at any age, even as early as the period of the first dentition. The majority of cases begin before the age of 25.

Sex.—Asthma is generally stated to be nearly twice as frequent in the male sex as in the female.

Heredity.—It certainly runs in families. The heredity is not always direct, the nervous instability sometimes being evidenced in other generations by migraine, epilepsy or hysteria. The view that hypersensitiveness to certain proteins is inherited is now discredited, and it is believed that an unduly irritable bronchial centre is the factor transmitted by heredity.

Other diseases.—Gout and syphilis are said to predispose to asthma. Bronchitis not infrequently leads to paroxysms in patients with asthmatic tendencies. Tuberculosis of the lung occasionally induces it, but here again it is probably in patients with the asthmatic diathesis.

Climate and locality.—Asthmatics seem very sensitive to both of these, but no general relationship can be proved, as the effects are most variable. Some patients are better in dry, others in damp, foggy climates, and in regard to locality each patient is a law to himself.

Conditions of the nose and naso-pharynx.—Nasal obstruction from swelling of the turbinates, deflection of the septum, spurs and polypi, and conditions of the naso-pharynx, such as adenoids and enlarged tonsils, undoubtedly predispose to asthma, and may also be exciting causes of the actual paroxysm.

Exciting causes.—Chemical substances.—The emanations from certain animals may be the determining cause. The best known of these are the horse and cat, but rabbits, hares, guinea-pigs, deer, dogs and monkeys may have a similar effect. Even human hair appears capable of discharging the paroxysm. The dust from some substances, such as corn, rice or oats, the smell of certain drugs, such as ipecacuanha, and the scent and the pollen of grasses and flowers may act in a similar fashion, as also may articles of diet, and many drugs. This factor in causation has attracted much attention recently—in this country by Freeman and Coke, and in America by Walker. It is claimed that at least 50 per cent. of asthmatics show hyper-sensitiveness to various protein antigens obtainable from animals, grains, bacterial bodies, foods and drugs, and over a hundred are now available for routine testing of these patients. The analogy with the causation of hay fever and paroxysmal sneezing is obvious.

Peripheral irritation.—As already mentioned, irritation of the nose, naso-pharynx and bronchi may be asthmogenic in those of asthmatic tendency.

Gastro-intestinal disturbance.—This is well recognised as a cause, and most asthmatics find by experience the penalties of a heavy late meal and of indigestible articles of diet. It is possible that actual metabolic errors may be a factor, as in the so-called "week-end asthma," due to altered conditions of diet and exercise at this period.

Genito-urinary conditions, particularly in women, notably ovarian or uterine disorders, sometimes act in inducing asthma.

Cutaneous.—Asthmatics are peculiarly liable to urticaria and eczema, although these conditions usually alternate with the asthmatic attacks.

Nervous factors.—Fatigue, emotion and nervous shock may precipitate an attack. This factor cannot be ignored, even in cases due to protein hyper-sensitiveness, as is shown by a well-known case in which a patient susceptible to roses developed asthma when handed an artificial rose.

Pathology.—Numerous theories have been propounded to explain the asthmatic paroxysm. Among these may be mentioned vascular turgescence of the bronchial mucous membrane, spasm of the bronchial muscle, and increased secretion of the mucous glands. Spasm of the diaphragm or of the inspiratory muscles has also been suggested. That bronchial spasm plays the major part seems to have been established by the experiments of Brodie and Dixon, and this view is strongly supported by their observations on the effects of drugs on the bronchial musculature. Muscarine, pilocarpine and physostigmine produce bronchial constriction and asthmatic symptoms in animals, while atropine, hyoscyamine and chloroform abolish these effects.

There can now be little doubt that the broncho-constrictor fibres of the vagus are the channel by which the impulses discharging the asthmatic paroxysm reach the bronchi, although the possibility that impulses leading to vaso-dilatation and to increased bronchial secretion are also concerned, must be admitted.

ANAPHYLAXIS.—The important part played by extraneous proteins in the genesis of asthma and the obvious analogy between the asthmatic paroxysm and the symptoms of anaphylactic shock have suggested that in many cases, if not in all, asthma is an anaphylactic phenomenon. Evidence is accumulating in support of this view. It has been shown that the lungs of the guinea-pig killed in anaphylactic shock show extreme constriction of the bronchioles. Asthmatics are well known to show anaphylactic tendencies, and especial care in the administration of antitoxic serums is necessary with them. It is of some interest to note that Eppinger and Hess' group of vagotonics show urticaria, dermatographia, eosinophilia and liability to anaphylactic shock, all conditions which occur in asthmatics. It is tempting, therefore, to assume that the foreign protein or toxin produces the asthmatic attack by inducing vagotonicity. Lastly, the observations of Freeman, Coke and the American workers have demonstrated the cutaneous hyper-sensitiveness of many asthmatics to special foreign proteins. Further research is needed before it can be accepted that anaphylaxis accounts for all cases of asthma, but it is almost certainly an important factor in many.

Asthma is rarely fatal apart from complications, so little can be stated about its morbid anatomy.

Symptoms.—The asthmatic paroxysm most commonly commences about 2 a.m. or later, but it may sometimes develop in the daytime. There are often preliminary indications some hours beforehand, constituting the "asthmatic aura." These include restlessness, irritability, mental exaltation, less frequently depression, itching of the nose or chin, flatulence or polyuria. Some attacks are ushered in by coryza. Such warnings are not constant, and the sufferer usually wakes from sleep with a feeling of suffocation. In early attacks great restlessness, anxiety and alarm occur. The difficulty

in breathing and the sense of suffocation increase; the patient sits up in bed, or gets up to throw open the window, and fixes his arms to bring into action all possible muscles of respiration. Respiration, although laboured and difficult, is often slow, inspiration being short while expiration is greatly prolonged. Both are accompanied by loud wheezing sounds, audible at a distance from the chest. The patient appears pale, but the lips are dusky and the expression is anxious and distressed. The jugular veins are distended and prominent. The accessory muscles of respiration are seen to be in violent action, notably the sterno-mastoids, scalenes and pectorals. The skin is moist and there may be marked sweating. The chest is much distended, and at each violent attempt at inspiration very little further enlargement occurs, while there is often sucking-in of the supra-clavicular and lower costal regions.

Percussion reveals marked hyper-resonance and encroachment on the cardiac and hepatic dullness. On auscultation inspiration is short and high-pitched, expiration very prolonged, and both are obscured by abundant sonorous and sibilant rhonchi, and later by bubbling râles at the bases. The pulse is small, quick and sometimes irregular. There is usually marked epigastric pulsation. A differential blood count during an attack may show an eosinophilia of as much as 35 per cent. Cough does not develop until late in the paroxysm, and is quickly followed in many cases by the expectoration of small pellets, called "perles" by Laennec, and often likened to boiled sago or tapioca. These were carefully studied by Curschmann, and when examined on glass on a black background, prove to consist of a central highly refractive mucinoid coil, with masses and threads of mucin wrapped spirally around it. Microscopically leucocytes, mostly eosinophils, may be seen entangled in the mucus. The sputum frequently contains Charcot-Leyden crystals, which are not now regarded as spermin phosphate but more probably as tyrosin. With the onset of expectoration the dyspnœa quickly lessens, and the attack subsides. The patient often passes a large quantity of pale urine and then may sleep until morning, awaking in apparent comfort. More frequently he appears pale, tired and anxious.

Course, Complications and Sequelæ.—Such an attack may last from a few minutes to several hours, and may remit and then return. More often the attacks recur at the same time each night for a considerable period extending to weeks, and then pass off, after which the patient may enjoy a period of freedom of weeks or months. The intermissions may become shorter with successive attacks, and increasing emphysema may develop. This in turn leads to secondary bronchitis, which persists, together with some degree of permanent œdema of the bases. Later still the cardio-vascular changes incidental to emphysema occur as sequels, namely, engorgement of the right heart, tricuspid regurgitation, venous stasis, ascites and œdema. Chronic asthmatics frequently present a characteristic appearance. Of thin build, with sallow complexion, anxious expression and nervous manner, they often have a long neck, high straight shoulders, and a forward stoop. Asthma necessarily imposes limitations upon those who suffer from it at all severely, although many asthmatics lead active, useful lives in spite of their disease.

Diagnosis.—This involves the differentiation from other forms of dyspnœa, particularly those of spasmodic expiratory type. The chief forms of paroxysmal expiratory dyspnœa are :

1. *Bronchial asthma or spasmodic dyspnœa complicating chronic bronchitis and emphysema.*—This condition is sometimes a late result of true asthma, but may occur independently. The dyspnœa is more persistent and is more definitely related to the bronchitic attacks, being therefore more common in the winter.

2. *Cardiac dyspnœa or cardiac asthma.*—This, like true asthma, is often nocturnal, but the signs of failure of compensation in association with valvular or myocardial disease usually make the nature of the dyspnœa clear.

3. *Uræmic dyspnœa or renal asthma.*—This is also not infrequently nocturnal and may be almost indistinguishable from true asthma. Examination of the urine and the presence of cardio-vascular changes with high blood-pressure enable the distinction to be made with certainty, although the latter is not invariable.

4. *Hay asthma* is probably only a severe form of hay fever and is to be regarded as a variety of true asthma.

5. *Pulmonary tuberculosis may be associated with asthmatic dyspnœa.*—The differentiation may not be easy during the attack, but the persistence of apical signs in the interval may give a clue. It is a wise precaution to examine the sputum for tubercle bacilli in all cases of asthma. A low blood-pressure in an asthmatic should also arouse suspicion of tuberculosis.

The dyspnœa of laryngeal or tracheal obstruction and of mediastinal pressure can usually be recognised by the fact that it is chiefly of inspiratory type, and may be associated with stridor, instead of wheezing. In all cases of doubt the chest should be examined with the X-rays to exclude aneurysm or new-growth.

Prognosis.—When the disease starts in childhood or in early adult life it may stop spontaneously or be relieved permanently when some causal condition is discovered and treated. During a severe attack the aspect of the patient may be so alarming that a fatal issue may seem imminent, yet death very rarely occurs. In chronic cases, the ultimate prognosis is made more serious by the complicating emphysema and bronchitis, and in spite of popular belief, the asthmatic has less than the normal expectation of life.

Treatment.—(*a*) *During the attack.*—The list of anti-spasmodic drugs and measures employed is a long one, and it is impossible to foretell which will be efficacious, for asthmatics vary as widely in their response to drugs as they do in regard to asthmogenic causes. Drugs may be administered for this purpose by inhalation, by nasal sprays, by the mouth or by hypodermic injection. Adrenalin hydrochloride, in doses of 2 to 5 minims of a 1 in 1000 solution hypodermically, may act with dramatic efficacy if administered sufficiently early, but it should be given cautiously to elderly asthmatics. It may also be combined with pituitary extract, as in the special preparations evatmine, pitrenalin and asthmolysin. It sometimes proves helpful as a nasal spray, especially in combination with chloretone. A weak solution of cocaine and atropine in an oily excipient has been much employed as a nasal spray, but it is not devoid of risk if used indiscriminately. The fumes of burning nitre paper, or of a powder composed of tobacco, stramonium and nitre, sometimes help to relieve the distress, but they should be avoided in cases with bronchitic complications. Smoking a cigarette or a cigar may be helpful in patients who do not smoke habitually; others are helped by cigarettes containing stramonium. Inhalations of amyl-nitrite, ethyl-

iodide or chloroform may be tried in some cases. Various drugs have been employed, of which potassium iodide and bicarbonate with tincture of stramonium, hyoscyamus, lobelia or belladonna are the most useful. Twenty or 30 minims of liquid extract of grindelia every 20 minutes for three doses have been found useful in some cases. Other drugs which have been recommended are chloral hydrate, phenacetin and the other coal tar antipyretic drugs, eupnine (caffeine tri-iodide) in drachm doses, and an emulsion of benzyl benzoate, 2 drachms every 2 hours. Other measures include drinking a cup of strong coffee, the application of a mustard leaf over the sternum, and placing the feet in hot water and mustard. In very severe cases, if all else fails, it may be necessary to inject morphine or heroin, but this should only be done after careful consideration, owing to the danger of inducing the morphine habit.

(*b*) *Between the attacks.*—The greatest care should be taken to discover and deal with any predisposing or exciting causes. The patient should live in that locality which his experience shows to be most suitable for him, and at present no rules can be formulated in advising on this matter.

Diet requires careful consideration. Any article of diet to which the asthmatic is susceptible should be entirely eliminated, and only the lightest of meals should be taken after midday. Fatigue, over-work and emotional stress are to be avoided. Care should be taken to see that the bowels act efficiently. The general health should be maintained by every possible means. Arsenic may be given by the mouth, or subcutaneously as sodium cacodylate (gr. $\frac{3}{4}$ in ♏xv water). During the period when the patient is having a series of attacks, iodide of potassium with one or more of the anti-spasmodic group of drugs, such as stramonium, lobelia, belladonna and grindelia, may be given regularly with great benefit. Any local source of irritation in the nose or naso-pharynx should be dealt with adequately. Sometimes touching the nasal septum with the galvano-cautery may alone be efficacious. In cases complicated by bronchitis, the sputum should be examined bacteriologically, and a vaccine may be made from the predominating organisms. If these prove to be *Micrococcus catarrhalis*, or Friedländer's pneumo-bacillus, great benefit may result, but the patient should be told that the vaccine can only help the asthma by lessening the accompanying catarrh. Some cases associated with marked emphysema obtain considerable relief from compressed air baths, at first on alternate days, then daily, the course extending to 1 or 2 months.

Careful investigation of the question of protein hyper-sensitiveness should be undertaken, and the recent method of testing by means of the cutaneous application of various antigens is worth consideration. For this purpose, the particular protein antigen, or a series of such antigens, may be applied to the skin of the forearm in the form of powder, solution or paste, and superficial scarification is then effected by means of a sterile needle or scalpel. A positive reaction is shown by the development of an urticarial wheal surrounded by a hyperæmic area. A control scarification with normal saline or a paste free from protein should be made at the same time. A positive result may be expected in about 50 per cent. of asthmatic patients. If such a condition is established to one or more such substances, they should be avoided if possible ; if not, the methods of desensitisation may be tried, but the results are frequently disappointing. The specific antigen may be employed in very minute doses by injection, starting, for example,

with 1 minim of a $\frac{1}{1000}$ solution and gradually increasing. Auld has endeavoured to achieve the same effect by intravenous injections of peptone. In adults $\frac{1}{10}$ gr. of Armour's No. 2 peptone is given for the first dose, successive doses being given every fifth day, increasing by $\frac{1}{50}$ gr. each time for 6 injections, when the dose is kept stationary for another three or four injections. In cases which fail to respond to such injection, he has recently suggested the use of "new serum peptone" injections, which consist of a mixture of the patient's own serum with agar solution and Armour's No. 2 peptone. These injections should not be given during an asthmatic attack.

Recently Storm van Leeuwen has emphasised the importance of dust and of some moulds, notably the genus *Aspergillus*, in the genesis of asthma. He tries the effect of putting the patients in rooms supplied with air relatively dust free.

BRONCHIECTASIS

Definition.—Bronchiectasis is a condition of permanent dilatation of one or more bronchi. When it occurs in the finer divisions it is sometimes described as bronchiolectasis.

Ætiology.—Bronchiectasis is invariably secondary, and may result from disease of the bronchi, the lung parenchyma or the pleura. Even the rare congenital cases are probably consequent on malformation, atelectasis or intra-uterine disease.

1. The bronchial conditions which may progress to dilatation are bronchitis, and any affection leading to partial bronchial obstruction, such as inhaled foreign body, stenosis from cicatrisation and external pressure from new growth or aneurysm. In children, measles and whooping-cough are not uncommon causes, especially when they follow one another in rapid succession, although either alone, if severe, may lead to it.

2. Conditions of the lung parenchyma which may cause bronchiectasis are unresolved pneumonia, broncho-pneumonia, collapse, syphilis and tuberculosis. Syphilis is rare and usually acts by leading to bronchial obstruction or stenosis. Fibroid tuberculosis is a common cause, but the clinical manifestations are as a rule masked by the primary condition. The pulmonary complications of influenza are not infrequently followed by bronchiectasis.

3. The pleural conditions which are followed by bronchiectasis are those which lead to pleural adhesion and are associated with pulmonary fibrosis, notably chronic pleural adhesion, or empyema leading to prolonged or permanent collapse of the lung.

In a lesion with such diverse antecedents the age relations are necessarily indefinite. It may occur at any age, but is commonest in the third and fourth decades. It frequently commences in childhood, although the characteristic clinical manifestations may not develop until adult life.

Sex.—In most recorded statistics there is a striking preponderance in the male.

Social state.—It is noteworthy that bronchiectasis in its fully developed form is much more common in the poor than in the well-to-do.

Pathology.—Three factors in the pathogenesis of bronchial dilatation have to be considered. (1) Weakening of the bronchial walls. This is admittedly the most important. Most of the conditions preceding bronchiec-

tasis tend to induce severe bronchitis and peribronchitis, and thus render the walls more yielding. Where stagnation of secretion occurs, putrefactive and other organisms develop, producing tryptic ferments which may act injuriously upon the lining membrane. (2) Increased pressure on the walls thus weakened is the determining factor. This is generally expiratory in origin and due to the strain of cough. The actual pressure of secretion accumulating behind an obstruction may promote yielding of the bronchial walls. In cases of bronchiectasis following on collapse of the lung the force of inspiration has been regarded as contributory, but this is doubtful and in any case is less important than the expiratory strain of cough. (3) The third possibility is the traction exerted upon the walls of the bronchi by contracting connective tissue in the surrounding fibroid lung. This obviously postulates the existence of pleural adhesion, which is not invariably present. While this must be admitted as a possible contributory factor, its importance is certainly less than that of the preceding ones.

Congenital bronchiectasis is a pathological rarity. It is usually unilateral, and the bronchi involved are of small size, although in some cases the lung may show a large central cavity, with smaller spaces around it. Bronchiolectasis is also more of pathological than of clinical interest. It occurs chiefly in children, as a result of acute broncho-pneumonic processes. It is said sometimes to follow influenza and possibly tuberculosis. The lung has a peculiar spongy appearance, to which the name "honeycomb" has been applied.

Bronchiectasis of the larger tubes may be either cylindrical or saccular. In the former condition several of the bronchi are more or less uniformly dilated, and when opened out they appear like the fingers of a glove. Sometimes the dilatations are fusiform, at others they show a beaded arrangement, described as moniliform. These forms of dilatation are usually associated with emphysema and chronic bronchitis. Saccular bronchiectasis is generally localised and may be found in any part of the lung, but is most common in the lower lobes and near the base. This is partly due to the fact that the antecedent processes fall with special stress on the bases of the lung, and partly to the influence of gravity in leading to retention of secretions in these parts. Although it may be unilateral in origin, it often spreads and may involve both bases or even all the lobes. There may be one large irregular cavity, or a series of smaller globular dilatations involving the whole or part of the walls of one or more bronchi. The cavities are usually filled with the fœtid secretion, to be described under expectoration. When this is washed away the walls are found to be thin, smooth and formed of thinned-out mucous membrane. In places this may have ulcerated, owing to the tryptic action of the secretion, and the lung tissue is thus exposed. An abscess may then form, and an aneurysm sometimes develops, as in a tuberculous cavity. The openings of the smaller bronchi, derived from that dilated, can often be recognised in its walls. In doubtful cases the histological demonstration of cartilage and muscle in the walls establishes the bronchial origin of a cavity. The surrounding lung tissue is usually airless and fibroid, and sometimes is almost of leathery consistence. Occasionally, however, it is emphysematous, congested or pneumonic. In the great majority of cases there is dense pleural adhesion over the area of lung involved.

Other morbid conditions found post mortem include lardaceous disease,

gangrene of the lung, empyema, pyo-pneumothorax, suppurative pericarditis and cerebral abscess. Owing to the obstruction of the pulmonary circulation which may result, engorgement and dilatation of the right side of the heart, tricuspid regurgitation and the results of systemic venous stasis are often found.

Symptoms.—The onset is usually insidious, the symptoms developing during the course, or as a sequel, of one of the acute or chronic affections mentioned above. In some few cases, however, they develop rapidly in patients previously in good health. This is particularly the case where bronchiectasis results from an inhaled foreign body, and a rapid onset should lead to the suspicion of this. The cough in well-developed cases is somewhat characteristic and occurs in paroxysms. These are frequently induced by change of posture—for example, bending forward or lying down. They occur with special frequency on rising, and are usually associated with the expectoration of large quantities of sputum, due to the overflow of the secretion, accumulated in the cavities during the night, into a sensitive or relatively healthy bronchus, which excites cough reflexly. They also occur on retiring to bed and at long intervals during the day. The sputum frequently amounts to as much as 20 or 30 ounces in the 24 hours. It is generally extremely fœtid, although in the earlier stages this is not invariable. The patient's breath is also often malodorous, and the stench may pervade the room or even the house in which he lives, although it is not persistent. The patient is himself much distressed by the unpleasant character of the sputum, of which he is, as a rule, acutely conscious. On standing in a glass vessel it can be seen to settle into three layers—a surface scum of light frothy mucus, an intermediate stratum of thin, turbid, greenish fluid, and a deep layer of brownish colour consisting of muco-pus, bacteria, and putrefactive products, including foul-smelling organic acids. Fœtid yellow bodies called Dittrich's plugs can usually be found in the deep layer. Elastic tissue is only present when erosion of the wall has occurred. Hæmoptysis is not infrequent, and may occasionally be fatal. Dyspnœa is not, as a rule, apparent unless the condition is widespread, or unless pulmonary or cardiac complications are present. The general condition of the patient is at first but little affected, and there may be no fever for long periods. As the disease progresses, lassitude, anorexia and some wasting slowly develop, while bouts of fever occur, due to retained secretions or to some complication.

Physical signs vary with the extent and degree of dilatation, and also with the amount of secretion present. In the early stages there is at most slight dullness at one base, with diminished air entry, peculiar sticky, "leathery" râles, and diminished vocal resonance. When bronchiectasis is well developed the signs are almost characteristic. The patient may appear well nourished and of good colour, although on cold days, especially in children, duskiness or cyanosis is often noticeable. There is well-marked clubbing of the fingers, generally of drum-stick character, and pulmonary osteo-arthropathy, involving many joints, sometimes develops. There may be localised flattening or retraction of the chest wall over the affected area, with diminished movement, and the heart is drawn over to this side. The remaining signs vary with the state of the cavity. If this is full, there is diminished vocal fremitus, dullness and weak or absent breath sounds and voice sounds. If the cavity is empty or partly empty, the vocal fremitus

is increased, the percussion note is boxy or dull, while the breath sounds are bronchial or cavernous. Adventitious sounds are then generally audible, the most characteristic being sharp metallic or "leathery" râles. Bronchophony and pectoriloquy are marked, and not infrequently the "veiled puff" of Skoda can be heard. Signs of bronchitis are often apparent in the adjacent lung tissues; compensatory emphysema may be demonstrable in the unaffected parts of the lung, and on the opposite side. X-ray examination serves to define the extent of the disease, the degree of fibrosis, and the presence of the cavities.

Complications and Sequelæ.—The chief pulmonary complications are septic broncho-pneumonia, gangrene and abscess. The pleura may become involved, giving rise to dry pleurisy, which sometimes progresses to empyema and rarely to pyo-pneumothorax, while in other cases pleural adhesion and contraction result. Septic pericarditis may develop and prove fatal. Septicæmia and pyæmia sometimes occur as terminal results. Cerebral abscess constitutes a serious and somewhat common complication, and may be found in the frontal, parietal or temporal regions, the cerebellum or cord. Occasionally multiple abscesses form. Lardaceous disease sometimes develops, especially in the liver, kidneys and intestines.

Course.—This is progressive, but is often slow unless fever or complications develop, though the morbid process may eventually involve the other lung. The sputum at first may be simply purulent, then becomes unpleasant and finally fœtid. The disease may start in childhood and not lead to death until well on in adult life. The course is slower in cases due to bronchitis and fibroid lung conditions than in those due to foreign bodies, new-growths or aneurysm.

Diagnosis.—In well-developed basic cases this is, as a rule, easy. The history of cough, influenced by posture and associated with copious sputum, is suggestive, especially when variable physical signs are observed. The development of the characteristic sputum with these signs renders the diagnosis almost certain, and the X-rays usually serve to confirm. Radiological investigation after the intra-tracheal injection of 20 c.c. of lipiodol, through the crico-thyroid membrane or between two rings of the trachea, under local anæsthesia, or with care directly between the vocal cords, has greatly facilitated the diagnosis of bronchiectasis. An attempt should be made to direct the lipiodol towards the affected side by turning the patient towards that side. The injection should be carried out in the X-ray room and the patient instructed to restrain cough if possible until the films have been taken. The pictures obtained are strikingly characteristic and of great value. In cases with less characteristic symptoms and signs the distinction has to be made from chronic bronchitis, especially the fœtid variety, pulmonary tuberculosis, gangrene or abscess of the lung, and fœtid empyema. The distinction from chronic bronchitis may be difficult, especially in the early stages when the sputum is not fœtid, but the paroxysmal cough, the copious expectoration with signs including bronchial breathing and sticky râles at a base, may be strongly suggestive. In fœtid bronchitis the fœtid sputum is not constant, and the cough and sputum may occur only during exacerbations of the bronchitis. Pulmonary tuberculosis may give rise to difficulty, particularly in cases of apical bronchiectasis. Repeated examinations for tubercle bacilli and also for elastic tissue in the sputum should be made. The history, the mode of spread, and X-ray examination may all

assist. It should be remembered that the two conditions may coexist, and this may be suspected in some cases of fibroid tuberculosis with basic excavation. Abscess and gangrene of the lung have a more acute onset and course, but the chronic cavities left by these conditions may give rise to difficulty. In such cases the history may be an important aid in diagnosis. In fœtid empyema rupturing through the lung, particularly when of interlobar origin, the patient is generally acutely ill, there may be a history of pleurisy at the onset and possibly some evidence of mediastinal pressure or cardiac displacement.

Prognosis.—This varies with the cause. If due to aneurysm or growth, the duration is determined by these conditions. Bronchiectasis induced by a foreign body is generally permanent, even when the latter is removed, but it is not progressive. If the foreign body is not removed, complications generally supervene, and the course may be rapid. In bronchiectasis due to bronchial or pulmonary disease the course may extend into years, particularly if treatment is followed strictly, but sooner or later toxæmia and general or local complications supervene, with the result that the duration of life is inevitably considerably shortened.

Treatment.—Prophylactic treatment in cases of chronic bronchitis, delayed resolution in pneumonia and other conditions tending to fibrosis should be carried out. This comprises respiratory exercises, climatic treatment, inhalations and vaccines.

The medical treatment of bronchiectasis consists in measures to promote the general health and well-being of the patient, to secure efficient emptying of the cavity, and to lessen or control the putrefactive processes occurring in it. The first of these involves a careful mode of life, adequate rest and change, a good and digestible diet, and medicine such as cod-liver oil, iron, quinine, strychnine or arsenic. The evacuation of the cavity may be promoted by postural methods, such as bending over the edge of the bed or stooping forwards. Expectorants, especially of antiseptic character, may be given, such as creosote, terebene, tar preparations, balsam of tolu or Peru, compound tincture of benzoin or the benzoates. If the sputum is tenacious, or if much bronchitis coexists, iodides and alkalis may be given in an ordinary expectorant mixture. To lessen the fœtor, creosote is most frequently given in perles of 3 to 5 minims three times a day after food, or in an emulsion with cod-liver oil. Guaiacol carbonate and other creosote derivatives may also be tried. Syrupus allii, in 1-drachm doses, is sometimes given, and is of value; but it is not always well tolerated by patients on account of its taste and tendency to repeat. Although these drugs are helpful, the amount of antiseptic reaching the cavity by the blood must necessarily be small. Attempts to secure more direct application by intratracheal injection and by inhalation have been made. For the former 1 drachm of a mixture of olive oil 88 parts, guaiacol 2 parts, and menthol 10 parts is injected down the trachea by a special syringe, the nozzle of which is slightly inclined towards the affected side. Care must be taken to do this with the aid of a laryngeal mirror to ensure that none of the solution touches the larynx. Another solution used is 1 part each of creosote, menthol and thymol in 10 parts of olive oil.

For inhalation purposes, solutions of volatile antiseptics are employed on a Burney-Yeo mask, such as creosote, terebene, menthol or eucalyptol in

spirits of chloroform. The mask may be worn almost continuously or at intervals during the day. The creosote vapour bath is, however, the most satisfactory form of inhalation treatment, and is of great value. This should be given in a concrete-floored room without furniture. The patient is covered with a smock, the eyes are protected by closely-fitting goggles, and the nostrils by cotton wool plugs. A small quantity of creosote is heated in a metal dish, on a tripod over a spirit lamp. When the patient inhales the vapour, which quickly fills the room, violent cough is excited and the cavity is emptied. The ensuing deep inspirations carry down creosote-laden air into the air passages. The baths should be at first given on alternate days and last from 10 to 15 minutes. When the patient becomes accustomed to them, they may be given daily for half an hour or longer. The results are often strikingly beneficial. Vaccines made from the predominant organisms found in the sputum have been given with benefit in some cases. Surgical treatment is now more often employed than formerly, but at present it should be considered only in cases where medical measures fail. The actual drainage of the bronchiectasis surgically is only practicable if the cavity is a single one, and it involves the risks of a permanent fistula and of cerebral abscess. Other procedures which are now sometimes employed are the induction of artificial pneumothorax, although this is often impracticable, owing to adhesions, except in early cases, in which it may be brilliantly successful. Thoracoplasty may also give excellent results in cases in which collapse by artificial pneumothorax is not practicable. It is, however, only to be considered in strictly unilateral cases. This is usually carried out in two stages, with an interval between them. A sufficient amount of a number of ribs is removed to allow the chest-wall to fall in and permit the lung to collapse and fibrose, thus allowing the bronchiectatic cavities to empty and contract. Ligature of the branch of the pulmonary artery going to the lower lobe has been performed in some cases. Phrenicotomy or exairesis (evulsion) of the phrenic nerve has also proved useful. Lobectomy or removal of the affected lobe has also been recommended, but the mortality of this operation is at present considerable.

INJURY

External trauma applied to the chest-wall may cause rupture of a main bronchus. This is especially liable to occur after severe crushing accidents. One or other of the main bronchi may be completely severed from the trachea. The chief clinical feature presented in such a case is emphysema of the neck and upper portion of the chest wall. Death usually ensues in 2 to 3 days.

R. A. Young.
G. E. Beaumont.

DISEASES OF THE LUNGS

HYPERÆMIA AND ŒDEMA

Hyperæmia of the lungs may be either active or passive. In the former there is an increased supply of arterial blood through the pulmonary and

bronchial arterioles. In passive hyperæmia there is engorgement of the pulmonary venous radicles and capillaries. With both forms there is frequently œdema, due to the exudation of serous fluid into the lung alveoli. The term " congestion " is sometimes employed as an alternative to hyperæmia, but owing to its erroneous popular use it is best avoided.

(*a*) Active Hyperæmia

Ætiology.—This may occur in association with any acute inflammatory process affecting the bronchi, lungs or pleura. It sometimes results from the inhalation of pulmonary or bronchial irritants, such as poisonous gases or heated air. Severe muscular exertion and exposure to extreme cold are described as causes, but the former at least is doubtful. An important variety is that known as *collateral* or *fluxionary hyperæmia*, which occurs when there is obstruction to the circulation in the whole or part of one lung, from conditions such as a large or rapidly developing pleural effusion, an extensive and spreading pneumonia, or in association with pneumothorax. This may develop in the sound lung, or in the unaffected parts of that diseased. A primary form of acute hyperæmia, the " maladie de Woillez " has been recognised by French authors, but this is generally regarded as a mild or abortive pneumonia.

The clinical manifestations of acute hyperæmia are merged in those of the processes with which it is associated, and therefore do not need separate description.

(*b*) Passive Hyperæmia

Ætiology.—Passive hyperæmia may be produced by (1) conditions impeding the venous return from the lungs; (2) those leading to increased resistance to the passage of blood through the pulmonary capillaries, and (3) failure of the driving power of the right ventricle. The commonest causes of impeded return are left-sided heart lesions causing overfilling of, and increased pressure in the left auricle. In mitral stenosis it may occur early and sometimes almost acutely, but aortic and myocardial lesions also lead to it, when the left ventricle fails and the mitral valve yields. Direct obstruction of the pulmonary veins sometimes results from external pressure by aneurysm, mediastinal tumour or enlarged bronchial glands, or from obstruction of the lumen by thrombosis. The passage of blood through the pulmonary capillaries may be impeded by emphysema, chronic bronchitis, pulmonary tuberculosis and fibrosis of the lungs. Failure of the right ventricle occurs in the late stages of right-sided heart lesions, such as tricuspid regurgitation, and as a late sequel of left-sided failure.

Passive hyperæmia is obviously in the main dependent on mechanical factors; it is not surprising, therefore, that gravity seems to play a part in the localisation of its effects, which are usually most marked in the bases or most dependent parts of the lungs. In bedridden, enfeebled or old patients, particularly if myocardial weakness or degeneration coexists, this factor becomes of great importance. Not infrequently some degree of œdema of the bases develops, and the condition is then called hypostatic congestion. If such an area becomes infected the resulting process is known as hypostatic pneumonia. Basal hyperæmia and œdema of the hypostatic type also result

from toxæmia due to diseases such as enteric fever, from poisoning by drugs such as morphine, and as a terminal event in many cerebral lesions causing increased intracranial pressure.

Pathology.—The pulmonary veins and capillaries are engorged, with the result that the lung is darker in colour and heavier, while the alveolar walls and septa are swollen. If the condition persists for some time, pigment derived from the hæmoglobin of red corpuscles escaping by diapedesis is deposited in the epithelium of the alveoli and in the fibroblasts in the inter-alveolar septa. In long-standing cases the lung is firmer than normal and brownish-red in colour, a condition described as *brown induration*. If any degree of œdema is present, serous fluid is found in the alveoli on post-mortem examination, and on section of the lung frothy serous fluid exudes, which may contain some of the pigmented alveolar cells, constituting what are called " cardiac cells." Although congested and œdematous lung is heavier than normal, it usually floats in water.

Symptoms.—In slight degrees of hyperæmia these may be absent or negligible. In more advanced cases, they are those resulting from the impeded circulation through the lungs and the deficient aeration which this entails. Dyspnœa is the most prominent symptom, and it is generally a measure of the degree of hyperæmia. It is markedly increased by exertion of any kind, and in extreme degrees it is distressing and eventually alarming. It may be inspiratory or expiratory in type, and in the latter case it is sometimes described as cardiac asthma. In severe cases there is usually orthopnœa. Cough is almost invariably present, and there is usually some expectoration of frothy fluid, which may be blood-stained. The pigmented cells referred to above as " cardiac cells " may be found in it. Cyanosis is common and indicates the degree of deficient aeration. This may be associated with distension of the jugular veins, and there is often obvious distress. As in other forms of cyanosis there is usually some increase in the number of red corpuscles. The vocal fremitus at the bases may be diminished, the percussion note impaired, the breath-sounds weak and accompanied by rhonchi, crepitations or bubbling râles, although these signs are for the most part due to the associated œdema. In addition, the signs of the primary condition in the lungs or heart will be apparent.

Complications.—Pulmonary œdema and infarction are the chief complications.

Course.—If the venous engorgement cannot be removed, it usually tends to become progressively worse, whereas when it results from temporary cardiac embarrassment, recovery is usually complete as soon as the heart function is restored.

Diagnosis.—This condition has to be distinguished from (1) chronic bronchitis, in which case there may be some rise of temperature and the physical signs are more variable and more disseminated; (2) infarction, in which pain and hæmoptysis of sudden onset are the rule.

Prognosis.—This is so entirely dependent upon the nature and degree of the condition responsible for the engorgement that no general rule can be formulated.

Treatment.—In elderly patients, or those likely to be confined to bed for long periods, attention should be directed to the decubitus. This should be changed frequently, and if possible the patient should be permitted to sit

up or to get into a chair, and encouraged to take a few deep breaths several times during the day. If the hyperæmia is associated with cyanosis and engorgement of the right heart, bleeding to the extent of 8 to 12 ounces may be helpful. If this is not practicable, the application of 6 leeches over the liver, or dry cupping of the bases of the lungs may be tried. Free purgation and the administration of diuretics may also help indirectly to relieve the engorgement. In cases associated with cardiac failure, the administration of cardiac tonics, such as digitalis, strophanthus or squills, the injection of strychnine, or camphor in oil may all be of assistance. Moderate hæmoptysis should not be checked, and cough, if effective, may be promoted by suitable expectorants. In cardiac cases a "régime lactée" or strict milk diet is advocated by some French physicians.

(c) Acute or Hyperacute Pulmonary Œdema

In this condition flooding of the alveoli with the serous exudate from the pulmonary capillaries occurs with great rapidity.

Ætiology.—It is more commonly met with after the age of 40 than before, although cases have been recorded in children. It is considerably more frequent in the female than in the male sex. Arterial disease and hypertension are the most common antecedents, but acute or chronic renal disease and pregnancy may all act as predisposing factors. It sometimes occurs in diabetes. The actual exciting cause is often obscure, and probably varies in different cases. A heavy meal, an epileptic fit, or the administration of an anæsthetic may be the immediate cause in those predisposed. In other cases it may be a manifestation of angio-neurotic œdema. Sometimes paracentesis of a pleural effusion is quickly followed by œdema, no doubt as a result of a collateral hyperæmia. In diabetes the lipæmic condition which sometimes occurs has been suggested as the determining factor, possibly causing multiple fat embolism. In some cases dissociation of the action of the two ventricles has been supposed to be the cause, the right contracting forcibly while the left is in an enfeebled or asystolic condition. In support of this contention may be adduced the fact that acute pulmonary œdema has been observed after rupture of the chordæ tendineæ of the mitral valve.

Pathology.—The alveoli are found to be flooded with a thin serous exudate. The lungs are heavier than normal, sodden, and on squeezing exude large quantities of greyish-yellow or pinkish fluid. Frothy fluid of similar character is found in the bronchi and even in the trachea and naso-pharynx in hyperacute cases.

Symptoms.—The onset is sudden, and generally occurs when the patient is lying down, hence being most frequently observed at night. The patient awakes with intense dyspnœa, and a sense of suffocation, then frequently rolls or rushes about in the endeavour to breathe, even clutching at the throat. Cyanosis is present, and the aspect is one of anxiety and alarm. Frothy fluid may soon stream from mouth and nose, or be brought up in great gulps. The chest movements are hurried, and the accessory respiratory muscles are in violent action. Vocal fremitus is diminished over the lower lobes. The percussion note soon becomes impaired over the lungs, commencing at the bases. The breath-sounds are at first vesicular or harsh with

prolonged expiration, then become faint and may be obscured by bubbling râles or crepitations, audible all over the chest. Voice conduction is diminished.

Complications and Sequelæ.—Owing to its acute and rapid course, complications do not occur. Bronchitis may result as a sequela.

Course.—The malady usually lasts only minutes or hours. Unless it remits, or treatment affords relief, the patient rapidly becomes unconscious and death follows, the heart continuing to beat after respirations have ceased.

Diagnosis.—The affection is usually so characteristic that the diagnosis is obvious. In the more protracted cases the dyspnœa and the physical signs are not unlike those of acute suppurative bronchitis or suffocative catarrh and broncho-pneumonia; but in both of these there is some degree of fever and the expectoration is less copious, and when it occurs is usually of purulent or muco-purulent character. The nocturnal onset of œdema may suggest asthma; but the physical signs and the late and scanty expectoration in the latter suffice to distinguish it.

Prognosis.—The prognosis is always very grave; but prompt treatment has saved some cases. Death may occur in less than 10 minutes, or be delayed for 24 or 48 hours. In the angio-neurotic type repeated attacks may occur.

Treatment.—The most successful treatment is the immediate subcutaneous injection of gr. $\frac{1}{3}$ morphine. Good results have also followed the injection of gr. $\frac{1}{100}$ atropine sulphate hypodermically. These are often given together. Oxygen inhalation will probably not be tolerated owing to the restlessness, and is of doubtful utility. Prompt venesection has been recommended, and should be tried if possible; but its value has not been established.

(*d*) Chronic Pulmonary Œdema

This is usually the sequel of chronic passive hyperæmia, and the causes and symptoms are those of that condition. It may also occur in chronic renal disease. In marked degrees of œdema, however, the signs may closely simulate those of pleural effusion, save for the displacement of the cardiac impulse. It is important to remember that some degree of hydrothorax may occur as a complication, and increase the difficulty in diagnosis.

INFARCTION OF THE LUNGS

Infarction of the lungs or "pulmonary apoplexy" results when a branch of the pulmonary artery becomes occluded by embolism or thrombosis.

Ætiology.—*Embolic forms.*—The obstructing plug may originate in any part of the systemic venous system, in the right side of the heart or on its valves or in the pulmonary artery itself. The commonest peripheral cause of embolism is detachment of a thrombus in cases of thrombo-phlebitis. This may occur in the veins of the lower extremity, or in those of the uterus after childbirth. Thrombosis with embolic detachment may also develop in prolonged or wasting diseases, such as enteric fever, tuberculosis and cancer; in acute processes, such as influenza, septicæmia and pyæmia; and in localised septic lesions, such as otitis. Pulmonary embolism is not infrequently

observed after abdominal or pelvic operations, and after the radical cure of hernia or hæmorrhoids.

Intracardiac thrombi from the right auricle or ventricle, becoming detached, lead to embolism, and this occurs especially in cases of right-sided heart failure secondary to left-sided valve lesions. Vegetations forming on the tricuspid or pulmonary valves in infective endocarditis on detachment produce pulmonary infarction. Rarer causes are fat embolism after injury to bone or to a fatty liver, the entry of pieces of new growth or hydatid daughter-cysts into systemic veins, and even air embolism.

The exciting cause of embolism is not infrequently sudden movement or strain leading to detachment of a thrombus or vegetations.

Thrombotic forms.—Thrombosis occurs as a secondary process around pulmonary emboli; but it is probable that some cases of infarction are due to a primary thrombosis. This condition may be produced by some acute or chronic pulmonary disease, such as gangrene, tuberculosis and fibrosis, and by atheroma of the pulmonary artery. Any process leading to chronic venous hyperæmia may also cause it.

Pathology.—Although the pulmonary arteries are not strictly speaking end arteries, since there is some degree of anastomosis between them and the bronchial arterioles, yet the result of their obstruction is to produce infarcts comparable with those in other organs. The origin of the blood in the obstructed area has been much discussed. Cohnheim regarded it as the result of regurgitation from the veins, a view subsequently disproved, since the infarct is hæmorrhagic even when the veins are also obstructed. It is now regarded as due to influx from the anastomosing bronchial capillaries into the pulmonary capillaries, and the escape of this blood from the latter owing to their altered nutrition. It is generally accepted that embolism is much more common than thrombosis. It has been suggested that some infarcts are not obstructive, but are the result of hæmorrhage *per rhexin* in cases of extreme passive hyperæmia, and that the shape is due to the alveolar distribution of the bronchial area affected. If a large embolus has caused sudden death, it will be found arrested at the bifurcation of a large branch of the pulmonary artery, or even in one of the main divisions of that vessel. In such cases there has not been time for pulmonary changes to occur, and the chief post-mortem condition found is engorgement of the right side of the heart.

In post-mortem examination of cases where smaller emboli have led to infarction, the infarcts are usually found in the lower lobes, more commonly in the right lung. They extend to the surface in the majority of cases, and can be seen before section as slightly raised, dark red areas, with the overlying pleura a little roughened from inflammatory exudate. They feel hard and firm, and on section are typically wedge-shaped, with the base on the surface and the apex centrally placed. In the rare deep-seated infarcts a spheroidal form is the rule. When recent, an infarct is dark red in colour, and suggests hæmorrhage with clot formation, hence the term "pulmonary apoplexy." In some cases infarcts have a purplish hue, and are said to resemble the colour of damson cheese; later they change to brownish-red. Infarcted areas sink in water. There may be a single large infarct almost occupying one lobe, sometimes only a small one, or several of varying size and age scattered throughout the lungs. In some cases a fortunate section

may reveal the embolus with its ensheathing thrombus, but sometimes a thrombus only is found. Microscopically, the alveoli and finer bronchioles are filled with red blood corpuscles, and there is a sharp delimitation from the healthy lung. If the embolus is infective, suppuration occurs, and abscess or empyema ensues.

Symptoms.—If a large embolus blocks one of the main divisions of the pulmonary artery, there is sudden intense dyspnœa, pain in the chest, distress, cyanosis, and rapid unconsciousness, death resulting in a few minutes from asphyxia. In other cases the patient gives a short cry, and falls unconscious, death occurring almost immediately from syncope. In some cases unconsciousness develops so rapidly, and the respiratory symptoms are so little apparent, that a cerebral vascular lesion may be suspected. On the other hand, life may be maintained for several minutes or even hours, the patient being unconscious or in acute distress and anxiety with urgent dyspnœa, lividity and cyanosis. Respiration is deep and laboured, but fails to give relief to the sense of suffocation. In such cases also, death may result eventually from asphyxia or syncope, or the patient may slowly recover. In less severe forms, such as occur in cardiac and in some post-operative cases, there is sudden pain with difficulty in breathing, followed in a few hours or in a day or two by cough with hæmoptysis or by the expectoration of deeply blood-stained mucus persisting for some days, and slowly clearing up. If the embolus is infective, fever, often of hectic type, results, sometimes delayed for a day or more.

In the severe cases there is cyanosis, distension of the veins of the neck, acute anxiety with exophthalmos and cold, clammy skin. The only physical signs apparent are the deep, laboured breathing, the harsh breath sounds, and the evidence of cardiac embarrassment with feeble, failing pulse.

In less severe cases the signs are also not characteristic. There are evidences of cyanosis and distress of less urgent character, possibly some limitation of movement on the affected side, increase of vocal fremitus, localised dullness, with weak or absent breath-sounds, and sometimes a pleural rub. In some cases definite bronchial or tubular breath-sounds may be audible. A few fine râles are sometimes present in the adjacent lung areas.

Complications and Sequelæ.—Localised dry pleurisy is almost invariably present. With infective emboli, abscess or gangrene, and later empyema may result. In organisation an infarct leads to a localised area of fibrosis.

Course.—As already described, death may occur from asphyxia or syncope in the course of a few minutes or hours, although recovery occurs in some very severe cases. In the less severe forms, after the initial urgent symptoms have passed off, recovery is often rapid and uneventful, save for pain, cough and bloodstained expectoration.

Diagnosis.—The dramatic onset, the history and the associated lesions of the veins or heart render diagnosis easy as a rule; but it may be necessary to eliminate other causes of hæmoptysis, notably pulmonary tuberculosis and chronic venous hyperæmia.

Prognosis.—This depends largely upon the initial shock. The prognosis is very grave when the patient rapidly becomes unconscious. As there is less likelihood of sepsis in cases due to cardiac lesions than in those due to localised venous thrombosis, the prognosis is rather better in the former; but, on the other hand, organisation of a clot in a vein may completely remove

the source of the emboli, while the source often persists when they are derived from the heart.

Treatment.—The coagulability of the blood may be lowered by the administration of 30 grains of sodium citrate three times daily. This is a wise prophylactic measure in prolonged illness, especially when a milk régime is being enforced. When thrombosis has occurred in a peripheral vein, such as in the leg, the affected limb should be immobilised until organisation of the clot has taken place. Morphine is useful in quieting a patient if there is much mental distress when a pulmonary infarct forms; but usually the patient is collapsed and stimulant measures are indicated. An injection of morphine gr. $\frac{1}{6}$, atropine gr. $\frac{1}{100}$, and strychnine gr. $\frac{1}{30}$ is found of value in some cases. If there is dyspnœa oxygen should be administered. Venesection to the extent of 10 or 12 ounces may be tried in cases where there is marked lividity with a forcibly acting heart. Hæmoptysis, when it occurs, should not be checked. Pain may be relieved by leeches, cupping or by application of iodine. In cases with heart failure the appropriate treatment by cardiac tonics should be administered.

COLLAPSE OF THE LUNGS

In collapse of the lungs the alveoli are completely or partly devoid of air. The condition may be congenital, and due to non-expansion of the lung, when it is referred to as atelectasis. On the other hand, collapse may be the result of removal of the air from lung tissue previously expanded, when it is called apneumatosis or acquired collapse. The three terms collapse, atelectasis and apneumatosis are, however, used as synonyms by many writers.

Atelectasis or Congenital Collapse

Ætiology.—This condition occurs in still-born and in premature infants, and probably persists to some degree for weeks or even months in weakly children. It may result from immaturity or from weakness of the inspiratory muscles, and from obstruction of the air passages by mucus and meconium. It may be a consequence of disease, such as congenital syphilis or lesions and developmental defects of the nervous system.

Pathology.—Atelectasis is due to failure of the respiratory mechanism to draw air into the alveoli and expand them, as occurs normally with the first few inspiratory efforts of the new-born infant.

Atelectatic lungs are solid, airless and small. They are usually described as presenting appearances similar to those of adult liver as regards colour and consistence. In partial atelectasis the lung appears mottled, and small expanded areas of pinkish colour may project from the surface. The condition is chiefly of medico-legal and pathological interest.

Apneumatosis or Acquired Collapse

Collapse of previously expanded lung may be active or passive, the former being due to active shrinking of the lung owing to defects in the inspiratory musculature, the latter to conditions disturbing the pressure relations within the thorax.

1. Active Pulmonary Collapse.

Synonyms.—Active Lobar Collapse; Massive Collapse.

Ætiology.—This condition was first described by William Pasteur in 1890 in cases of diphtheria associated with paralysis of the diaphragm. In 1908 he pointed out that it occurred also as a sequel of operations, especially of those upon the abdominal organs, less frequently of those upon the neck and pelvis. It is highly probable that many post-operative lung conditions formerly recorded as pneumonia were in reality due to active collapse. It may also follow after injuries, such as those resulting from falls from a bicycle or a horse. During the Great War, when chest wounds were collected in special hospitals, it was found that massive collapse was not infrequently an important complication of penetrating and non-penetrating wounds of the chest. It was also noticed in some cases after severe wounds of the buttocks and pelvis.

Pathology.—The mechanism by which deflation results is obscure, and is the subject of controversy. Pasteur regards the condition in the diphtheritic cases as due to paralysis of the diaphragm through the phrenic nerves or their nuclei, and in the post-operative and traumatic cases as a consequence of reflex inhibition of this muscle. Briscoe, on experimental, pathological and clinical evidence discards Pasteur's explanation. He maintains that the deflation is caused by an exaggeration of the normal phenomena of breathing in the supine position, in which he states that the crural portion of the diaphragm alone contracts, the costal portion being in abeyance. In the supine position, with quiet breathing, deflation of the lower lobes occurs, and this is promoted by conditions of debility, toxæmia or operation. The clinical manifestations described by Pasteur are regarded by Briscoe as the result of superadded pleurisy, or of inflammation of the crura of the diaphragm.

Recently Boland and Sheret have put forward the suggestion that massive collapse is due to obstruction of the bronchi, followed by removal of the air in the corresponding lung areas by absorption into the blood stream. The obstruction is supposed to be due to increased secretion and the inhibition of the cough reflex.

Post mortem, the lower lobe of one lung is usually found to be deflated and retracted towards the spine. Sometimes the whole of one lung may be affected, or both lower lobes. The collapsed area is bluish-red, firm, does not crepitate and sinks in water. Pleurisy or pneumonic changes may be seen, and these are regarded by Pasteur as secondary to infection of the deflated lung, the resistance of which is lowered, and by Briscoe as the essential factor in the production of the symptoms. In massive collapse the heart and mediastinum are displaced towards the affected side, and the sound lung is often bulky and distended.

Symptoms.—The symptoms commonly commence within 24 or 48 hours of the injury or operation, although they may rarely be delayed for 5 to 7 days. The onset is generally sudden, with pain in the lower part of the thorax or behind the sternum. Severe dyspnœa quickly follows, and the patient appears dusky, cyanosed and alarmingly ill. Cough, with viscid mucoid expectoration, generally develops in a few hours. The latter may become copious and muco-purulent if pneumonic changes ensue. The pulse and respirations are markedly increased in rate, and the temperature not infrequently rises to 103° F. Occasionally the onset is more gradual with pain

and cough, and in some cases of wounds it may give rise to few symptoms and be discovered only on routine examination.

Examination of the chest shows diminished movement on the affected side, and often absence or reversal of epigastric excursion with respiration, whereas the movement on the other side may be exaggerated. In other respects the signs usually simulate those of lobar pneumonia. Over the collapsed lung the vocal fremitus is increased, the percussion note is dull, the breath sounds are tubular, and bronchophony and whispering pectoriloquy are present; but as a rule there are no adventitious sounds, although occasionally rhonchi and a few fine râles may be heard. In some cases the breath sounds are very weak or almost absent, and voice conduction is diminished. Over the healthy lung, loud and harsh breathing is audible. The displacement of the cardiac impulse towards the collapsed lung is a point of cardinal importance. It is noteworthy that in certain cases of gunshot wounds of the chest the collapse affects the contra-lateral lung.

Complications and Sequelæ.—Bronchitis, lobar pneumonia, or pleurisy may occur as complications. There are usually no sequelæ, except that pleural adhesions may occur.

Course.—The course of the affection is rapid. After periods extending from 2 to 5 days the temperature falls to normal, the symptoms disappear, the lung quickly re-expands, the heart returns to its normal position, and there is complete recovery.

Diagnosis.—The most important conditions from which this malady has to be distinguished are lobar pneumonia, pulmonary embolism, pneumothorax and pleural effusion. The position of the cardiac impulse is often the deciding factor: in collapse it is displaced towards the lung involved, in pleural effusion and pneumothorax it moves away from the affected side, whereas in lobar pneumonia there is usually no cardiac displacement, although there may be dilatation. Labial herpes and blood-stained expectoration are frequently seen in pneumonia, but not in collapse. When in right-sided collapse there is marked distension of the left lung with obliteration of the normal cardiac dullness, the signs superficially resemble those of a left-sided pneumothorax; but with careful examination no such error should be made. The distinction from pulmonary embolism may be difficult at first, but the localisation of the signs, and the blood-stained expectoration, may give useful indications.

Treatment.—*Prophylaxis.*—The administration of morphine and atropine before the anæsthetic, propping up of the patient in bed as soon as possible after it, and the insistence upon periodic deep breaths are useful measures in preventing the onset of lobar collapse. When the "collapse attack" develops oxygen should be administered and pain relieved by local applications, such as leeches or poultices, or by an injection of morphine, atropine and strychnine. Expectorants may be given if the cough is ineffective, and cardiac tonics, such as digitalis, strophanthus and caffeine if there is much cardiac embarrassment. Injections of strychnine or camphor in oil are useful if the patient is collapsed at the onset.

2. **Passive Pulmonary Collapse.**—This form of collapse may affect the whole of one lung, or be confined to one lobe or to groups of lobules.

Ætiology.—Total collapse is generally the result of pleural effusion, empyema, pneumothorax or obstruction of a main bronchus. In a large

effusion and in pneumothorax collapse is complete, unless the shrinkage is prevented by adhesions. In a smaller effusion, the process may be limited to the lower parts of the lung. Other causes of lobar or partial lobar collapse are conditions leading to complete obstruction of a main bronchial division, particularly new growth, aneurysm or foreign body. It also occurs in aged or bedridden patients, or in those with enfeebled inspiratory muscles, when prolonged fever has enforced a dorsal decubitus. Abdominal distension from tympanites or ascites can also cause collapse of the bases of the lungs.

Lobular collapse results from any condition impeding the air entry to the smaller bronchi or bronchioles, such as bronchitis, broncho-pneumonia, pulmonary tuberculosis, whooping-cough and diphtheria. Obstruction of the naso-pharynx by enlarged tonsils and adenoids may cause partial collapse, especially in the upper lobes.

Pathology.—The deflation of the lung area may be produced in three ways—(1) By complete obstruction to the air from blocking of a bronchus or bronchiole, the residual air being absorbed; (2) by enfeeblement of the inspiratory mechanism similar to the process in active collapse; and (3) by disturbance of the intrapleural pressure by fluid or air, the lung at first contracting in virtue of its elasticity until the intrapleural pressure becomes equal to that of the atmosphere, when any further accumulation of fluid or air causes positive pressure and compression of the collapsed lung. It is said that a plug of mucus in a bronchus may act as a ball valve, allowing the escape of air during expiration, and preventing its entry during inspiration. This view has now few adherents.

Post mortem, in complete or lobar collapse the appearances are similar to those in active collapse. In lobular collapse the deflated areas are contracted and depressed below the level of the healthy lung. They are dark red or slaty in colour, while the adjacent areas are pinkish and often emphysematous. The collapsed areas do not crepitate.

Symptoms.—Total collapse of the lung or of a lobe being usually a secondary process, the symptoms and signs are masked by those of the primary condition, such as pleural effusion, pneumothorax, growth or aneurysm. It can, however, usually be demonstrated by X-ray examination, the collapsed lung being apparent as a fairly dense shadow lying alongside the vertebral bodies. Not infrequently, however, in pleural effusion definite tubular breath sounds, with bronchophony and pectoriloquy, may be audible in the relatively dull area above the level of the fluid posteriorly, and these signs are due to the collapsed lung. In aortic aneurysm, or less commonly in mediastinal, pulmonary and bronchial neoplasms, distinctive signs due to the local collapse may be apparent. These consist of slightly diminished movement of the corresponding part of the chest wall, with diminution of vocal fremitus and impairment of percussion note or actual dullness. Breath sounds are weak, as a rule, but may be bronchial or tubular. Voice conduction is increased, and in incomplete collapse crepitations are often audible. The cardiac impulse may be displaced towards the affected side, but this is less apparent than in active collapse, and it is not infrequently displaced to the opposite side by the primary condition. Lobular collapse gives rise to no symptoms which can be differentiated from those of the condition inducing it.

Course and Complications.—The lung usually re-expands wholly or in part when the condition causing collapse has been removed. Thus a lung that has been maintained continuously collapsed by artificial pneumothorax, with repeated refills for as long as 2 years or more, will re-expand when the gas in the pleural cavity is allowed to be absorbed. In chronic effusion, or in large or neglected empyemata, re-expansion may be incomplete, and some falling in of the chest wall results. Fibroid changes may occur in lung tissue which has been long collapsed.

Diagnosis.—This is frequently a matter of inference, owing to the nature of the primary disease. Valuable help may be afforded by X-ray examination.

Treatment.—No special treatment apart from that of the condition causing the collapse is required. If a pleural effusion is slow to absorb, the necessity for paracentesis, to avoid too long collapse, may have to be considered.

HÆMOPTYSIS

It should be recognised that hæmoptysis is a symptom, not a disease. It is here considered separately because the accurate diagnosis of its origin is essential to its treatment, which differs widely in different conditions.

Definition.—The term hæmoptysis is arbitrarily restricted to the expectoration of blood, entering the air passages from structures below the larynx or from the larynx itself. When the blood is derived from the naso-pharynx or mouth it is sometimes described as spurious hæmoptysis.

Ætiology.—1. Pulmonary tuberculosis is the commonest cause, the blood being derived from an aneurysm in a pulmonary cavity, or from ulceration of a small vessel, or congestive processes around the early lesions.

2. Chronic venous congestion, particularly in mitral stenosis. These two conditions account for the majority of cases.

3. Inflammatory and destructive diseases of the lungs, air passages or pleura, such as pneumonia, broncho-pneumonia, especially the influenzal variety, abscess, gangrene and bronchiectasis with ulceration of the walls. Pneumokoniosis, streptotrichosis and ulceration of the larynx, trachea or bronchi from tuberculosis, gumma or new-growth may also be associated with hæmoptysis. Breaking down of a caseous or calcareous bronchial gland is a rare cause, as also is rupture of an empyema through a bronchus.

4. Infarction of the lung.

5. New-growths of the lung, bronchi or mediastinal glands.

6. An aortic aneurysm may cause hæmoptysis by "weeping" through an eroded bronchus, or by direct rupture, the latter being of course immediately fatal.

7. Traumatic causes.—Injury may cause hæmoptysis, by fractured ribs wounding the lung, by contusion and by breaking down of healed tuberculous lesions. Hæmoptysis occurs frequently in wounds of the chest, both penetrating and non-penetrating.

8. Certain abnormal blood conditions, chiefly leukæmia, purpura, hæmophilia, scurvy and occasionally pernicious anæmia. Hæmoptysis occasionally occurs in the malignant specific fevers, especially small-pox and measles.

9. Parasitic causes, such as pulmonary distomatosis and spirochætosis, are common in Asia but rare in Europe. Hydatid disease of the lung may cause slight hæmorrhages.

10. Vicarious menstruation.—Some cases in women have been regarded as vicarious menstruation, and this view dates back to Hippocrates. It is probable, however, that most cases are to be explained as due to leakage from obscure pulmonary lesions.

11. Hæmoptysis occasionally occurs in apparently healthy persons. In some, with high systemic arterial tension, it is probable that the pulmonary arterial pressure is also raised, and the condition may be regarded as analogous to the epistaxis which occurs more commonly in such patients. Sometimes the hæmoptysis is due to leaking from an old arrested tuberculous lesion.

12. Rupture of an hepatic abscess or hydatid cyst through the diaphragm into a bronchus is an occasional cause.

Spurious hæmoptysis is usually due to staining of the saliva or the pharyngeal secretion with blood, generally derived from the gums, which are spongy and congested, often from early pyorrhœa. The condition is common in anæmic girls, and is, as a rule, observed in the morning. Hæmorrhage from an enlarged pharyngeal vein is often suggested as a cause, but is rarely seen. Hæmorrhage after tooth extraction, and staining of the mucus expectorated after epistaxis, are other causes of spurious hæmoptysis.

Pathology.—From the list of causes it might be inferred that the origin of the blood differs in different cases. It may come from the pulmonary or bronchial vessels in pulmonary tuberculosis and other lung or bronchial conditions, and also in chronic venous congestion or infarction. It may come from the thoracic aorta direct, or from some of its branches, in aneurysm and mediastinal new-growth, and from the hepatic vessels in abscess of the liver. In cases due to disease of the trachea and larynx it comes direct from the vessels supplying them.

On examination, the larynx, trachea and bronchi may contain clots, or blood-stained froth and mucus, and their walls may be stained in places. Dark reddish areas of lobular distribution, due to inhaled blood, may be seen in various parts of the lungs, particularly at the bases. Sometimes this may induce bronchitic changes, described as hæmoptoic bronchitis. Careful search in cases of profuse hæmoptysis will usually reveal the source of the hæmorrhage, and in pulmonary tuberculosis this is generally a ruptured aneurysmal dilatation in a cavity. The aneurysm may be small and escape notice unless many cuts are made into the lung.

Symptoms.—In hæmoptysis, the patient often experiences a tickling in the throat, followed by a gush into the mouth with a salt taste, and on expectoration notices blood. The alarm and anxiety this occasions lead to restlessness and rapid action of the heart. If the bleeding is profuse, cough is frequent, and large clots, together with liquid alkaline blood, may be expectorated to the extent of 20 or 30 ounces in a few hours. The bleeding may cease temporarily to recur at intervals for several days, until the patient becomes blanched, weak and syncopal, with rapid, weak pulse. In any profuse hæmoptysis, death may occur in a few minutes, either from asphyxia or syncope. In the former case, the blood, at first bright and arterial, is soon dark and frothed, while the patient becomes cyanosed and livid. In

slighter degrees of hæmoptysis there may be only streaks, small clots or liquid blood mixed with ordinary sputum. After the actual bleeding has ceased, the sputum may be blood-stained for some days, owing to the expectoration of blood inhaled into other parts of the lungs. This can be recognised by its colour, which varies from dark red to brown, owing to the changes undergone by the pigment.

Diagnosis.—This involves two problems—first the differentiation from hæmatemesis and spurious hæmoptysis, and secondly the recognition of the cause of the hæmorrhage. If the patient is seen at the time of the bleeding the first of these is easy. The nature of the blood, and its association with cough and possibly with pulmonary or cardiac signs, are conclusive. When the diagnosis has to be made upon the history given by the patient or by friends it may be difficult, especially in the absence of physical signs.

In hæmatemesis there is frequently gastric pain and faintness before the vomiting, the blood is acid in reaction, dark in colour, even brown from acid-hæmatin, and is sometimes mixed with food. The fact that in hæmoptysis blood may be swallowed and subsequently vomited increases the difficulty. Patients often give very dubious answers to questions as to whether the blood was coughed or vomited up. They should then be questioned as to whether sputum was brought up on the following day, and if so whether it was blood-stained. In cases of doubt the investigation of the pulmonary and abdominal physical signs, when the patient's condition permits, may decide the diagnosis.

Great caution should be exercised to exclude tuberculosis before making a diagnosis of "spurious hæmoptysis." Only when there are no pulmonary symptoms or signs, and when some obvious cause, such as anæmia or pyorrhœa, is found, is it safe to do so.

While distinguishing between the various causes of hæmoptysis it is well to regard and to treat it as due to pulmonary tuberculosis until some other cause is conclusively established. The sputum should be examined for tubercle bacilli on several occasions, the temperature recorded, and the physical signs most carefully watched.

The presence of a valvular lesion, especially mitral stenosis with signs of pulmonary engorgement, may render the cause of hæmoptysis clear. When tuberculosis and cardiac disease can be excluded, a careful study of the history, the symptoms and signs, may throw light on the diagnosis or suggest some investigation which will serve to establish it, *e.g.* examination of the sputum for parasites and hydatid hooklets, the cytological examination of the blood and an X-ray examination.

In other cases, as in bronchiectasis, abscess or gangrene, the history, the physical signs and the nature of the sputum are often characteristic.

Prognosis.—Apart from hæmoptysis, which is rapidly fatal, due to aneurysm or pulmonary tuberculosis, the immediate prognosis in cases of pulmonary hæmorrhage is not unfavourable, even when it continues for days. The ultimate prognosis depends upon the cause.

Treatment.—This is so entirely dependent upon the cause and origin of the bleeding that reference should be made to the corresponding diseases.

EMPHYSEMA OF THE LUNGS

Emphysema of the lungs, or alveolar-ectasis, is a condition of distension of the alveoli; it is usually progressive and is associated with definite changes in the inter-alveolar walls. The following varieties are generally recognised — (1) Large-lunged or hypertrophic; (2) small-lunged or atrophic; (3) compensatory; (4) acute vesicular; and (5) acute interstitial emphysema. The last-named condition has no relation to true emphysema except in name, but will be described in this group for convenience.

1. Large-lunged or Hypertrophic Emphysema (Substantive or Idiopathic Emphysema)

This is a chronic affection and is usually bilateral.

Ætiology.—*Predisposing causes.*—It may occur at any age, even in childhood, but is most frequently seen in middle and late adult life. It is commoner in men than in women, probably because they are more exposed to the conditions inducing it. Although not strictly hereditary, it often shows a familial incidence. Certain occupations are credited with being concerned in its production, notably those involving violent or prolonged muscular effort with closed or partially closed glottis, such as blowing wind instruments and lifting heavy weights. Dusty occupations also favour its onset by leading to bronchitis and cough.

The common exciting cause seems to be the strain of prolonged and repeated cough, induced by chronic bronchitis, bronchiectasis, asthma, whooping-cough, cigarette smoke inhaling, and other causes of irritation of the upper air passages.

Pathology.—The pathogenesis of emphysema has been much debated and various explanations have been offered. (1) Primary degeneration theory. Villemin suggested that the essential lesion was a fatty degeneration of the alveolar walls, while Cohnheim believed that there was a congenital defect of the elastic tissue of the lung. (2) The inspiratory theory, first suggested by Laennec and developed by Gairdner, postulates the force of inspiration as the distending agent. (3) The expiratory theory, first enunciated by Mendelssohn, was independently brought forward and established by Jenner. The distension of the alveoli is regarded as due to the effect of forced expiration and cough. Jenner pointed out the special and early involvement of the apices, the anterior and lower margins of the lungs; in other words, the parts least supported by the thoracic cage. (4) Freund regarded the changes in the lungs as secondary to calcification of the costal cartilages, the chest becoming fixed in the inspiratory position and the lung permanently expanded in consequence. The expiratory explanation is now generally accepted, and emphysema is regarded as the result of increased intra-alveolar tension, due to violent expiratory efforts, acting on walls weakened by congenital defects, by inflammatory processes or by toxic agents, such as alcohol (Nothnagel).

The characteristic conformation of the chest is usually apparent (see Symptoms), the costal cartilages are often calcified, and on opening the thorax post mortem, the lungs bulge instead of retracting, so that the peri-

cardium may be almost completely obscured. They are pale in colour, even in town-dwellers, a condition called albinism of the lung by Virchow. They are soft and pit on pressure, and, as described by Laennec, give the sensation of a down pillow. The surface of the lung under the pleura shows a finely vesicular appearance, due to the distension of the alveoli, the vesicles often being nearly as large as pins' heads. Not infrequently large bullæ or blister-like protuberances, varying in size from a pea to a Spanish olive, may be seen projecting from the surface, particularly at the apices and margins. These bullæ when incised show fine fibrous bands crossing them, the remains of inter-alveolar walls and of atrophied blood vessels. It was formally customary to refer to such cases as bullous or marginal emphysema and to describe those in which the dilatation is less obvious but more widely diffused as general emphysema; but the conditions are so commonly associated together in varying degrees that little is gained by so doing. On section the lungs are anæmic and dry, except at the bases, where there is frequently some œdema in advanced cases. The bronchi may show some general dilatation, although less commonly than might be expected from the close similarity of the causal factors of emphysema and bronchiectasis. Where bronchitis coexists, muco-pus can be squeezed from the cross-sections of these tubes. As pointed out by Fowler, pleural adhesion is relatively uncommon. The infundibula and alveoli are dilated, and the inter-alveolar walls are thin and atrophic, even disappearing wholly or in part. The distension and coalescence of adjacent alveoli result in the formation of bullæ. The calibre of the pulmonary capillaries is diminished by stretching of the alveolar walls, and where atrophy of the inter-alveolar septa occurs the capillaries are destroyed. These two processes result in a considerable diminution in the total aerating surface, and cause the dyspnœa and cyanosis characteristic of the disease. Moreover, the normal anastomoses between the terminal bronchial and pulmonary capillaries increase considerably, and some of the blood in the latter may therefore fail to reach the alveoli and so escape aeration. Atrophic changes in the elastic tissue have been described. In order to maintain the circulation through the diminished capillary area, the right ventricle hypertrophies and the resultant high blood-pressure sometimes induces atheroma of the pulmonary artery. Emphysema being a progressive lesion, and the defective aeration of the blood perhaps interfering with the nutrition of the heart muscle, cardiac failure eventually ensues, causing tricuspid regurgitation, engorgement of the right auricle, and the visceral effects of venous engorgement, such as "nutmeg" liver.

Symptoms.—Dyspnœa of varying degree is the most characteristic symptom. In uncomplicated cases of moderate extent it is only present on exertion, unless bronchitis coexists. In advanced emphysema, dyspnœa is marked and becomes extreme in the bronchitic or "asthmatic" attacks and in foggy weather. Cyanosis is common, and is to some extent a measure of the degree of emphysema. The patient may walk about with a more extreme degree of cyanosis than in any other condition except congenital heart disease. Clubbing of the fingers of moderate degree is common. Cough is usually due to the associated bronchitis, and is worse in the winter and in foggy weather. It is frequent, noisy and often hacking and paroxysmal. Expectoration is also the result of the bronchial catarrh, and varies from a few grey mucoid pellets to copious muco-pus.

The chest is enlarged, particularly in the antero-posterior diameter, the upper thoracic spine is rounded and kyphotic, the sternum protrudes forward, and the angle of Louis (angulus Ludovici) is prominent, the general effect being the so-called barrel-shaped chest. The ribs run forward less obliquely and the intercostal spaces are wider than normal, the chest being as a whole in the inspiratory position. The respiratory movements are much restricted, the patient elevating the rigid thorax with little expansion on taking a deep breath, so that the inspiratory increase at the level of the nipples may be only half to 1 inch, instead of the normal 2½ to 3 for an adult. There is often filling and even bulging of the supra-clavicular hollow, while the neck appears short, the sternomastoids stand out, and the jugular veins are full. A zone of dilated venules, the "emphysematous girdle," is often visible along the line of the costal attachment of the diaphragm, but is not pathognomonic. The cardiac impulse is not visible as a rule, and may only be felt with difficulty, but epigastric pulsation is usually apparent. Vocal fremitus is diminished, and the percussion note is hyper-resonant. The superficial cardiac dullness is greatly diminished or even absent, and the lower limit of pulmonary resonance may extend to the costal margin, back and front, the hepatic dullness being encroached on.

It is said that in bullous emphysema the breath-sounds are harsh over the outer part of the upper lobes in front, and weak at the bases. In general emphysema the breath-sounds are weak everywhere, inspiration is short, and expiration is greatly prolonged. A loud rumbling, from contraction of the thoracic muscles, may entirely obscure the breath-sounds. A few fine bubbling râles may be heard at the bases or at the sternal margins. If bronchitis is present, scattered rhonchi may be audible. Vocal resonance is generally slightly diminished. The heart-sounds are weak and distant, and in late stages a tricuspid systolic murmur may develop. The "vital capacity" of the lungs, measured by a spirometer, is often reduced even to one-half; for example, to 1800 c.c., instead of the normal 3600 c.c. Examination by the X-rays shows increased extent, and undue translucency of the lung tissue. The liver is sometimes palpable, possibly from downward displacement by the bulky lung, but more often from enlargement due to passive hyperæmia. The spleen may also be depressed and enlarged.

Complications.—Bronchitis is the commonest, and often constitutes a vicious circle. Asthmatic attacks, so-called "bronchial asthma," are common in later stages; on the other hand, spasmodic asthma may be the cause of the emphysema. Pneumothorax and interstitial emphysema may occur from rupture of the bullæ, although these accidents are surprisingly rare. Pulmonary tuberculosis is an occasional complication of emphysema, which, contrary to popular opinion, is not antagonistic to it, although it may mask and obscure the early stages. Right-sided cardiac failure, with its train of consecutive changes, is a late and often terminal complication.

Course.—Emphysema is progressive, unless the cause is removed or the effects of the disease are mitigated by residence in a warm, dry climate, especially in the winter. Conversely, residence in unsuitable districts, persistence in detrimental employment, and repeated attacks of bronchitis accelerate its course.

Diagnosis.—This is never difficult in advanced cases. The slighter degrees may be more difficult, and the diagnosis is then largely a matter of

inference from the association of chronic cough and dyspnœa, with physical signs of hyper-resonance and prolonged expiration.

Confusion may occasionally arise in regard to pneumothorax, thoracic aneurysm and pulmonary tuberculosis. Careful record of the symptoms and signs and the investigation of the sputum generally suffice to distinguish these conditions. In doubtful cases the X-rays may assist.

Prognosis.—This depends upon the degree of emphysema and the circumstances of the patient. If progressive, it exerts an increasingly crippling effect, and it certainly shortens life under urban conditions. A "vital capacity" of less than 50 per cent. of the normal is of serious import. The advent of severe bronchitis or of cardiac complications may affect the prognosis gravely.

Treatment.—Emphysema may be arrested but cannot be cured. Attention must be directed to prevention of the causes of chronic cough and increased intra-alveolar tension. In any person with hereditary tendency to emphysema or to winter cough, the questions of occupation and place of residence should be carefully considered. When the disease is established, the patient, if in a position to afford it, should spend the winter in a warm, dry climate, either abroad or at the south-west coast of England.

Various attempts have been made to increase the respiratory ventilation of the lungs, *e.g.*, by compression of the chest during expiration, by expiring into rarefied air, or by breathing compressed air. Of these the compressed air bath seems to have given the best results. The patient enters a special iron chamber fitted with a window, and the air pressure is raised during the course of half an hour to 1½ atmospheres. He remains at this pressure for an hour, and is then decompressed to normal during the next half-hour. These baths may be given every other day and gradually increased in duration and frequency. This treatment is often efficacious in cases of emphysema associated with bronchial spasm or with bronchitis. It is possible that the increased pressure overcomes the obstruction caused by catarrhal inflammation or by spasm of the finer bronchi, and allows the alveolar air, pent up under pressure, to escape. Cases with marked arterial disease or with much rigidity of the chest-wall are unsuitable for this form of treatment.

The diet should be simple and easily digestible, especially in the later stages. If there is spasmodic dyspnœa or asthma, no late meal should be permitted. Cod-liver oil in the winter seems to help some patients. Clothing should be warm, but the excess of under-garments, often worn in fear of chill, is harmful.

In other respects treatment is largely symptomatic. In acute bronchitic attacks the measures to be adopted are in no way different from those in bronchitis uncomplicated by emphysema. In the more chronic bronchitis so commonly present in the winter, iodides with alkalis and balsamic expectorants seem beneficial. Terebene (♏ x) in emulsion or in capsule has been recommended. Counter-irritation to the chest by liniments, such as the lin. terebinthinæ aceticum, is often grateful to the patient, when cough is troublesome. When asthma or paroxysmal dyspnœa occurs, antispasmodic drugs and measures similar to those used in spasmodic asthma may be employed. When cardiac failure supervenes, the appropriate treatment must be vigorously applied. If there is marked cyanosis and venous engorge-

ment, venesection, leeching, purgative and diuretic drugs may be employed, and digitalis and other cardiac tonics administered.

2. Small-lunged Emphysema (Atrophic or Senile Emphysema)

Ætiology.—This condition occurs in old age and forms part of the general atrophy of the tissues.

Pathology.—The alveolar walls become thinned and disappear, so that adjacent alveoli coalesce. The condition is primarily atrophic, and therefore differs from true emphysema, although the result is to produce a diminished area for aeration. Post mortem the lungs are small and do not bulge or obscure the pericardium. They are often deeply pigmented, and are more spongy than normal, but although bullæ occur they are small. On section the lung tissue is bloodless and friable. The bronchi may be slightly dilated and show catarrhal changes.

Symptoms.—These are slight and are masked by the enfeeblement due to the general atrophy and debility. There is shortness of breath only on exertion, or on exacerbation of the chronic bronchitis which is frequently present. The chest is small, flat and thinly covered, the movements are poor and there is elevation of the chest as a whole, with poor expansion. There is little cyanosis, and no clubbing. The vocal fremitus is unaltered or slightly diminished. The percussion note is hyper-resonant, but there is no encroachment on the cardiac and hepatic areas of dullness. Breath-sounds are weak, and there is but little prolongation of expiration. Rhonchi and râles may be heard, especially if bronchitis is present, or if the heart is failing.

Diagnosis.—The condition is generally so obvious that no difficulty arises.

Treatment.—This is chiefly a matter of careful regimen and diet, with treatment of coexisting bronchitis or cardiac failure.

3. Compensatory Emphysema (Localised or Secondary Emphysema)

Ætiology.—Localised emphysema is a sequel to some process inducing collapse, contraction or destruction of areas of lung tissue. It may be lobular in distribution in bronchitis, broncho-pneumonia, tuberculosis and diphtheria. It may affect one or more lobes, or the whole of one lung, especially in cases of fibrosis following tuberculosis, pneumonia, chronic pleural effusion and empyema.

Pathology.—It is generally conceded that the inspiratory theory of Laennec and Gairdner satisfactorily explains the genesis of this condition. When shrinkage of an area of lung occurs, the chest wall may fall in, if there is pleural adhesion, but otherwise inspiration tends to expand the normal parts of the lungs so as to contain the normal intake of air or the major part of it, owing to the difference it induces between the intrapulmonary and intrapleural pressures. None the less, it must be admitted that the expiratory strain of cough may assist in its production.

Although it may be compensatory and physiological at its inception, it is doubtful whether a true hypertrophy takes place after adolescence. In any case it soon leads to atrophy of the alveolar walls, as in true emphysema,

and thus becomes pathological and harmful. Post mortem the condition may be found in an upper lobe around contracted scarred lung tissue, or in a lower lobe when the upper lobe is contracted or disorganised. In cases where one lung is fibroid and contracted, compensatory emphysema may be found throughout the sound lung. The enlargements and contractions of the lung may produce some striking displacements, the lower lobe extending upwards nearly to the clavicle, or the anterior margin of the sound lung crossing the mid line. The general appearances are closely similar to those of ordinary emphysema, except that bullæ do not occur, at any rate until the process is advanced and definitely pathological.

Symptoms.—This condition does not produce symptoms that can be differentiated from those of the primary disease. When it affects a lobe or the whole of one lung, there is hyper-resonance over the area involved, which often contrasts strikingly with the dullness due to the primary lesion. The hyper-resonance may extend across the sternum and even for an inch or more beyond it. The heart is displaced towards the side where fibrosis is in progress. Vocal fremitus and vocal resonance are little altered, but may be increased at first and subsequently diminished. In the early stages, when there is alveolar dilatation without degenerative mural changes, the breath-sounds are exaggerated, harsh or puerile, but when such processes develop, they become weak and there are indications of dyspnœa and cyanosis on exertion.

Diagnosis.—This is easy, owing to the difference between the diseased and "compensatory" areas, and to the indications of contraction and displacement.

Treatment.—No special treatment apart from that of the primary condition is required.

4. Acute Vesicular Emphysema

Although tradition has included this condition with emphysema, it is in reality only a temporary acute distension of the alveoli resulting from any condition causing widespread obstruction of the smaller bronchi. It is sometimes observed after death in cases of acute bronchitis, whooping-cough or asphyxia, and its existence may be inferred in severe asthma. Post mortem the lungs are bulky and the alveoli distended.

The symptoms are dependent upon the primary condition, although dyspnœa is invariably present. The chest is found to be fully expanded, the vocal fremitus is diminished, the percussion note is hyper-resonant and the breath sounds vary with the condition inducing it.

5. Acute Interstitial Emphysema

In acute interstitial emphysema air is present in the stroma of the lungs, and in the subpleural connective tissues. It may follow external trauma, such as fractured ribs, or wounds penetrating the lungs. The alveoli may rupture with violent expiratory efforts, as occur in whooping-cough or influenzal broncho-pneumonia. It may occur in diphtheria. The air sometimes tracks along the pulmonary roots to the mediastinum, and appearing in the neck or on the chest-wall gives rise to surgical emphysema.

Post mortem, subpleural bullæ may be seen containing air, and on section of the lung minute air vesicles may be found in the inter-alveolar connective

tissue. A diagnosis cannot be made unless the visible signs of surgical emphysema are present. The air is usually completely absorbed, and a perfect recovery takes place. No special treatment is required beyond keeping the patient at rest, and giving sedative drugs to allay cough.

ABSCESS OF THE LUNG

Definition.—Abscess of the lung includes any circumscribed collection of pus formed in the lung tissue, but softened tuberculous areas and bronchiectatic accumulations are usually excluded.

Ætiology.—*Predisposing causes.*—These include any diseases producing general cachexia or malnutrition, notably diabetes and chronic alcoholism, also any conditions leading to diminished resistance locally in the lung, such as injury, disease or exposure.

Exciting causes.—These are pyogenic organisms, which reach the lung by inhalation, by extension from adjacent suppurative processes, or by the blood stream, either directly or in septic emboli. The common organisms found are streptococci, staphylococci, the pneumococcus, Friedländer's pneumo-bacillus, and the ***Bacillus coli***—sometimes acting in conjunction with putrefactive bacteria. Pulmonary abscess may form under the following conditions:

(1) As a result of lobar or lobular pneumonia, especially after the deglutition and aspiration varieties of the latter. Such abscesses are sometimes called meta-pneumonic. (2) Secondary to an inhaled foreign body. (3) From infection of the lung tissue due to spread from adjacent disease. This may occur in bronchiectasis, in ulcerating new growths of the lung, bronchi, œsophagus or mediastinal glands, in caries of the vertebræ or ribs, and in suppurating mediastinal glands. Rupture of an empyema, of a subphrenic abscess, of a liver abscess, or of infected hydatid cysts of the lung or liver may also lead to pulmonary suppuration. (4) As a sequel of perforating chest wounds, or of fractured ribs piercing the lung. (5) In pyæmia, or following on septic pulmonary emboli due to right-sided infective endocarditis, or derived from distant septic processes such as otitis media, and infective thrombo-phlebitis. Amœbic abscess occurs occasionally after dysentery, and pulmonary abscess may be found as a rare complication of enteric fever.

Pathology.—Abscess of the lung is generally single and basic when consequent on pneumonia, whereas embolic abscesses are often small and multiple, and may be found in any part of the lung. Abscesses due to extension from adjacent disease, are generally solitary and are often large and irregular. The walls of acute abscesses are generally formed of congested and œdematous lung tissue or of a zone of unresolved pneumonia. Since acute abscesses commonly rupture quickly into a bronchus, a fibrous capsule is unusual, but in chronic abscess there is often considerable fibroid change in the neighbouring lung tissue. The pleura may become involved over superficial abscesses, leading to empyema, or to pyo-pneumothorax if rupture follows.

Symptoms.—These are usually an intensification of those due to the primary or antecedent condition. The patient invariably appears seriously ill, the fever becomes of septic type, remittent or intermittent in character, and of a high range. Rigors and sweating are common. The pulmonary

symptoms at first may be only slight cough with scanty muco-purulent expectoration. Dyspnœa may be present and pain of acute character develops if the pleura is involved. A considerable leucocytosis may be found, and occasionally the breath may be offensive, even before rupture into a bronchus occurs leading to the sudden expectoration of a large quantity of pus. The pus is sometimes unpleasant or offensive-smelling, but has not the extreme fœtor of gangrene. Microscopical investigation will demonstrate the presence of pulmonary débris, especially elastic tissue, together with pus cells and micro-organisms. After the expectoration of the pus, the temperature usually falls and the general condition of the patient is much improved, though cough and expectoration persist. The physical signs in a deep-seated or small abscess are often inconspicuous and consist in slight dullness over a small area, weak breath-sounds and possibly a few râles in the surrounding infiltrated or œdematous lung tissue. With a large or a superficial abscess, the signs before rupture may be those of consolidated or collapsed lung. After evacuation occurs, the characteristic signs of excavation develop at once. In multiple embolic abscesses the signs are usually those of disseminated broncho-pneumonia.

Complications and Sequelæ.—The commonest complication is dry pleurisy. This may progress to empyema, or to pyo-pneumothorax if rupture into the pleura occurs. In some cases mediastinitis or pericarditis may develop. Gangrene is described, but is a rare sequel. Metastatic abscesses may be produced in other parts of the body, especially in the brain, and meningitis is a rare and serious complication. The most important sequelæ are fibrosis of the lung, pleural adhesion, and rarely indurative mediastinitis.

Diagnosis.—This is difficult before rupture, but abscess may be suspected from the gravity of the symptoms in relation to the history and signs, especially if leucocytosis and fœtor of the breath are present. An X-ray examination may be helpful by demonstrating a localised shadow before rupture, and excavation afterwards, and also by establishing the situation of the abscess. The sudden expectoration of pus followed by retrogression of symptoms and signs of excavation is very suggestive of abscess. After rupture has occurred the differential diagnosis has to be considered from—

1. **Interlobar empyema.**—The signs are generally most marked in the region of an interlobar septum, there may be some cardiac displacement and the sputum, though purulent, does not contain elastic tissue.

2. **Bronchiectasis.**—The history, the characteristic cough and sputum, and the variation of the physical signs with the state of the cavity usually suffice to distinguish this condition.

3. **Gangrene of the lung.**—The distinction is not always easy in acute abscess, since the two processes are closely related. The extreme gravity of the patient's general condition and the horrible fœtor of the breath and sputum are the most characteristic features of gangrene.

4. **Tuberculous excavation.**—The history, the distribution of the signs and the characters of the sputum, including the presence of tubercle bacilli, are the distinguishing indications.

5. **Purulent bronchitis.**—The history, the widespread physical signs and the absence of elastic tissue from the sputum usually serve to establish the diagnosis.

In multiple or pyæmic abscesses, it is often impossible to recognise the

condition, though it may be suspected from the severity of the symptoms and signs. In any doubtful case an X-ray examination should be carried out, if the condition of the patient permits.

Prognosis.—The prognosis, though grave in all cases, is better than might be anticipated. Many of those in which rupture into a bronchus occurs, recover. The chance of recovery is greatly increased by operation. Death is inevitable in the pyæmic cases.

Treatment.—Surgical treatment is indicated in cases of localised abscess before rupture, when the patient's general condition is good. The lung is exposed over the abscess by rib resection, adhesion of the pleura is produced by packing if its layers are not already adherent, and the abscess is subsequently opened along the course of an exploring needle. After rupture has occurred, the decision as to operation depends upon the drainage of the cavity. If it does not drain well and the temperature remains raised, operation should be advised. In the case of a large chronic abscess cavity, a more or less extensive thoracoplasty may be required to enable the lung to collapse.

Medical measures consist in attempts to evacuate the cavity by postural methods, the use of expectorant drugs and of antiseptics such as creosote, guaiacol carbonate and garlic if the sputum is offensive. Antiseptic inhalations may also be used on a Burney-Yeo mask, as for bronchiectasis. In like manner intratracheal injections of menthol, guaiacol and olive-oil have been used with benefit. Autogenous vaccines are sometimes valuable, but are contra-indicated if free drainage is not established.

GANGRENE OF THE LUNG

In this condition localised or diffuse areas of lung tissue undergo putrefactive necrosis.

Ætiology.—*Predisposing causes.*—These include old age, over-indulgence in alcohol, general debility, diabetes and insanity. In certain rare cases, especially after broncho-pneumonia complicating measles, gangrene of the lung is met with in children.

Exciting causes and associated conditions.—These are, in the main, identical with those of pulmonary abscess (see p. 1080). In addition, the pressure of aneurysm or of new-growth on branches of the pulmonary artery may lead to gangrene. The causal organisms are also very similar to those found in abscess of the lungs, and include staphylococci, streptococci, sarcinæ, the *Micrococcus tetragenus*, the *Bacillus coli communis*, the *B. pyocyaneus*, the *B. fusiformis* with its associated spirochæte, and various anaerobes. In some instances acid-fast bacilli, classed as streptothricæ, occur. Some of these organisms yield putrefactive products, with the liberation of phenol, indole and skatole compounds in the lung.

Pathology.—It is not quite clear what are the factors determining whether abscess or gangrene occurs in an infected area of lung. Doubtless the general resistance of the body, the degree of local vascular disturbance, and the virulence of the infecting organisms all play their part. Laennec first described the two varieties of gangrene, the circumscribed and the spreading or diffuse. Around the former there are indications of a line of demarcation, formed by congested lung tissue, which may present the appear-

ance of red hepatisation. The surrounding lung tissue is invariably somewhat œdematous. The gangrenous area is soft and pulpy, and its colour varies from reddish-brown to greenish-black. As the necrosis advances, putrefactive liquefaction occurs, with the formation of a horribly reeking fluid, containing shreds and masses of necrotic lung tissue. When this is discharged, excavation results, and isolated vessels may be seen running across the resulting cavity, the walls of which are rough and covered with fœtid pus. The diffuse variety of gangrene is less common; there is no attempt at a zone of demarcation, and the whole of a lobe or of one lung may be affected. In both forms, the overlying pleura is intensely inflamed, and empyema or pyo-pneumothorax may be produced.

Symptoms.—These are similar to those occurring in abscess of the lung, but are more acute. The patient is desperately ill, rigors are more common and sweating is more profuse. The breath has a peculiar fœtor, which, on account of the presence of the skatole group of putrefactive products in the gangrenous lung, has an almost fæcal odour. The sputum is intensely offensive, and on standing separates into three layers, similar to those of the expectoration in cases of bronchiectasis. Elastic tissue is usually present, but it may undergo rapid disintegration. Hæmoptysis is not infrequent and may prove fatal. In rare cases gangrene is not accompanied by fœtid expectoration, especially when developing in the insane, in young children, and in diabetics, or after pulmonary embolism. The physical signs closely resemble those present in cases of pulmonary abscess, and are those of consolidation before liquefaction occurs, and of excavation afterwards. The signs of the antecedent condition such as bronchiectasis, aneurysm, or malignant disease may also be present.

Complications and Sequelæ.—These are similar to those met with in pulmonary abscess, but owing to the rapid course and greater fatality of gangrene, they are not so common. Cerebral abscess may occur.

Course.—The course is usually rapid, unless the disease is small and circumscribed. In rare cases of localised gangrene of small extent, absorption and subsequent fibrosis occur.

Diagnosis.—The differential diagnosis is as for pulmonary abscess, the distinguishing features being the extremely critical condition of the patient and the revolting fœtor of the breath and expectoration. X-ray examination may give great assistance if the patient's condition permits it to be made.

Prognosis.—This is invariably extremely grave, though a few cases of localised gangrene recover spontaneously. The prognosis is improved by early operation in suitable cases. The outlook is said to be worse if the condition is apical, and diffuse gangrene is invariably fatal.

Treatment.—Operation is indicated when the general condition of the patient permits, if the gangrenous area can be localised by physical signs or X-ray examination. Exploratory puncture should not be carried out unless the preparations for immediate operation are complete. The other operative procedures are similar to those for abscess of the lung. Operation is contra-indicated in cases of diffuse gangrene. The medical treatment is in all respects similar to that for pulmonary abscess. Injections of neoarsphenamin, in doses of 0·3 gramme, have given good results, especially in cases due to fuso spirochætosis.

PULMONARY FIBROSIS

Synonyms.—Fibroid Disease of the Lung; Chronic Interstitial Pneumonia; Cirrhosis of the Lung.

Definition.—Pulmonary fibrosis is a late sequel of many acute and chronic inflammatory or irritative processes affecting the bronchi, lungs and pleuræ. It is therefore rather of pathological than of clinical interest, and in no sense constitutes a separate disease, although the end results are remarkably similar in different forms. It is described here partly in deference to tradition, and partly to point out the methods of diagnosis between the various causes producing such strikingly similar effects.

Ætiology.—(1) The commonest cause is pulmonary tuberculosis, particularly the fibroid and fibro-caseous varieties. (2) The group of pneumokonioses contributes a considerable number of cases, and possibly some varieties of gas poisoning may induce fibroid changes. (3) Bronchopneumonic processes, particularly the forms associated with measles and whooping-cough, may be followed by widespread fibrosis, especially in children. (4) Although fibroid induration is commonly described as a sequel of lobar pneumonia, this disease is one of the rarer causes. (5) Localised fibrosis may occur around any circumscribed pulmonary or bronchial lesion, such as that produced by syphilis, leprosy, glanders or streptotrichosis. Similarly it occurs about infarcts, pulmonary abscesses and parasitic cysts. (6) Chronic venous congestion, if prolonged, leads to fibroid change, which is referred to as "brown induration." This is usually of moderate degree and does not affect the clinical manifestations. (7) Chronic pleural affections, particularly those leading to adhesions or causing pulmonary collapse, may induce fibroid changes within the lung, and these forms are described as "pleurogenous cirrhosis." (8) Any condition causing obstruction of a bronchus and leading either to collapse or to bronchiectasis may, if long continued, cause fibrosis of the corresponding lung area. Among such may be mentioned inhaled foreign body, new-growth, cicatricial contraction and thoracic aneurysm.

Pathology.—The fibroid overgrowth may be (1) Massive or lobar; (2) localised or insular; (3) peribronchial; and (4) reticular.

Any part of the connective tissue framework of the lungs and bronchi may contribute to the fibrosis. In the massive form, which generally affects the whole or the major part of a lobe or even of one lung, the appearances in cases due to tuberculosis differ from those due to other causes. In the tuberculous variety the primary distribution is apical, and evidence of other tuberculous processes may be apparent in the form of large or small dried-up cavities, inspissated caseous material or calcareous masses enclosed in fibrous strands. In non-tuberculous processes, the early localisation is commonly basic, and although the primary cause may be obvious in the form of bronchial obstruction or some pleural condition, this is not always the case. On the other hand, non-tuberculous processes may involve the upper lobe primarily and fibroid tuberculosis may fall with special stress upon the lower lobe. In both forms of fibrosis, bronchiectasis may result, although this is more common in the non-tuberculous cases. Apart from the special tuberculous lesions, the end results are very similar in both forms.

The affected area of the lung is shrunken and often devoid of air except for that in the bronchi and in the cavities. It is dark in colour, very firm and hard. On section it presents a mottled appearance owing to the strands of blue-grey fibrous tissue traversing it, contrasting with the pigmented, condensed, airless lung tissue. The fibroid area may be honeycombed by cavities or may present one large excavation due either to tuberculous cavitation or to bronchiectatic dilatation. There is nearly always thickening and adhesion of the pleura. The contraction of the abnormal fibrous tissue leads to marked displacement of the heart and mediastinum.

The localised form is commonly due to healed tuberculous processes at an apex. There may be simple puckering with or without pleural thickening and adhesion, or a dense mass enclosing dried-up caseous matter or calcareous spicules. In bronchitic or broncho-pneumonic processes a patchy fibrosis may occur, described as insular fibrosis by Fowler.

Peribronchial fibrosis is common and figures largely in X-ray reports on pulmonary cases. It is generally assumed that this is a sequel of tuberculous lesions acquired in early life. Although this is probably correct, it has not been incontrovertibly established.

Reticular fibrosis is a rare condition in which the fibrous tissue in the interlobular septa seems to become increased as well as that around the bronchi. It is at present only of pathological interest.

Symptoms.—The symptoms of pulmonary fibrosis are, in the main, expectoration and dyspnœa together with those of the primary affection. In the non-tuberculous cases, bronchiectasis is so frequently associated that the symptoms and signs found are practically those of this condition. Even in tuberculous cases, some degree of bronchial dilatation is the rule, although the sputum is rarely offensive. The cough is generally periodic and associated with change of posture. The expectoration is abundant, and if bronchiectasis is present, it has the usual characteristic features. The dyspnœa is proportional to the extent of lung involved. It may be extreme in the later stages, when the heart becomes embarrassed and begins to fail. Fever is usually absent, except when complications occur.

The patients are generally spare, although nutrition may sometimes be well maintained until late. They may show signs of deficient aeration in duskiness, cyanosis and congested cheeks. Polycythæmia of some degree is the rule. Clubbing of the fingers is almost constant. Evidence of contraction is generally forthcoming in the flattening and retraction of the affected side, with the dropped shoulder and compensatory spinal curvature. Movement is greatly restricted, contrasting with the increased expansion of the other side. The cardiac impulse is sometimes much displaced, especially in left-sided cases, when it may be in the left posterior axillary line or even under the angle of the scapula. In right-sided cases, it is drawn to the right of the sternum, even sometimes under or outside the right nipple. Vocal fremitus is usually diminished and percussion gives dullness of varying degree over the fibroid area, while the unaffected parts may be hyper-resonant from "compensatory" emphysema. The diaphragm may be drawn up, and the liver or stomach correspondingly displaced. The breath-sounds are often weak or inaudible unless there is bronchiectasis or cavitation, when the characteristic signs of these conditions can be

recognised. The vocal resonance is diminished if there is much pleural thickening, increased if cavities are present. Adventitious sounds may be entirely absent, and when present vary from rhonchi and bubbling râles to coarse metallic râles, according to the presence or absence of excavation. X-ray examination gives useful confirmation, showing displacement, excavation and pleural thickening.

Course.—The course is invariably chronic, and may extend to years, even ten or twenty.

Diagnosis.—The diagnosis is usually easy. The evidence of contraction and of mediastinal displacement towards the affected side, especially if signs of cavitation are also present, is highly suggestive. In the absence of the latter some difficulty may arise in regard to chronic pleural effusion or empyema. In the earlier stages the contra-lateral displacement of the cardiac impulse should prevent any mistake, but where partial absorption has occurred, this may be very slight or absent. In such cases an exploratory puncture or an X-ray examination may be helpful.

When the diagnosis of pulmonary fibrosis has been made, the differentiation of the cause is an essential to prognosis and treatment. If the condition is apical, there is a presumption in favour of tuberculosis; if basic, some other cause is more probable. Repeated examinations of the sputum should be made for tubercle bacilli, and if these prove negative, X-ray examination may reveal some cause such as new-growth, aneurysm or even foreign body. In some cases a careful consideration of the history may afford a clue to the diagnosis.

Prognosis and Treatment.—These depend upon the primary condition, but in most cases the latter is mainly symptomatic.

PNEUMOKONIOSIS

Synonyms.—Pneumonokoniosis; Dust Disease of the Lung.

Definition.—Pneumokoniosis comprises all the pathological changes induced in the bronchi, lungs and pleura by the inhalation of dust particles.

Ætiology.—*Predisposing causes.*—Pneumokoniosis is one of the occupational diseases. It is practically limited to men, and usually develops between the ages of 25 and 40. Defective ventilation, bad hygienic conditions and alcoholism promote its incidence.

Exciting causes.—Various forms of dust, both inorganic and organic, serve to produce pneumokoniosis, and in general the harder and more gritty the particles, the more marked are the changes induced. Organic forms of dust lead especially to bronchitic changes, the inorganic forms to pulmonary fibrosis.

The following varieties are recognised:

1. *Anthracosis*, from coal dust (coal-miners' phthisis).

2. *Siderosis*, from the inhalation of fine metallic particles in tin, copper lead and iron-miners, and in grinders of steel goods (grinders' rot).

3. *Silicosis* or chalicosis, met with in workers in quartz, gannister and slate quarries, also in potters (quartz-miners' phthisis, and potters' asthma). Gold-miners' phthisis, the most serious form of pneumokoniosis, and especially prevalent in the South African gold mines, is due to the fine dust caused by the rock drills.

4. *Byssinosis*, a rare variety is met with in cotton workers, felt-hat makers, and the employees in shoddy mills.

5. *Asbestosis.*—A condition found occasionally in those working in the manufacture of asbestos articles.

Pathology.—The lungs of persons living under rural conditions are practically free from deposited pigment. A certain amount of carbon is invariably present in the lungs of town-dwellers, giving them a dark-grey mottled appearance, but producing no pulmonary fibrosis. In coal-miners this occurs to such an extent that the lungs are black (anthracosis), although even here little fibrosis occurs, except in miners of hard coal or anthracite. In siderosis and silicosis, fine sharp particles of metallic oxides or silica are deposited in the lung tissue. In asbestosis, iron-containing granules with discoid bodies, possibly asbestos fibres, are found in the lungs. There is also much fibrosis, and tuberculosis is liable to be a later development.

It is generally accepted that these particles are conveyed to the bronchi and alveoli by inhalation. It has been suggested by Calmette and others that they are swallowed and reach the lungs through the mesenteric and bronchial glands. It is admitted that particles can reach the lungs by this route under experimental conditions, but this factor is certainly of small importance in the genesis of pneumokoniosis. In normal breathing, most of the coarse particles are detained in the nose, and are discharged with the nasal mucus, whereas in mouth-breathers they readily gain access to the trachea and bronchi. Even then, the coarser particles may be discharged in the expectoration through the agency of the ciliated epithelium, but owing to the catarrhal processes induced by the irritation of the inhaled dust, this epithelium may be desquamated and the absorption of the particles is promoted. As a further consequence of this initial bronchitis, the finer particles may reach the alveoli, and passing between the epithelial cells, gain access to the tissue spaces, or in some cases they may be taken up into special "dust cells." Later, particles of dust become deposited in the connective tissue, and chronic peribronchial and perialveolar fibrosis develops. The bronchial glands also become enlarged and pigmented by the deposition of similar particles conveyed by the lymphatics. Other changes more or less constantly present are emphysema, pleural adhesion and bronchiectasis.

The relationship to tuberculosis has been much debated. It is now established that pneumokoniosis is non-tuberculous in origin, and that it may remain so throughout its course. On the other hand, certain forms undoubtedly favour the development of tuberculosis. In England and Wales coal-miners suffer less from tuberculosis than do all other males. On the other hand, gold-miners are extremely liable to it. It would appear that the determining factor is the presence of particles of silica. Silicates, as in clay, do not induce tuberculosis. Workers in freestone develop this disease, limestone workers do not. Slate quarriers do not acquire tuberculosis very readily, while metalliferous miners working in quartzite very frequently suffer from it. Mavrogordato describes three types of silicosis. (1) Silicosis, the damage found being due to dust alone. It is non-progressive if exposure ceases. (2) Tuberculo-silicosis, in which most of the damage is due to dust and tuberculosis is secondary. (3) Silico-tuberculosis, in which the chief lesions are due to the tubercle bacillus and the silicosis is

secondary or at any rate less marked. Haldane and Mavrogordato have demonstrated that particles of coal are absorbed by the "dust cells" whose movements are thereby stimulated, with the result that they appear in the black spit, which is therefore a healthy sign. The particles of silica are also absorbed by these "dust cells," but no stimulus to their movement is induced and they remain *in situ*.

Post mortem, the lungs are generally firm and pigmented, the colour varying with the cause, being black in anthracosis, reddish-brown in siderosis, and greyish-black in silicosis. The pleura is generally adherent, especially at the bases. On section the lungs are firm, and often gritty. Small hard nodules may be felt with the finger. Fibroid changes are especially marked in silicosis. The bronchi are inflamed and sometimes dilated. Some degree of emphysema is usually apparent. If tuberculous lesions are also present, these vary from fibroid areas to miliary nodules. Destructive processes resulting in cavitation may also be seen. Microscopically, the alveolar walls are thickened, the connective tissue is everywhere found to be increased, the "dust cells" may be seen in the connective tissue or in the alveoli, and particles of pigment or silica are found widely deposited in the connective tissue cells.

Symptoms.—The onset is insidious, bronchial irritation and cough, especially in the morning, may be the first indications, but increasing shortness of breath and debility are frequently early symptoms. The expectoration, at first scanty and mucoid, becomes more abundant and may present characteristic features as in the "black spit" of anthracosis. Tinging of the sputum and later hæmoptysis occur, but these suggest the possibility of superadded tuberculosis. The patient may appear healthy and be but little troubled except by the shortness of breath, but later emaciation and an appearance of premature old age are not uncommon.

The physical signs are not characteristic; at first they are simply those of persistent bronchitis, then emphysematous changes may become apparent. Later, signs of fibrosis appear, very similar to those described in the preceding section. Even when tuberculosis develops the signs are often but little characteristic, and repeated sputum tests may be necessary to establish the diagnosis. Examination by X-rays may be helpful, showing mottling of the lung by sharply defined shadows.

Complications and Sequelæ.—The most important complication is tuberculosis, which forms the terminal stage of many cases of silicosis. This may be suspected when fever, night sweats, hæmoptysis or emaciation develop. Bronchiectasis of considerable degree sometimes results as a consequence of the fibrosis, and leads to the symptoms and signs characteristic of that condition.

Course.—This is progressive, unless the sufferer is removed from the exciting causes. Anthracosis runs a very chronic course, siderosis somewhat less so, while gold miners only live a few years (5 to 6—Oliver) after the onset of the disease.

Diagnosis.—The diagnosis can usually be made from the history of shortness of breath, cough and expectoration, developing in a worker in a dusty occupation. In the early stages, cigarette smoker's cough and bronchitis may give rise to difficulty. In the later stages, the possibility of a primary fibroid tuberculosis has to be considered.

Prognosis.—This is unfavourable except in anthracosis. If recognised early, and if the patient is taken from the dusty conditions, recovery may be anticipated. The development of tuberculosis affects the outlook very gravely.

Treatment.—*Prophylactic.*—Every means should be adopted to avoid the dusty conditions leading to the disease. Mines should be well ventilated, and respirators should be worn where practicable in dusty occupations. Factories and workshops should be provided with apparatus to draw away dust. Sprays or jets should be used with drills to moisten the dust produced.

Curative.—Directly the condition is diagnosed, the patient should be advised to change his occupation. Nutrition should be kept at a satisfactory level. Symptoms and associated conditions, such as bronchitis or tuberculosis, should be treated on general principles.

PULMONARY TUBERCULOSIS

Synonyms.—Phthisis ; Consumption ; Decline.

Pulmonary tuberculosis embraces all the abnormal conditions induced by infection of the lungs, pleuræ and bronchial glands with the tubercle bacillus.

Ætiology.—Predisposing Causes.—**Age.**—The maximum age incidence is between the 15th and 45th years, although the disease may be encountered at any age.

Sex.—The disease is more frequent in males, but between the ages of 5 and 15 the female sex shows a preponderance.

Heredity.—Pulmonary tuberculosis certainly occurs with undue frequency in certain families. Since the direct transmission of the tubercle bacillus to the infant is extremely rare, two explanations seem possible—(1) Children born of tuberculous stock may inherit an increased susceptibility or diminished resistance, the tuberculous diathesis; or (2) they may contract tuberculosis on account of their exposure to massive infection in early life.

Race.—Differences in racial susceptibility probably depend upon the degree of inherited resistance acquired by the race from infection of previous generations. Native races suffer severely when first exposed. In Europe the Irish are particularly susceptible, whereas the Jews are relatively immune.

Climate.—Tuberculosis occurs in all climates. The prevalence of strong rainy winds and defective subsoil drainage may tend to increase its incidence.

Occupation.—The highest mortality from tuberculosis occurs in England amongst the workers in dusty occupations, thus Cornish tin miners head the list. On the other hand, coal miners are notably free from the disease Any conditions leading to overwork or to underfeeding increase the liability to tuberculosis.

Environment.—Overcrowding, defective sanitation, dampness, dirt, lack of sunlight and insufficient ventilation are most potent factors in the spread of the disease, causing both lowering of the resistance and increased facilities for direct infection.

Trauma.—Trauma, involving the chest-wall, may be followed by active pulmonary tuberculosis. This is probably because the injury leads to activity of previously arrested disease, rather than to fresh infection at a spot of lowered resistance.

Gassing.—In certain cases the inhalation of poison gases causes rapid activity and spread in latent disease, or it may possibly prepare the ground for reinfection, but it is not a factor of great ætiological importance.

The influence of other diseases and conditions.—The following diseases predispose to the development of pulmonary tuberculosis: measles, especially when complicated by broncho-pneumonia, whooping-cough, influenza, pneumokoniosis, alcoholism, diabetes, syphilis, congenital heart disease and insanity. Tuberculosis may manifest itself for the first time during prolonged lactation or after repeated pregnancies; when previously existent it often remains quiescent during pregnancy, but it may spread rapidly after childbirth. Contrary to the usual belief, pulmonary tuberculosis not infrequently coexists with mitral stenosis. A partial antagonism between tuberculosis, asthma, emphysema and gout has been assumed. Cases apparently following pneumonia, pleurisy or bronchitis are usually tuberculous from the onset.

EXCITING CAUSES.—The causal organism is the *Bacillus tuberculosis*, discovered by Koch in 1882. It exists in four main forms, human, bovine, avian and reptilian; only the two former usually occur in man, but avian infection has been recorded. The human type is found in over 99 per cent. of pulmonary tuberculous lesions. In surgical tuberculosis, on the other hand, and in glandular tuberculosis up to the age of 5 years, nearly 80 per cent. of the bacilli isolated conform to the bovine variety.

The bacilli may gain access to the body by inhalation, by alimentary ingestion, through the tonsils, through the skin, or possibly, in rare instances, by hereditary transmission. It is probable that in the majority of cases of pulmonary tuberculosis in adults, the organisms are carried direct to the lungs in the inspired air, and Ghon showed that in children, who had died of tuberculosis of the lungs, a primary focus was present in the lungs in 92·4 per cent. As, however, extensive tuberculous lesions are frequently found in the bronchial glands in cases of pulmonary tuberculosis, it is believed by some that the glands are primarily affected, and that the bacilli pass from them to the lungs, either against the lymphatic flow or in the blood stream. Calmette and others have demonstrated that the bacilli may gain access to the bronchial glands from the alimentary tract through the lymphatic duct, or from the tonsils through the cervical and mediastinal glands. Cases have been recorded in which primary cutaneous infections have been followed later by active pulmonary tuberculosis. Direct transmission of the tubercle bacillus is believed to occur only when the mother is suffering from advanced tuberculosis, and even then is of great rarity.

The incubation period of tuberculosis is uncertain, owing to the difficulty in determining when infection takes place. It is now believed by many authorities that the majority of individuals are originally infected in infancy or early childhood, either from the ingestion of tuberculous milk, or by the inhalation of bacilli from dried sputum. Pulmonary tuberculosis is thus regarded as a late manifestation comparable with the tertiary stage of syphilis. On this hypothesis, active pulmonary disease in adult life may result either

from reinfection or from the activation of a dormant lesion in the body. As the organisms found in early life are frequently of the bovine type, whereas in pulmonary tuberculosis they are almost invariably of the human variety, it is probable that reinfection is the more common, since mutation of type has not so far been proved.

Provided that the proper precautions are taken, the risk of infection from person to person is not great, and only exists in "open" cases of tuberculosis, *i.e.*, in cases with tubercle bacilli in the sputum. There is no increased incidence in workers in hospitals or sanatoria for consumptives, and the occurrence of conjugal disease can be as well explained by mating of those with hereditary diathesis, as by direct infection.

Pathology.—The earliest lesion in the lung is the formation of tubercles, whose structure is described in the general article on tuberculosis. They appear first near the apex. This may be due to the relative immobility of this portion of the lung, possibly as the result of calcification of the first costal cartilage (Freund), but in some cases the bacilli may spread from the cervical to the supraclavicular glands and thence to the adjacent lung. The initial deposit is usually in or around the small bronchioles of the third to fifth degree (Hirschfeld's bronchioles). The inflammatory swelling of the bronchioles obstructs their lumen, leading to collapse of the alveoli beyond and the formation of broncho-pneumonic areas. At the same time peri-bronchiolar inflammation develops.

Secondary Changes.—1. *Caseation.*—The tubercle is avascular, and owing to this, and possibly also to the action of tubercle toxins, coagulation necrosis and fatty degeneration frequently ensue. This combined process is known as caseation and results in the formation of a structureless, cheesy mass. Further changes may now occur, either softening, with the development of a "cold abscess" filled with tuberculous "pus," or calcification, with the subsequent formation of gritty masses known as "pneumoliths."

2. *Cavitation.*—Cavities result from the liquefaction of caseous areas, and the expectoration of the resulting débris. They may be no larger than a pea, or may occupy the whole of one or more lobes. A recent cavity has an irregular outline, with rough, shaggy walls and a vascular line of demarcation. It is often traversed by trabeculæ, formed by bronchi and vessels which may be partly or completely obliterated, while sometimes the trabeculæ consist of condensed lung tissue which originally separated adjacent cavities. In chronic cases, the cavity is surrounded by fibrosed lung tissue forming a pseudo-capsule, and its interior becomes lined by a thin, smooth, false membrane. Small aneurysms may be found, arising either from vessels running in the walls or in the trabeculæ of the cavity, the former being the more common. In some cases, where hæmoptysis has occurred, rupture of such an aneurysm is the cause.

3. *Fibrosis.*—Reactive changes in the lung stroma lead to the formation of fibrous tissue. This may occur early or after caseation has taken place.

In the majority of deaths from all causes, old tuberculous lesions are found post mortem near the apex of one lung. These consist of small nodules of arrested disease, with thickening and dimpling of the adjacent pleura.

Dissemination in the Lungs.—The disease may spread from the primary peri-bronchial deposit—(*a*) By direct infiltration; (*b*) By the peri-bronchial

lymphatics and capillaries, leading to a racemose appearance or to peribronchial fibrosis; (c) By the subpleural and interstitial lymphatics, with localised miliary dissemination; (*d*) By inhalation into a bronchus of tuberculous material, which is then carried to other parts of the same or to the opposite lung—this not infrequently happens after hæmoptysis; (*e*) By the blood vessels, *e.g.* generalised miliary tuberculosis may result from erosion of a caseous tubercle into a vein.

The pathology of the clinically distinguishable forms of pulmonary tuberculosis will now be described.

1. Acute Miliary Tuberculosis.—A primary caseous focus may be discovered at the apex of one lung, in the bronchial glands, or at some distant spot in the body. Local erosion of a vein may be found, accounting for the dissemination of the disease. The lungs are usually studded with minute grey tubercles, the smaller ones requiring a hand lens for their recognition. In very acute cases death occurs before any secondary broncho-pneumonic changes take place. Miliary tuberculosis may develop as a terminal event in chronic fibro-caseous or fibroid tuberculosis. The tubercles are then found in large numbers around the old foci of disease, but to a less extent in the more remote portions of the lung.

2. Acute Caseous Tuberculosis.—Large areas of consolidation form rapidly, which differ histologically from the common chronic tuberculous broncho-pneumonia in that the alveolar exudate is more definitely inflammatory and contains fibrin. In the rare lobar cases, the rapid caseation and the presence of tubercle bacilli show that the caseous pneumonia is a specific process. Firm yellowish patches, which may be confluent, are seen, usually scattered throughout both lungs. The affected areas are airless and sink in water. Softening is generally present in varying forms up to actual cavity formation, which may be extensive, involving even a whole lobe.

3. Fibro-caseous Tuberculosis.—This is the commonest variety of the disease; the appearances of the lung vary with the relative preponderance of the caseous and fibrotic changes. The early lesions are miliary or broncho-pneumonic, but areas of caseation in varying stages are always present. The older lesions show considerable fibrosis, the strands of sclerotic tissue being pigmented and glistening. The earliest lesion is usually near the apex of the upper lobe at the back, more rarely a little lower and towards the front. The apex of the lower lobe is next affected, and the disease then spreads in the direction of the interlobar septum. The apex of the upper lobe of the opposite lung is next involved (Fowler's law of spread). Pleural adhesions are usually present over the oldest lesions, and in the interlobar fissures.

4. Fibroid Tuberculosis.—Fibrosis may be localised around a small arrested lesion, or may spread throughout a lung in which caseation or excavation has occurred. One lobe or the whole lung is then contracted and firm. In the interstices of the fibrous tissue, which is usually pigmented, inspissated caseous material, calcareous patches, or cavities are seen. The shrinkage may lead to bronchiectasis, especially in the lower lobes. The overlying pleura is much thickened and adherent, and the mediastinum is drawn over towards the affected side. The opposite lung, or the sound portions of the fibrosed one, may show compensatory emphysema.

The bronchial glands.—The tracheo-bronchial glands are affected in all forms of pulmonary tuberculosis. They are enlarged, sometimes pigmented,

and may present miliary, caseous, calcareous or fibroid changes, in some cases primary, in others secondary to the lesions in the lungs.

The pleura.—This, too, is almost constantly affected. The commonest changes are an early dry pleurisy, and a later thickening with adhesions which may completely unite the visceral with the parietal layers. In acute disease or active spread, the pleura may be studded with miliary tubercles, leading to a large serous effusion.

The post-mortem appearances of the lesions situated in the other organs, found as complications of pulmonary tuberculosis, are described in the respective sections dealing with them, and include tuberculous meningitis, peritonitis, enteritis and genito-urinary tuberculosis. There is usually atrophy of the skeletal muscles, sometimes lardaceous and fatty degeneration of the liver, and hypoplasia with fatty degeneration of the heart.

Symptoms.—The symptoms fall into three groups (Pottenger)—(1) pulmonary, as catarrh, expectoration, hæmoptysis and pleurisy; (2) reflex, such as pain, cough and laryngeal irritability; (3) toxæmic, including malaise, tachycardia, pyrexia and loss of weight.

ONSET.—The mode of onset is very variable, but certain forms can be recognised.

(*a*) Insidious.—The early symptoms may be malaise, anæmia, amenorrhœa, cardiac irritability, progressive loss of weight, and slight rise of temperature, generally towards evening. Cough and expectoration often appear only when the signs in the chest are quite apparent. When there is intestinal stasis, the cutaneous pigmentation may suggest the diagnosis of Addison's disease.

(*b*) Catarrhal.—A series of febrile "colds" may usher in the disease, and such a sequence is always suspicious.

(*c*) Phthisis ab hæmoptoë.—Hæmoptysis may first draw attention to the lungs. It may be slight, and is then due to early congestion around the focus of infection. If it is more marked, it indicates breakdown of an old arrested lesion, or may afford dramatic evidence of extensive disease which had not been recognised previously.

(*d*) Laryngeal.—Hoarseness or aphonia may be the first symptom, but laryngeal tuberculosis is usually secondary to pulmonary disease, although the latter may have been unsuspected.

(*e*) Gastro-intestinal.—Anorexia and flatulence often occur early. When they are accompanied by slight loss of weight and pyrexia, the possibility of pulmonary tuberculosis should be suspected.

(*f*) Pleural.—Dry pleurisy is a frequent manifestation of latent pulmonary tuberculosis. When a serous effusion develops, its tuberculous character can be determined by laboratory investigations. Pneumothorax, developing in a previously healthy individual, is a rare but serious clinical mode of onset.

(*g*) Pneumonic.—"Galloping" consumption often begins with pneumonic manifestations, especially in the young.

(*h*) Traumatic.—Pulmonary tuberculosis may follow injury or "gassing," as described under ætiology.

(*i*) Neurasthenic.—Neurasthenia may occur as a complication of tuberculosis; but in some cases an initial neurasthenia dominates the picture, and the pulmonary lesion is only detected on careful examination.

(*j*) Malarial.—Regular attacks of sweating and fever may occur, especi-

ally in those who are or who have been residing in malarial climates, suggesting malaria, but in reality due to tuberculosis.

(*k*) Associated with other diseases.—Tuberculosis may follow immediately on an attack of measles, influenza or whooping-cough, especially if complicated by broncho-pneumonia. In some cases it develops at a later period after the acute disease.

THE CHIEF SYMPTOMS of pulmonary tuberculosis are—

Cough.—This varies considerably in different types of disease. It may be very slight or absent in generalised miliary tuberculosis, or in any form in the insane. It is sometimes dry, persistent and ineffective, especially in miliary extension in the lungs from an old focus of disease, in bronchial gland tuberculosis, or in pleurisy. When there is associated bronchitis or caseation, the cough is usually accompanied by expectoration, which, if very tenacious, may lead to retching or even to vomiting, particularly in the morning. In laryngeal tuberculosis the cough is husky and frequently painful.

Expectoration.—In early disease there is usually no sputum, and in some cases, more especially in the fibroid type, widespread lesions may be present with practically no expectoration. When caseation is in progress, or when there is secondary infection with bronchitis, the sputum may be abundant and amount to as much as 20 or more ounces in the 24 hours. It may be clear or mucoid, or thick tenacious muco-pus. If mucoid, it often contains small particles, the size of a pin's head or larger, of yellow caseous material. Nummular sputum may be met with in active caseous disease, especially with excavation. This consists of flat rounded masses of muco-pus, with a somewhat distant resemblance to coins. In tuberculosis the sputum is usually inoffensive, but may have the characteristic sickly odour which is also noticed to emanate from the patient himself (odor phthisicus). If bronchiectasis or gangrene occur as a complication, the expectoration becomes typically malodorous. Pulmonary calculi or pneumoliths, composed chiefly of calcium carbonate or phosphate, are sometimes expectorated. They vary in size from a pin's head to a pea, are irregular in outline and sometimes branched, being derived generally from the walls of a cavity. Although the occurrence of these does not necessarily indicate fresh activity in the lungs, yet such a possibility should always be suspected, and a careful watch maintained on the temperature during the next few days. In some cases larger pneumoliths, as big as a cherry, may be coughed up, and these are frequently derived from caseous tracheo-bronchial glands. They may give rise to alarming symptoms at once, and be the forerunner of fresh activity in the lungs.

The albumin reaction.—The significance of albumin in the sputum has been investigated by Ridge and Treadgold. It is found in nearly all cases of active pulmonary tuberculosis, and in the absence of tubercle bacilli, three consecutive negative albumin tests are strong evidence against the presence of active disease. Albumin, however, also occurs in the sputum in other destructive lesions of the lungs.

Microscopical examination.—The presence of tubercle bacilli in the sputum is the most decisive test of the existence of this disease. The small yellowish caseous particles should be selected from the sputum, and appropriately stained. If no tubercle bacilli are found, samples from the whole sputum of the 24 hours, concentrated by the antiformin method, can be ex-

amined. The cells present are usually of the mononuclear type, either mononuclear leucocytes or altered alveolar epithelial cells. The presence of elastic tissue indicates that destructive pulmonary lesions are in progress. Secondary infecting organisms may be demonstrated by cultural methods.

Dyspnœa.—Slight dyspnœa occurring early in the disease may be due to diminished movement of the diaphragm on the affected side. In more advanced cases the degree of dyspnœa is proportional to the amount of lung tissue involved. In addition, cough and pyrexia play a part in its production. Complications such as pleurisy, pleural effusion, pneumothorax and cardiac failure increase the shortness of breath. It is rare to find orthopnœa even in acute and rapidly spreading disease. In arrested cases the dyspnœa is proportional to the extent of fibrosis.

Cyanosis.—This is not an early symptom of tuberculosis. It is dependent upon the amount of lung tissue involved, but is increased by the coexistence of emphysema or cardiac failure. The typical "hectic flush" of tuberculosis is a vasomotor effect caused by toxæmia.

Pain.—Not every sufferer from tuberculosis experiences pain, even in the acute stages of the disease. The commonest cause of pain is dry pleurisy. When the diaphragmatic layer of the pleura is affected, pain may be referred to the epigastrium or to the corresponding shoulder. In chronic fibroid phthisis there is frequently a dull, aching pain in the chest, which is more noticeable in damp weather. This is caused by the contraction of the condensing fibrous tissue. Cutaneous tenderness of the chest-wall is met with in some cases of advanced disease, and is probably due to a cachectic neuritis. A "cold abscess" forming along one of the ribs or costal cartilages is a rare cause of localised pain in the chest-wall. Cough may be painful, especially when paroxysmal or frequent, the pain being referred to the costal attachments of the diaphragm and upper abdominal muscles. The sudden occurrence of pneumothorax may cause such severe pain as to induce collapse; but when of more gradual onset no severe discomfort may be experienced. Tuberculous laryngitis may be the cause of very great suffering.

Night sweats.—Although not pathognomonic, night sweats occur more frequently in tuberculosis than in other diseases. They are met with in all stages of active lesions, and may be of great severity.

Loss of weight.—This is often an early symptom. It is most marked in acute disease and in the late stages of chronic fibro-caseous tuberculosis.

Fever.—Pyrexia is one of the most important indications of activity at any stage of pulmonary tuberculosis, although it does not follow that the disease is arrested when there is no fever. During treatment the temperature should be recorded at certain definite hours in the day. (*a*) On waking. The normal mouth temperature at 7 or 8 a.m. is 97° or 98° F. in the mouth, and 97°·2 to 99° F. in the rectum. This temperature should be taken in bed, before eating or drinking. (*b*) At 1 p.m., after the hour's recumbent rest. (*c*) At 6 p.m. (*d*) At 9 p.m., after retiring to bed. The maximum temperature is usually reached between 4 and 6 p.m., but may be delayed to 8 or 9 p.m. In most sanatoria the rectal temperature is taken, and a centigrade thermometer employed. The temperature is dependent upon the extent and the activity of the disease, and upon the amount of exercise taken.

(*a*) In acute miliary tuberculosis.—It may be continuous or remittent, and

the "typus inversus" is not uncommon, the morning temperature being higher than the evening. This is generally regarded as a sign of grave prognosis.

(*b*) In acute caseous tuberculosis the high temperature at the onset is continuous, and the record resembles a pneumonic chart. When caseation occurs it becomes hectic or intermittent, with a daily swing of 4° or 5° F. This is probably due to the action of tubercle toxins, and not to the presence of a secondary infection.

(*c*) In chronic fibro-caseous tuberculosis there is no characteristic temperature record. There may be only a very slight rise occurring at intervals of a few days. On the other hand, the patient may be afebrile while resting, but febrile when ambulant (Stage 2. Inman's classification). Further an afebrile ambulant patient may over-exert himself, and by excessive auto-inoculation develop a sharp rise of temperature which subsides in a few days with rest. The temperature chart is thus a guide to prognosis and to treatment, and if acute miliary tuberculosis or caseation occurs, a typical temperature variation ensues.

(*d*) In fibroid tuberculosis the temperature is usually normal, unless excessive auto-inoculation results from exercise, or the disease advances. The occurrence of hæmoptysis may have a very definite effect upon the temperature. In some cases it is not followed by pyrexia, but if the inhaled blood leads to a hæmoptöic bronchitis, there may be a slight degree of fever lasting for a few days. When a definite and persistent pyrexia follows, it usually indicates activity around an old focus of disease, or fresh spread by inhalation of blood containing tubercle bacilli to a distant portion of the lung.

A premenstrual rise of temperature may occur; but as it is also met with in healthy women it is not pathognomonic.

Hæmoptysis.—Hæmoptysis occurs at some stage of pulmonary tuberculosis in about 50 per cent. of all cases. With early lesions the sputum is only streaked. This may result from the congestion of tuberculous bronchitis, or from a small area of collapse or broncho-pneumonia. In the pneumonic or broncho-pneumonic forms rusty sputum may be seen. Profuse hæmoptysis generally occurs in chronic disease; but it is occasionally met with in acute caseous forms. Recovery may take place after coughing up 2 or 3 pints, or death may ensue rapidly from suffocation before any considerable quantity of blood has been expectorated. After the cessation of bleeding the sputum may be coloured for several days. The source of profuse hæmoptysis is generally an aneurysm of a branch of the pulmonary artery lying in a cavity or in fibroid lung, although occasionally ulceration without previous aneurysm formation may occur. In the majority of cases hæmoptysis begins while the patient is lying down or resting, so that exercise or work are not frequent exciting causes.

The patient notices a salt taste, feels a warm gush in the mouth, and then expectorates the blood. He is usually greatly alarmed, flushed and sweating, with rapidly beating heart. The blood at first is as a rule bright and frothy, but some clots may be present; later it is mixed with muco-purulent expectoration, in the form of clots or streaks.

Circulatory system.—The heart may be small, but the right side often hypertrophies in chronic fibroid cases. Tachycardia may be due to nervousness, but when constant it generally indicates active disease or over-exertion on the part of the patient. The blood-pressure is usually low in the stages

of activity, and a steady rise during treatment is a favourable sign. If tuberculosis is coexistent with other diseases, such as atheroma, which raise the blood-pressure, higher readings are naturally obtained.

The blood.—The red cells are usually normal in number, but there may be a slight anæmia. On the other hand, when there is much cyanosis, or after sanatorium treatment, the red cells may be increased. The colour index is usually low. In the early stages the leucocytes may be slightly increased. A polymorpho-nuclear leucocytosis occurs in caseation and in early cavity formation, and at times with secondary infection of the lungs. A special differential count of the polymorpho-nuclear leucocytes themselves may be made by subdividing them into groups, according to the number of their nuclear lobes, as suggested by Arneth. An increase in number of immature cells with only one or two nuclear lobes constitutes a deviation to the left from the normal, and raises the Arneth index. This lævo-deviation is said to indicate toxæmia, and if it is not present, the disease will probably be chronic.

Alimentary system.—The tongue is usually clean and the appetite good even in cases with marked fever. When tuberculosis of the larynx is present, there is frequently severe dysphagia. Dyspepsia may be complained of, usually of a nervous type. Anorexia, flatulence, distension with nausea are the commonest symptoms, pain being rarely noticed. There may be marked intolerance of fat in the diet. The early hyperchlorhydria in tuberculosis, previously described, has not been confirmed by Mohler and Funk in America, using the fractional method of gastric analysis. Atonic dilatation of the stomach may occur in some cases towards the end of the disease. Constipation is common; on the other hand, diarrhœa may occur apart from intestinal ulceration or lardaceous disease.

Nervous system.—The classical "spes phthisica" is distinctly rare, but when present is very striking from its contrast with the realities of the disease. It is most commonly seen in acute caseous tuberculosis. More often the patient becomes emotional and self-centred, depression is common and hard to combat, and melancholia with delusions occasionally develops. Neurasthenia is frequent, and as mentioned above, may lead to errors in early diagnosis. Insomnia may be due to cough, pyrexia, night sweats or pain, especially in laryngitis. With marked cachexia, a definite peripheral neuritis may occur.

Genito-urinary system.—In the early stages there is often an increased sexual desire, and this may recur when arrest is taking place. This is probably in part due to the therapeutic régime, the rest, abundant food and lack of interesting occupation reacting upon the nervous system of young adults. In advanced disease, all sexual desire is lost. Menstruation often ceases early, and the patient may seek advice for amenorrhœa. Women remain fertile even in advanced disease. The urine is normal in the early stages, later a febrile albuminuria may occur, and casts or even sugar may be excreted without the occurrence of true nephritis or diabetes.

The Physical Signs of Early Disease.—The general appearance of the patient may be healthy, or may be that of malnutrition with the characteristics of the "habitus phthisicus," the hair being lank and lustreless, the skin white, thin, dry and shiny, and the thorax of the alar or phthinoid type. Certain stigmata are described, which although useful, are not pathognomonic. The eyelashes may be long, dark and curling, the

back hairy and the thoracic cutaneous venules dilated. When present around the upper thoracic vertebral spines, they are sometimes known as "the varicose zone of alarm." Deficient movement may be observed below one clavicle, at the point of one shoulder, or at the lower costal margin. The corresponding shoulder may be slightly drooping, with flattening above or below the clavicle, and slight hollowing of the supra-spinous fossa with wasting of the trapezius muscle may be observed. Pottenger regards these shoulder signs, when not due to scoliosis or kypho-scoliosis, as reflex, and comparable with the fixation of a tuberculous joint and wasting of its adjacent muscles. In women it may be noticed that the breast on the affected side is smaller and hangs at a lower level, although a non-tuberculous mastitis is sometimes seen causing enlargement, especially in males.

Palpation confirms the diminished expansion, and reveals a slight increase of vocal fremitus over the affected area of the lung, usually at one apex. The normal increase in fremitus of the right apex over the left must be borne in mind, in order to prevent mistakes.

With light percussion slight dullness and a small increase in the sense of resistance can be detected. This is usually most apparent in the supra-spinous and upper interscapular regions. The extent of pulmonary resonance above the clavicle, known as "Krönig's isthmus," may be diminished by ½ to 1 inch on the affected side.

Various types of breath-sounds may be heard over the affected portion of lung. They are—(*a*) weak inspiration, with expiration vesicular or inaudible; (*b*) cog-wheel inspiration, with expiration vesicular, prolonged or rarely jerky; (*c*) the "granular" breathing of Grancher, the breath-sounds being somewhat coarse and irregular, suggesting fine or distant râles, although none can be definitely detected; (*d*) harsh inspiration, with expiration vesicular or prolonged; (*e*) broncho-vesicular breathing; (*f*) definitely bronchial when early consolidation is in progress.

Often there are no adventitious sounds. Occasionally a few small rhonchi or fine crackling or bubbling râles may be heard with the first few deep breaths, or only with the inspiration immediately following coughing. If râles are constantly heard, it indicates that the lesion is already of some extent. Care must be taken to differentiate them from atelectatic râles, emphysematous râles audible along the sternal margin and pleural friction or fascial creaks. There is usually a slight increase in the conduction of both the spoken and whispered voice, and the more definitely this extends away from the trachea in front, and from the vertebral spines behind, the more reliable is the sign as an indication of disease.

Mensuration is seldom practised in routine examination. but graphic records of the chest contour, which are of interest in following the progress of a case, can be obtained by cyrtometry.

THE PHYSICAL SIGNS OF CONSOLIDATION.—Limitation of movement and flattening over the affected part of the lung, usually the apex, is now more noticeable.

The diminution of movement is confirmed on palpation, and vocal fremitus is found to be definitely increased.

The pulmonary resonance is diminished to definite dullness and the sense of resistance is correspondingly increased.

The breath-sounds are bronchial, or in acute caseous disease may even approximate to tubular.

Adventitious sounds may be absent, but usually fine or medium crackling râles are heard with inspiration, especially after coughing. When active softening is in progress the râles frequently become coarse and sticky. The voice conduction is much increased, bronchophony and whispering pectoriloquy being audible.

Mensuration may confirm the presence of flattening.

THE PHYSICAL SIGNS OF EXCAVATION.—Flattening of the chest-wall and diminished movement over the cavity are now more marked; if the cavity is apical there is in addition notable dropping of the shoulder, and wasting of the shoulder-girdle muscles.

The diminution of movement is confirmed by palpation. Vocal fremitus is generally increased owing to the surrounding consolidation, but if the cavity is full or there is much pleural thickening, it is diminished.

The percussion note is dull when the cavity is small or filled with secretion. A peculiar boxy or "cracked-pot" note, the "bruit de pot fêlé," is obtained over large superficial cavities, especially when communicating with an open bronchus. This is best heard on percussing with the mouth open, and Wintrich showed that the note may be altered in pitch over such cavities when percussing with the mouth open or closed, apart from the actual presence of the cracked-pot sound. Gerhardt's sign (alteration of note with the position of the body) is supposed to indicate a cavity of oval shape. It is rare, and of little value.

The breath-sounds are bronchial, broncho-cavernous, cavernous or amphoric, according to the size of the cavity, and to the amount of its contents. When it is full the breath-sounds may be distant, weak or even absent, and this is especially noticeable in basal bronchiectasis.

With a dry cavity there may be no adventitious sounds. Usually râles are audible; they may be medium or large, and bubbling or crackling in character. Over a large cavity a metallic tinkle and amphoric echo may be heard. With a very large cavity, extending through the whole of one lung, a typical *bruit d'airain* is at times obtainable. Voice conduction is increased, bronchophony and whispering pectoriloquy are present, and in some instances post-tussive suction is heard.

Mensuration affords a graphic representation of the flattening of the chest-wall.

THE PHYSICAL SIGNS OF FIBROSIS.—The chest is asymmetrical, the affected side being flattened and moving little, while compensatory scoliosis or kypho-scoliosis is often present. The cardiac impulse is seen to be displaced towards the affected lung and may be higher or lower than normal. It may be drawn over to the right axilla, or on the left side as far back as to the posterior axillary line, or even to the angle of the scapula. The intercostal spaces may be retracted, and dilated venules are sometimes seen over the front of the chest as the result of obstruction, caused by displacement of the mediastinum and traction on the deeper veins.

Diminution of movement is confirmed by palpation, and the cardiac impulse can be more accurately localised. Vocal fremitus may be increased or diminished; the former occurs when the lung is consolidated and the large bronchi patent, the latter when there is much pleural thickening.

The percussion note over fibroid lung is dull and the sense of resistance increased, unless cavities are present. The opposite lung may be hyper-resonant, and its resonance extend across the mid-sternal line. The cardiac dullness is often continuous with that of the fibroid lung, and its area can only be determined by the cardiac pulsation.

The breath-sounds are weak and distant, unless modified by the presence of a cavity.

Often there are no adventitious sounds, although fine or medium râles of a sticky or metallic nature may be heard. The voice conduction is usually diminished, and there is no pectoriloquy unless excavation has occurred, when bronchophony and pectoriloquy are audible.

It must be borne in mind that in actual disease the lesions are not so clear cut and well-defined. In a case of some duration different stages of disease can be found in the same individual, thus infiltration, consolidation with softening, excavation and fibrosis, may be present in different lobes of the lungs, and so it is possible to determine the site of origin and path or spread of the disease.

Certain other signs are occasionally seen in pulmonary tuberculosis.

Myoidema is an undue irritability of the muscles to direct mechanical stimulation, revealing itself by a flickering fibrillary contraction on tapping with the finger, and may occur in tuberculosis at all stages. It is best seen over the pectoralis major on the affected side. It may be present quite early, but is not pathognomonic, as it may occur in any cachectic state.

Clubbing of the fingers is commonly seen in chronic cases, the nails are curved and present a parrot-beak appearance, the thumb, index and middle fingers being most affected. Drum-stick clubbing is only seen in fibroid lesions with bronchiectasis.

Hilum Tuberculosis.—The existence of a special type of pulmonary tuberculosis commencing at the root of the lungs and spreading thence in a fan-shaped manner along the bronchi has been postulated by some in recent years, chiefly on X-ray evidence. According to Riviere the physical signs are always bilateral, and consist chiefly in alterations to percussion, the contraction of Krönig's apical isthmus of resonance, and the presence of parasternal and paravertebral bands of dullness when the tracheo-bronchial glands are also involved. The breath-sounds at the apex are often "granular" and adventitious sounds are frequently absent. When present, they consist usually of fine crackling râles, and may come to the surface at any point on the chest-wall over the lungs. Excavation occurs especially in the middle of the upper lobe, in the axilla, or at the base rather than at the apex. X-ray examination reveals signs of disease in the bronchial glands and extensions radiating from them throughout the lungs. It is doubtful whether this is common in adults, but in the relatively rare pulmonary tuberculosis of children, it is probably the usual type.

Pulmonary Osteo-arthropathy.—In cases with bronchiectasis the joints also may be affected, swelling occurring especially in the wrist, ankles and knees, and rarely in the hips and shoulders. A serous effusion into the joints may be present. Pain is usually slight, but there is much deformity and functional impairment. X-ray examination reveals productive periosteal changes, which may also affect the long bones and the spine.

Radiography of the Chest.—If possible, the chest should be examined

in every case with the fluorescent screen, and a photograph taken on a plate or film. Certain important points can only be determined by a screen examination. The chief of these are the respiratory movements of the diaphragm, lighting up of the apex of the lung with inspiration, and the cardiac pulsation. Unilateral restriction of diaphragmatic movement not infrequently occurs in early apical tuberculosis, but as it may be observed under other conditions, notably with pleural adhesions, it is not diagnostic. The plate will show the extent of the disease and in some cases it may suggest the existence of activity; thus areas of consolidation, caseation or excavation can be demonstrated, and thickening of the pleura, pleural effusion and pneumothorax give their characteristic appearances.

The significance of "root shadows" is still debatable. Although the presence of calcareous deposit in the glands at the roots of the lungs is usually obvious, the interpretation of shadows radiating out along the bronchi is a matter requiring great experience. They may be due to peribronchial thickening, caused by the formation of fibrous tissue, or may merely represent the shadows cast by the normal bronchial wall and vessels which in some are more apparent than in others. As the claims for the special type of hilum tuberculosis are largely dependent upon the X-ray evidence, this is clearly a point of great importance, and the physiological variations must always be remembered. Dilatation of the bronchi is more easily recognisable.

A plate is of less value in determining the presence of early disease, slight diminution of translucency of one apex may be due to an old arrested lesion, or, on the other hand, there may be definite physical signs of active disease, without abnormalities being found on X-ray examination. The heart shadow is often narrow and vertical in tuberculosis, and this form is said to be the typical one in hilum disease. Displacement of the heart due to pulmonary fibrosis or to affections of the pleura is clearly indicated. A good plate may also give valuable information as to the extent of lung involved and as to the presence of complications, such as effusion, pneumothorax or bronchiectasis. As the X-rays only cast shadows lacking in all pictorial details, tuberculous shadows cannot always be distinguished from those due to other pulmonary lesions, and, further, early disease may not obstruct the passage of the rays. It is thus clear that undue reliance must not be placed on the X-ray findings, which should always be interpreted in connection with the history, symptoms and physical signs of the case. The X-rays, although often of great help, do not afford a simple road to diagnosis or supply infallible evidence in determining the nature of an obscure case. On the other hand, they are absolutely essential in the determination of the suitability of a case for the artificial pneumothorax treatment and in controlling its application.

Complications and Sequelæ.—Compensatory emphysema is common in chronic fibroid disease, but bronchiectasis occurs less frequently. Gangrene of the lung is not often observed. Colds and catarrhal affections of the respiratory passages are frequent in sufferers from tuberculosis, and lobar pneumonia may develop as a complication. Bronchitis often occurs, due either to spread of the tuberculous process or to a secondary infection. In some instances asthma appears for the first time after tuberculosis has become manifest. A tuberculous abscess occasionally forms about a rib or costal cartilage.

Small areas of dry pleurisy are present at some stage in nearly every case; a serous pleural effusion is common, and an empyema may develop as the result of a mixed infection, or from the tubercle bacillus alone. Pneumothorax may occur as an early complication, or late in the disease, generally from rupture of a caseous focus just under the pleura; this frequently progresses to the formation of a pyo-pneumothorax. The deposition of tubercle bacilli from the expired air and sputum may lead to secondary foci in the larynx, trachea and epiglottis, or more rarely in the pharynx, tonsils, base of the tongue or nose. Swallowing of sputum containing tubercle bacilli gives rise to gastro-intestinal complications in many cases. The most common site for tuberculous ulcers is the terminal portion of the small intestine, but the appendix may be affected, and the connective tissue around the cæcum is sometimes matted and thickened to form a palpable mass (hypertrophic tuberculoma). Tuberculous peritonitis is not common in adults and is usually secondary to intestinal lesions. The stomach is very rarely ulcerated, but an atrophic gastritis may occur in advanced cases. Fistula-in-ano and ischio-rectal abscess are comparatively common complications.

Small vegetations may be found post mortem in the heart on the aortic and mitral valves, but these are usually due to some terminal infection. Fatty degeneration of the myocardium occurs as a result of toxæmia, and infection by direct spread along the lymphatics may lead to serous or purulent pericarditis. The peripheral circulation is not infrequently poor, chilblains are common, and cachectic purpura may be seen. Lardaceous degeneration as a consequence of chronic tuberculosis is not so common nowadays as formerly, but when present may affect the liver, spleen, intestines, lymph glands and kidneys.

The genito-urinary complications include lesions in the kidneys, bladder, epididymis and prostate. If the suprarenal body is affected Addison's disease will usually develop. Spinal caries is occasionally observed. A peripheral neuritis may form part of the lesions occurring with marked cachexia. Generalised dissemination of the tubercle bacilli by the blood stream is followed by tuberculous meningitis.

Course.—The course pursued by pulmonary tuberculosis is variable, depending upon the clinical type of the disease. In acute miliary tuberculosis, death may occur in from 1 to 3 weeks from toxæmia or generalisation of the lesions. In acute caseous tuberculosis, death usually results in from 1 to 6 months. In chronic fibro-caseous tuberculosis, the disease may be completely arrested, or after a temporary arrest may become active at intervals and again become arrested under suitable treatment; in other instances it progresses steadily to a fatal termination. In fibroid tuberculosis, the disease may become completely arrested or smoulder quietly for many years.

Apart from the question of the expectation of life, various stages of tuberculosis are described based upon anatomical lesions, toxæmia and functional disablement. The most important of these are as follows:

1. The Turban-Gerhardt Classification.—An anatomical classification based upon the extent of lung tissue involved. Three stages are described. *Stage* 1. Early cases in which physical signs, if unilateral, only extend from the apex to the second rib, and, if bilateral, are limited to the

supra-clavicular and supra-spinous regions. *Stage* 2. The signs, if unilateral, do not reach lower than the fourth rib, and, if bilateral, are situated above the second ribs. Excavation is not present in this stage. *Stage* 3. This includes more extensive lesions or localised ones in which excavation is present.

2. Sir Robert Philip's Classification.—Both the extent of lung tissue involved and the degree of toxæmia present are taken into consideration. Twelve stages are described, which are indicated by the following signs:

L_1, L_1s, L_1S, and 1_1S; L_2, L_2s, L_2S, and 1_2S; L_3, L_3s, L_3S, and 1_3S. L_1, L_2, and L_3 represent lung involvement to the extent of stages 1, 2 and 3 respectively, according to the Turban-Gerhardt scale. s applied to these letters indicates that there is only slight systemic disturbance, whereas S signifies marked systemic disturbance, and the signs 1_1S, 1_2S and 1_3S show that the systemic disturbance is excessive in relation to the lung involvement.

3. Inman's Classification.—This is based solely on the temperature in relation to exertion.

Stage 1. The patient is febrile when resting. Stage 2. The patient is resting afebrile, but ambulant febrile. Stage 3. The patient is ambulant afebrile. Stage 4. The patient is working afebrile.

The course taken by tuberculosis of the lung may lead to several terminations. These are—(1) permanent arrest, either by fibrosis prior to caseation, or, if the latter has occurred, by calcification and fibrosis; (2) incomplete arrest, as shown by the persistence of tubercle bacilli in the sputum, or by slight degrees of pyrexia on over-exertion; (3) rapid extension, here the disease spreads, and the toxæmia is out of all proportion to the extent of the lesions; (4) death, this may result from the pulmonary lesion or from complications. The former may prove fatal as the result of progressive asthenia or cardiac failure, from asphyxia due to acute miliary tuberculosis or hæmoptysis, or in a small proportion of cases directly from loss of blood in repeated hæmoptysis. The complications that most often prove fatal are meningitis, enteritis, laryngitis leading to dysphagia and starvation, or pneumothorax. Intercurrent diseases, such as pneumonia, influenza or diabetes, are occasionally the cause of death.

Diagnosis.—This is easy when definite signs are present in the lungs, and when tubercle bacilli are found in the sputum. On the other hand, the diagnosis of early cases may present one of the most difficult problems in clinical medicine. Tuberculosis may be suspected on account of symptoms, although the physical signs are indefinite. The conditions which most frequently lead to doubt are dyspepsia, neurasthenia, debility, visceroptosis and intestinal stasis, oral sepsis, tachycardia associated with early Graves' disease or heart disorders, chlorosis, affections of the nose and throat, and in children enlargement of the bronchial glands or acidosis. The history and symptoms are of great importance in these cases, and a careful examination should be made of each system. A test meal, opaque meal, or blood examination may be required before the correct diagnosis is established.

On the other hand, there may be definite signs of disease in the lungs which have to be differentiated from those produced by other conditions simulating tuberculosis. The cases included in this group embrace the majority of pulmonary lesions, especially chronic bronchitis, fibrosis, bronchiectasis, asthma, emphysema, apical catarrhs and collapse, pleurisy, new-growths and cysts. Diagnosis depends upon the history and course

of the disease, together with a careful record of the physical signs in the chest, examination of the sputum for infecting organisms, and in some cases the determination of the Wassermann reaction or an X-ray examination.

When the diagnosis still remains doubtful the patient should be placed under observation, and a series of examinations carried out, the object of which is to determine whether or not active tuberculosis is present. The temperature should be observed with the patient in bed, a daily rise to 99° F. or a swing of 1·5° to 2° below normal being suspicious. The sputum should be examined repeatedly for tubercle bacilli by the ordinary method, and if not found the antiformin process should be carried out. The albumin test may also be employed.

Before applying any tuberculin tests the blood may be examined serologically. The determination of the opsonic index requires expert skill, and should be only carried out by a pathologist versed in its technique. The blood is examined before and after exercise, and figures below 0·8 and above 1·2 are believed to indicate an active lesion. The use of the Arneth blood count in diagnosis has been referred to on page 1097. The complement fixation test is still in the experimental stage, and does not yet afford reliable criteria of activity or quiescence.

The stability reaction of the blood, *i.e.* the rate of sedimentation of the erythrocytes in blood diluted with sodium citrate solution, is affected in this disease. In active cases the sedimentation rate is increased, but this reaction is not specific. It is also present in other conditions such as pregnancy, carcinoma, syphilis and acute infections. The test would be of value in pulmonary tuberculosis, if it should be established, as some observers claim, that a normal sedimentation rate is incompatible with active disease.

It has also been used as a guide to prognosis, since it is affirmed by some that arrest should not be considered as firmly established until the sedimentation rate has returned to normal. This may not occur until some time after the usually accepted clinical symptoms and signs of activity have disappeared.

THE TUBERCULIN TESTS.—1. *Cutaneous (the Pirquet reaction).*—Scarifications are made on the skin of the forearm through a drop of Koch's old tuberculin, human and bovine, and through a drop of saline as a control. A positive reaction is shown by the formation of a slightly raised, reddened papule at the site of the scarification through one or other varieties of tuberculin, whereas the control is not affected. Unfortunately, except in the first two years of life, this affords no indication of active disease, but only reveals the presence of previous infection with resulting tuberculin sensitiveness. A positive reaction is therefore given by the majority of adults. The graduated Pirquet is said to give an indication of the activity of the disease. In this process four scarifications are made through old tuberculin of strengths 1, 4, 16 and 64 per cent. respectively, and the resultant sizes of, and the differences in size between the papules, are measured and compared with a table.

2. *Calmette's ophthalmic reaction.*—A drop of 1 per cent. old tuberculin is instilled into one conjunctival sac. A positive result is shown by the development of conjunctivitis in from 3 to 12 hours. This test also affords no indication of the activity of the disease, and, as there is some risk of permanent damage to the eye, it is not usually carried out in this country.

3. *The subcutaneous test.*—The patient must be apyrexial, and must be

kept in bed—$\frac{1}{10}$th mgrm. of old tuberculin is injected subcutaneously, and its effect determined. The reactions that may develop are—(*a*) local, an inflammatory swelling at the site of the injection; (*b*) focal, an increase of the signs observed at the seat of disease in the lungs, such as the temporary appearance of a few râles at one apex. This is the most important; (*c*) general, as judged by a rise of temperature and sense of malaise. The temperature should be charted 4-hourly after the injection, and a rise to over 99° F. indicates a positive reaction. If no reaction follows this initial dose, larger injections are given at intervals of 2 or 3 days, in this sequence: $\frac{1}{5}$th, $\frac{1}{3}$rd, 1, 5 and even 10 mgrms.

This test has the drawback of the two former tuberculin tests, that it does not indicate activity of disease, and it has the additional disadvantage that it may cause a quiescent pulmonary focus to light up and spread, and so cause irreparable damage. It is therefore wise to avoid it in cases of suspected lung disease.

Finally the X-rays may afford some assistance in the diagnosis of early cases with doubtful signs, and may also assist in the differential diagnosis of tuberculosis from other lung diseases with well-marked signs.

Prognosis.—A number of factors must be critically considered in the determination of the prognosis in pulmonary tuberculosis.

A marked family incidence generally suggests an unfavourable course, though this rule is not invariable.

Personal history.—Chronic alcoholism is serious, chiefly because the régime of treatment is then peculiarly irksome, while the digestion and powers of resistance are often impaired in alcoholics. Tuberculosis in syphilitics frequently assumes a fibrotic type, and its course may be beneficially influenced by anti-syphilitic treatment. The outlook is grave when tuberculosis is conjoined with diabetes. Congenital heart disease and pulmonary stenosis are unfavourable factors; but hypertrophy of the heart and mitral stenosis are said to be beneficial.

The prognosis is very grave in infants and young children; but slightly less serious up to the age of 20. Between 20 and 50 age has little influence; but in later years the outlook becomes progressively less favourable.

Apart from the effects of pregnancy and exposure, sex plays no important part.

Freedom from financial embarrassment improves the prognosis, inasmuch as advice can be sought early, and treatment carried out thoroughly.

Marriage often leads to a breakdown in arrested cases, and induces more rapid spread of active lesions.

Persistence in an unfavourable occupation, or return to it after completion of institutional treatment, affects the prognosis adversely.

Poor chest development and the "habitus phthisicus" are usually bad prognostic signs, although tuberculosis often runs a rapid course even in patients with good physique.

Patients with resolute and persistent personality are more likely to persevere with treatment and to recover, than those of weaker moral fibre.

The prognosis is greatly affected by the type of the disease—acute miliary tuberculosis is usually rapidly fatal, whereas in acute caseous tuberculosis, although the prognosis is very grave, recovery may occur. In fibro-caseous tuberculosis the prognosis is most uncertain and difficult

to forecast. Every factor must be carefully considered, and the response to treatment noted. The best outlook is in fibroid disease, which often undergoes complete and permanent arrest. The prognosis is usually fair in hilum tuberculosis, but acute and rapid spread sometimes occurs.

SYMPTOMS IN THEIR RELATION TO PROGNOSIS.—Persistent cough, by exhausting the patient and disturbing sleep, is often unfavourable.

The amount of sputum is usually dependent upon the type of disease and upon the presence of secondary infection, and may therefore be of value in prognosis.

The significance of tubercle bacilli in the sputum.—The figures obtained at the Midhurst Sanatorium, over a period of 8 years, in which the after-history of the patients was traced for the ensuing 6 years, show that the prognosis is best in "closed" cases; but that it is nearly as good in those cases in which the tubercle bacilli disappear from the sputum during the sanatorium treatment. Persistence of bacilli in the sputum is an unfavourable sign. The actual number of bacilli in the sputum and the presence of "beading" have no definite prognostic significance.

Cases commencing with hæmoptysis progress more satisfactorily than those with other modes of onset, chiefly because they are diagnosed earlier. Hæmoptysis occurring later may exert an unfavourable influence, either indirectly by spreading the disease into previously healthy portions of the lungs, or actually by the loss of blood.

If dyspnœa is not due to attacks of bronchial spasm, it has usually an unfavourable significance.

The temperature affords a clue to the type and activity of the disease, and is thus a valuable aid to prognosis. Profuse and persistent night sweats, or marked anorexia, especially when occurring early in the disease, are grave signs. Tachycardia due to toxæmia, and signs of cardiac failure, are of bad omen. The blood-pressure is thought by some to be a useful guide, systolic figures below 100 mm. Hg being unfavourable, whereas a rise of pressure may be associated with amelioration of the disease. In fibroid lesions the pressure may be raised throughout.

THE EXTENT OF PHYSICAL SIGNS.—The activity of disease rather than its extent is the important factor in determining prognosis. The development of compensatory emphysema is of value only as an indication of fibrosis in the tuberculous portion of lung, and therefore of chronicity.

THE INFLUENCE OF COMPLICATIONS ON PROGNOSIS.—Generally speaking, the presence of complications increases the gravity of the disease. Involvement of the larynx is a very serious complication, especially when accompanied by dysphagia; but complete recovery may take place if the pulmonary lesion is quiescent. In early cases spontaneous pneumothorax occasionally acts favourably; but when it develops in association with extensive tuberculosis, and especially if it progresses to pyo-pneumothorax, it is almost invariably fatal.

Pleural effusion often has a beneficial influence by diminishing the movements of a lung in which there is an early tuberculous focus.

Secondary catarrhal affections tend to increase the cough and expectoration, and may lead to further spread of the disease.

Meningitis is almost invariably fatal. Tuberculous peritonitis or enteritis is a very grave complication, but *fistula-in-ano* often occurs in chronic

cases, and exerts no marked deleterious effect. Involvement of the genito-urinary system increases the severity of the disease, especially if the kidneys or bladder are affected. If the epididymis alone is involved the prognosis is not materially affected, as the lesion can be dealt with surgically, although the administration of a general anæsthetic may cause spread of the pulmonary disease. For this reason when operations are urgently needed on these patients, gas and oxygen, local or spinal anæsthesia should be insisted on.

As shown by the figures obtained at the Midhurst Sanatorium, a fairly accurate guide to prognosis is afforded by observing the condition of the patient on admission to the sanatorium, and his response to treatment. Even in the most favourable cases, which are diagnosed in an early stage, and progress satisfactorily under treatment, the mortality rate is six times greater after discharge from sanatorium than it is for the remainder of the population of England and Wales for the same age periods; whereas in the cases of advanced disease the mortality rate is thirty-eight times greater than for the average population. As the most critical time is during the two or three years succeeding discharge from sanatorium, the prognosis is largely affected by the conditions of life during this period.

It seems probable that the rate of sedimentation of the erythrocytes (see p. 1104) may prove to be a valuable aid to prognosis. A persistently rapid rate is unfavourable.

Treatment.—*Prophylactic.*—The prophylaxis of tuberculosis involves a consideration of public health questions dealing with the purity of the milk supply, the infection of meat, sanitation and housing, the early diagnosis of tuberculosis, the examination of contacts, and the segregation of "open" cases. All these questions are considered in the general article on Tuberculosis.

Curative.—This varies with the type and stage of the disease. In all acute or febrile cases treatment should be commenced at home or in a nursing home or hospital, where the patient can be under careful observation in bed. The various forms of treatment which may be considered are—(1) sanatorium treatment; (2) home or institutional treatment; (3) dietetic treatment and personal hygiene; (4) climatic treatment; (5) graduated rest, exercise and labour; (6) medicinal treatment; (7) specific measures; (8) operative treatment; (9) symptomatic treatment.

1. Sanatorium Treatment.—This constitutes the best mode of treatment for early and for certain types of chronic disease; but is totally unsuited for acute febrile or very active cases. The advantages obtained are—(*a*) the patient learns the most suitable mode of life, and the methods employed to check the spread of the disease; (*b*) the housing is specially designed and the climatic conditions are good; (*c*) the dietary is abundant and adapted to the patient's needs; (*d*) there is constant skilled medical supervision, and the daily routine is adapted to the actual physical condition of the patient.

On arrival a newcomer is kept in bed for a few days in order that his resting temperature may be observed, and the necessary examinations carried out. If there is pyrexia, rest in bed must be enforced until the temperature falls to normal. If the temperature rises above 99° F. when the patient is up, return to bed is usually necessary. The routine of sanatorium treatment varies in different institutions, the most important divergence

being whether or not a system of "graduated exercise" is employed. In nearly all an hour's recumbent rest is enforced before lunch and dinner.

After three months' stay it is usually possible to decide whether the patient is responding to treatment, and if so it should, if possible, be prolonged for at least another three months, or until the sputum is free from tubercle bacilli.

2. Home and Institutional Treatment.—Treatment at home, in nursing homes or in special hospitals is essential in early cases with fever, and in cases in which it is necessary to establish the diagnosis. Home treatment is also usually necessary on return from sanatorium or climatic treatment, if arrest is incomplete. An endeavour should always be made to carry out the principles inculcated at the sanatorium, and the patient should be under regular medical supervision. Advanced cases are best looked after in special institutions.

3. Dietetic Treatment and Personal Hygiene.—It is desirable to graduate the diet in each case so that the patient is restored to the previous maximum weight; but, in order to accomplish this, the food should be slowly increased and all ideas of enforced over-feeding discountenanced. A total calorie value of 3000 to 3500 is usually ample; but, if the patient is performing heavy work, as much as 4000 may be necessary. Meat, fish, eggs and fats are usually well tolerated. It is not often necessary to give large quantities of milk when the patient is on a full dietary. If extra food is required, the protein may be increased by raw meat sandwiches, and additional carbohydrates may be taken.

In all cases in which there is expectoration the patient should be clean-shaven. Great care must be taken in the disposal of sputum to ensure that it does not become dry, and that flies do not have access to it. All patients who are up should carry special sputum flasks, while those who are in bed should have sputum cups suitably covered and containing disinfectant. The sputum should be burnt, or, if this is impossible, it should be emptied into the water-closet after disinfection with carbolic acid or other simple or cheap disinfectant.

Smoking is best avoided in cases of active disease or laryngeal tuberculosis, and in no instance should inhaling be allowed. Woollen under-garments should be worn; but all excess of clothing is harmful.

4. Climatic Treatment.—This is undoubtedly of value in carefully selected cases. The climatic resorts fall into three groups—mountain, marine and inland.

The mountain resorts.—In Europe the most suitable places are found in Switzerland. Among these are St. Moritz (6090 feet), Arosa (6000 feet), Davos (5150 feet), Montana (5000 feet) and Leysin (4690 feet). In America the most celebrated resorts are in the Rocky Mountains at Colorado Springs (5000 feet) and Denver (5000 feet), or in the Andes or Adirondack Mountains. The advantages of high altitudes consist in the stillness, purity and rarefaction of the air, and the greater diathermancy of the atmosphere to the sun's rays. Metabolism and the general circulation are thereby increased.

High altitudes are suitable for early cases which are afebrile, or for quiescent cases of more advanced type. Contra-indications are recent hæmoptysis, active disease with fever, extensive fibrotic lesions and complications such as emphysema, asthma, cardio-vascular lesions or nephritis.

Marine and coast resorts.—Among the important coast resorts in the British Isles are Bournemouth, the Isle of Wight, Torquay, Falmouth, Llandudno, Penmaenmawr, Scarborough, Mundesley and the various seaside towns in Thanet. Farther afield are the French and Italian Riviera, Madeira, the Canary Isles, Morocco, Algiers and Egypt. The climate tends to be warm, moist and equable, and the amount of ozone is probably increased. These resorts are especially suitable for cases of more advanced and active disease, and for those complicated by hæmoptysis, bronchitis, emphysema and laryngitis.

Inland resorts.—These are to be found on the English and Scottish moorlands. The climate of California, the South African veldt, and parts of Australia and New Zealand are admirably suited to this disease, especially for arrested or early uncomplicated cases; but the laws against the admission of tuberculous patients are strictly enforced at all of them.

Sea voyages.—These are contra-indicated for all except completely arrested cases, owing to the lack of fresh air in cabins, the possibility of sea-sickness, and the difficulty of obtaining suitable treatment if the disease advances.

5. Graduated Rest and Exercise.—Treatment in bed is necessary so long as there is fever, and if the raised temperature is persistent, "absolute rest" should be enforced. This consists in keeping the patient recumbent in bed, sufficiently well covered to prevent any muscular contraction from chill, while feeding and washing are attended to by the nurse, and the use of the bed-pan and slipper for evacuations is insisted upon. When the temperature becomes normal the patient is allowed up for varying periods, commencing with 1 hour daily, and increasing slowly to 6 or 8. If still apyrexial, walking exercise of 1 or 2 miles or more daily can be allowed.

The system of "graduated exercise" which Paterson instituted at the Frimley Sanatorium has proved of great value. There are six grades, the first and lightest consisting of walking up a slope carrying a light weight such as a basket of earth, while the sixth and heaviest involves hard manual labour with a pickaxe or shovel for 6 hours daily. This system is based on the principle that muscular exercise leads to the discharge of tubercle toxins from the pulmonary focus, and by liberating these in gradually increasing doses, a condition of active immunity is induced. A careful watch must be kept during this controlled process of auto-inoculation to prevent excessive doses of toxin being discharged, which are early indicated by rise of temperature and of pulse-rate, headache, increased cough and expectoration, lassitude and malaise. If such occur, the patient should be put back to bed for a few days, and when the condition has subsided the graduated exercise may be resumed at the grade which induced the over-inoculation or that immediately below it.

6. Medicinal Treatment.—No specific drug has yet been discovered for the treatment of tuberculosis. Amongst the medicines in most general use are:

(*a*) Cod-liver oil.—This may be administered by the mouth in doses up to 2 ounces daily, or 0·5 to 2 c.c. of a 3 per cent. solution of sodium morrhuate may be injected subcutaneously once or twice a week (Rogers). The cod-liver oil may be of value either on account of its fat-soluble A vitamin content, or, as suggested by Rogers, it may assist by dissolving the capsules of the tubercle bacilli and so facilitating their disintegration.

(*b*) Creosote.—This may be given in doses of ℥ij to iij three times a day after food, either in combination with cod-liver oil, or in capsules. It should be discontinued if gastric disturbance or hæmoptysis ensue.

(*c*) Hypophosphites.—These are not so generally used as formerly, and beyond their "tonic" effect upon the nervous system, have no demonstrable influence upon the pulmonary lesion.

(*d*) "Nascent" iodine.—With the idea of liberating free iodine in the tissues, potassium iodide grs. xxx is administered after breakfast in half a pint of water, and throughout the day 3 to 5 ounces of chlorine water are consumed with lemonade. This treatment is of value in certain chronic fibroid cases, but it often produces no appreciable results, and may cause dyspepsia.

(*e*) Arsenic.—Liquor arsenicalis ℥ ij to iij by mouth, or sodium cacodylate gr. ¼ to ½ subcutaneously, are of value in some cases associated with anæmia. Salvarsan or novarsenobillon, administered intravenously, is useful in chronic cases complicated by syphilis.

(*f*) Inhalations.—Disinfectant drugs when inhaled often check cough, lessen expectoration and improve the general condition of the patient. Lees's inhalation, or some modification of it, is of value. It consists of creosote, parts 2; acid. carbol. 2; tinct. iodi mitis, 1; sp. ætheris, 1; and sp. chlorof. 2. About 6 drops an hour are placed upon a Burney-Yeo mask, which should be worn almost continuously throughout the day.

(*g*) Recently there has been a revival of interest in preparations of gold in the treatment of this disease, notably by Mollgaard, who uses sodium aurothiosulphate, to which the name of sanocrysin has been applied. In view of the toxic reactions, which are frequently obtained, a special anti-tuberculous serum is sometimes used at the same time, on the supposition that the toxic effects are due to the disintegration of tubercle bacilli in the lesions. This substance is now being employed in smaller doses than were originally used and seems likely to become established as a useful means of treatment in selected cases.

7. Specific Measures.—(*a*) *Active immunisation.*—Tuberculins.

The tuberculin treatment has not fulfilled the high hopes held out on its introduction by Koch. There are now numerous forms of tuberculin available, indicated by certain letters, and falling into three groups. (1) Those containing the exo-toxins only. These include Koch's old tuberculin T., O.T., and T.O.A., Denys' bouillon filtré (B.F.) and albumose-free tuberculin, T.A.F. (2) Those containing the endo-toxins chiefly, as Koch's "new" tuberculin, T.R. (3) Mixtures of endo- and exo-toxins, the most important of which are Koch's bacillary emulsion, B.E., the sensitised bacillary emulsion, S.B.E. and Béraneck's tuberculin, T.Bk.

Tuberculins may be prepared from human or bovine bacilli; if from the latter the letter P. (perlsucht) placed before the letters indicating the variety of tuberculin, signifies its origin, *e.g.* P.T. In administration, some aim at producing reactions and establishing tuberculin tolerance by giving large doses at fairly frequent intervals; others believe in minute doses at longer periods, the chief object being to avoid the production of any reaction. The actual doses are either measured in milligrammes of dried tubercle bacilli, or in cubic centimetres or cubic millimetres of the fluid tuberculin. The usual method is to measure the doses in cubic centimetres or fractions

thereof, and to make the necessary dilutions in a series of bottles. Smaller initial doses should be used with a strong tuberculin such as the B.E. than with the weaker ones such as the T. or A.F. Thus, if adopting minute doses $\frac{1}{500,000}$ mgrm. of B.E. would be a suitable initial dose, then for T.R. $\frac{1}{100,000}$ mgrm. would be used and $\frac{1}{1000}$ mgrm. of T., B.F., or A.F. As the different tuberculins are supplied by the makers in varying strengths, 0·001 c.mm. of the original fluid is equivalent to the above doses.

Those who believe in minute doses commence with 0·001 c.mm. and work up to 0·1 c.c., whereas others commence with 0·5 to 1 c.mm. and increase to 1 c.c. The tuberculin should be injected subcutaneously, and a careful observation kept for local, focal and general reactions. Tuberculin if used injudiciously can be productive of harm. At Midhurst Sanatorium it was tried for some years, and no better ultimate results were obtained than in the "non-tuberculin" years. It seems wise, therefore, to use tuberculin only in very carefully selected cases, thus T.R. does at times appear beneficial in chronic tuberculosis, promoting the formation of fibrous tissue and leading to the disappearance of tubercle bacilli from the sputum.

Recently various attempts have been made to remove as far as possible the fatty and waxy constituents from the tubercle bacilli before preparing a vaccine from it. The best known of these is the *diaplyte* vaccine of Dreyer. Much and his collaborators have employed partial antigens or partigens derived from tubercle bacilli or in varying combinations. Some good results are on record from both of these methods, but on the whole their use has so far been disappointing.

(*b*) *Passive immunisation.*—The various serums such as those prepared by Marmorek and Maragliano have not proved successful, and this applies to the "contra-toxin" of Mehnarto and the "I.K." (immune bodies) of Spengler.

8. Operative Treatment.—(*a*) *Artificial pneumothorax.*—This mode of treatment is now becoming more generally adopted in selected cases. It is not indicated in early disease and in cases progressing favourably. In extensive bilateral disease it may be dangerous. If old and dense pleural adhesions are present, it is impracticable. If there is much emphysema or cardiac embarrassment, it involves risk. Only a relatively small group remains which comprises cases in which the disease is mainly unilateral, and those which remain febrile in spite of prolonged bed treatment. It is also of value in certain cases of repeated severe hæmoptysis. Tuberculous laryngitis or enteritis are not contra-indications, providing that other conditions are suitable. Nitrogen or sterile air is introduced into the pleural cavity, and the lung allowed to collapse. The method of induction of artificial pneumothorax is as follows: A preliminary subcutaneous injection of $\frac{1}{3}$ grain of omnopon is given half an hour before the start. The patient lies on the sound side with the head low and supported on a pillow. A second pillow is placed under the chest to expand the intercostal spaces. The skin and the tissues down to the pleura are anæsthetised with 2 per cent. novocain solution after the application of iodine. The site usually chosen is in the sixth intercostal space in the mid-axillary region. A special pneumothorax needle, attached by a rubber tube to the pneumothorax apparatus, which is carefully examined to see that it is in proper working order, is then pushed through the intercostal space until the pleural cavity

is reached. The apparatus is then adjusted so that the intrapleural pressure can be observed. No air should be introduced until the manometer shows a normal negative pressure range with inspiration, of 5 to 10 or more c.c. This is the test of entry into the pleural space, and when this is established 200 to 300 c.c. of sterile air may be allowed to enter the pleural cavity. The final pressures are then recorded and the needle is withdrawn. A refill is given next day and again after two more days, the quantities of air introduced being determined by the final pressures, which should be kept slightly negative. Subsequent refills are gradually spaced out to a week, then ten days and later to two, three and four weeks' intervals. The tendency now is to maintain the collapse for two or three years or even longer. If the condition of the patient is satisfactory, re-expansion may then be permitted cautiously. It should be remembered that after expansion pleural adhesion almost invariably occurs and the treatment by artificial pneumothorax cannot be repeated. In a few cases of bilateral disease, which is active but not very extensive in either lung, a cautious use of bilateral artificial pneumothorax has proved practicable and helpful, but very great care is necessary.

There are certain dangers in the procedure. These are now rare, and they can usually be prevented by careful attention to the technique. Death has occurred from pleural shock when the needle has reached the pleura and before any air has been introduced. Adequate anæsthesia of the pleura is the only known method of eliminating or minimising this risk. If the lung is adherent to the chest-wall, owing to pleural adhesions, or if the needle is pushed in too far, it may be inserted into the lung or into a pulmonary cavity; the manometer will then show a swing above and below the zero line instead of entirely below it. Under these circumstances, no air should be allowed to enter. The needle may be inserted into a blood vessel. In this case the manometer pressure will rise above zero and blood may appear in the glass section inserted in the rubber manometer lead from the needle. The needle should be withdrawn immediately, lest air should enter the vessel.

If the pleura is found to be adherent at the site of the first puncture, another attempt may be made elsewhere, *e.g.* just below the inferior angle of the scapula. This spot may be selected for the initial puncture in left-sided cases where there is marked cardiac displacement.

(*b*) *Thoracoplasty.*—If owing to adhesions it is impossible to collapse the lung temporarily by an artificial pneumothorax, permanent collapse may be considered. This can be effected in suitable cases by removal of a sufficient amount of the ribs from the first to the tenth to allow the chest-wall to fall in and so permit the lung to collapse. This may be done in one or two stages, and under local or general anæsthesia or both combined.

(*c*) *Evulsion (exairesis) of the phrenic nerve.*—This has also been performed in order to produce basal collapse. Division alone is not sufficient as a rule.

9. Symptomatic Treatment.—When cough is ineffective it may be relieved by a sedative lozenge or linctus containing heroin or codeine, or by the well-known liquorice lozenge. If there is difficulty in bringing up the sputum, a simple saline mixture is of value, such as sodii bicarb. grs. x, sodii chlorid. grs. iij, sp. chlorof. ℥ 10, and aq. anisi ad ʒi.

Pain in the chest is usually alleviated by local application of pigmentum iodi, liniments, mustard leaves or other counter-irritants.

Night sweats.—The windows should be widely opened at night. A pill containing zinc. oxid. grs. iij and ext. belladonn. sicc. gr. ¼ is often of value. Picrotoxin, agaricin and strychnine have also been used.

Fever.—Rest in bed up to the extent of "absolute rest" is the best means of lowering the temperature. Antipyretic drugs have no effect upon the course of the disease, but may alleviate malaise. Amongst these may be mentioned aspirin, cryogenin and pyramidon.

Slight hæmoptysis, in which the sputum is only streaked, calls for no special treatment. Moderate hæmoptysis, with expectoration of 3 or 4 ounces of blood, requires more active measures. The patient should be put to bed, a saline aperient administered, and if there is anxiety or alarm a sedative drug should be given, such as heroin or morphine. In profuse or persistent hæmoptysis the patient should be confined strictly to bed, and if it is known from which side the bleeding has occurred, it is best to lie on this side. If the cough is troublesome, or if the patient is alarmed, morphine gr. ⅛ to ¼, or heroin gr. $\frac{1}{12}$ to $\frac{1}{8}$ should be injected subcutaneously. The food is best given cold, and may be iced; no alcohol must be taken. A course of calcium lactate grs. x, t.d.s., may be commenced; but its action is somewhat uncertain, and should not be prolonged for more than 3 or 4 days. If the bleeding persists, various other remedies should be tried, these include the inhalation of amyl nitrite, or the injection of "coagulose," horse serum, or emetine hydrochloride subcutaneously. Ergot and adrenalin are both contra-indicated. If the hæmorrhage is still unchecked, or is frequently repeated, the advisability of establishing an artificial pneumothorax must be considered.

Gastro-intestinal symptoms.—Anorexia or dyspepsia can often be relieved by changes in diet, or by the administration of suitable drugs. Alkalis and gentian are especially valuable, and when hypochlorhydria is present, dilute hydrochloric acid in large doses (♏ x–xxx) should be given well diluted after meals. Digestive ferments, such as taka-diastase or papain, may be required at times. All tendency to constipation should be checked by laxatives, and if diarrhœa develops avoidance of diet leaving bulky or irritating residues should first be tried, before administering drugs containing lead, opium, bismuth or tannic acid.

Insomnia is often a troublesome symptom, and every endeavour should be made to obtain a good night's rest by administration of mild hypnotics, and by relieving distressing cough and pain.

The treatment of the complications of pulmonary tuberculosis is described under their respective headings. The after-care of patients discharged from sanatoria is an important subject, to which considerable attention is being devoted, and involves a consideration of the advisability of establishing training centres or colonies for consumptives.

THE PULMONARY MYCOSES (PNEUMONOMYCOSES)

A number of fungi produce pulmonary lesions. Considerable confusion exists in regard to their nomenclature, and at the present time it is difficult to give accurate accounts of them. The pulmonary mycoses have one feature in common, in that they produce chronic pulmonary lesions

practically indistinguishable clinically from those of the chronic forms of pulmonary tuberculosis.

Among the varieties of mycotic infection at present separated clinically may be mentioned — (1) Actinomycosis (Nocardiasis, Streptotrichosis); (2) Aspergillosis; (3) Blastomycosis; (4) Sporotrichosis; (5) Moniliasis; (6) Mucormycosis.

Actinomycosis (Nocardiasis, Streptotrichosis)

Ætiology.—The general characters of the streptothrix group of organisms are described in the section on Actinomycosis. It is now recognised that more than one of these may be pathogenic for man, and some authors give separate descriptions of the forms due to the various streptothrix organisms. At the present time there seems little advantage in so doing, since the important point in regard to treatment is to recognise that the morbid process is due to some form of streptothrix infection, the identification of the variety being a pathological refinement. The mode of access to the body is at present obscure. The organism is found especially in straw, barley and other grains. It is believed to enter the body by ingestion or by inhalation. A large proportion of cases show the first lesions in the head and neck regions, but primary pulmonary cases occur, and are probably more frequent than is generally recognised.

Pathology.—The streptothrix group of organisms produces an inflammatory reaction which leads to the formation of granulomatous tissue. This, like the granuloma of tubercle, is very liable to undergo secondary changes producing small areas of pus formation or leading to fibrosis. Unlike tuberculosis, however, streptotrichosis tends frequently to transgress anatomical limitations and spreads by contiguity. In the primary pulmonary cases the distribution of the lesions is at first very similar to that of tuberculosis, and the disease may extend in an identical manner. In the forms due to spread from other organs such as the liver, the base may be first involved, while in cases extending down from the neck the path of the infection is easily followed.

Owing to the tendency of the lesions to spread by contiguity, subcutaneous abscesses may form and simulate caries of the ribs. Pleural adhesion is the rule, but occasionally empyema results. When a subcutaneous abscess ruptures or is opened, the characteristic "sulphur granules" may be found, although this is not invariable. The skin around the sinuses which result is often puckered in a somewhat characteristic fashion.

Symptoms.—These are in general identical with those of the chronic forms of pulmonary tuberculosis, as cough, expectoration, which may be offensive, dyspnœa, fever and night sweats. The occurrence of local abscesses under the skin or the presence of the parasite elsewhere may give rise to special features; but these are late developments in primary pulmonary cases.

Complications and Sequelæ.—These are usually due to the other localisations of the parasite; but in addition empyema and bronchiectasis may be mentioned.

Course.—This is progressive, and leads eventually to asthenia, emaciation and death.

Diagnosis.—This can only be established by the discovery and identification of the parasite in the sputum and the discharge. The characteristic "sulphur grains" are not invariably present, and may escape notice unless looked for carefully. In any obscure case of pulmonary disease in which tubercle bacilli are not found after repeated search, the possibility of streptotrichosis should be considered, and direct films should be specially examined.

Prognosis.—This is serious, although some cases respond well to treatment.

Treatment.—Large doses of potassium iodide should be administered, commencing with 5 or 10 grains three times a day, and increasing until the dose reaches a drachm or even more thrice daily. If the parasite grows well in culture, a vaccine may be prepared and employed cautiously, especially if the iodides do not act satisfactorily. Surgical treatment of local abscesses or of empyema may be required.

Pulmonary Aspergillosis

Ætiology.—Infection of the bronchi and lungs sometimes occurs by the *Aspergillus fumigatus*, more rarely by the *A. nidulans*. The disease has been most frequently observed in France. It occurs among pigeon breeders and hair sorters and combers. The former acquire the disease from the process of artificial feeding, from grains in the mouth to the beak of the bird; the latter from the use of rye flour in cleaning the hair. Millers and farm labourers have also been the subjects of the disease.

Pathology.—The fungus induces nodular formations in the lung tissue somewhat resembling aggregated tubercles. Bronchitis, patchy lobular consolidation and fibrosis result. Emphysema, bronchiectasis and cavity formation may follow. A secondary aspergillosis may occur in chronic cases of bronchitis or lung disease, but is of little clinical importance.

Symptoms.—Primary aspergillosis produces symptoms similar to those of bronchitis, broncho-pneumonia or pulmonary tuberculosis, according to the localisation and degree of the lesions. The sputum may be blood-stained, or definite hæmoptysis may occur. There is generally wasting with irregular fever.

Course.—Acute broncho-pneumonic forms may be fatal in a few weeks or months. The chronic lesions may extend to years, and arrest with fibrosis is not uncommon.

Diagnosis.—The condition has to be differentiated from pulmonary tuberculosis, and from other varieties of pneumonomycosis. This depends upon the recognition of the fungus by microscopical and cultural examination of the sputum.

Treatment.—This consists in avoiding further infection, and giving large doses of potassium iodide as in streptotrichosis. Open-air measures and general tonic treatment are also to be recommended.

Other Mycotic Infections

Fungi of the genera *Blastomyces* (*Oidium*, *Coccidioides*) and *Sporotrichum* are well known to produce cutaneous affections simulating chronic gummatous

or tuberculous lesions. They may also give rise to pulmonary disease producing symptoms like those of tuberculosis.

Castellani has described various broncho-pulmonary conditions due to species of the genus *Monilia*, including the "tea-tasters' cough" and "tea-factory cough." Another fungus, *Mucor mucedo*, has been found in the sputum, and is regarded as pathogenic to man.

All these moulds produce bronchitic symptoms and mild infections, while more severe forms simulate pulmonary tuberculosis. The diagnosis in each case depends upon the recognition of the fungus, and the treatment recommended is large doses of potassium iodide.

SYPHILIS OF THE LUNGS

Ætiology.—Clinically recognisable pulmonary syphilis is a rarity; but syphilitic lesions occur in the lungs in both the congenital and acquired forms of the disease.

Pathology.—Even post mortem it is often difficult to establish the syphilitic nature of the pulmonary lesions found in cases of syphilis, owing to the fact that they tend to the formation of scars presenting no characteristic features.

Congenital syphilis.—The essential changes are (1) Round-celled infiltration with eventual fibrosis, starting round the bronchi and spreading to the inter-alveolar framework; (2) periarteritis of the smaller arteries; and (3) desquamation and degeneration of the epithelium of the alveoli and bronchi. Gummata may be present, but are rare. Spirochætæ can be demonstrated in the lesions by Levaditi's method. The microscopic appearances comprise the "white pneumonia" of Virchow and an interstitial pneumonia, which is commoner, although both conditions are frequently associated. White pneumonia is found in premature or still-born infants, and in those dying soon after birth. The condition may be widespread or localised. The affected areas are firm, consolidated, smooth and greyish-white in colour. There are no interstitial changes, and the consolidation is due to the filling of the alveoli with desquamated, degenerating epithelial cells.

In the commoner interstitial form the lung is firmer, harder and darker grey in colour, and the connective tissue is mainly involved. To this condition the term "pancreatisation of the lung" has been applied by Rogers.

Acquired syphilis.—Syphilitic lesions of the bronchi have already been described in the section on diseases of the bronchi. Gummata may occur in or around the intra-pulmonary bronchi or in the lung tissue. They may be single or multiple, and vary in size from that of miliary granules to a hen's egg. They are said to be more common in the deeper parts of the lung near the roots and in the lower lobe. They undergo changes similar to those occurring in gummata elsewhere, but tend more to fibrosis and contraction than to softening. Owing to these secondary changes, the following conditions may result: broncho-pneumonic processes, widespread fibrosis and contraction with pleural adhesion, bronchiectasis and occasionally excavation.

Symptoms.—Small gummata may be latent and give rise to no symptoms or signs. When fibrosis occurs, they are similar to those of pul-

monary fibrosis from other causes. It is generally recognised that in rare cases a destructive process occurs, formally called "syphilitic phthisis," and almost exactly similar in its clinical manifestations to those of caseous or fibro-caseous tuberculosis.

Complications and Sequelæ.—Syphilitic lesions in the larynx, trachea or bronchi may complicate the course. Bronchiectasis has already been mentioned, and tuberculosis may occur as a complication.

Diagnosis.—This is often difficult and sometimes inconclusive. Obscure pulmonary signs in a syphilitic subject should arouse suspicion. The Wassermann reaction should be determined, and other indications of syphilis looked for in all fibrosing and destructive lung conditions when no tubercle bacilli are found in the sputum. The difficulty of diagnosis is increased by the association of syphilis and tuberculosis mentioned above.

Course and Prognosis.—Where the lesions are localised and can be recognised early, the course is favourable if anti-syphilitic treatment is applied. Where fibrotic changes occur, leading to bronchiectasis, the course is less favourable, and in the destructive form it is serious. An intercurrent tuberculous infection increases the gravity of pulmonary syphilis.

Treatment.—When a diagnosis of pulmonary syphilis has been established, vigorous anti-syphilitic treatment should be carried out. Its beneficial effect is undoubtedly promoted by open-air treatment. In cases where tuberculosis coexists with syphilis, anti-syphilitic treatment is strongly recommended, especially by French physicians.

NEW-GROWTHS OF THE LUNGS

Both simple and malignant tumours may occur in the lungs, the latter being the more common.

Ætiology.—Malignant tumours occur more frequently in the male sex; carcinoma is rare before the age of 40, but sarcoma may develop in earlier years. Simple tumours may arise at any age, but are found chiefly in adult life. The exciting cause is unknown. In some cases of malignant growth there is a history of thoracic trauma.

Pathology.—Simple tumours found in the lungs usually arise in the bronchial mucous glands or in the bronchi. They include adenoma, fibroma, lipoma and chondroma. Malignant tumours may be primary or secondary, the latter being much more common. The primary growths are carcinoma, sarcoma or endothelioma. Carcinoma arises either in the bronchi, as a columnar-celled growth, or in the alveoli as a spheroidal-celled carcinoma; but pleomorphism is often a marked feature of growths in the lung. Round-celled and spindle-celled sarcomata growing from the pulmonary connective tissue are met with, while endotheliomata are usually derived from the endothelium of blood vessels and lymphatics, or from the pleura. A primary carcinoma of the breast, œsophagus or mediastinum may directly invade the lungs. Secondary carcinoma may have its primary focus in the breast, stomach, intestines, liver, pancreas or prostate, whereas a secondary sarcoma most often results from metastasis of a primary bony growth. Chorion-epithelioma and hyper-nephroma also give rise to secondary deposits in the lungs.

Primary malignant tumours are usually unilateral; but secondary growths are often multiple and diffuse. Dissemination in the lungs may occur by spread along the bronchi or vessels, and a condition of miliary carcinomatosis is at times produced. The pleura is often affected by direct extension. Infiltration of, or pressure upon, the mediastinal structures frequently occurs.

Symptoms.—Simple tumours are pathological curiosities and, as a rule, only produce symptoms when they cause destruction of a bronchus or press on mediastinal structures.

The early symptoms of malignant growths are slight, and consist of malaise with, perhaps, cough and expectoration. Later, when the growth becomes more extensive and exerts pressure on, or involves the larger bronchi, mediastinum or pleura, they are more noticeable. Pain, dyspnœa and loss of weight with cachexia usually develop, and the cough and expectoration are more marked. The latter is often of the typical "currant jelly" or "prune juice" appearance due to altered blood. Microscopically, groups of large fatty cells, or irregular epithelial cells may be seen. There are usually no definite physical signs until the tumour causes pressure upon the bronchi, mediastinum or deep thoracic veins or nerves. The chest wall may bulge locally, owing to the presence of a growth near the surface, or it may be retracted if a main bronchus is obstructed. An actual subcutaneous swelling caused by the tumour eroding through the chest-wall may be visible. Enlarged veins often run across the chest, and one or other arm may be swollen or œdematous if there is mediastinal obstruction. Vocal fremitus is often unaffected; but is increased when the growth is near the surface, and diminished if pleural effusion has occurred. The percussion note over a moderate-sized tumour is impaired and may be extremely dull. The breath sounds vary with the size and position of the growth, and with the displacement or pressure effects produced. They may be weak, or loud and stridorous. Adventitious sounds depend upon the presence of complications such as bronchitis. Some degree of fever often occurs. The supra-clavicular and axillary glands are not infrequently enlarged, and evidence of malignant disease may be present in other parts of the body such as the abdomen.

Complications and Sequelæ.—Bronchitis is nearly always present in some degree. Pulmonary collapse, fibrosis, bronchiectasis, emphysema, gangrene, hæmoptysis and pleural effusion are sometimes observed. The latter is frequently bloodstained. In cases of primary malignant disease of the lungs, secondary deposits may occur in other parts of the body.

Course.—This is progressive, the patient gradually losing strength and dying from cachexia or some intercurrent affection.

Diagnosis.—This is difficult in early cases, and not easy in some advanced ones. Difficulties may arise in connection with pulmonary tuberculosis, fibrosis and gumma of lung, aneurysm, pericardial and pleural effusion and enlargement of the mediastinal glands due to Hodgkin's disease or tuberculosis. The whole body should be searched for evidence of malignant disease elsewhere. The sputum should be examined repeatedly for tubercle bacilli and for cellular elements, and an X-ray examination made of the chest. By the stereoscopic method excellent evidence of pulmonary neoplasms is often obtainable.

Prognosis.—Apart from those cases in which early recognition may in

suitable conditions render lobectomy, with removal of the growth, possible, this is hopeless, death occurring in a few weeks, or being delayed for two or three years.

Treatment.—In cases unsuitable for lobectomy, this can only be palliative and symptomatic. Useless cough should be checked by sedative lozenges or a linctus. Dyspnœa due to pleural effusion may be relieved by tapping; but the fluid often reaccumulates rapidly. Pain should be relieved by analgesic drugs, and in the later stages those containing opium or its alkaloids may be required. Deep X-ray treatment is sometimes used, and also radium.

PARAGONIMIASIS

Synonyms.—Pulmonary Distomatosis; Lung Fluke Disease; Endemic Hæmoptysis; Parasitic Hæmoptysis.

Ætiology.—(See p. 330.)

Pathology.—The flukes settle down in the lungs and form burrows. These burrows may coalesce and give rise to cystic swellings, varying from ½ to 1½ inches in diameter. These in turn develop fibrous sheaths and may give rise to abscess formation or pleurisy. The adult fluke is hermaphrodite, and lays numerous eggs which measure $100 \times 70\,\mu$. These are coughed up in the sputum, and are easily recognisable owing to their large size. The adult parasites are also occasionally found in the brain, liver, lymph glands and peritoneal cavity.

Symptoms and Complications.—The onset of symptoms, after infection has taken place, is insidious, with cough and expectoration. The latter is very constantly blood-stained, and there may be profuse hæmoptysis. Secondary pleurisy occurs when the cysts reach the surface of the lungs, causing pain. Examination may reveal no abnormal signs, at most there are a few scattered râles, together with signs of dry pleurisy at one point. Later in the disease the characteristic signs of the various complications may appear.

For general, abdominal and cerebral symptoms and complications, see pp. 330, 331.

Course.—This is chronic: the disease often persists for years, without giving rise to any acute disturbance apart from periodic hæmoptysis.

Diagnosis.—Distinction from other forms of hæmoptysis is accomplished by discovering the ova in the sputum. To facilitate the examination a little 0·1 per cent. sulphuric acid should be added to it.

Prognosis.—The immediate prognosis is good, the ultimate unfavourable, as there is considerable difficulty in eliminating the parasites, and permanent damage is wrought in the lungs when they settle there.

Treatment.—Prophylaxis is important where the disease is endemic. No bathing should be allowed in infected rivers, and all water used for drinking or washing should be boiled or filtered. Crabs should not be eaten. When the disease has developed the patient should move from the infected area. Potassium iodide (grs. x–xx, t.d.s.) is recommended, but other treatment is symptomatic.

HYDATID DISEASE OF THE LUNG

Hydatid cysts may develop in the lung in patients infected by the ova of the *Tænia echinococcus*.

Ætiology.—Man is the intermediate host of this parasite, and becomes infected directly or indirectly from the dog. The modes of infection and the life history of the parasite are elsewhere considered. Males are more often affected, and the condition is commoner among the poor than the well-to-do. It is rarely seen in this country except in patients from abroad, especially from Australia.

Pathology.—Hydatid cysts have been described in the lungs in from 5·6 to 16·8 per cent. of cases of hydatid disease in different parts of the world. The right lung is more often the site of the disease than the left, and the cyst is usually basic, though it may occur in the upper parts of the lung. It is generally supposed that infection of the lung is usually secondary to the liver, the ova reaching the lung through the diaphragm; but the occurrence of primary lung hydatid suggests the possibility of the embryo gaining access to the general blood stream, and thus reaching the lung by the pulmonary artery. There is, as a rule, a single cyst in the lung, but multiple or multilocular cysts are occasionally observed. The cyst may become as large as a cricket ball, but usually ruptures before it reaches this size. It has the same structure as hydatid cysts of other organs, with ectocyst and endocyst. It may develop brood capsules and daughter cysts, but is often sterile in this situation.

The reactive changes in the lungs are at first irritative and congestive, but eventually some fibroid changes occur, producing a more or less definite fibroid capsule around the ectocyst. The overlying pleura may become inflamed, thickened and adherent when the cyst grows near the surface. Rupture may occur into a bronchus, into the pleura, pericardium or peritoneum, or occasionally into the pulmonary vein. Rarely the contents of a small cyst may become inspissated, thus producing spontaneous cure.

Symptoms.—Until the cyst becomes large enough to cause irritation, there may be no symptoms, but sooner or later cough and expectoration develop. The latter is generally mucoid, and frequently bloodstained. Dyspnœa becomes apparent and pain results if the pleura is involved. The signs may be: diminished vocal fremitus, localised dullness and weak or absent breath-sounds and voice-sounds over a limited area, generally in the lower lobe. A few râles may be audible round the dull area. Occasionally with a large cyst there may be some bulging on the affected side, and "hydatid fremitus" has been described. The heart may be displaced in rare cases. Examination by the X-rays generally shows a suggestive rounded shadow with very little change in the surrounding lung, except in chronic cases where some fibrosis may be observed.

Some degree of eosinophilia is common but not invariable. When rupture into a bronchus occurs, there is usually sudden copious expectoration of watery fluid containing hooklets. Daughter cysts and parts of the ectocyst may be coughed up and lead to dyspnœa and even suffocation from laryngeal obstruction.

After rupture, spontaneous cure may result if the ectocyst is expectorated.

More commonly the cavity becomes infected and the symptoms and signs become those of chronic abscess (see pp. 1080, 1081). Rupture into the pleural cavity produces great pain, dyspnœa, cyanosis and shock, similar to the condition induced by pneumothorax. Rupture into the pericardium or into a vein is usually quickly fatal. When rupture occurs into a serous cavity, urticaria and severe toxic symptoms sometimes develop.

Course.—This is generally progressive, though occasionally spontaneous cure occurs either before or after rupture. More commonly the cyst causes increasing pressure or irritative symptoms, and eventually rupture or suppuration produces acute manifestations.

Diagnosis.—The clinical features of pulmonary hydatid may be suggestive of pulmonary tuberculosis, pleural effusion or new-growth. Diagnosis may be difficult before rupture occurs; after this the discovery of hydatid hooklets or pieces of cyst-wall may establish the diagnosis. In suspicious cases the X-ray findings may be of great assistance, and confirmatory evidence may be obtained from cytological and serological examination. The former frequently shows eosinophilia, and the latter gives complement deviation when a suitable antigen, such as extract of hydatid cyst-wall, is used. A precipitin reaction may also be obtained with the fluid from another cyst.

Prognosis.—The prognosis is serious owing to the risks of rupture and suppuration. Spontaneous cure is rare, but can occur. After rupture into a bronchus, recovery may ensue, but more commonly abscess formation results. Rupture into a serous cavity is frequently fatal. Early surgical treatment either before or after rupture improves the outlook.

Treatment.—Aspiration of the cyst, either exploratory or therapeutic, is to be avoided. If the cyst can be diagnosed and localised before rupture, the lung should be exposed by thoracotomy, the pleura stitched together and the cyst incised, the endocyst removed, and the cavity drained. Suppuration of a pulmonary hydatid must be treated as a pulmonary abscess.

THE PNEUMONIAS

The term pneumonia has been somewhat loosely applied to any inflammatory condition of the lung producing consolidation. When the consolidation affects large areas of lung uniformly it is described as lobar pneumonia, and when it is patchy or lobular in distribution it is called lobular or broncho-pneumonia.

LOBAR PNEUMONIA

Synonyms.—Croupous or Pleuro-Pneumonia.

Definition.—This is an acute infectious disease characterised by an inflammatory lobar consolidation.

Ætiology.—*Predisposing causes.*—Pneumonia may occur at any age. It is common in children up to the sixth year, the incidence being about equal in the two sexes. It is commonest between the ages of 15 and 40, when there is a preponderance in the male sex of two or three to one. It is also a fre-

quent terminal malady in the aged of both sexes. It may be doubted whether race has much influence, although in America and in the Rand mines the incidence and mortality among the black races are both high. Pneumonia is met with all over the world, but it is more rife in localities with changeable climate and cold winds. Its seasonal incidence is well marked; it is uncommon in the summer and autumn, and is most prevalent from November to March in this country. Although pneumonia is as a rule endemic and sporadic in its incidence, it is generally admitted that localised epidemics occur. Recent studies of its bacteriology lend support to this view. Urban conditions, defective sanitation, overcrowding and insufficient ventilation all conduce to the incidence of pneumonia. A previous attack of pneumonia is an important predisposing condition, since this disease seems to confer an increased susceptibility, although this may be preceded by a brief period of relative immunity. It is not uncommon to obtain a history of several previous attacks. Although the disease often attacks those in normal robust health, there can be no doubt that debilitating conditions and diseases predispose to it, among them being chronic nephritis, diabetes, over-fatigue, exposure and alcoholic excess.

Exciting causes.—The exciting cause in most cases is the presence of the pneumococcus of Fränkel in one of its more virulent forms. It may be the only pathogenic organism found in the lung lesions and in the sputum, but not infrequently others, such as streptococci, staphylococci or Pfeiffer's bacillus are also present. Occasionally these organisms, and others, such as Friedländer's pneumo-bacillus, the *Bacillus typhosus*, the gonococcus and the *B. pertussis*, cause lobar consolidation; but these conditions should be regarded as varieties of secondary pneumonia, and differentiated from the acute primary condition now under consideration.

The pneumococcus.—The pathogenicity of the pneumococcus has been the subject of an interesting study at the Rockefeller Institute, New York, by Cole, Dochez, Avery and Gillespie. By serological reactions they have separated four types. The organisms of types I., II. and III. are clearly defined and account for about 75 per cent. of the cases of pneumonia investigated. They differ in virulence, type III. producing a more serious form of pneumonia with a high mortality, but fortunately it is the least common form. This organism has a somewhat characteristic morphology and distinctive cultural appearances. It is sometimes described as the *Pneumococcus mucosus*, and is probably identical with the *Streptococcus mucosus* of Schottmüller. Specific agglutinating serums exist for each of these three types. Type IV. is a heterogeneous group of organisms, mostly of low virulence, and no common agglutinating serum exists for them. It is now generally referred to as group IV. They are frequently present in the mouth and saliva of healthy persons, but may cause a mild form of pneumonia with a low mortality, and they are commonly found in pneumococcal lesions in other situations than the lungs. It is probable that other types exist, since F. S. Lister found that among the cases he investigated in South Africa types I and II. were common, but nearly one-third of the cases were associated with one and perhaps two types which were not described in the New York cases.

The American observers have shown that 40 per cent. of contacts with cases of pneumonia due to types I. and II. may harbour the corresponding

organism for an average period of 23 days, and that they may develop pneumonia from it. They have further demonstrated that a convalescent patient may carry pathogenic pneumococci in his mouth for as long as 90 days from the onset of the disease. They have also found pathogenic pneumococci in the dust of rooms in which patients suffering from pneumonia have been nursed, whereas in other rooms only the relatively non-virulent type IV. has been found. The significance of this work is obvious. It confirms the view that pneumonia is an infectious disease, capable of being spread by carriers, by the convalescent patient, and by the dust of rooms.

Although the pneumococcus is the specific exciting cause, its activities are often determined by some other factor, such as chill, exposure, overexertion or injury. The presumption is that these conditions lower the general resistance of the individual, and thus impair the defensive mechanisms. Post-operative pneumonia may be a further instance of this, but doubtless some supposed cases are in reality due to lobar collapse.

Pathology.—The pneumococcus can be found in the blood, in the pulmonary lesions, and elsewhere when complications occur. Recent experimental investigations on animals indicate that the avenue of infection is to the lungs by way of the trachea and bronchi, the blood infection being secondary to the pulmonary lesion. This is in opposition to the view, current till recently, that infection occurred from the mouth or pharynx to the blood and thence to the lungs. Four stages are commonly described in the process by which the lung becomes consolidated and returns to normal, namely, engorgement, red hepatisation, grey hepatisation and resolution.

In the stage of engorgement the affected part of the lung is slightly enlarged, deep red in colour, and heavier than normal, although it still crepitates and floats in water. The pleura over it may be injected and lustreless and may even show early fibrinous exudate. On section, the hyperæmia is obvious and there may be some œdema. On squeezing, frothy, bloodstained fluid exudes. Microscopically, the engorgement of the capillaries, the swelling and partial desquamation of the alveolar epithelium are the chief changes to be noted. In the stage of red hepatisation the affected area becomes completely consolidated, the general aspect on section being remotely similar to liver, hence the name hepatisation. The pleura is now notably inflamed and may be obscured by yellow fibrinous exudate. The hepatised area of lung is larger and much heavier than normal and bears the impress of the ribs upon it. On section, it is seen to be red in colour, solid and completely airless. It does not crepitate and it sinks in water. The lung tissue is found to be more friable than normal. On scraping the cut surface, which has a granular appearance, a reddish fluid is collected, containing small fibrinous plugs, which are practically alveolar casts. Microscopically, the alveoli are occupied by a coagulated exudate rich in fibrin and red blood corpuscles, with scanty leucocytes and a few larger cells derived from the alveolar epithelium. In the stage of grey hepatisation the lung tissue, although still solid, airless and non-crepitant, is greyish in colour, softer in consistence and still more friable. The surface of the section is less granular, and on scraping, a pale yellowish, almost puriform fluid is obtained. Microscopically, the blood vessels are found to be relatively empty, the alveoli are now incompletely filled, the fibrin and red corpuscles have largely disappeared, and the alveoli are occupied by leucocytes and

desquamated alveolar cells. In the stage of resolution, the exudate becomes more liquid and its cellular constituents undergo fatty degeneration. The liquefied exudate is largely absorbed, although expectoration may possibly assist in its removal. The lung returns to its normal spongy state and the alveolar epithelium is replaced. Some pleural thickening or adhesion may, however, result. In very severe and fatal cases, the stage of resolution may be replaced by one of purulent infiltration, in which the lung becomes paler, softer and in places almost diffluent. The scrapings are practically purulent.

Although these four stages are described, it should be remembered that they are not sharply defined from one another, and that they only represent special appearances in a continuous process. Consequently, although the major part of the affected area of lung may be characteristic of any one of them, all four stages may be recognisable, especially in cases of a spreading type. The base is more often affected than other parts, and the right side more than the left, in the ratio of 3 to 2. The unaffected parts of the lung may show some catarrhal bronchitis, or some degree of collateral hyperæmia or œdema. Pleurisy is an integral part of the affection, but it may proceed to serous or purulent effusion. Pericarditis and less frequently acute endocarditis may be found in fatal cases. Pneumococcal meningitis, arthritis and otitis are very occasionally observed. The liver and kidneys may show cloudy swelling, and the spleen is often slightly enlarged and soft. Jaundice may be observed, especially in right-sided cases. The right side of the heart may be engorged and dilated.

Symptoms.—The exact incubation period is not yet established, but it is short, being probably from 1 or 2 days up to a week. The onset is sudden and acute, with chill, shivering or rigor in the majority of cases. In children convulsions take the place of rigors. Vomiting at the onset is not infrequent, occurring in about one-third of the cases. Less commonly the onset is insidious, or is preceded by malaise and catarrhal symptoms. The temperature rises with the rigor, and as a rule a short, dry, irritating cough develops quickly, accompanied by a severe cutting pain on the affected side. The pain often becomes intense, and coughing may cause the patient great distress. The cough is frequently restrained as much as possible, and the breathing is rapid and shallow. By the second or third day the pain becomes less and the cough easier and more effective. Sputum, which at first is scanty, extremely viscid, tenacious and difficult to expectorate, now becomes more abundant, although remaining viscid. In typical cases it is characteristically rusty at this stage, containing mucus, altered red blood corpuscles alveolar epithelium and large numbers of pneumococci. In a few instances a small but definite hæmoptysis occurs. Occasionally the sputum is thinner and of "prune juice" type.

Sleeplessness is often a distressing symptom, especially in the early and late stages. In some cases there are marked cerebral symptoms. Headache at the onset is common. Delirium is frequent, particularly in the asthenic type, in apical cases, and in alcoholics. In the latter it may be violent and is often like delirium tremens. The temperature is usually of high continuous type throughout, reaching 103°, 104° and even 105° F. or more on occasions, especially in the sthenic type. In the asthenic it is often of lower range. Defervescence is by crisis in about 60 per cent. of the cases. Crisis is commoner in the sthenic type, and occurs more often on the odd than on

the even-numbered days of the disease. The most common day for the crisis is the seventh. It is rare before the third or after the ninth day. At the crisis the temperature falls to normal or subnormal in about 12 hours. The patient often sleeps soundly at this time and may sweat profusely; respiration is slower and easier and the pulse-rate falls. On waking, a dramatic change in the condition is usually noticeable. Pain and distress are ameliorated, cough is loose and easy, and the patient feels better, although weak. Looseness of the bowels and free diuresis are not infrequent, constituting the "critical evacuations." The crisis is sometimes preceded by a pseudocrisis, in which a considerable fall of temperature occurs, with little or no improvement in the general condition. A slight post-critical rise of temperature of 1° or 2° F. is sometimes seen, but as a rule the temperature remains subnormal for a few days and slowly returns to normal. The pulse-rate may be slow for a time. Convalescence is generally rapid, although in cases which have had marked delirium, some mental confusion may be present for a day or two. *Defervescence by lysis* is more common in the asthenic type. The temperature remits and may take from 2 to 4 days to reach normal or subnormal levels.

The physical signs vary with the stage of the disease. At first there is some restlessness, but soon the patient assumes a dorsal decubitus, or lies more on the affected side. The cheeks are flushed, often markedly so on the side of the lesion. The eyes are bright, but the expression is one of pain or anxiety. A crop of herpes on the lips is very common. The tongue is thickly coated and white, becoming dry and cracked in bad cases at a later stage. The skin feels dry and pungently hot. The alæ nasi are in action, and in children a puff or grunt accompanies each expiration, while the pause follows inspiration, instead of expiration. The respiration and pulse-rate are increased, the former disproportionately, so that the pulse respiration ratio becomes 3 or even 2 to 1, instead of the normal 4 or 5 to 1.

In the early stage the pulmonary signs are slight. At the most there is lessened movement and diminished vocal fremitus over the affected area, with dubious impairment of note, weak air entry and possibly a few crepitations (indux), or pleural friction sounds, vocal resonance being unaltered. Of these, lessened air entry is probably the most common. Slight hyperresonance of the opposite lung, with harsh breathing, may lead to error in diagnosis as to the side affected.

The signs of consolidation (hepatisation) are generally apparent on the second or third day, except in cases where the disease starts deeply (central pneumonia). There is definite limitation of movement on the affected side, which is, however, slightly increased in size, as can be demonstrated by mensuration. Vocal fremitus is markedly accentuated over the affected area except in massive pneumonia, and friction fremitus may be palpable. The note on percussion is dull, but has not the resistant stony character of that over an effusion. The note above or below the consolidated area is sometimes skodaic. The breath-sounds are tubular, and a few crepitations may be heard, but frequently adventitious sounds are absent. In some cases a friction rub is audible. Bronchophony and pectoriloquy are usually very marked over the consolidated area. The breath-sounds in other parts may be vesicular or harsh, and a few rhonchi may be present. The heart is usually in its normal situation, but is sometimes slightly displaced away

from the affected side. In later stages the signs of dilatation of the right heart may become apparent.

During resolution, which begins after the crisis or during lysis, the tubular character of the breath-sounds disappears, and they become at first bronchial and later harsh or vesicular. Coarse moist sounds, known as redux crepitations, are heard both with inspiration and with expiration. The dullness gradually diminishes, and the voice-sounds return to normal. In basal cases, in which the diaphragmatic pleura is involved early, there may be pain, tenderness and abdominal rigidity simulating peritonitis, perforation or appendicitis. X-ray examination is usually not practicable, and in any case should only be employed where diagnosis is in doubt. It is rare for the spleen to be sufficiently enlarged to be palpable. The blood shows a leucocytosis up to 40,000 or 50,000 per c.mm. in sthenic infections. Blood culture may yield pneumococci, although this was successful in only 30 per cent. of cases at the Rockefeller Institute. The urine is diminished in quantity, and there is a great reduction in the sodium chloride excretion until the crisis. Albumin and albumose are frequently found in small quantities in the urine during the febrile stage, and a few granular casts may be present. The uric acid excretion is increased to two or three times the normal, commencing the day before the crisis and generally falling to normal during the ensuing week. This is probably due to disintegration of the exudate in the alveoli, and so forms a measure of resolution, although some authorities maintain that it runs parallel with leucocytosis and not with cell destruction. Palmer has recently shown that an organic acid of unknown nature is excreted in the urine in considerable quantities in many cases of pneumonia with severe intoxication, but estimation of the CO_2 in the plasma shows that the degree of acidosis produced is not great. Pneumococci can sometimes be obtained from the urine at the height of the disease. The blood-pressure usually falls during the course of pneumonia, and according to G. A. Gibson a sudden rise indicates the imminence of some complication, such as delirium, whereas a sudden fall suggests the onset of cardio-vascular paralysis.

The disease does not always follow the typical clinical course, and certain varieties are described:

Apical pneumonia.—The consolidation may be limited to the apex or upper lobe of one lung. This is more common in children, the aged and alcoholics, and is often associated with marked cerebral symptoms.

Creeping pneumonia (*Migratory or wandering pneumonia*).—The consolidation spreads irregularly in one or both lungs. Partial resolution occurs, but there is no true crisis, and as successive portions of the lungs become involved the temperature exacerbates, eventually falling by lysis in cases that recover.

Central pneumonia.—The symptoms and appearance of the patient may suggest lobar pneumonia, and yet no abnormal signs can be detected in the lungs. In some of these cases there may be a deep-seated consolidation, whose presence can be revealed by X-rays. A typical crisis may occur.

Massive pneumonia.—The bronchi, as well as the alveoli, may be filled with a fibrinous exudate. It is a rare condition and leads to difficulty in diagnosis, as the physical signs resemble those of pleurisy with effusion, vocal fremitus being diminished and breath-sounds weak or absent. The heart, however, is not displaced, or only slightly so.

Post-operative pneumonia.—It is probable that a large proportion of cases that were formerly described as post-operative pneumonia were in reality instances of massive lobar collapse (see p. 1068). At times a pneumococcal pneumonia follows the administration of a general anæsthetic, but it does not present any peculiar features.

Traumatic pneumonia.—The fact that an injury to the chest may be followed after a short interval by a pneumonic process in the lungs has long been recognised. The condition was called "contusional pneumonia" by Litten in 1881. Külbs showed later that the changes in the lungs in dogs following local trauma were mainly hæmorrhagic, and that the lung opposite to the side injured may be affected by "contre-coup." In the recorded cases of traumatic pneumonia two types can be differentiated—(1) those with hæmorrhagic lesions only, and (2) those showing hæmorrhagic foci with a superimposed bacterial infection. The former recover rapidly, the latter often lead to a fatal issue.

Pneumonia in children.—This often presents certain characteristic features. There is rarely any sputum, the expectoration being swallowed. Convulsions at the onset are common. The lesion is often at the apex of the lung. Cerebral symptoms are frequent, and empyema or otitis media often occurs as a complication.

Pneumonia in the aged.—This occurs frequently as a terminal infection, often leading to a rapid and comparatively painless death. The onset may be insidious and the physical signs slight.

In *pneumonia in the insane*, lobar consolidation is often observed, without marked constitutional disturbance other than fever.

Secondary pneumonia.—Lobar pneumonia may develop during the course of certain acute specific fevers, notably enteric, typhus and plague. It is doubtful whether a true lobar pneumonia occurs in influenza, the condition to which the name influenzal pneumonia is applied being due to coalescing lobular pneumonia with hæmorrhagic extravasations.

Complications.—Delayed resolution not infrequently occurs, the signs of consolidation persisting for weeks instead of days. Frequent careful examinations should be made and possible errors in diagnosis considered, such as the presence of tuberculosis or empyema. Gangrene and abscess are rare but recognised complications.

Dry pleurisy is an invariable accompaniment when the consolidation reaches the surface, and in a considerable proportion of cases slight serous effusion occurs. This occasionally becomes frankly purulent and an empyema results. Bronchitis is common and may be due to a complicating secondary infection. Cardiac failure is a grave occurrence and can be recognised by increasing cyanosis, lividity and dyspnœa, with signs of enlargement of the right heart and with enfeeblement of the heart-sounds. Pericarditis is not very uncommon and is a serious complication. It may be dry or proceed to serous or purulent effusion. Acute endocarditis, sometimes of infective type, occurs. Abdominal complications are comparatively rare. They include pneumococcal peritonitis, colitis and nephritis. Acute dilatation of the stomach occurs in rare cases, and is usually rapidly fatal. Meteorism is more common and, although serious, is more amenable to treatment. Jaundice, due to catarrh of the bile-ducts, or to hæmolysis, is sometimes present.

Pneumococcal meningitis supervenes in rare cases, and is invariably

fatal. Delirium has already been referred to, and is especially serious when occurring in alcoholics. Peripheral neuritis has been described, but is very uncommon. Otitis media and arthritis, proceeding sometimes to suppuration, occur as complications, both being commoner in children. A parotitis sometimes going on to suppuration, is an occasional and serious complication, especially in old people. During convalescence, thrombosis of the veins of the legs may occur in rare instances.

Sequelæ of lobar pneumonia are uncommon. Perhaps the most remarkable is the liability to subsequent attacks. Some permanent pleural thickening or adhesion may occur, and after an empyema the usual sequelæ may result. Pulmonary fibrosis (chronic interstitial pneumonia) is rare, especially in comparison with its frequency after broncho-pneumonia; this may lead to bronchiectasis.

Course.—The course depends on the type and virulence of the infection and on the resistance of the patient. In a typical sthenic case, consolidation is well established by the second or third day, defervescence by crisis occurs usually on the seventh day, signs of resolution become apparent a day later, and all signs clear up within 14 days of the onset. In asthenic cases the course is less typical and often prolonged to 9 or 10 days, defervescence occurring by lysis. In fatal cases, death commonly occurs between the fourth and tenth days, although severe cases may prove fatal as early as the first or second day. After the tenth day a fatal result is generally due to complications. An abortive course is described, in which typical symptoms occur with slight or indefinite signs, the temperature falling by crisis within 36 hours, followed by rapid recovery. This group includes the "maladie de Woillez." It is difficult in many instances to establish the true causation of such cases.

Diagnosis.—When the disease is well established and the history is available, diagnosis is as a rule easy. To prove the pneumococcal origin, sputum examination, lung puncture, or blood or urine culture is necessary. It would seem probable that in the future the investigation of serum reactions will be necessary to establish the type of pneumococcus concerned as an essential to specific treatment.

At the onset, especially before the signs of consolidation develop, difficulties in diagnosis often occur. The initial rigor or convulsion with vomiting may suggest scarlet fever. In children, especially those with early apical pneumonia, headache, vomiting, convulsions, head retraction, squint and even slight Kernig's sign may lead to an erroneous diagnosis of meningitis. Pain in the side and cough, the altered pulse respiration ratio, and the presence even of slight abnormal physical signs in the chest, usually suffice in both instances to suggest the correct explanation.

Occasionally the onset of pneumonia may simulate an acute abdominal condition, such as appendicitis or perforation of a gastric ulcer, owing to referred abdominal pain, sometimes with rigidity. The diagnosis may be very difficult, and laparotomy has not infrequently been carried out in error. The history, the pulse respiration ratio, the absence of tenderness on rectal examination, and the presence of pulmonary signs usually enable a correct decision to be made.

Influenza may start acutely and simulate pneumonia, but the distribution of the signs and the examination of the sputum generally serve to dis-

tinguish between them. Typhoid fever less often gives rise to difficulty, but some cases of pneumonia pass quickly into a typhoid state, while some cases of typhoid fever develop consolidation in the first week.

When consolidation is well established, the chief conditions to be differentiated are—(1) Broncho-pneumonia. The slower onset, the more prolonged course, the bilateral patchy physical signs, and the marked predominance of the bronchitic manifestations usually suffice to differentiate this group of conditions. (2) Secondary pneumonias, such as those in plague, typhoid fever, and influenza,can be diagnosed only from the history, the associated symptoms and signs, and from the bacteriological examinations. (3) Friedländer's pneumonia is rare. Its course is short, its prognosis grave, and it can only be recognised by bacteriological investigation. (4) Massive collapse. The diagnosis of this condition and its differentiation from pneumonia are discussed on pp. 1068, 1069. (5) Acute pneumonic tuberculosis. The onset and early signs may be identical with those of pneumonia. The persistence of the fever, its tendency to become remittent or intermittent, and the occurrence of night sweats should suggest looking for tubercle bacilli in the sputum. (6) Pleural effusion and empyema. Differentiation is generally easy, except in cases of massive pneumonia. Investigation of the position of the cardiac impulse, and of vocal fremitus and resonance, affords the most valuable aid. Grocco's triangle may also assist. In some cases the diagnosis can only be established by the exploring needle. (7) Infarction of the lung in cardiac disease, causing pain, cough, blood-stained expectoration, and dyspnœa, may simulate pneumonia. The absence of fever, the presence of the cardiac condition and the localised physical signs are generally characteristic. (8) Acute œdema of the lung, especially in mitral stenosis, may suggest pneumonia. Fever is generally absent, the sputum is typical, and the primary cause may be apparent. An attack of paroxysmal tachycardia may give rise to difficulty, when it leads to dullness and crepitations at the bases, but careful examination should establish the very rapid action of the heart and the evidence of venous engorgement in other parts.

Prognosis.—Lobar pneumonia is a serious disease, with a high mortality rate. This is profoundly influenced by age. It is but little fatal in childhood, except in the first years of life. After the age of 60, it may show a mortality of 60 to 80 per cent. The New York investigations at the Rockefeller Institute have demonstrated the importance of the type of pneumococcus in prognosis; thus, it was found that the mortality of cases with types I. and II. was about 25 to 30 per cent., of those with type III. 50 per cent., and of those with type IV. only 12 per cent.

The previous habits and history of the patient influence prognosis considerably; chronic alcoholism doubles the risk of a fatal issue, and the outlook is grave in patients who are the subjects of diabetes, chronic cardio-vascular disease, nephritis, marked debility or obesity. Unfavourable indications during the course of the disease are profound toxæmia, a pulse-rate persistently 130 or more, a blood-pressure in millimetres of mercury lower than the pulse-rate, and a temperature remaining at 105° F. or over for several days. Absence of the usual leucocytosis is generally of sinister import. Dilatation of the right heart, with cyanosis progressing to lividity, is most grave. Modern statistics confirm the traditional view that labial herpes is a favourable prognostic sign.

Of complications, meningitis is invariably fatal, while infective endocarditis is extremely grave. Cases with abscess or gangrene, although serious, sometimes recover, especially if operative treatment is practicable. The prognosis of those with pericarditis is serious, but not uniformly unfavourable. Cases with bilateral empyemata show a high mortality. Late delirium is a very serious indication.

Treatment.—*Prophylactic.*—Prophylactic vaccination has been used with success by Lister in South Africa. He employed a triple vaccine, made from three types, and gave 6000 millions of each. Three injections were made at weekly intervals.

When a case has occurred, all contacts should have a throat examination, and if virulent pneumococci are found a suitable antiseptic mouth wash should be used. Quinine preparations have a high pneumococcicidal action. The best is optochin or ethyl-hydrocupreine hydrochloride, or else quinine bisulphate in a dilution of 1 in 10,000 with liquor thymolis diluted 1 in 10. The room in which the patient has developed the disease should be disinfected afterwards. If possible, no case of pneumonia should be nursed in a general ward of a hospital, and the doctor and nurse in attendance should wear gauze masks. All sputum should be disinfected. The patient should lie in a narrow bed away from a wall to facilitate nursing. The room should be well ventilated, and the temperature maintained at 60° to 65° F. Treatment in the open air is not advisable, except in very mild weather. Two important factors are rest and sleep. The patient should, therefore, be disturbed as little as possible by the examination of the physician and by the attentions of the nurse. He should not, however, be allowed to lie flat all the time, to avoid basal congestion. The diet should be restricted to fluids and semi-solids, eggs, milk, meat extracts and the various invalid foods being given up to 2 or 3 pints in the 24 hours. Too much milk should be avoided, as it is liable in adults to cause indigestion and flatulence. The irritating cough, which induces such intense pain, should be checked by a sedative linctus, or by lozenges, but it may be necessary to inject $\frac{1}{12}$th grain heroin, or even $\frac{1}{6}$th grain morphine to relieve pain and to induce sleep in the early stage. Local applications to the chest help to relieve pain. Usually hot linseed poultices to the back and side are employed, but antiphlogistine applied on lint does not require such frequent changing and disturbs the patient less. A pneumonia jacket is preferred by some, by others the ice poultice or ice-bag is found very soothing. A dose of calomel should be given at the onset, and the bowels should be opened daily, either by a laxative or by a small soap enema.

Medicinal treatment has probably but little influence on the course of the disease, and should be in the main symptomatic. In the early stage, a simple saline diaphoretic mixture may give comfort by promoting the action of the skin and by rendering the sputum less viscid. For this purpose liq. ammon. acetat. ℥ij, potass. citrat. grs. xx, syrup. aurantii ℥i and water to the ounce, may be given every 4 to 6 hours. The use of depressant drugs, such as tartar emetic, aconite, or pilocarpine, although formerly recommended, is now generally discarded. Expectorants such as ammonium carbonate or iodide of potassium in doses of 3 to 5 grains are often recommended after the second day, but are of doubtful utility. Potassium iodide in doses of 5 to 10 grains, with creosote 5 minims, in a mixture, had a recent vogue, but it

may be doubted whether its beneficial effects are commensurate with its unpleasantness and its bad influence on appetite and digestion.

Cardiac embarrassment and failure are the conditions requiring the most active treatment in this disease. A careful watch should be kept upon the colour of the patient, the condition of the pulse and the size of the heart. Digitalis, in doses of 5 to 15 minims of the tincture, may be added to the mixture, or given with brandy. Camphor grs. xx, in sterile olive oil ℥ij, may be given hypodermically every other day, or smaller doses may be given once or twice daily. If signs of acute heart failure occur, strophanthin gr. $\frac{1}{200}$ may be given intravenously, or digitalin gr. $\frac{1}{100}$ with strychnine sulphate or hydrochloride gr. $\frac{1}{60}$ to $\frac{1}{30}$ hypodermically. The latter may be repeated in from 4 to 6 hours if necessary. Strychnine may be given in doses of gr. $\frac{1}{60}$ every 4 hours, and is often very useful. Other cardiac tonics which may be employed hypodermically are pituitrin $\frac{1}{2}$ to 1 c.c., or adrenalin 5 to 10 minims of 1 in 1000 solution. Alcohol is often useful; it should not be given too early in the attack, but where there are indications of incipient cardiac weakness 4 to 6 ounces daily may be given, and this even to alcoholics.

Oxygen inhalations may be helpful in any case where there is distress or cyanosis. It should be warmed, and may be bubbled through alcohol or administered more economically through a nasal tube. Venesection to the extent of 10 or 12 ounces is of some value if there is lividity from right-sided engorgement, especially in sthenic cases. As a rule it is best not to interfere with the temperature by antipyretic drugs and measures unless it remains over 104° F., when sponging, either tepid or cold, should be tried.

Sleeplessness is a frequent and distressing symptom and requires treatment. In the early stages 10 grs. of Dover's powder or an injection of morphine or heroin are usually effective. In the later stages, morphine should only be given with care, and then in association with atropine gr. $\frac{1}{200}$ to $\frac{1}{100}$ and strychnine gr. $\frac{1}{60}$ to $\frac{1}{30}$. Paraldehyde ℥ij with syrup of orange in 2 ounces of water, is safe and often effective. Chloralamide grs. xx to xxx, with bromides may be tried. In cases with delirium an ice-cap should be applied to the head, and the patient sponged with tepid water. Morphine may be necessary, and in severe cases hyoscine, gr. $\frac{1}{100}$, may be injected; but the latter is a dangerous drug and the patient's condition should be watched, and strychnine administered if necessary. Tympanites, when present, is distressing and exhausting, and should be treated by passing a rectal tube or by the administration of an enema of asafœtida or a turpentine wash-out.

Specific.—Various serums have been introduced and employed with varying success. The researches at the Rockefeller Institute afford the explanation of the discordant results, and promise to put this matter on a scientific and practical basis. So far an effective serum seems to have been obtained only for type I., although serum has been prepared for type II. but is less effective. At present antiserums have not been obtained for type III. and group IV. Consequently, if it is proposed to employ serum treatment, it is necessary first to determine the type of pneumococcus concerned by serological tests. The patient's sensitiveness to the serum must then be determined by an intradermic injection of 0·02 c.c. of diluted serum (diluted $\frac{1}{10}$ with saline), and if he shows a reaction he must be desensitised by small injections to prevent anaphylaxis. The serum is then diluted with an equal volume of warm sterile saline and 10 to 15 c.c. injected intravenously

at the rate of 1 c.c. a minute, followed by 90 c.c. more during the next quarter of an hour. This dose is repeated every 8 hours until improvement occurs.

Vaccine treatment is recommended by some, but the results are generally disappointing during the acute stage. A common method is to give 20 millions of a stock pneumococcus vaccine, and then to use an autogenous one as soon as it can be made. Sensitised and detoxicated vaccines have also been prepared. Vaccines seem to be more valuable in cases of delayed resolution.

BRONCHO-PNEUMONIA

Synonyms.—Lobular Pneumonia; Catarrhal Pneumonia; Capillary Bronchitis.

Pulmonary consolidation of lobular distribution occurs in a variety of conditions which have little else in common. A satisfactory classification is at present difficult. The term capillary bronchitis is misleading and should be regarded as obsolete, since any inflammatory condition affecting the finer bronchi is invariably associated with alveolar changes. For convenience the following varieties of broncho-pneumonia may be described: (1) Primary. (2) Secondary. (3) Aspiration or deglutition. (4) Tuberculous.

1. Primary Broncho-pneumonia

Ætiology.—This form almost invariably affects infants under 2 years of age, in whom a lobular pneumonia seems sometimes to occur under conditions which would induce lobar pneumonia in older children or adults. It occurs equally in the two sexes, and is commoner in the winter and the spring. Rickets, malnutrition and debility are predisposing conditions, but it sometimes develops in healthy robust infants after exposure or chill. The pneumococcus is the organism usually found, either alone or in association with others, such as streptococci, staphylococci, the *Micrococcus catarrhalis* or Friedländer's pneumo-bacillus.

Pathology.—Widely scattered patches of consolidation are found in one or both lungs. These may be small and separated by areas of collapse or emphysema. Occasionally they are almost confluent, and at first sight appear like lobar pneumonia, constituting the pseudo-lobar form; but careful observation shows that the distribution is lobular and that zones of incomplete consolidation or of normal lung tissue separate the solid areas. If the process reaches the surface some degree of pleurisy is present, although this is less than in lobar pneumonia.

Microscopically, the appearances approximate to those of the lobar form; the alveoli are found to be filled with exudate, in which leucocytes and desquamated epithelial cells are present, together with some fibrin and red blood corpuscles. Catarrhal changes are also present in the bronchi.

Symptoms.—The onset is acute, with vomiting and chill, or convulsion, as in lobar pneumonia. Cough, cyanosis and dyspnœa develop rapidly. There is no expectoration, since infants and young children swallow the sputum. Cerebral symptoms simulating meningitis are common. The

temperature rises quickly to 103°, 104° F., or higher, and the range is of the same character as in lobar pneumonia. Defervescence by crisis is the rule.

The physical signs are variable. In cases with widespread consolidation they are very similar to those of lobar pneumonia, with dullness, tubular breathing, increased voice-sounds and crepitations. In other cases, although the aspect of the infant appears characteristic of pneumonia, with rapid breathing, cyanosis, reversed rhythm of inspiration and expiration, sucking in of the lower ribs and dilatation of the alæ nasi, the signs are more scattered. Tubular breathing and increased voice-sounds may only be heard in localised patches, especially in the lower lobes. Crepitations are commonly present, and rhonchi may be audible over both lungs.

Complications and Sequelæ.—These are similar to those of lobar pneumonia.

Course.—This is usually short, the temperature falling by crisis in from 3 to 7 days, but it may be more prolonged and be suggestive of tuberculosis, or some other form of secondary bronchitis.

Diagnosis.—Primary broncho-pneumonia has to be distinguished from the lobar form, to which ætiologically and pathologically it is so closely related. The acute onset without previous respiratory symptoms will suggest its primary character, while the patchy distribution of the signs generally suffices to establish its lobular distribution. In pseudo-lobar forms, this differentiation may be almost impossible during life. The cerebral symptoms at the onset, and the early absence of pulmonary signs may give rise to difficulty, as in the first stage of lobar pneumonia.

Prognosis.—The prognosis of primary broncho-pneumonia is generally favourable, except in very young or debilitated infants.

Treatment.—This is practically identical with that of secondary broncho-pneumonia in children.

2. Secondary Broncho-pneumonia

In this condition there is inflammation of the bronchi, spreading down to and involving the alveoli. It is generally a catarrhal process, but may go on to septic or suppurative manifestations.

Ætiology.—A secondary broncho-pneumonia may occur at any age, but is much more common in early and advanced life. It is equal in its incidence in the two sexes. It frequently occurs as a complication of measles, whooping-cough and influenza, less commonly in cases of diphtheria, scarlet fever, plague and the enteric group. A bronchitis starting in the larger tubes may spread downwards to the alveoli. Broncho-pneumonia may develop during the course of acute gastro-enteritis. A secondary broncho-pneumonia occurs as a terminal infection in many old and debilitated persons and in those with chronic wasting or cachectic diseases, and also in chronic cardio-vascular conditions, chronic renal disease and in many progressive nerve degenerations. Any septic process may produce a metastatic broncho-pneumonia. This occurs in association with otitis media, suppurative processes about the appendix or Fallopian tubes, and cerebral abscess.

Bacteriology.—This is, as might be expected, very varied. Streptococci are frequently present, generally associated with other organisms, such as the pneumococcus, Pfeiffer's bacillus, staphylococci and those found in

catarrhal conditions of the upper air-passages. The *B. pertussis* may be found in cases associated with whooping-cough, the *B. pestis* in plague, and occasionally the *B. diphtheriæ* in diphtheritic broncho-pneumonia. The importance of Friedländer's *B. pneumoniæ* was formerly over-estimated in this connection.

Pathology.—When, from any of the above-mentioned causes, an inflammatory process reaches the finer bronchi, the alveoli become affected in three different ways. Owing to the blocking of the bronchi by secretion or exudate, small areas of collapse of lobular distribution are produced. The inflammatory process extends into some or all of these, and areas of lobular consolidation result. Not infrequently the adjacent groups of alveoli become distended and are thus in a condition of acute emphysema. The lungs are normal in size or slightly enlarged. The surface presents a somewhat uneven, mottled appearance. There are small projecting patches of firmer consistence and reddish-grey colour, due to the consolidated lobules. Adjacent areas may be depressed and slaty blue, from lobular collapse, while the intervening lung tissue is normal or pinkish and emphysematous. There may be dimness or slight roughening of the pleura where the consolidated areas reach the surface, but serous or purulent effusion is uncommon. On section, the lung is found to be congested and sometimes œdematous, especially at the bases, while the bronchi exude pus or muco-pus from their cut ends. The reddish-grey areas of consolidation are found to vary in size from a pin's head to a hazel nut. They are generally more abundant in the lower lobes, especially posteriorly. The consolidated and collapsed areas both sink in water, and do not crepitate. There is often some peribronchitis, and the bronchial glands are usually enlarged. Microscopically, the finer bronchi and the consolidated alveoli are found to be filled with an exudate containing large numbers of leucocytes and desquamated, proliferating epithelial cells, but in which few red blood corpuscles and little or no fibrin are found.

In the very acute condition to which the name capillary bronchitis was formerly applied, consolidation may not be apparent, but microscopical examination invariably demonstrates the involvement of the alveoli. In influenzal broncho-pneumonia the pathological changes probably commence as an exudative bronchiolitis, associated with capillary hæmorrhages. Secondary infections are probably responsible for the consecutive broncho-pneumonic process, which results in flooding of the alveoli with an exudate containing red cells, but little or no fibrin.

Symptoms.—In the cases ensuing on bronchitis in infants or old people (formerly called capillary bronchitis), initial symptoms may be slight, and simply those of ordinary bronchitis, namely, malaise, slight fever and cough, with or without expectoration. The implication of the finer tubes and alveoli is usually marked by a rapid rise of temperature, great prostration, quick breathing and an irritating, persistent and often ineffective cough. In children, the alæ nasi work, the lower ribs are sucked in, and the pneumonic type of breathing develops. The patient becomes cyanosed, the pulse is rapid, 120 or more, and the respirations 50 or 60 per minute. The physical signs are in general indistinguishable from those of primary broncho-pneumonia, but breath sounds are often harsh and puerile, while tubular breathing is not heard, or only in very localised areas. In old people, cyanosis, rest-

lessness and delirium may occur, and later the cough may become less frequent, the patient being drowsy and tending to sink down in the bed, whereas previously there was orthopnœa. These symptoms are ominous and indicate failure of the respiratory centre.

The physical signs are often those of bronchitis, harsh or weak inspiration and prolonged expiration, sibilant and sonorous rhonchi and crepitations or crepitant râles especially at the bases. Patches of tubular breathing with increased voice sounds may develop but are not always present.

In other forms of secondary broncho-pneumonia similar symptoms and signs develop more insidiously in the course of the primary disease. Broncho-pneumonia should be suspected when cough, expectoration and dyspnœa, together with a remittent type of temperature, develop in the course of an acute specific fever or other severe illness. In all forms, anorexia is common, the mouth and tongue become dry, and thirst is complained of. The urine presents the usual high-coloured, concentrated character of febrile conditions. It is often diminished in quantity, may contain a small quantity of albumin, and not infrequently deposits urates.

Complications and Sequelæ.—These are relatively infrequent. Pleurisy may proceed to effusion, and when this occurs it is often purulent. Abscess and gangrene are rare, but develop rather more frequently than after lobar pneumonia. Other complications, such as pericarditis, endocarditis, meningitis and nephritis, are probably due to blood-borne metastases.

The most important sequel is pulmonary fibrosis, which is often the origin of bronchiectasis later in life. Pulmonary tuberculosis is frequently described as a sequel, especially after measles, and may be due to inflammatory changes in the bronchial glands activating a quiescent tuberculous deposit there. In many cases of tuberculosis described as following on broncho-pneumonia, it is more probable that the original lung affection was tuberculous.

Course.—Secondary broncho-pneumonia generally has a longer course than either the primary form or the lobar variety of pneumonia. The fever often persists in remittent type for two or three weeks, and sometimes even for two or three months, although in this case tuberculosis should be suspected. The decline is almost always by lysis. Convalescence is often slow, the patient being left thin, weak, anæmic and debilitated.

Diagnosis.—The development of pulmonary symptoms, and of more or less characteristic physical signs in the course of measles, whooping-cough or one of the other diseases mentioned above, usually renders the diagnosis easy. Difficulty may arise in regard to tuberculosis, which in one form produces lobular pneumonic lesions with symptoms and signs indistinguishable from other varieties of secondary broncho-pneumonia. In any case where the fever lasts more than three weeks, or where the signs show no tendency to resolve or are chiefly apical, tuberculosis should be suspected. Unfortunately in children sputum is rarely available. An attempt is sometimes made to obtain it on gauze held in forceps, after exciting cough by touching the fauces. The mucus in the fauces may also be examined for tubercle bacilli. The diagnosis may, however, remain doubtful, until signs of softening become established.

Bronchitis rarely gives rise to difficulty. The fever is usually less high, and of shorter duration, while the physical signs are different, signs of consolidation being entirely absent. Hypostatic pneumonia may have to be

considered. There is usually some obvious cause for this, such as cardiac disease and failure, or prolonged confinement to bed. The temperature is generally lower and the distribution is lobar.

Pleural effusion and empyema can generally be differentiated by the alteration of vocal fremitus and the displacement of the cardiac impulse. In case of difficulty the exploring syringe enables a distinction to be made.

Prognosis.—The prognosis in secondary pneumonia is serious. Many deaths occur from this complication in the acute specific fevers, particularly with measles and influenza. Even the form following on severe bronchitis is frequently fatal, especially in old people and in wrongly fed or debilitated infants. The development of delirium, of a pulse-rate over 150, of marked cyanosis and dyspnœa are unfavourable. In old people, drowsiness, sinking down in the bed, and cessation of cough are very grave indications.

Treatment.—The treatment is very similar to that of lobar pneumonia, except that stimulant and expectorant drugs may be necessary from the first. At the present time there is practically no difference in the methods of treatment applicable to the primary and secondary forms, although, as the means of specific treatment become more developed, there is hope for the discovery of specialised methods.

The patient must be in bed, and the position should often be changed so as to prevent hypostatic congestion. The room should be well ventilated, but without draughts, and the temperature kept at 65° F. both night and day. In the early stages the air may be moistened by a steam kettle, but the use of a tent is generally to be avoided. Poultices are now less generally employed than formerly, especially for children, and a light pneumonia jacket of Gamgee tissue is usually preferred. The diet should be restricted to fluids and semi-solids, as in pneumonia. Stimulants may be given early if the pulse becomes weak, in doses of 10 drops of brandy every 2 hours to infants, and quantities up to 4 or 6 ounces in the 24 hours to old people. The dry, distressing cough at the onset may be loosened by giving a simple alkaline febrifuge mixture, such as liq. ammon. acetat. ℥ij, pot. citrat. grs. x, sod. bicarb. grs. x, with flavouring agents, such as a syrup of tolu and chloroform water. Later, ammon. carb. and vin. ipecac. may be given, but large doses of expectorants are to be avoided because of their irritant effect on the stomach. Opiates should not be administered except as tinct. camph. co. or possibly Dover's powder in the early stages. In infants they should not be given at all.

When in infants or children, the bronchi are becoming blocked by the secretion within them, as evidenced by increasing dyspnœa, an emetic should be given. For this purpose vin. ipec. or ammon. carb. in emetic doses is the most effective. In old people, ammon. carb. may be given in milk in doses of grs. x two or three times a day, and energetic counter-irritation applied to the bases by means of turpentine stupes, dry cupping or strong liniments.

Strychnine either by the mouth or hypodermically is strongly recommended in cases in which the respiratory centre shows signs of failure. It may be pushed, if necessary, to the point of producing slight muscular twitchings. Camphor injections and cardiac tonics may be given under the same conditions as in lobar pneumonia. The administration of warmed oxygen may give relief to dyspnœa and distress.

In cases in which resolution is delayed the question of vaccine therapy may be considered. It seems sometimes to be of distinct value.

3. Inhalation, Aspiration and Deglutition Broncho-pneumonia

Acute broncho-pneumonic processes may be caused by the inhalation or aspiration of fluid or solid particles, derived from the upper air-passages or from other parts of the lung. To this form the name of aspiration, or inhalation pneumonia is applied. When from any cause food particles are drawn in to the bronchi and broncho-pneumonia results, the condition is referred to as deglutition pneumonia. The resultant processes are similar, and are in effect analogous to those caused by other septic or infected foreign bodies inhaled into the bronchi.

Ætiology.—These conditions may occur at any age, but are more common in adult life. They result from septic processes in the mouth, naso-pharynx, larynx or trachea, and from any morbid state leading to anæsthesia of the pharynx, or to difficulty in deglutition. They occur in association with ulcerating growths of the mouth, tongue, tonsil, pharynx or larynx, and after operations for these conditions or upon the nose and throat, including tracheotomy. Carcinoma of the œsophagus eroding the trachea may be a cause. Diphtheritic or other forms of paralysis, coma from any cause, especially cerebral vascular lesions and uræmia, may lead to the passage of food particles into the air-passages. Other cerebral lesions, such as abscess or tumour and bulbar paralysis, can also produce the same condition. Infected material may be aspirated from diseased to healthy parts of the lung, as in hæmoptysis, abscess, gangrene and bronchiectasis, or after rupture of an empyema into a bronchus.

Pathology.—Any material reaching the air-passages in this manner is certain to be laden with infective micro-organisms, which may induce bronchitis and broncho-pneumonia. Since pyogenic organisms are often present, suppuration is frequent and multiple abscesses result, or even gangrene. If the pleura becomes involved, empyema may develop.

Symptoms.—These are in general similar to those of secondary broncho-pneumonia and are superadded to those of the primary condition. There is generally high temperature, sometimes with rigors, cough and expectoration which is occasionally offensive. It may be mixed with food material and with blood. The physical signs are those of bronchitis and widespread broncho-pneumonia.

Complications and Sequelæ.—These are somewhat similar to those of other inhaled foreign bodies, and comprise abscess, gangrene and empyema.

Course.—The course is generally short, owing to the severity of the process and the gravity of the primary cause. In the comparatively rare cases that recover the course may be severe and protracted.

Prognosis.—From the nature of the primary condition and the intensity of the resulting broncho-pneumonia, this is usually grave.

Treatment.—*Prophylactic.*—The utmost care should be paid to the toilet of the mouth and pharynx in disease of, or operations upon, these parts. In paralysed or unconscious patients it may be necessary to resort to nasal feeding. In hæmoptysis or bronchiectasis the patient should lie rather on the affected side.

The treatment of the developed condition can be only palliative or symptomatic in many cases. In most instances the general treatment is similar to that of secondary broncho-pneumonia.

4. Tuberculous Broncho-pneumonia

This constitutes one form of pulmonary tuberculosis (see Acute Caseous Tuberculosis, p. 1092).

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DISEASES OF THE PLEURA

PLEURISY

Pleurisy or pleuritis is an inflammation of the pleural membrane covering the lung, or of its parietal reflexions.

An ætiological classification, based on the bacteriological findings, would be the most satisfactory one, but is at present impracticable, chiefly owing to the difficulty of establishing the bacteria concerned in many cases. The classification usually adopted depends upon the effects produced. If the process leads only to fibrinous deposit it is described as *dry pleurisy*. If, in addition, much serous fluid is poured out, the condition of *pleurisy with effusion* results, while if pus-formation occurs, the affection is described as *purulent pleurisy or empyema*.

It is, however, important to recognise that, although such a classification is convenient from a clinical standpoint, the three conditions are in reality only stages or degrees in the pleural response to irritative or noxious agents. The form occurring in any given case depends upon the nature of the cause, the extent of the infection and the degree of resistance possessed by the individual affected. Further, pleural inflammations may be primary or secondary to local disease or to blood infection, and they may be acute or chronic in course.

A.—ACUTE DRY PLEURISY. (ACUTE FIBRINOUS OR PLASTIC PLEURISY)

Ætiology.—This affection may be primary or secondary, the latter being much more common. Even in many cases of so-called idiopathic or primary pleurisy, the condition is in reality secondary to latent or unrecognised disease of the lung or adjacent structures.

Primary dry pleurisy.—Predisposing causes include occupation and climate. Exposure to sudden changes of weather or cold winds, and the necessity of remaining in wet or damp clothing, favour its onset. It is commoner in men, particularly in those of poor physique. It may occur at any age, but is most frequently seen between the ages of 20 and 40 years. Chill seems to be common as a determining cause. Formerly this variety was often described as "*pleuritis a frigore*." It is now certain that the great majority of cases

are due to the tubercle bacillus, and that chill or injury is simply concerned in lowering resistance and thus promoting activity of the bacillus. It is possible that some cases may be due to acute rheumatism.

Secondary dry pleurisy.—Dry pleurisy is a frequent complication or concomitant of many diseases of the lungs, notably of pulmonary tuberculosis in any form. It is almost invariably present in lobar pneumonia. It occurs in association with pulmonary collapse, interstitial pulmonary fibrosis, bronchiectasis, abscess, gangrene, infarcts and new growths of the lung. Injuries of the chest-wall, disease of the ribs, chronic nephritis, septicæmia or pyæmia may all be complicated by acute dry pleurisy.

Pathology.—The inflamed area is often localised, but the process may be widespread or even involve the whole pleural surface. Either the visceral or parietal layer may be first affected, but as a rule both become involved. There is at first hyperæmia with exudation of serum into the subpleural connective tissue. The pleura then appears slightly dull or matt, instead of shiny. Further exudation leads to the deposit of fibrin on the roughened pleural surfaces in the form of a thin false membrane, which often presents a rough or even shaggy appearance. This membrane consists of fibrin entangling leucocytes, a few red blood corpuscles and desquamated epithelial cells.

During the process of resolution, localised adhesions commonly form, but this is not invariable, and a patch of thickening without adhesion may be the ultimate result.

Symptoms.—The onset is usually sudden with acute pain in the side, often described by the patient as a "stitch." Occasionally a sense of malaise may precede the development of the pain by a few hours or even days, but this is not the rule. The pain is aggravated by deep inspiration, by coughing or even by movement. Cough is generally an early symptom, and it is characteristically short, dry, ineffective and distressing. The temperature is usually raised, but, as a rule, only to 100° or 101° F., and some cases are practically apyrexial. In secondary pleurisy these symptoms are added to those of the primary condition.

The decubitus is variable. The patient may lie on the affected side, but in some cases this aggravates the pain, and it is more comfortable to lie on the back or slightly turned towards the sound side. There is diminished movement on the affected side, and breathing may be rapid, although not dyspnœic. On palpation, vocal fremitus is unaffected, but local tenderness is sometimes elicited, and occasionally a friction fremitus may be felt. The breath-sounds are generally unaltered, but they may be short or jerky in the neighbourhood of the lesion. The characteristic sign of dry pleurisy is the friction rub. This is typically a creaking, rubbing or leathery sound heard towards the end of inspiration and sometimes at the beginning of expiration. In the early stages there may be fine crepitant friction sounds only at the end of inspiration. These are very similar in character to intrapulmonary crepitations and can only be distinguished by their association with local pain, and by being unaltered by cough. Pleural friction sounds may be localised to a small area, and may not be present with every respiration. They may sometimes be brought out again after disappearance by moving the arm, or by taking a deep breath. The voice-sounds are not altered.

Complications and Sequelæ.—Dry pleurisy may proceed to effusion, or may lead to pleural adhesion, and this in turn may result in interstitial pulmonary fibrosis. The most common sequel is pulmonary tuberculosis, sometimes after an interval of years, the explanation being that the original pleurisy is frequently tuberculous. Aching pain in the side with some dyspnœa may be a temporary sequel of dry pleurisy.

Course.—The temperature usually subsides in 2 or 3 days, the pain in the side and cough disappear, and convalescence is rapid, unless effusion occurs.

Diagnosis.—The differentiation of dry pleurisy from the other causes of pain produced in, or referred to, the chest-wall is not always easy and requires careful observation of the case. The distinction is important, since an erroneous diagnosis of pleurisy may arouse a suspicion of tuberculosis in subsequent febrile diseases. In the conditions comprised in the term pleurodynia, which include fibrositis of the intercostal muscles and membranes, the pain is increased by deep inspiration, by other muscular movements, and by local pressure, but there is no rise of temperature and pleural friction is not present. In intercostal neuralgia, the pain follows the course of the nerve and is often periodic in character. It may be influenced by movement, but is less affected by respiration than that of pleurisy. There may be tenderness and hyperalgesia over the points of exit of the posterior primary, lateral or anterior cutaneous branches of the nerve affected. Similar manifestations may occur at the onset of acute posterior ganglionitis or herpes zoster. Other conditions inducing pain referred to the chest-wall are tumours or aneurysm pressing on the intercostal nerves, malignant disease of the spinal cord or of its membranes, and caries of the vertebræ. Where the pain lasts more than a few days, and no friction is heard, these conditions should be borne in mind.

Occasionally adventitious sounds of extra-pleural origin may give rise to some difficulty. Contraction of the muscles of the chest may cause a muscular "susurrus"; grating sounds may be produced in the shoulder-joint or in the fascial planes of the back muscles. The origin of these sounds can usually be determined by causing the patient to cease breathing while carrying out movements of the shoulder or back muscles. Occasionally true friction sounds may have a cardiac rhythm as well as a respiratory one, when the area of pleura involved is near the pericardium. It is then referred to as pleuro-pericardial friction.

Having established the evidence of dry pleurisy, a careful search should be made for some primary condition before regarding the case as one of simple primary dry pleurisy. Pulmonary tuberculosis, pneumonia, bronchiectasis and the other causes mentioned above should be considered and excluded.

Prognosis.—The immediate prognosis is good, but as has been mentioned already, the condition may be of tuberculous origin, and eventually be followed by active disease of the lung.

Treatment.—The patient should be kept in bed, no matter how mild the attack. The diet should be fluid or semi-fluid, especially if more than a moderate degree of fever occurs. The pain can often be relieved by strapping the affected side. Strips of adhesive plaster are applied from the sternum to the vertebræ, beginning from above and working downwards. Occasion-

ally this fails to afford relief and may even induce dyspnœa. As alternatives, a local application of tincture or ointment of iodine, a mustard leaf, capsicum ointment or small flying blisters may be employed. Leeches may also give relief in severe cases. Sometimes the pain is so intense that a small injection of heroin or morphine is necessary. A dose of Dover's powder is useful in the early stage to ensure a night's rest. The irritative cough is often relieved by strapping, but a sedative linctus or lozenge may be a comfort to the patient. An aperient is usually advisable. As a rule no other drugs are necessary, but in cases suspected to be due to rheumatism, salicylates and alkalis should be administered. Convalescence is usually rapid, but the patient should not be allowed to resume work until fully restored to health, and if a tuberculous origin is suspected prolonged treatment on sanatorium lines should be advised.

Certain localisations of dry pleurisy require separate notice. These are the diaphragmatic and interlobar forms.

Diaphragmatic Acute Dry Pleurisy

Ætiology.—This affection may occur primarily under conditions similar to those causing dry pleurisy in other parts; more commonly it is secondary to pathological changes in the abdomen. Thus hepatic cirrhosis, perihepatitis, perisplenitis, perinephric suppuration or peritonitis may lead to a spread of infection through the diaphragm to the adjacent pleura. It may also occur as a localised variety of secondary dry pleurisy, when the primary lesion is situated near the base of the lungs.

Symptoms.—Pain is usually very severe and may be referred to the shoulder or to the abdomen. The former is caused by nociceptive impulses ascending the phrenic nerve to its origin in the third to the fifth cervical segments of the spinal cord, leading to pain and hyperæsthesia in the cutaneous area of distribution of the fourth cervical root, at the summit of the shoulder. The abdominal pain is in the epigastric and hypochondriac regions, and in addition there is a localised tender spot, known as the "bouton diaphragmatique" of Guéneau de Mussy. This is situated in the subcostal plane, about 2 inches from the mid-line. The diaphragm is nearly motionless on the affected side, and there is often some rigidity of the corresponding upper abdominal muscles. Hiccough may be a noticeable and troublesome symptom. The diaphragm, being nearly fixed in the inspiratory position, may cause a slight downward displacement of the liver if the pleurisy is on the right side. A pleural friction rub is rarely heard, the only abnormal signs commonly present being diminution of air entry, and possibly slight dullness over the corresponding lower lobe of the lung.

Diagnosis.—This is often difficult, owing to the fact that the severity of the symptoms and their localisation frequently suggest the occurrence of some acute abdominal catastrophe such as perforation of a hollow viscus. The abdomen should be most carefully examined in every case. The history, the collapsed state of the patient and the evidence of free gas in the peritoneal cavity in perforation may assist in distinguishing between these conditions.

Treatment.—This is similar to that of simple dry pleurisy elsewhere, save that morphine should be withheld until the diagnosis is conclusively established.

Interlobar Dry Pleurisy

Just as inflammation may be limited to the diaphragmatic portion of the pleura, so the membrane in the cleft between two lobes of the lung may be alone affected. This does not give rise to definite symptoms and signs by which it can be diagnosed during life, though its effects are not infrequently seen in X-ray films. It is frequently discovered on autopsy, but is generally secondary to pulmonary tuberculosis or pneumonia, and there is usually evidence of pleurisy elsewhere. It only assumes clinical importance when followed by effusion, and this condition is considered later.

B.—CHRONIC DRY PLEURISY

Under this heading a variety of conditions are included. Strictly it should be restricted to those rare cases, probably usually tuberculous in origin, in which the signs of dry pleurisy persist for long periods, or recur at frequent intervals. In such cases coarse dry friction may be heard over large areas of one lung, often with little or no accompanying pain.

Pleural adhesion and thickening are usually included in the group of chronic dry pleurisies. There may be no symptoms, or at most slight dyspnœa on exertion, with aching or pain on straining, or on lifting weights. Signs suggesting adhesion are local flattening and limitation of movement of the chest-wall. Litten's sign is also absent or diminished when the adhesion is basic, that is, the shadow cast by the movement of the diaphragm, best seen in the region of the seventh and eighth ribs in the anterior and mid-axillary lines, is not present or is much restricted. The vocal fremitus may be diminished and the percussion note impaired. The breath-sounds are often slightly weaker, and the voice-sounds may be diminished over the area where the thickening or adhesion exists.

Chronic diaphragmatic pleurisy or adhesion may give rise to a group of symptoms simulating chronic gastric ulcer. There is pain in the hypochondrium extending through to the back and aggravated by food. A radiogram may be of value in demonstrating limitation of movement of one cupola of the diaphragm, together with an angularity due to alteration of its normal contour. Investigation of the gastric functions may also prove of value in diagnosis.

The treatment of chronic dry pleurisy is mainly symptomatic.

C.—PLEURISY WITH EFFUSION

Many cases of pleurisy, possibly the majority, proceed to effusion. The effusion is usually serous in character, but may be hæmorrhagic. Inflammatory effusions must be distinguished from passive transudates, which will be considered separately under the heading of hydrothorax.

Sero-fibrinous Pleurisy

Ætiology.—This is in the main identical with that of dry pleurisy, of which it is, in effect, a later stage. It has now been established that the

majority of cases of sero-fibrinous pleurisy are due to the tubercle bacillus. The evidence on which this conclusion has been arrived at is—(1) the subsequent history of the cases shows that a considerable proportion develop active lung signs within 5 years; (2) the cytological and bacteriological examination of the exudate; (3) post-mortem examination of fatal cases; (4) the results of tuberculin reactions.

Other conditions which may give rise to serous effusions are lobar and lobular pneumonia, pulmonary infarcts and new growth. It may also occur in the course of generalised infections such as the enteric group, acute rheumatism, and septicæmia due to streptococci or staphylococci. In most of these conditions the exudate often becomes purulent. Inflammatory serous effusion may also occur as a complication of severe anæmias, leukæmia, chronic nephritis, injury to the chest-wall and inflammatory conditions below the diaphragm or in the pericardium. It is also a common feature of polyorrhomenitis.

Pathology.—The affection commences with dry pleurisy spreading over the visceral and parietal pleura, the fibrinous exudate soon forming a thick rough layer on the surface. Further exudation of fluid occurs and accumulates in the pleural cavity, the lung collapsing *pari passu* to accommodate it. Owing to the hilar attachment of the lung, it retracts upwards and inwards, allowing the fluid to accumulate at the bases and in the axillary region, where it reaches its highest level, unless previously existing adhesions prevent it. The lung retracts in this way owing to its elasticity, until the pleural negative pressure is completely abolished. In like manner the mediastinal contents, including the heart, are displaced away from the affected side. If fluid continues to be effused after the lung has retracted to the full extent, and after the negative pressure has become abolished, a positive pressure is produced. The lung is now compressed, and the diaphragm with the liver and spleen are pushed down, while the mediastinal structures are now displaced further towards the sound side. In long-standing cases, the lung may undergo the change known as carnification, as the result of the compression apneumatosis. The lung appears dark red or slaty grey in colour, is firm, airless and heavier than water. If old adhesions are present, the effused fluid may be loculated and the collapse of the lung may be only partial.

If there is much positive pressure collateral hyperæmia of the sound lung may result and progress to œdema. The fluid in the pleural cavity is pale and clear; it often coagulates after withdrawal. Its characters are further described on page 1146. The quantity may amount to as much as 5 or 6 pints.

Symptoms.—The onset is usually similar to that of dry pleurisy, but the constitutional symptoms are often more marked. There may be an initial rigor, but as a rule pain and dry cough are the earliest symptoms. The fever is of moderate degree, although it may reach 103° F. or more. When effusion develops the pain is often relieved owing to the separation of the inflamed pleural surfaces. If a large quantity of fluid is poured out rapidly, distress of another kind becomes apparent, namely dyspnœa caused by the mechanical effects of the fluid, collapsing the lung and dislocating the mediastinum. In more slowly developing effusions there may be little or no dyspnœa, except on exertion. Expectoration is not common, unless there is co-existent pulmonary disease, or unless œdema of the sound lung develops.

The patient often lies on the affected side or may be propped up in bed. Cyanosis is not a marked feature even in large effusions, unless there is collateral hyperæmia of the sound side. There is generally some prominence on the side of the effusion, but the intercostal spaces are rarely bulged. Movement is restricted or absent in the lower part of the chest on the affected side, although with a moderate effusion the apical region may still expand. The cardiac pulsations may be seen in an abnormal position, the impulse being displaced away from the side of the fluid. In left-sided effusions, the pulsation may be most marked in the fourth space on the right side as far out as the nipple line. On palpation, the position of the impulse should be verified, and then the amount of chest movement and the character of the vocal fremitus determined. The latter is diminished or completely absent over an effusion of moderate or large size, although it may be obtained over the area where the collapsed or relaxed lung is in contact with the chest-wall. The percussion note over the fluid is one of stony dullness, and the sense of resistance is greatly increased. The exact limits of this area of dullness should be determined with the patient sitting up and recumbent. With moderate effusions the upper level is usually found to assume a curved line, with the summit in the mid-axilla; this is known as the S-shaped curve of Ellis or Damoiseau's line. In the recumbent position, a change in the level of this line may be observed particularly in the front of the chest and in the axilla. This shifting dullness forms one of the pathognomonic signs of fluid, but it is not always easy to demonstrate. It is much more apparent in cases of pyo-pneumothorax. In large effusions, the dullness may extend up to the level of the clavicle and reach across the mid-line of the sternum; moreover, in left-sided effusions it blends with the cardiac dullness, and the area of gastric resonance, known as Traube's space, may be encroached on or obliterated. The relaxed lung above the effusion in front often yields a skodaic note, which becomes dull if the quantity of fluid increases. At the back there is a triangular area of relative or moderate dullness above the stony dull area of fluid. This is known as Garland's dull triangle. It also corresponds with the relaxed or collapsed lung. At the extreme base on the contralateral side there is often a small area of dullness known as Grocco's triangle. The apex is usually at the vertebral column, about the upper level of the effusion, the base extends outwards at the lower margin of the lung for 1 or 2 inches. This paravertebral dull area is believed to be due to mediastinal displacement by the effusion. Elsewhere over the sound lung the note may be slightly hyper-resonant. The area of deep cardiac dullness should be carefully marked out. In left-sided effusions it is displaced to the right and extends beyond the sternum in the third and fourth spaces, even to the nipple line or beyond it. In right-sided effusions, the displacement may be very obvious, the left margin of the dullness extending as far out as the left mid-axillary line. The auscultatory signs are very variable, and much less characteristic than those obtained by palpation and percussion. In some cases, the breath-sounds over the dull area are distant and weak or even absent, in others they are loud and bronchial or tubular. This inconstancy probably depends upon the extent of pulmonary collapse and the degree of patency of the bronchi. With marked collapse and patent bronchi, bronchial breathing is heard; with partial collapse and obstructed bronchi, the breath-sounds are almost or quite abolished. As a rule, no

adventitious sounds are heard, but râles may be audible in the lung above the effusion. Conduction of spoken voice is diminished or abolished, but towards the upper part of the effusion and just above it, the sound produced is heard distantly and with a peculiar nasal or bleating twang, a condition known as ægophony. Baccelli stated that the whispered voice is conducted through a serous but not through a purulent effusion, and called this sign "pectoriloquie aphonique," but no reliance can be placed upon this as a diagnostic sign. The breath-sounds heard under the clavicle over the relaxed lung above the effusion are frequently harsh or puerile. In the contralateral lung the breath-sounds may be vesicular or exaggerated, and in cases of large effusions, where there is marked circulatory obstruction, there are frequently signs of congestion or œdema at the base. Similarly pressure on the descending thoracic aorta may cause lowering of the blood-pressure in the leg as compared with that in the arm (O. K. Williamson). There may be a systolic murmur over the cardiac region (displacement murmur). The abdomen should be examined to determine any downward displacement of the liver or spleen. The blood count in sero-fibrinous pleurisy rarely shows any leucocytosis, apart from complications.

Complications and Sequelæ.—Acute œdema with albuminous expectoration is not uncommon, and is a dangerous condition unless treatment is prompt. Permanent collapse and carnification of the lung may remain after absorption in prolonged cases, and may progress to diffuse interstitial fibrosis. More commonly some degree of pleural thickening and adhesion persists, and expansion of the lower lobe may never be completely restored. Sero-fibrinous effusion due to tuberculosis rarely becomes purulent, but this sequence is common in other forms. Tracking of the fluid externally through the chest-wall and rupture through the lung occur but rarely. An infrequent complication is hemiplegia, probably due to an embolus derived from a thrombus originating in a pulmonary vein. Miliary tuberculosis occasionally follows rapidly on an effusion; more commonly active tuberculosis of the lung occurs after a lapse of some years.

Course.—In effusions of moderate size the temperature usually subsides in from 7 to 10 days, and spontaneous absorption is complete in 2, 3 or 4 weeks. In large effusions reaching up to the second rib or higher, the course may be less favourable. The fever may persist even for weeks, and absorption of the fluid may be slow or wanting entirely. Aspiration may accelerate the resolution, and usually only one tapping is necessary, the fluid left behind being absorbed rapidly. In rare cases fluid reaccumulates quickly after repeated tappings, and a so-called inexhaustible effusion occurs. In some such patients fluid may remain in the pleura for the rest of life.

Diagnosis.—The recognition of the presence of fluid in the pleural cavity is generally easy, but with small or localised effusions it may be difficult. The most valuable signs are the displacement of the heart, the absence of vocal fremitus, and the stony resistant dullness. The auscultatory signs are of less value, and may even be misleading. The chief conditions which may simulate effusion are fibroid lung with thickened pleura and bronchiectasis, pneumonia, particularly the massive form, malignant disease of the lung, pleura or mediastinum, massive collapse, a large pericardial effusion, and an aneurysm pressing on one or other main bronchus. Subphrenic abscess may also give rise to difficulty (see Empyema). Fibroid disease can usually be

recognised, since there is generally flattening and sinking-in of the affected side instead of bulging. The heart, if displaced, is drawn towards instead of away from the affected side, vocal fremitus is present although possibly diminished, and the dullness is rarely of the stony character obtained over fluid. The breath-sounds are generally weak, and if bronchiectasis is also present, the characteristically variable signs of that condition should be helpful in diagnosis. In massive pneumonia the differentiation may be difficult, since breath-sounds and voice-sounds are sometimes completely absent, but the position of the cardiac impulse is generally of decisive importance. In malignant disease and aneurysm, careful observation should afford diagnostic indications, such as glandular enlargement or abnormal pulsation, and in both instances the X-rays may establish the diagnosis. Malignant disease of the pleura may first show itself as a pleural effusion; the tendency to recur after tapping and the onset of emaciation may help to suggest the cause. In massive collapse there is, as a rule, but little difficulty, owing to the displacement of the cardiac impulse to the affected side. In pericardial effusion the shape of the cardiac dullness may be suggestive, and the dislocation of the impulse may indicate the real condition; moreover, the dullness over the lung behind is rarely of extreme degree unless pleural effusion coexists. In any doubtful case, examination by the X-rays is desirable, since it may give valuable aid in diagnosis. The shadow of serous fluid is generally dense, but does not obscure the rib shadows completely. The upper level is curved and shifts to some extent with the position of the patient. It merges into the shadow of the collapsed lung above. The diaphragm is immobile on the affected side. A further aid to diagnosis consists in exploratory puncture, which has the advantage of establishing the nature of the fluid as well as its presence. The technique of puncture is similar to that of paracentesis described on pages 1147, 1148, save that a 5 or 10 c.c. syringe with a needle long enough to enter the pleura is used instead of an aspirator. The preliminary local anæsthesia by novocain is often dispensed with, but it is wiser to employ it to obviate the risk, remote though it be, of pleural shock. Serous pleural fluid of inflammatory origin varies in colour from pale greenish yellow to brown. The specific gravity is usually 1018 or over. Protein is present as serum albumin, serum globulin and fibrinogen, the total quantity being, as a rule, over 4 per cent. The fluid generally clots spontaneously after withdrawal. The cytology of the fluid is varied, showing lymphocytes, polymorpho-nuclears, erythrocytes and altered endothelial cells in varying proportions. A marked preponderance of lymphocytes is very suggestive of a tuberculous origin, while the presence of large numbers of polymorpho-nuclears is usually an indication of some other infection, generally by a pyogenic organism. In rare cases large numbers of eosinophils have been found. The origin of these cases of so-called "eosinophil pleurisy" is at present doubtful. Cultural examination of tuberculous fluid usually proves sterile, but in fluid from other causes the infecting organism can often be grown. To establish the tuberculous nature of a pleural fluid, inoculation of 15 c.c. of the fluid into a guinea-pig may be tried. Other methods formerly employed were examination of the centrifugate from the fluid, and Jousset's "inoscopy," which consists in examination of the clots derived from the fluid after they have been submitted to artificial gastric digestion. These two methods, however, fail in many cases. The methods

of differentiation of an inflammatory exudate from a passive transudate are given on page 1153.

Prognosis.—The immediate prognosis is good, although with large effusions of 4 pints or more, sudden death sometimes occurs from acute œdema of the lungs, cardiac failure or embolism. The ultimate result depends on the cause. In non-tuberculous effusions, recovery may be complete, save for pleural adhesion, or they may progress to empyema. In tuberculous effusions arrest may remain complete, but, as already stated, a considerable proportion of the cases develop active pulmonary disease in after years.

Treatment.—The patient should be kept in bed in an airy and well-ventilated room until the temperature is normal. Fluid should be restricted, and the diet may be salt-free with advantage. The administration of diuretics, diaphoretics and saline or mercurial aperients may assist in the disappearance of the exudate. The use of iodide of potassium has been recommended, but it is of doubtful value in these cases. The application of counter-irritants to the chest-wall in the form of iodine or of fly blisters is often helpful. A sedative lozenge or linctus may be given for the irritating cough present in the early stage. Exploratory puncture is generally advisable to permit the examination of the fluid, but in young children special care is necessary, owing to the risk of shock. Opinions differ somewhat as to the indications for paracentesis, which, however, is nowadays performed earlier and more frequently than was formerly the case. It is unnecessary in cases in which absorption of the fluid is apparent within 10 days. The following conditions may be considered to suggest its employment: (1) if the effusion is large and causing positive pressure, as shown by dulness up to the clavicle, marked dyspnœa, downward displacement of the liver or spleen, and collateral hyperæmia of the sound lung; (2) if absorption is slow, the fluid remaining at the same level for a fortnight or more; (3) if acute œdema with albuminous expectoration occurs; (4) in cases of bilateral effusion with increasing dyspnœa, the side with the larger effusion may be aspirated. Paracentesis can be performed in various ways. The simplest method is that of siphonage; a long rubber tube filled with sterile saline solution is attached to a trocar and cannula, which are passed into the pleural cavity and the fluid is siphoned into a receptacle at a lower level. This method has the great advantages that the degree of suction employed is under control, and the lung expands gradually as the fluid is withdrawn. It is often difficult to remove a large quantity of fluid by this means, and it fails in loculated effusion. Aspiration is more generally effective, and may be carried out either by Dieulafoy's pump and two-way tap, or by Potain's apparatus. With these methods it is impossible to withdraw all the fluid, and removal with oxygen, nitrogen or air replacement is now often practised with advantage. For this purpose a Potain's aspirator and an apparatus like that used in the induction of artificial pneumothorax is required. This method lessens the tendency to recurrence of the effusion and promotes expansion of the lung. In performing aspiration the patient should sit up in bed, or lie slightly turned on the unaffected side, and the area for operation should be painted with iodine. The skin and muscles should be anæsthetised with novocain and a small incision made through the skin, though this is not essential in the case of a small instrument. The trocar and cannula are then pushed quickly into the pleural cavity just above a rib to avoid puncturing the intercostal artery.

The sites chosen depend on the situation of the fluid, but the most convenient are in the sixth space in the mid-axilla, the seventh space in the posterior axillary line, or the eighth space just below the angle of the scapula. Aspiration should be stopped if cough becomes troublesome, if pain is severe, or if albuminous expectoration with signs of œdema supervenes. In rare cases sudden death from pleural shock has occurred. The risk of this may be obviated by careful local anæsthesia with successive injections of novocain down to the pleural level. Other risks are due to faulty technique, and comprise entrance of air into the pleural cavity from wrong connection of the apparatus or from wounding the lung, and infection of the pleural cavity from failure in the aseptic preparations causing empyema. It has been recommended to inject 3 to 6 c.c. of adrenalin solution (1 in 1000) after paracentesis to check reaccumulation, but oxygen replacement seems preferable.

After absorption or removal of the fluid, re-expansion of the lung may be promoted by the use of Wolff's bottles, or by appropriate breathing exercises. With the former, fluid is forced from one bottle to another by blowing. In the latter, the patient takes deep inspirations while seated in a chair with the sound side partly fixed. In all cases in which a tuberculous origin is proved or suspected, prolonged convalescent treatment on sanatorium principles is advisable.

Anomalous Pleural Effusions

Two unusual forms of pleural effusion require brief mention—they are encysted interlobar and encysted diaphragmatic sero-fibrinous pleurisy. The former of these can only be recognised by X-ray examination followed by exploratory puncture. Encysted diaphragmatic sero-fibrinous pleurisy is rare, but a case has been erroneously recorded as acute serous mediastinitis. This condition is simply one of pleural effusion localised to the space between the mediastinal pleura, the diaphragm and the lung. Both of these conditions, if diagnosed, should be treated on general principles. The effusion may absorb spontaneously, but if not, aspiration may be necessary.

Purulent Pleurisy (Empyema)

In this condition the pleural exudate becomes purulent. The fluid may be turbid and the presence of pus be apparent only on microscopical examination, or it may consist of typical pus.

Ætiology.—Predisposing Causes.—Empyema is common in children under 10 years of age, and the younger the child the greater the probability that any effusion will be purulent. In adults it is commonest between the ages of 20 and 40 years, probably owing to the heavy incidence of pneumonia in this age period. Debility, exposure and alcoholism may promote its occurrence. Purulent pleurisy is but rarely primary, except in the form due to the pneumococcus. It is most commonly due to extension from the lungs, especially from lobar pneumonia and from bronchopneumonia. Other pulmonary causes are tuberculosis, bronchiectasis, abscess, gangrene, new-growth, or septic infarcts in infective endocarditis. It may develop in association with mediastinal lesions, such as suppurating glands, ulcerating carcinoma of the œsophagus, or from suppuration in the neck track-

ing downwards. Infection of the pleura may occur through the chest-wall as a result of gunshot wounds, stabs, fractured ribs, and faulty technique in aspiration of a serous effusion. The primary source of pleural infection may be in the abdomen, the organisms passing through the diaphragm from a subphrenic or hepatic abscess, or from localised or generalised peritonitis consequent on rupture of a gastric or duodenal ulcer. The involvement of the pleura may take place through the blood in septicæmia, suppurating gunshot wounds, compound fracture of the femur, and in otitis media with lateral sinus thrombosis.

Empyema may develop during the course of many of the acute specific fevers, such as scarlet fever, variola, measles and the enteric group; but since in these conditions it is usually secondary to broncho-pneumonia, it belongs strictly to the pulmonary group.

EXCITING CAUSES.—The organisms most frequently found in purulent effusions are the pneumococcus and the streptococcus, the former accounting for more than half of the cases. Occasionally the pus proves to be sterile on culture; such cases are generally the result of the tubercle bacillus or of a pneumococcus which has died out. Other organisms less commonly found are staphylococci, Pfeiffer's *Bacillus influenzæ*, the *B. typhosus*, and Friedländer's pneumo-bacillus. Streptothrix organisms are occasionally found (see Actinomycosis), also various saprophytes and anaerobic organisms, especially in fœtid empyema.

Pathology.—The initial stages are similar to those of dry and sero-fibrinous pleurisy, but when the effusion occurs, it proves to be rich in leucocytes undergoing disintegration and to contain the infecting organism. It varies from a slightly turbid semi-translucent fluid to typical thick, opaque, creamy pus. Its colour ranges from pale amber to green or greenish grey. It may be odourless or extremely offensive. In cases secondary to gangrene, it may be thin and horribly fœtid, while in pneumococcal cases it may be curdy and of slightly sweetish odour. The pleura is covered with a more or less thick layer of sodden fibrinous exudate. In cases due to the pneumococcus this false membrane may be very thick. Adhesions form quickly, leading to encystment or loculation of the pus. Such adhesions also prevent the lung from expanding after evacuation of the pus, with the result that the lung becomes carnified and interstitial fibrosis results. There is usually some enlargement of the bronchial glands. In long-standing cases there may be lardaceous disease of the liver, spleen, kidneys and intestines.

Symptoms.—Since empyema usually develops in the course of, or as a sequel of, some other disease, its symptoms are often masked by those of the primary disease and may easily be overlooked. In primary cases due to the pneumococcus the onset may be like that of pneumonia; in the more common secondary cases a rise of temperature and increase of signs develop after the crisis. In general it may be stated that the symptoms are similar to those of sero-fibrinous pleurisy, but more severe. There is more malaise, and the patient may appear profoundly ill, with rigors, sweats and dyspnœa. The temperature ranges higher, up to 103° F. or more, and may be of septic type with marked daily remissions, but some cases are almost if not completely apyrexial. The signs are usually exactly similar to those of sero-fibrinous effusion, but in some instances special features may be noticed. In neglected or prolonged cases, wasting, pallor and cachexia become marked. The

intercostal spaces may be found to bulge, and œdema of the chest-wall is sometimes apparent. The pus may track through an intercostal space, generally the fifth near the nipple, producing a fluctuating swelling known as a pointing empyema or empyema necessitatis. This may infiltrate the skin and simulate a superficial abscess. The swelling so induced may pulsate, especially if it be on the left side—a condition known as pulsating empyema. Pulsation communicated to the chest-wall may also be observed in some large left-sided purulent effusions without local swelling. The displacement of the liver or spleen may be greater than with serous effusions, probably owing to the higher specific gravity of the pus, which is usually 1030 or more, and to the associated inflammation of the diaphragm. In fœtid empyema, the breath and sputum may be offensive, even before rupture into a bronchus occurs. Clubbing of the fingers and toes occurs in empyema of long standing. Blood examination reveals a moderate leucocytosis in the majority of cases. Counts of 15,000 leucocytes per cubic millimetre are usual, and in some instances figures up to 100,000 per cubic millimetre are obtained.

Complications and Sequelæ.—In neglected or untreated empyema the pus may track and become discharged in various directions. The commonest is rupture through the visceral pleura into the lung and discharge through a bronchus. This may lead to sudden death from suffocation; on the other hand, in small empyemata spontaneous cure may follow this evacuation of the pus. In other instances pyo-pneumothorax results, and occasionally gangrene of the lung. A second method of discharge is through the chest-wall, as an empyema necessitatis. Perforation may occur into the pericardium, or into the œsophagus with the formation of a pleuro-œsophageal fistula. The diaphragm may be perforated with the production of a subphrenic, lumbar or psoas abscess, while in other cases general peritonitis may ensue.

The pericardium or the mediastinum may become infected without perforation; similarly costal periostitis may be induced. After spontaneous or operative evacuation the cavity may fail to close and a chronic empyema or sinus result. This is generally due to the lung being permanently collapsed and adherent, and therefore failing to expand. It subsequently undergoes fibrosis with development of bronchiectasis. Sometimes the failure to close may be due to the nature of the infection, particularly when it is due to tuberculosis or nocardiasis. In other cases it may be due to a bronchial fistula, or to a foreign body in the pleura. Generalised infection is rare, but cerebral abscess, probably of embolic origin, is not very uncommon, especially in cases due to streptococci. Chronic pulmonary osteo-arthropathy is an occasional complication, and lardaceous disease sometimes occurs in cases of long duration. Diphtheritic infection of the wound, with subsequent paralysis, has been recorded after operation, more especially in cases secondary to influenzal broncho-pneumonia.

The sequelæ in untreated cases may be fistulæ, such as pleuro-bronchial, pleuro-œsophageal or external, and various deformities. The sequelæ after operation may be a small amount of pleural thickening, or if operation were delayed and re-expansion incomplete, there is falling-in of the chest, with flattening, dropping of the shoulder and secondary scoliosis. In other cases, as mentioned above, a chronic sinus may result.

Course.—Apart from spontaneous cure of small empyemata by inspissation of the pus, or discharge through a bronchus or through the chest-wall,

death generally occurs in untreated cases within a month or two. As in sero-fibrinous pleurisy, sudden death may occur, but much less commonly. Death may occur after operation from exhaustion or from cerebral abscess.

Diagnosis.—The diagnosis of empyema involves two distinct problems—one, the recognition of the presence of fluid in the pleura, which is considered under sero-fibrinous pleurisy; the other, the demonstration of its purulent character. In spite of the more severe symptoms, empyema is frequently overlooked even by physicians of experience. This is partly due to the fact that its development may be insidious, with signs increasing but little from day to day, and partly to its secondary character, its onset being obscured by the clinical features of the primary condition. It is wise, therefore, to suspect its existence in any case of obscure lung signs, especially those with dullness, cardiac displacement and fever, consequent on pneumonia of any variety.

There are a few special difficulties as compared with sero-fibrinous effusion which merit separate mention. The first of these is subphrenic abscess. This may lead to immobilisation of the diaphragm on one side, more commonly the right, and cause collapse of the lung and even pleural effusion. The difficulty is the greater when the subphrenic abscess contains gas as well as pus. The history, the absence of displacement of the heart's impulse, and examination by X-rays may all assist, but the differentiation is often extremely difficult.

Empyema necessitatis may simulate a tuberculous or other abscess about a rib, and empyema should always be suspected in any case of local fluctuating swelling about the chest-wall. Pulsating empyema requires to be distinguished from aortic aneurysm; the pulsation is less forcible and little, if at all, expansile in the former. The cardiac displacement, the X-rays and cautious exploratory puncture, enable the nature of the condition to be recognised.

In any case in which empyema is suspected three examinations may be undertaken—a blood count, radiographic methods, and exploratory puncture. A polymorpho-nuclear leucocytosis of 14,000 per cubic millimetre and over, a dense shadow in the radiogram obscuring the ribs, together with cardiac displacement may be very suggestive, while puncture may prove the presence of pus. Sometimes, however, puncture may fail, although pus is present. This may be due to the pus being too thick to pass through the needle, to loculation of the pus, or to wrong choice of the site for puncture. In this case, if the other signs indicate pus, repeated punctures with a larger needle under anæsthesia are called for, but it is well to be prepared to proceed to operation if pus is found.

Prognosis.—This depends upon the primary cause, the method of treatment adopted, and the duration of the effusion before the operation. The most favourable forms are those due to the pneumococcus, which are recognised and treated at an early stage. In neglected cases, with profound toxæmia, with gangrene of the lung or lardaceous disease, the outlook is extremely grave. Empyemata due to streptococcal infection are serious, unless recognised early; similarly with cases of fœtid empyema due to anaerobic infections. Infected hæmothorax consequent on gunshot wounds of the chest is of grave prognosis. The outlook is serious in cases of bilateral empyema, but recovery may follow successive evacuation of the pus on the two sides.

Treatment. This consists in the evacuation of the pus by operation as

soon as the diagnosis is established in pneumococcal cases. In those of streptococcal origin, operation should not be resorted to while the fluid is of thin sero-purulent character, but should be postponed until it is definitely purulent. A preliminary aspiration is of advantage in large effusions, and may be repeated in streptococcal effusions until they are ready for operation. The operation consists in drainage by removal of a piece of rib subperiosteally and incision of the parietal pleura. For the operation a general anæsthetic may be given, but it is now often carried out under local anæsthesia; but if the patient's condition renders this undesirable, an incision under local anæsthesia may be made through an intercostal space and a drainage tube inserted, a piece of rib being removed later under general or local anæsthesia when improvement has occurred. The wound is dressed at least daily and the drainage tube sterilised, every endeavour being made to prevent secondary infections. To this end the pleural cavity may be irrigated daily by the Carrel-Dakin method, or washed out with some antiseptic such as flavine or brilliant green. By some authorities pneumococcal empyemata, particularly in young children, are treated by repeated aspirations or by siphon drainage. If the pus is thick and difficult to evacuate, incision of the pleura with immediate suture is performed, any reaccumulation being treated by aspiration with or without oxygen replacement. If, however, toxic symptoms persist, drainage should be effectively established at once.

In cases of chronic empyema, or of sinus failing to close, the question of some plastic operation must be considered. This is rarely practicable or advisable in cases due to the tubercle bacillus or to streptothrix organisms. Various forms of operation have been devised, involving removal of portions of many ribs, the most important of which are those suggested by Estlander and Schede, and the decortication operation of Fowler and Delorme. The general condition of the patient must be carefully considered before these operations are advised. In some cases an autogenous vaccine seems to be of value, if drainage is satisfactory.

Special varieties of empyema.—Certain special localisations of purulent pleurisy require separate consideration, notably apical, interlobar and diaphragmatic empyemata.

Apical empyema.—This condition is usually secondary to apical pneumonia, less commonly to pulmonary tuberculosis. It is one variety of encysted empyema, the pus being shut off from the rest of the pleural cavity by adhesions. The symptoms and signs are not characteristic, but may be suggestive. There is very marked dullness below the clavicle, not transgressing the middle line, with weak or absent breath-sounds, and possibly some indications of mediastinal displacement. Diagnosis can, as a rule, be established only by the X-rays and exploratory puncture, the latter being carried out in the second space near the mid-clavicular line. The treatment consists in drainage by incision as near the lower limit of the effusion as possible.

Interlobar empyema.—Pus collecting between two of the lobes may be difficult to differentiate from pulmonary abscess, gangrene and bronchiectasis. It is often not diagnosed until rupture into a bronchus draws attention to it. The signs are generally most marked in the axilla or near the angle of the scapula. They are often slight until rupture occurs, and even then there may be only a small area of dullness in the line of an interlobar fissure, with distant or weak bronchial breathing and a few râles. The pus expecto-

rated may be fœtid, and the patient's breath may be offensive a few days before rupture occurs. The condition simulates abscess of the lung, and may be almost impossible to differentiate from that affection. Examination by the X-rays gives the greatest help in the diagnosis. Recent observations suggest that interlobar empyema is much less common than abscess. The treatment is identical with that for pulmonary abscess.

Diaphragmatic empyema.—The pus is usually encysted, and may be so deeply situated as to give but few signs. The initial symptoms are generally severe, being those of diaphragmatic pleurisy, but hiccough is often a troublesome feature. When pus forms, there may be marked constitutional symptoms, and obscure signs may develop, such as dullness, at a point just above the base behind, with weak or distant bronchial breathing. With such a history and obscure basic signs, especially when they occur after an attack of pneumonia, the use of the X-rays and of the exploring needle should not be neglected. In cases not recognised and treated, rupture into a bronchus or through the diaphragm may occur. The treatment is similar to that for ordinary empyema.

HYDROTHORAX (DROPSY OR HYDROPS OF THE PLEURA)

Hydrothorax is the name applied to a collection of clear fluid in the pleural cavity, the result of passive transudation from the capillaries.

Ætiology.—The commonest cause of hydrothorax is cardiac failure from chronic valvular disease, or from myocardial weakness or degeneration. It occurs in acute and chronic renal disease, under conditions similar to those leading to dropsy in these affections. It is sometimes found in severe anæmias, especially pernicious anæmia. Obstruction to the azygos veins may lead to transudation into one or other pleural cavity or into both. This obstruction may be induced by pressure from without by a mediastinal or pulmonary new-growth, or by internal causes such as thrombosis.

Pathology.—The pathology of hydrothorax is that of dropsy elsewhere. It is produced by mechanical or chemical conditions affecting the blood flow through the capillaries, and it must be distinguished carefully from inflammatory effusion. There is a difference in the composition as well as in the origin of the two kinds of pleural fluid. The characters of inflammatory effusions have been described under pleurisy with effusion. The fluid in hydrothorax is pale yellow in colour, and the specific gravity is 1015 to 1010 or less. It is clear and does not clot after removal. There is little protein, often not more than 1 per cent., but transudates due to local obstruction may contain as much as 3 per cent. The cellular elements are scanty, although some endothelial cells may be present, often united together in plaques. The fluid may be definitely bloodstained, when it is described as hæmo-hydrothorax.

Hydrothorax is usually bilateral in cases due to cardiac or renal disease, but in the former there is often more fluid on the right side, or the fluid may be confined to that side. The explanation of this is somewhat obscure. It has been suggested that it is due to pressure or traction on the vena azygos major by the enlarged right heart, but according to Fetterolf and Landis, a more likely explanation is pressure of the distended right auricle upon the

pulmonary veins. Fluid may also collect in greater quantity on the side upon which the patient lies most constantly. In cases with unilateral pleural adhesion, œdema of the lung may occur on that side, while hydrothorax occurs upon the other.

Symptoms.—The symptoms of hydrothorax are generally overshadowed by those of the condition causing it, but the occurrence of dyspnœa and cyanosis in any case of cardiac or renal disease should suggest careful examination of the bases of the lungs. In the absence of inflammatory complications the condition is afebrile. The signs are identical with those of sero-fibrinous pleurisy, save that no friction sounds are audible at any stage. It is, however, more difficult to assess the significance of displacement of the cardiac impulse, owing to the increased size of the heart in the cases of cardiac origin.

Diagnosis.—This depends upon the presence of signs of fluid in the pleura in association with cardiac or renal disease, with absence of fever, and also upon the characters of the fluid withdrawn by puncture or aspiration.

Treatment.—Removal of the fluid, with or without oxygen replacement, may give great relief. It may be necessary to repeat the operation, since the fluid often reaccumulates. The treatment of the primary condition should also be carried out.

HÆMORRHAGIC PLEURAL EFFUSIONS

All fluids poured out into the pleura contain a certain number of red blood corpuscles. It is only when a number sufficient to give a definite red colour are present, that the fluid is regarded as hæmorrhagic.

For convenience of description three forms may be differentiated—(1) Hæmorrhagic pleurisy or hæmo-serothorax; (2) hæmo-hydrothorax; and (3) hæmothorax.

1. HÆMORRHAGIC PLEURISY.—This is simply a pleurisy with effusion, in which the exudate is blood-stained.

Ætiology.—The commonest causes are tuberculosis of the lung and pleura, and malignant disease of the lungs, pleura or mediastinum. Hæmorrhagic pleurisy may occur in association with hepatic cirrhosis, but in this case it is often the result of a terminal tuberculosis. It occurs less frequently in association with blood diseases, such as purpura, and with the malignant or hæmorrhagic varieties of acute infectious fevers such as scarlet fever and small-pox, and occasionally with lobar pneumonia. Sometimes in tapping a sero-fibrinous effusion for the second time, it is found that the fluid, which was originally clear, is now bloodstained. This is not necessarily an indication of increase in the severity of the process, but may be due to injury of a blood vessel at the first operation.

Symptoms.—The symptoms and signs are identical with those of serous effusion, and the hæmorrhagic character can only be recognised by withdrawal of the fluid. An interesting point is the frequency of excess of eosinophils in these effusions. Diagnosis and treatment are the same as for sero-fibrinous pleurisy.

2. HÆMO-HYDROTHORAX.—This condition has been referred to under hydrothorax. It consists simply in blood-staining of a passive transudate into the pleura.

3. **Hæmothorax.**—Hæmorrhage into the pleural cavity is the result of injury or disease of the vessels of the lung, mediastinum or chest-wall.

Ætiology.—The chief causes are injury, such as penetrating chest wounds or fracture of the ribs, rupture of an aneurysm, and erosion by new-growth. Experience of the traumatic group has been largely increased during the Great War. Hæmothorax was noted in about 70 per cent. of chest wounds.

Pathology.—The effused blood generally comes from the lung vessels, less commonly from the intercostals. It is "whipped" by the movements of the heart and lungs, with the result that fibrin is deposited in layers upon the diaphragmatic pleura, and the parts of the visceral and parietal pleura in contact with the blood. The fluid remaining in the pleura or withdrawn by aspiration is largely defibrinated and therefore does not clot, unless a secondary pleurisy develops.

The lower lobe of the lung on the affected side becomes collapsed and eventually carnified, unless absorption occurs or unless the blood is aspirated. The upper lobe may show some compensatory emphysema, and adhesions may form in the pleura, separating it from the hæmothorax below. When secondary infections of the bronchi or lungs occur, such as bronchitis or broncho-pneumonia, the collapsed lower lobe is not affected.

Symptoms.—The symptoms of hæmorrhage into the pleura from medical causes, such as rupture of an aneurysm or erosion of a large vessel, are collapse and rapid death. When due to disease or injury of an intercostal vessel, they may be insidious and slowly ingravescent until dyspnœa, restlessness and the other indications of internal hæmorrhage develop. When due to injury, similar symptoms occur, but may be masked or overshadowed by the shock, hæmoptysis and cough, induced by the wound of the lung or chest-wall. The signs are those of pleural effusion, but in traumatic cases certain special features may be mentioned. There is a great tendency to retraction of the chest-wall on the affected side, and the cupola of the diaphragm on this side is displaced upwards. This is thought to be due to an active lobar collapse of the lung, the lung contracting, not as the result of the pressure of the effusion, but in consequence of a nervous protective reflex initiated by the trauma. Vocal fremitus is usually diminished or absent. The breath-sounds over the effusion are frequently bronchial, and well-marked bronchophony and pectoriloquy may be present.

Complications and Sequelæ.—The most serious complication is infection of the effusion. This is generally due to organisms introduced at the time of the wound, either by the missile or by portions of the clothing or skin carried in with it. Aerobic organisms, such as a streptococcus, or anaerobic ones, as the *B. aerogenes encapsulatus* or the *B. sporogenes*, may be present. A hæmo-pneumothorax may develop, the gas entering the pleural cavity from the wound in the lung or through the chest-wall. Gas may also be formed by gas-producing infecting organisms in the effusion. Massive collapse may occur in the contralateral lung, or other complications may arise, such as bronchitis, broncho-pneumonia, lobar pneumonia or œdema of the lungs. If the effusion is small and not infected, there are usually no permanent after-effects. In severe cases sequelæ, similar to those of serofibrinous pleurisy and empyema, may result.

Course.—This depends upon the cause and size of the hæmothorax, and upon the mode of treatment adopted. It is profoundly and gravely

influenced by infection of the effused blood. A small sterile hæmothorax is generally absorbed spontaneously. Medium-sized and large effusions may not disappear unless aspirated. An infected hæmothorax will inevitably prove fatal, if untreated.

Diagnosis.—Hæmothorax should be suspected when basic dullness develops shortly after a gunshot wound of the chest. The mistake that is most likely to be made in such cases is to confuse hæmothorax with lobar pneumonia. The cardiac displacement and the diminution of vocal fremitus over the dull area are the most valuable diagnostic signs. An active lobar collapse is distinguished by the fact that the heart is displaced towards the affected side. The X-rays afford valuable confirmatory evidence in most cases. When air and blood are present, the upper border of the dark area in the radiogram has a sharply defined edge, while the pleural cavity above is very translucent. The use of the exploring syringe generally settles the diagnosis, except in certain cases in which, although a considerable quantity of blood may be present, none is removed by aspiration owing to the needle entering the clot.

Prognosis.—In a sterile hæmothorax due to a chest wound the prognosis is good. If infection occurs, the prognosis depends upon the promptitude with which this condition is recognised and radically treated, although in very acute infections death may occur in 2 or 3 days despite immediate operation.

Treatment.—A small sterile hæmothorax may be left untouched. In medium and large-sized effusions, recovery is accelerated by aspiration. The possible danger of renewal of the hæmorrhage, as the result of lowering the pleural tension by this operation, is very slight, and negligible if it is delayed until 2 or 3 days after the wound. If the temperature in a case of hæmothorax rises suddenly to 102° or 103° F. in the evening, it is criminal to wait until the next morning to see what will happen. A specimen of fluid should be withdrawn and examined microscopically. Direct films may occasionally reveal the presence of organisms, but the important point to determine is the number of polymorphonuclear leucocytes present. When these are numerous, operation should be performed without awaiting the findings of aerobic and anaerobic cultures. A rib should be resected as in empyema, and the blood and clots should be removed from the pleural cavity and drainage established.

CHYLOUS AND OTHER MILKY EFFUSIONS

A milky fluid is occasionally obtained on exploratory puncture or aspiration of a pleural effusion. It is usual to classify such fluids into three groups —(1) Chylothorax; (2) chyliform fluid; (3) pseudo-chylous fluid.

1. *Chylothorax.*—There is an effusion of pure chyle or of serous fluid mixed with chyle.

Ætiology.—Chylothorax is usually the result of injury to, or disease of, the thoracic duct. The traumatic form is, as a rule, secondary to crushing of the chest-wall with fracture of the ribs. In disease, the thoracic duct may be pressed on by a malignant growth or enlarged mediastinal glands, or the flow may be obstructed by a thrombosis of the left subclavian vein. Invasion of the thoracic duct by the *Filaria sanquinis hominis* may also be a cause.

Pathology.—The fluid in true chylothorax is a milky emulsion which remains so on standing, although a cream-like layer may form at the top. With the microscope fat globules can be seen, which stain with the usual fat stains and can be dissolved by ether.

2. *Chyliform effusion.*—In this condition fat is present, but it is not derived from the thoracic duct.

Ætiology.—Chyliform effusions occur in association with tuberculosis and carcinoma of the pleura or lung.

Pathology.—The fluid is milky and contains fat in emulsion, although in smaller quantities than in true chylothorax. On microscopical examination large fat droplets are seen, and numbers of cells, chiefly leucocytes undergoing fatty degeneration. It is, no doubt, from this process that the fat is derived.

3. *Pseudo-chylous effusion.*—In this condition the milky appearance is not due to fat, but to other particles causing opalescence.

Ætiology.—Pseudo-chylous fluid has been observed in chronic effusions due to heart disease, nephritis, tuberculosis and malignant disease.

Pathology.—The milky appearance is due in some cases to a lecithin globulin complex (Wallis and Schölberg). Other rare causes of milky, opalescent or turbid effusions are the presence of particles of calcium phosphate, cholesterin or filarial embryos. These fluids are distinguished from the above by showing a deposit on standing.

Diagnosis.—This can only be established by microscopical and chemical investigation of the fluid withdrawn.

Prognosis.—The prognosis in most cases of milky effusions is serious, owing to the gravity of the primary condition. Some traumatic cases of true chylothorax recover.

Treatment.—The treatment is for the most part symptomatic and dependent upon the primary condition. In true chylothorax, removal of the fluid is inadvisable, unless it is causing dyspnœa or other symptoms of pressure. The drain of fat caused by it is a serious loss, especially if the tapping has to be repeated frequently. In chyliform effusions there is a marked tendency to recur after removal of the fluid.

PNEUMOTHORAX

In pneumothorax, gas, usually air, collects between the layers of the pleura, which now becomes a real instead of a potential space. When serous fluid is present as well as the gas it is called a hydro-pneumothorax, when pus forms the condition is described as pyo-pneumothorax, and when blood and gas collect the term hæmo-pneumothorax is applied.

Ætiology.—Pneumothorax is more common in men, and the maximum incidence is between the ages of 20 and 40 years, but it may occur at any age. The air may gain access to the pleural cavity in the following ways: (1) Through the visceral pleura from the air in the lungs and bronchi. This accounts for 95 per cent. or more of the cases. The commonest cause is rupture of a subpleural tuberculous focus, which is said to be responsible for 90 per cent. of all cases. Rupture of an empyema into the lung is the next most frequent antecedent condition. Other pulmonary causes are gangrene,

abscess, septic infarct, bronchiectasis and rupture of an emphysematous bulla or vesicle. Puncture of the lung during paracentesis, or rupture of the pleura over a diseased focus, owing to rapid expansion of the lung during the same operation, may lead to pneumothorax. A broken rib perforating the lung can also induce it. (2) Through the chest-wall, as a result of penetrating wounds, although pneumothorax is not a common result. An abscess in the chest-wall opening externally and through the pleura, or a discharging empyema necessitatis, may be a cause. (3) Through the mediastinum, by ulceration of an œsophageal growth, or of a diseased bronchial gland, into the pleura, or from accidental perforation of the œsophagus during the passage of an œsophageal bougie or œsophagoscope. (4) Through the diaphragm, from some hollow abdominal viscus, *e.g.* an ulcer of the stomach or duodenum may perforate, leading to the formation of a subphrenic abscess, which in turn may break through the diaphragm into the pleura. (5) Gas may accumulate in the pleura owing to infection of a pleural effusion by gas-producing organisms. This is generally the result of wounds. In a few cases pneumothorax occurs in apparently healthy persons; this is probably due to rupture of an emphysematous vesicle or bulla, or of a small latent tuberculous focus.

The exciting cause of pneumothorax may be physical strain or violent cough, but many cases occur while the patient is at rest or even during sleep.

Pathology.—The entrance of air between the layers of the pleura disturbs the pressure relations in the thorax in a similar way to the effusion of fluid; but whereas with the latter the process is gradual, in pneumothorax it is rapid, and the pressure within the pleura changes from the normal negative figure to that of the atmosphere, often in a few minutes or less. Mediastinal and cardiac displacements like those in pleural effusion, and due to the unopposed traction of the sound side, are also rapidly produced. The subsequent pressure relations depend upon the source of the air. If the opening is in the chest wall, the intrapleural pressure will remain equal to the atmospheric, until the opening becomes closed. If the opening is in the lung, three varieties occur: (1) the opening may remain patent, when the pressure keeps at atmospheric level; (2) the opening may be valvular, permitting the entry of air into the pleura during inspiration, but preventing its escape during expiration. In this case the pressure in the pleura rises above that of the atmosphere, and the air within it is at a positive pressure, causing further cardiac and mediastinal dislocation with downward displacement of the diaphragm; (3) the opening becomes sealed, and there is a condition of closed pneumothorax in which the pressure may be equal to, greater or less than, that of the atmosphere.

To demonstrate pneumothorax post mortem, the autopsy may be performed under water, or a flap being made of the skin and muscles at the side of the thorax, this may be filled with water before puncturing the intercostal spaces. A third method is to dissect carefully through an intercostal space down to the pleura, when the lung will be found to be retracted. On opening the thorax the appearances vary. If the air entering the pleura is sterile, no inflammatory reaction occurs, the pleura remains shiny and no fluid is formed, the condition being one of simple pneumothorax. More

commonly, bacteria gain access to the pleura with the ingoing air, or subsequently through the opening when this remains patent, with the result that either serous fluid or pus collects. In the former case the condition is described as hydro-pneumothorax, in the latter as pyo-pneumothorax. The appearances of the pleural membrane are similar to those found in serofibrinous pleurisy and empyema respectively. The lung is collapsed in every case of pneumothorax, and lies retracted towards the hilum and the spine. In tuberculous disease, a caseous focus or small cavity just under the pleura is the most frequent cause. The perforation may be a large circular rent or a small pin-hole, but multiple apertures may occasionally be present. The opening can usually be found, even if small, by submerging the lung under water while pumping air down the trachea. When extensive adhesions are present, the collapse of the lung is largely prevented and the pneumothorax is only partial. In such cases the perforation is frequently near the adhesions. In cases where fluid is present the diaphragm may be seen to be depressed on the affected side and its curvature lessened or reversed.

Symptoms.—In a considerable proportion of cases the onset is sudden and the condition of the patient becomes alarming at once. On the other hand, pneumothorax may develop insidiously, with surprisingly little pain and dyspnœa, so that its occurrence may only be discovered on routine physical examination. This is more likely to be the case when perforation occurs in a lung extensively diseased or when the aperture is small, and the leak of air is slow. In the acute form of onset the patient is seized with severe pain while coughing or engaged in some extra exertion. There is often a feeling of "something having given way," and at once great dyspnœa, with signs of collapse and severe mental anguish develops. The patient may appear blue, cold and clammy, breathing is rapid and shallow, the temperature falls to subnormal, the heart beats quickly and the pulse becomes small and weak. The patient is often restless, very alarmed and unable or afraid to speak. Occasionally death occurs in a few minutes. As a rule, the more acute symptoms subside in a few hours, but the temperature rises and the rapid breathing usually persists for some time. On examination the patient will usually be found sitting up, with alæ nasi working and with rapid shallow breathing. The affected side is almost or entirely immobile and is usually bulged. The displacement of the cardiac impulse towards the unaffected side is generally obvious, and is almost immediate. Palpation confirms the absence of movement, and vocal fremitus is found to be absent, except where the collapsed lung remains in contact with the chest wall, over which area it may be increased. The exact position of the cardiac impulse should also be determined: in right-sided cases it will be found in the left axillary region; in left-sided cases it may be under or beyond the right nipple. The liver may be felt much depressed in right-sided cases. The note over a pneumothorax is characteristically tympanitic or drum-like, as a rule, but in cases with positive pressure the tympany may be flat and muffled. The tympanitic area should be carefully mapped out; it may be found to extend across the middle line, or to encroach on the liver dullness in right-sided cases. On the other hand, in partial pneumothorax, the area may be small and easily escape recognition. In left-sided cases, the cardiac dullness may be completely wanting on that side, and a dull area found to

the right of the sternum. This may give a useful hint as to the diagnosis. On auscultation, the breath-sounds are often absent, but they may be present at the apex, although weak. In other instances distant tubular breathing may be audible from the collapsed lung; in cases with a large patent opening hollow cavernous breathing may be heard. The voice sounds have an amphoric or metallic quality, and an amphoric echo may occur with any sound produced near the pneumothorax. Metallic tinkling is an example of this, being the quality conveyed to râles or other adventitious sounds produced in breathing. The bell sound or *bruit d'airain* is a valuable sign, but is not invariably present. It is elicited by listening over the chest, near where a coin is placed flat and tapped with another. A similar sound may be heard with the stethoscope on flicking over a pneumothorax with the thumb and finger. The displacement of the heart can be confirmed by auscultation, and the heart sounds may be found to have a metallic character. When air and fluid are present in the pleura the signs are somewhat modified. There is dullness at the base, which shifts its level with the patient's movements, the upper limit being straight, in contrast with the curved line of ordinary effusions. A marked succussion splash may be heard and felt on shaking the patient, or the patient may demonstrate the sign by a sudden shake or jerk.

Complications and Sequelæ.—Cardiac failure and rapid death occur occasionally. The chief complications are due to the entry of infective organisms into the pleura, leading to pleurisy and the effusion of sero-fibrinous fluid or pus. The sequelæ may be pleural adhesions in cases that recover, especially if effusion occurs. There may be also permanent collapse of the lung in long-standing cases, and in pyo-pneumothorax a fistula, either pleuro-pulmonary or external, may remain in spite of treatment.

Diagnosis.—The recognition of a large or of a complete pneumothorax is easy as a rule, the signs being characteristic. When a large quantity of fluid is present in an open pneumothorax, the presence of air may not be recognised until after paracentesis or X-ray examination. The latter gives information of the greatest value and sometimes demonstrates the presence of local pneumothorax where it has not been suspected. The air space between the lung and pleura shows most clearly in radiograms, and if fluid is present as well, the dead level of the upper border of the shadow, varying with position, is most characteristic. Diagnosis is more difficult in cases where pleural adhesions exist, or where the pneumothorax is small and localised, especially if X-ray examination is impracticable. The following conditions may give rise to difficulty and should be considered in doubtful cases. (1) Total excavation of a lung, or a large pulmonary cavity, in either of which the note may be boxy or even tympanitic, the breath sounds amphoric and the râles metallic or tinkling, while the coin sound may be obtained. These conditions can usually be distinguished by the flattening and retraction of the chest-wall over them, and the absence of cardiac displacement, or if it exists, the traction of the heart towards the affected side by fibrosis. (2) Advanced emphysema, with complete obliteration of the cardiac dullness, may be confused with pneumothorax. (3) Massive collapse of one lung, with compensatory emphysema of the opposite side, may also be mistaken for it. In both these conditions careful examination will establish the real nature. (4) A subphrenic abscess containing gas (subphrenic pyo-pneumo-

thorax), in this condition the diaphragm may be displaced upwards, and the note over the lower ribs may be markedly tympanitic. These signs are more suggestive when right-sided. Succussion splash and bell sound may be elicited. The heart, if displaced, is pushed upwards. The history of previous abdominal disease may be helpful, and a radiogram may give conclusive evidence of the subphrenic origin of the condition. (5) A hernia of the stomach or bowel through the diaphragm, or eventration of the diaphragm, all rare conditions, may simulate pneumothorax but in all there is generally abdominal flattening and little if any cardiac displacement. Examination by X-rays after an opaque meal will, as a rule, establish the nature of the condition.

Course and Prognosis.—The course and prognosis of pneumothorax are profoundly influenced by the cause. In cases due to rupture of an emphysematous vesicle, or of a small localised tuberculous focus, where the pleura remains sterile and the aperture of entry closes, the air is usually completely absorbed in a few weeks and recovery is often complete. In tuberculous cases with moderate disease, in which the pleura remains sterile, pneumothorax may exert a favourable influence. In tuberculous cases with extensive disease, the pleura becomes infected and death usually results in a few weeks or months, although with judicious treatment life may be prolonged for years in some cases. In pneumothorax secondary to some grave disease, such as carcinoma or gangrene, the course is brief and the prognosis is grave in the extreme. In cases secondary to empyema, surgical treatment may be followed by complete recovery, unless a bronchial fistula is present.

Treatment.—The indications in cases of acute onset are to relieve the patient's pain, distress and anxiety, and to lessen the intrapleural pressure, if this is positive. A hypodermic injection of morphine, gr. $\frac{1}{4}$ for an adult, with oxygen inhalations if necessary, may achieve the first of these. If dyspnœa is extreme and the cardiac displacement marked, a trocar or large hypodermic needle should be inserted through an intercostal space to allow air to escape. A Southey's trocar with a long rubber tube, the end of which is placed under water, is the safest. This simple manœuvre may be the means of saving the patient's life in valvular pneumothorax, as well as of relieving distress. In simple cases no other treatment may be required, although the puncture may need to be repeated. If serous fluid or pus collect in the pleura, they may be withdrawn, preferably by siphonage, and in this case, as also with removal of air, too much should not be withdrawn in the early stages, as a slight positive pressure may assist in closure of the aperture in the lung, whereas a negative pressure may open it, after it has begun to close.

The question of operation in pneumothorax may be difficult to decide. In cases secondary to empyema, resection of a part of a rib and drainage often lead to satisfactory results. In cases of moderately severe or advanced tuberculosis with pyo-pneumothorax operation is generally contra-indicated, and if performed is liable to result in a permanently open pneumothorax. It is preferable to remove fluid from time to time by aspiration, with or without oxygen replacement. The latter method of aspiration sometimes seems to assist the lung to re-expand.

HYDATID DISEASE OF THE PLEURA

Hydatid cysts may be primary in the pleura, or may encroach on the pleura, although originating in adjacent structures such as the lung, liver, spleen or mediastinum (parapleural hydatid).

Ætiology and Pathology.—Primary pleural hydatid is rare, but secondary invasion of the pleura is more common. In this situation the cyst may reach a large size, even 5 or 6 inches in diameter, before rupture occurs. As in other situations, a fibrous capsule is developed around the cyst from the irritative changes set up in the adjacent tissue. Contrary to what might be expected, extensive pleurisy is uncommon until rupture or suppuration of the cyst occurs. The pressure of the cyst may lead to collapse of the contiguous areas of lung and to displacement of the heart and mediastinum.

Symptoms.—These may be absent until the cyst is large enough to produce pressure symptoms, such as dyspnœa, pain and cough. There is little or no expectoration, unless rupture into a bronchus occurs, when cyst wall, daughter cysts and hooklets may be found in it. There is no fever until suppuration occurs. The signs are practically identical with those of encysted pleural effusion.

Complications and Sequelæ.—Rupture and suppuration are the two most important complications. Rupture may take place into the lung, into the pleural cavity, rarely through the chest-wall or through the diaphragm. At the time of rupture an urticarial rash may develop. This is probably an anaphylactic phenomenon associated with the liberation of toxin present in the fluid of the cyst.

Course.—The cyst may be latent for some time, but it usually enlarges and produces increasing symptoms, culminating in rupture or suppuration. Very rarely death of the cyst occurs and its contents become inspissated.

Diagnosis.—The symptoms and signs generally suggest either pleural effusion or new growth, and hydatid disease may not be suspected. Obscure basic signs, in patients coming from countries where hydatid disease is common, should suggest special methods of investigation as to the possibility of its presence. Should it be suspected, aspiration is to be deprecated, unless all preparations for immediate operation are complete, if the diagnosis is confirmed. These methods comprise X-ray examination, an eosinophil blood count, the complement fixation test and the precipitin reaction.

Prognosis.—If untreated until rupture occurs, a fatal result is most probable. If diagnosed and treated before rupture, the prognosis is not unfavourable.

Treatment.—The former practice of aspiration and injection with formalin or iodine, although sometimes successful, is dangerous and should be discarded. Exposure of the cyst by thoracotomy, and its removal entire, should be the treatment if practicable, or if too large, it may be aspirated and then dissected out.

ACTINOMYCOSIS (NOCARDIASIS, STREPTOTRICHOSIS) OF THE PLEURA

The general characters of infection by the nocardia or streptothrix group of organisms, and the special features of the pulmonary localisations have been described. It is possible, although improbable, that the infection may be primarily pleural, more commonly clinical manifestations may point to a predominating involvement of the pleura, although the primary lesions may be in adjacent structures, such as the lungs, mediastinum or liver.

Symptoms.—The symptoms and signs in such cases are those of empyema, but the following points are noteworthy. The empyema is rarely large, and it commonly extends through the chest wall, producing a local swelling which soon discharges through the skin if untreated, causing a suggestive infiltration and puckering around. Exploratory puncture of a nocardial empyema often fails, since the grumous caseous material it contains may be too thick to pass through the needle.

Diagnosis.—The characteristic "sulphur granules" in the pus may draw attention to the real nature of the condition, but they are not always present. Direct films should always be made from the pus obtained from empyemata. The streptothrix may be found in this way, when culture fails. If the lung is involved as well as the pleura, the organism may be found in the expectoration, and the nature of the pleural condition may thus be established before operation.

Prognosis.—Some cases respond to treatment, but prognosis is in general unfavourable, death resulting from exhaustion or toxæmia due to dissemination of the disease.

Treatment.—The pultaceous pleural contents should be removed as far as possible by operation, and large doses of potassium iodide given by the mouth, increasing the quantity until 60 to 90 grains, three times a day, are given. An autogenous vaccine may be tried if the organism can be grown.

SIMPLE TUMOURS OF THE PLEURA

These are very rare and are, as a rule, only discovered after death. They are almost invariably of extrapleural origin and their presence in the pleura is due to the direction taken by the growth. Lipoma of the subpleural or of the mediastinal fat may occur as small pedunculated tumours or very rarely as a large mass.

MALIGNANT TUMOURS OF THE PLEURA

Primary malignant disease of the pleura is rare, and may take the form of endothelioma, carcinoma or sarcoma. Secondary carcinoma and sarcoma are more common.

Ætiology.—Primary endothelioma of the pleura is more common in late adult life and in the male sex. Sarcoma is more likely to occur in children and in young adults. Secondary growths may occur at any age, but more commonly in later life.

Pathology.—Endothelioma of the pleura is a growth of obscure origin. It has not been conclusively established that it is derived from the pleural endothelial cells, and by some writers it is classed as a carcinoma. It is generally unilateral, but it involves the affected pleura over a wide area, sometimes universally. The membrane appears to be overlaid with an irregular, rough hard covering, sometimes nodular. In other cases there is more thickening and the condition may be localised. There is nearly always a large amount of blood-stained serous effusion. The condition may spread to the bronchial or supraclavicular glands, the lung, the diaphragm and the peritoneum.

Primary carcinoma of the pleura has also been described, but is very rare. Primary sarcoma is also extremely uncommon, but the round-celled and spindle-celled varieties may occur, and angio-sarcoma, fibro-sarcoma, myxo-sarcoma and chondro-sarcoma have all been recorded.

Secondary carcinoma and sarcoma of the pleura are relatively common, and may occur from direct *extension* in growths of the lung, bronchi and mediastinum, by *metastases* of growths in almost any distant part, or by *lymphatic permeation* in mammary carcinoma. In the last-named condition pleural and pulmonary growths are a not infrequent form of recurrence, sometimes occurring months or years after removal of the primary growth.

Symptoms.—These are not characteristic, and increasing dyspnœa due to an accumulation of fluid may be the first indication. More commonly pain and cough, similar to those of pleurisy, may occur acutely or develop more gradually. Although afebrile as a rule, the occurrence of fever does not exclude malignant disease. Cachexia and wasting are often not marked until the condition is advanced. The signs are generally indistinguishable from those of ordinary pleural effusion, unless secondary growths become manifest in the cervical or axillary glands. Sometimes coarse dry friction may be heard, or there may be signs of pleural thickening without fluid. There is often local pain and tenderness over the chest. Exploratory puncture may demonstrate the hæmorrhagic character of the effusion. The specific gravity is generally 1018 or over, and the cytology of the fluid may be suggestive, especially if excess of endothelial cells, often aggregated into plaques, is found.

Complications.—The growth may spread to the lung and cause cough and expectoration, often blood-stained, or it may involve the chest-wall. Metastases sometimes develop along the course of the needle track after aspiration of the fluid. The secondary growths, especially those in the glands, may exert pressure, *e.g.* the axillary glands may cause œdema and swelling of the arm.

Course.—This is almost invariably progressive, the duration being rarely more than 2 years, and occasionally much less.

Diagnosis.—A chronic pleural effusion in a middle-aged man, not associated with fever, and not due to tuberculosis, should arouse suspicion of malignant disease of the lung and pleura. Evidence of fluid in one pleura, at an interval after excision of the breast for malignant disease, is very suggestive of secondary pleural growth. A hæmorrhagic effusion, not due to tuberculosis or renal disease, should also arouse suspicion of malignancy, especially if reaccumulation after tapping is rapid, and if the subsequent tappings show increasingly hæmorrhagic characters. When aspiration of a considerable quantity of

fluid gives little relief to symptoms, or when irregular dull areas remain where resonance might be expected, the probability of growth must be borne in mind. Involvement of the chest-wall, or the presence of cervical or axillary glandular metastases render it certain.

Prognosis.—Malignant growth of the pleura is invariably fatal.

Treatment.—From the nature of the condition this can only be palliative. Analgesic drugs may be given freely for the relief of pain, morphine being reserved for the severe forms and later stages, as far as possible. Repeated tappings may be almost compulsory, if there is much distress from the reaccumulation of the fluid, but it must be remembered that in hæmorrhagic effusions the loss of blood by this means is considerable. Oxygen or nitrogen replacement may sometimes give relief for a longer period than simple aspiration.

INJURY

Injury to the pleura may occur in fracture of the ribs, the fragments piercing or tearing it. Similarly in penetrating wounds of the chest, the pleura may be extensively lacerated. It may also be torn by direct violence without breaking of the ribs, and in rare cases a hernial protrusion of lung may occur, forming a small swelling in an intercostal space, protruding with inspiration and emptying with expiration.

R. A. Young.
G. E. Beaumont.

DISEASES OF THE DIAPHRAGM

SPASM OF THE DIAPHRAGM

Diaphragmatic spasm may be either clonic or tonic, the former being termed *hiccough*.

Clonic spasm.—This may be due to a variety of causes, namely: (A) Alimentary: From irritation of the œsophagus or stomach by pungent or irritant substances, such as pepper, pickles, or tobacco. It occurs also as a symptom in gastritis, dilatation of the stomach, enteritis, intestinal obstruction, tympanites and peritonitis. (B) Nervous: as in hysteria, cerebral tumour, meningitis, hydrocephalus, epilepsy and alcoholism. It may also result from peripheral nerve irritation, in such conditions as mediastinal tumour, mediastinitis, enlarged thoracic glands, diaphragmatic pleurisy, or pericardial effusion. *Epidemic hiccough* has been regarded as a form of encephalitis lethargica. There is usually some slight pyrexia, and the condition may persist without intermission for several days. (C) Renal: As in chronic nephritis and uræmia.

Tonic spasm.—This may be met with in tetanus, strychnine poisoning, laryngismus stridulus, eclampsia, epilepsy and hydrophobia. If there is associated intercostal or laryngeal spasm, there is grave risk of death from asphyxia.

Treatment.—Simple hiccough may often be relieved by holding the breath, pressure on the chest, or by simple inhalations, such as of ammonia,

ether, or spirits of chloroform. Hiccough due to organic disease or to peripheral irritation may only be relieved by removal of the cause. In epidemic hiccough, in obstinate cases of hiccough due to other causes and in the tonic form of spasm, various antispasmodic measures may be tried, such as trinitrin, bromides, musk, or luminal, by the mouth, adrenalin, or adrenalin and pituitrin, hypodermically, or the inhalation of chloroform.

DIAPHRAGMATIC PLEURISY

This condition is described on page 1141 under the heading of Pleurisy.

PARALYSIS OF THE DIAPHRAGM

Definition.—Paralysis and inactivity of either leaf of the diaphragm, or of both.

Ætiology.—Paralysis of the diaphragm may be caused by disease damaging the centre in the spinal cord, by conditions affecting the phrenic nerve in its course, or by reflex inhibition of the centre. Causes involving the centre include poliomyelitis, hæmorrhage into the spinal cord, and tumours of the spinal cord or its membranes, or of the spine itself. The phrenic nerves may be affected by diphtheritic neuritis. Either or both of the nerves may be compressed by mediastinal tumours, or by inflammatory exudates. They may be severed or injured by wounds in the neck. Exairesis or evulsion of the phrenic nerve is now frequently employed therapeutically, in order to promote collapse of the base of one lung in cases of tuberculosis and in bronchiectasis.

Symptoms.—Diaphragmatic paralysis results in the affected leaf of the diaphragm becoming immobile and remaining at a higher level in the thorax than normal. This can easily be seen on X-ray examination. Sometimes there is a reversal of the ordinary abdominal movements during respiration, with the result that there is epigastric recession during inspiration. Massive collapse of the lung, described on page 1068, has been regarded as due to reflex inhibition of the diaphragm on one side, though this explanation is not now generally accepted.

Treatment.—This is, in general, that of the condition causing the paralysis.

HERNIA OF THE DIAPHRAGM

Definition.—Protrusion of some part of the abdominal viscera through an opening in the diaphragm into the thoracic cavity.

Ætiology.—Diaphragmatic hernia may be congenital or acquired. The congenital form is due to an error in development. Acquired hernia generally results from gunshot wounds or stabs involving the diaphragm. More rarely, it may be caused by severe and prolonged vomiting. As might be expected from anatomical considerations, diaphragmatic hernia is much commoner on the left side.

Symptoms.—These are more definite and characteristic when the hernia is on the left side. In the congenital variety the symptoms may be slight,

and the condition may only be discovered accidentally on X-ray examination. More often there is dyspnœa and discomfort, particularly after meals. In acquired cases, if the onset is sudden, there may be great shock and dyspnœa. More often the condition develops gradually, and the symptoms are those of discomfort or dyspnœa and distress after eating. In left-sided cases, vomiting is not infrequent. Hiccough and cough are common symptoms. The disturbance of digestion may cause considerable loss of weight. There may be some flattening of the upper part of the abdomen and some displacement of the heart. There is often diminished vocal fremitus at the base behind, and palpation may confirm the dislocation of the heart to a higher level than normal, or to the right. The percussion note may be tympanitic and breath sounds may be absent or weak.

Diagnosis.—This has to be made from pneumothorax and from eventration of the diaphragm, and in regard to these the X-ray findings are generally crucial. The physical signs of left-sided hernia may be strikingly similar to those of pneumothorax, and it is only by X-ray examination that the real nature of the affection may be recognised.

Treatment.—The treatment of the condition is surgical.

EVENTRATION OF THE DIAPHRAGM

Definition.—This name has been applied to a condition in which, owing to congenital or acquired thinness of half of the diaphragm, the pressure of the intra-abdominal contents causes the affected leaf of the diaphragm to bulge upwards. It is a rare condition. Symptoms are often entirely lacking, and the diagnosis may only be made by X-ray examination. When symptoms are present, they may be somewhat similar to those of hernia of the diaphragm.

DISEASES OF THE MEDIASTINUM

The mediastinum is the interpleural space, and occupies the median part of the thorax, from the superior aperture above to the diaphragm below. Strictly speaking, any affection of any of the important structures occupying this space, such as the pericardium, heart, great vessels, air passages and the thymus, might be included under this heading. They are, however, more conveniently grouped under the various systems to which they belong, and diseases of the mediastinum are commonly restricted to conditions arising in, or affecting the connective tissue and glands found in this space.

MEDIASTINITIS

Mediastinitis, or inflammation in the mediastinal connective tissue, may be acute or chronic. In the acute forms there may be an inflammatory serous exudate causing œdema, or the inflammation may progress to abscess formation. The chronic forms are indurative or fibroid in character, although chronic abscess may occur.

Acute Simple Mediastinitis

Ætiology.—Acute mediastinitis without suppuration may result from injuries to the chest-wall or sternum, and from lacerating wounds of the œsophagus or trachea. It is sometimes secondary to inflammatory processes in the lungs, pleuræ, pericardium or peritoneum, and to periostitis of the sternum or vertebræ. Pneumonia is a not uncommon cause.

Pathology.—There is hyperæmia of the mediastinal connective tissue with inflammatory œdema. Mediastinal serous effusions have been described, but these are, without doubt, encysted pleural effusions encroaching on the mediastinum.

Symptoms.—The clinical manifestations of acute mediastinitis are vague and not characteristic. There is a mild pyrexia, the temperature reaching 99° or 100° F. Pain under the sternum may be complained of, and on auscultation over it a few fine crepitations may be heard on deep breathing, or they may occur synchronously with the heart beats.

Course.—The affection may subside or proceed to abscess formation. It may result in fibroid thickening or adhesions.

Diagnosis.—Mediastinitis is often not recognised or suspected, since it is masked or overshadowed by the clinical manifestations of the primary condition

Treatment.—No special treatment is required, apart from that appro priate to the condition inducing it.

Acute Suppurative Mediastinitis

Ætiology.—Acute suppurative mediastinitis or mediastinal abscess is more common in males, and may occur at any age, although it is more frequently seen in early adult life than at other periods. Some cases are of traumatic origin, and follow perforating wounds or blows on the sternum, not necessarily causing fracture. Perforation or injury of the œsophagus is a comparatively frequent mode of access of pyogenic organisms to the mediastinum. This may occur from ulceration of an œsophageal new-growth, from injury due to a swallowed body such as a tooth plate, or from the passage of an œsophagoscope or bougie. Perforation of the trachea or main bronchi by an inhaled foreign body is sometimes the cause of mediastinal suppuration. Various pulmonary conditions may lead to pyogenic infection of the mediastinum, such as pulmonary abscess or gangrene, pneumonia and bronchiectasis. Periostitis or osteomyelitis of the sternum, vertebræ or ribs, suppuration in the mediastinal glands, or tracking down of deep cervical abscesses may all lead to mediastinal abscess. Extensions of pyogenic processes from the pericardium, pleura or peritoneum may also be causes. A suppurating hydatid or dermoid cyst may rupture into the mediastinum, and, lastly, the infection is blood-borne in some cases from infective endocarditis, pyæmia, erysipelas or enteric fever. Dieulafoy pointed out that certain cases of empyema, originating near the mediastinum, may, by encroaching on this region, induce predominating mediastinal symptoms, which he described as the "mediastinal syndrome." Such cases,

although abscesses in the mediastinum, are not mediastinal abscesses, but are in reality special instances of encysted empyema.

Pathology.—The suppuration may be limited to any part of the anatomical subdivisions of the mediastinum, or may spread from one compartment to another. The pus sometimes tracks in various directions, *e.g.* upwards to the neck, downwards to the abdomen, or it may point in the chest-wall. The abscess may rupture into the œsophagus, trachea, aorta, pleura or pericardium.

Symptoms.—The onset may be insidious or acute. In the latter case it may be ushered in by severe pain under the sternum, radiating to the back and shoulders. The symptoms may be divided into those due to the inflammatory process, and those resulting from the pressure exerted by the collection of pus. The former comprise malaise, fever and sometimes rigors, while blood examination may demonstrate a leucocytosis of 10,000 per c.mm. or over. The pressure symptoms vary according to the amount of pus produced and its situation. They include dyspnœa and paroxysmal or brassy cough, from compression of the vagus nerve or direct pressure on the trachea. There may also be dysphagia from obstruction of the œsophagus, and hoarseness from pressure on the left recurrent laryngeal nerve. Pressure on the spinal nerve roots, intercostal nerves, or brachial plexus may lead to severe neuralgic pains. Partial or complete obstruction of the great veins may be apparent from distension of the superficial thoracic veins or of those in the neck. Œdema of the chest-wall is sometimes seen from this cause, or it may result from the inflammatory process extending to the chest-wall. The signs in severe cases will be those caused by the pressure effects just described. The patient looks ill, distressed, dyspnœic and more or less cyanosed. The respirations may be noisy, as there is sometimes inspiratory dyspnœa with stridor, this being known as the *bruit de cornage*. The dilated veins may be apparent and the direction of the current may help to localise the seat of the obstruction. There is sometimes local redness and œdema from pointing of the abscess, near the sternum, in the neck, or in the interscapular region on either side. Palpation may reveal local tenderness and even fluctuation in any of these areas. There is often dullness over the sternum, sometimes extending to one or other side, or the dullness may be found in the interscapular region. It is said that the dullness may shift with the position of the patient in some cases. Breath sounds are distant, and weak or bronchial over the dull area, except when it is behind the sternum, when they are harsh.

Complications and Sequelæ.—The important complications are those due to rupture of the abscess. If this occurs into the lung or the œsophagus, pus is expectorated, or passes into the stomach. Gangrene of the mediastinum may follow, or death may occur from suffocation or hæmorrhage. Extension of the abscess may lead to purulent pleurisy, pericarditis or peritonitis, or to suppuration in the neck. In cases that recover, chronic mediastinitis with matting together of the mediastinal contents may be a sequel.

Course. The disease is acute and rapidly progressive, unless relieved by operation or by spontaneous external drainage in a few fortunate cases.

Diagnosis. The "mediastinal syndrome" of dyspnœa, stridor, paroxysmal cough, hoarseness and dysphagia with signs of pressure on arteries, veins and nerves is common to many conditions causing mediastinal pressure,

notably mediastinal new-growth, enlarged mediastinal glands, aneurysm and pericardial effusion. The differential diagnosis of these is more fully considered under mediastinal new-growth. The occurrence of fevers and rigors, the presence of a pointing swelling, and the demonstration of a leucocytosis may give strong suggestion as to the inflammatory origin of these symptoms and signs. The X-rays may reveal a localised mediastinal shadow, often non-pulsating, although it must be remembered that in rare cases a mediastinal abscess may pulsate.

Prognosis.—This is very grave, and the majority of cases die unless recognised and treated early. If gangrene develops, a fatal result is inevitable. The outlook is more hopeful when the anterior mediastinum alone is involved.

Treatment.—*Prophylactic.*—Foreign bodies in the œsophagus and trachea should be removed as rapidly and as gently as possible. The utmost care should be exercised in the passage of a bougie or the œsophagoscope in cases of œsophageal stricture.

Remedial.—As soon as mediastinal suppuration has been diagnosed and localised, surgical measures should be adopted. The mediastinum can be reached by resection of pieces of costal cartilage or by trephining the sternum.

Chronic Mediastinitis

This also occurs in two forms, chronic indurative mediastinitis and chronic abscess.

Chronic Indurative Mediastinitis.—This may occur as a sequel of any form of acute mediastinitis. The best known is that associated with chronic adhesive pericarditis, and usually known as chronic indurative mediastino-pericarditis. This condition is dealt with in the section of diseases of the pericardium. Other forms include the chronic inflammation and thickening which occur around enlarged, sclerotic and pigmented mediastinal glands, and around the same glands when affected by caseous or calcareous tuberculous lesions.

Chronic Mediastinal Abscess is generally of tuberculous origin, arising from breaking down caseous bronchial or mediastinal glands, or from tuberculous disease of the spine or ribs. A chronic abscess may, however, be caused by a foreign body, such as a bullet.

Symptoms.—Simple indurative mediastinitis may give rise to practically no symptoms or signs. Chronic abscess may cause symptoms of ill-health and of mediastinal pressure, or may only become apparent when it points superficially.

Treatment.—The treatment of chronic mediastinal abscess is practically the same as that for other "cold" abscesses due to tuberculosis, incision and drainage being avoided if possible in favour of aspiration and injection of antituberculous substances. Other cases may require operation.

EMPHYSEMA OF THE MEDIASTINUM

In performing tracheotomy, the pretracheal layer of deep cervical fascia is of necessity incised. If difficulty arises in inserting the tube into the

tracheal incision, air may be drawn deep to this fascia by the vigorous attempts at respiration and thus pass into the superior mediastinum, or superficial to it into the anterior mediastinum. Rupture of the trachea, bronchi or œsophagus, or rupture of air vesicles or pulmonary lesions where the pleura is adherent, may also cause it. In acute interstitial emphysema of the lungs, the escaped air may track along to the root and reach the mediastinum.

Symptoms.—Emphysema of the mediastinum may give rise to very indefinite indications. A few fine crackling sounds may be heard on listening over the sternum, sometimes varying with respiration or with the heart movements. The percussion note over the præcordium may be hyperresonant, and the heart sounds may be distant and muffled. Small quantities of air escaped into the mediastinum can be rapidly absorbed and may not be of serious import.

Diagnosis.—This is often a matter of speculation, unless the air spreads upwards to the neck and causes superficial surgical emphysema.

Prognosis.—This depends entirely on that of the underlying cause, which is often of serious nature

Treatment.—No special treatment is required, as a rule, apart from that of the primary condition, except that pain may necessitate the use of analgesic drugs at the onset.

ENLARGED MEDIASTINAL GLANDS

The mediastinal lymphatic glands are arranged in three groups. A few small ones are found in the anterior compartment, another group is situated in the posterior mediastinum. The third and most important is the tracheo-bronchial group, situated around the bifurcation of the trachea and extending along the bronchi. It is enlargement of this group that most often gives clinical manifestations.

Ætiology and Pathology.—A simple inflammatory enlargement of these glands may occur in many acute affections of the bronchi and lungs, and in certain acute specific fevers, notably influenza, pertussis and measles. A more chronic enlargement, associated with indurative changes, results from chronic respiratory diseases, such as chronic bronchitis and the pneumokonioses. In the latter case, considerable pigmentary changes may be found, from deposition of the particles derived from the dusty inspired air. In town-dwellers, these glands are often grey or black in colour from deposited carbon. Tuberculosis is the commonest cause of enlargement of the mediastinal glands, particularly of the tracheo-bronchial group, those about the right bronchus being most affected as a rule. This is a frequent early localisation of tuberculous disease in children. The infection spreads from the lungs in the majority of cases (Ghon), but in some instances the path of infection is from the tonsils through the cervical lymphatics and glands, while in others the mode of entrance is from the intestines through the mesenteric glands. The lesions may be miliary tubercles, or small caseous nodules which calcify subsequently, or which may soften and lead to local spread or generalisation. In other cases a fibroid hyperplasia of the glands results.

In syphilis, mediastinal adenitis may occur in the secondary or tertiary

stages. In Hodgkin's disease and in lymphatic leukæmia, the mediastinal glands may share in the general adenopathy, and in the former the condition may be primary in these glands. Enlargement due to malignant disease is of great importance and receives separate consideration.

Symptoms.—These may be slight and escape notice, unless the enlargement is sufficient to produce pressure or irritation. Cough is the commonest symptom; it is usually dry, irritative, noisy and ineffective. It may occur in paroxysms, somewhat suggestive of those of whooping-cough. Dyspnœa and dysphagia occur only when the enlargement is considerable. Vomiting sometimes develops, probably reflexly from vagal stimulation. Pain behind the sternum or in the upper thoracic region posteriorly may be complained of. In children with tuberculous disease in these glands, there is often languor, anorexia, anæmia and wasting, sometimes with slight irregular fever and night sweats. Such symptoms in a child of 5 to 12 years of age are very suggestive. The signs are also variable and frequently inconclusive. In tuberculous cases, the appearance of the child, pale, delicate looking or sallow, with long eyelashes and fine hairy growth over the back, may also be suggestive. In glandular enlargement from any cause there may be dilated veins over the front or back of the chest, especially in the upper part, and a "hilum dimple" has been described as appearing in the second intercostal space beside the sternum, on holding the breath at the end of inspiration. One pupil may be larger than the other, owing to sympathetic stimulation. Small areas of dullness may be found at the back, near the upper thoracic spines, or in front close to the manubrium. Breath sounds over these areas may be bronchial or harsh. Occasionally the enlarged glands impede the air entry to a lower lobe, generally the right, in which case breath sounds are notably weakened over this area, while the percussion note may be impaired. Normally, whispering pectoriloquy ceases at the seventh cervical spine; with enlarged mediastinal glands it may be heard along the middle line or close beside it, in the upper thoracic region from the first to the fifth thoracic spines. This is known as d'Espine's sign or tracheophony. It is a valuable confirmatory sign, when other indications are present. Eustace Smith's sign is of little value. It consists in a venous hum, audible over the manubrium sterni, when the child's head is thrown back as far as possible. Occasionally pressure on the recurrent laryngeal nerve may lead to an abductor paralysis of one vocal cord. In cases of tuberculosis, syphilis, Hodgkin's disease or leukæmia, enlarged glands may be present in other parts of the body, and may thus assist in diagnosis.

Complications.—A caseous gland may ulcerate into a bronchus or into the trachea, and death has resulted from glottic impaction of a portion of the gland. Ulceration into the œsophagus has been described. Rupture into the mediastinum may lead to mediastinal abscess. Invasion of the pleura, lung or pericardium may occur, or generalisation causing widespread miliary tuberculosis.

Diagnosis.—Whenever the condition of mediastinal glandular enlargement is suspected, an X-ray examination should be made if possible. It may help to distinguish between other conditions causing mediastinal pressure, such as aneurysm, abscess and malignant growth. Unfortunately in regard to tuberculous disease, it shows best the condition of least importance, namely, the old healed calcified glands. "Soft" or "woolly" shadows are regarded

as indicative of active disease, but in doubtful cases it is wise to act upon the clinical indications.

Prognosis.—This varies with the cause, being serious in Hodgkin's disease and leukæmia. In tuberculous cases, the prognosis is as a rule good, apart from complications, provided treatment is prompt and adequate.

Treatment.—In tuberculous adenitis, the general condition should be improved by every possible means. The child should be taken from school, rest and exercise are to be carefully graduated, and a liberal diet supplied, with extra milk, cream and butter. In England, the Isle of Thanet seems especially valuable in the climatic treatment of glandular tuberculosis. Cod-liver oil, malt extracts and the syrup of the iodide or phosphate of iron are useful. In afebrile cases, tuberculin cautiously given may be of value in children of 8 years or over, but it is not necessary, as a rule. If given, the initial dose should be small, $\frac{1}{500}$ to $\frac{1}{1000}$ mgrm. B.E., and the dosage gradually increased. In glandular enlargements due to syphilis, Hodgkin's disease and leukæmia, the treatment appropriate to these diseases should be employed, and symptoms due to pressure relieved as far as possible.

MEDIASTINAL NEW-GROWTHS

The mediastinum may be the seat of either simple or malignant new-growths, the latter being much more common.

Simple Tumours of the Mediastinum.—A bare enumeration is sufficient for their dismissal, since they rarely give rise to symptoms, and the recorded cases have, as a rule, only been discovered in the course of a routine post-mortem examination. The chief varieties found are lipoma, chondroma, osteo-chondroma and myoma.

Malignant Tumours of the Mediastinum.—Although it is certain that some malignant growths arise primarily in the mediastinal tissues, while others invade the mediastinum secondarily by extension or metastasis, it is often impossible, even at autopsy, to determine whether a mediastinal growth originated in the mediastinal tissues or in one of the adjacent organs, particularly the lungs. The differentiation between primary and secondary growths is therefore less sharp than in other situations.

Sarcoma of the Mediastinum.—Recent research has proved that the majority of mediastinal growths are sarcomatous. A primary sarcoma may arise in the lymphatic glands, connective tissue, periosteum of the sternum or vertebræ, or in the remains of the thymus gland. The commonest variety is the lympho-sarcoma, but spindle-celled and chondro-sarcomata may occur. Mediastinal sarcoma is commoner in males than females; it may occur in early life, and the majority of cases occur before the age of 40 years.

Carcinoma of the Mediastinum.—This is rare as a primary tumour. It occurs in older people. It may originate from the trachea, bronchi or œsophagus, in the remains of the thymus or in a retro-sternal goitre.

Secondary Malignant Growths of the Mediastinum.—These usually result from direct extension of primary growths of the lung, bronchi, trachea, œsophagus, chest-wall or breast, but true metastases may occur from mammary growths or from more distant primary tumours. Endothelioma has been described in the mediastinum, but is probably generally secondary to endothelioma of the pleura.

Pathology.—The morbid appearances depend upon the situation of origin, the directions of growth, and the nature of the tumour. Sarcomata are generally soft, pinkish in colour and vascular, while carcinomata are paler and firmer. There may be one large mass weighing several pounds, or there may be multiple growths. When the tumour reaches a considerable size it may infiltrate, surround, compress or displace contiguous structures. This is particularly the case in the lympho-sarcomata. The trachea, œsophagus, and large vessels may be surrounded, the pericardium and heart may be extensively infiltrated, and the nerve trunks may be enclosed and compressed. Secondary deposits are common in other glands, but not infrequently the pigmented bronchial glands may be seen entirely enclosed in growth without being infiltrated.

Symptoms.—The onset is often insidious, and the condition may not be suspected until the cachexia and pressure signs develop. Malaise, weakness, shortness of breath, cough and pain are often early symptoms, which become more pronounced as the case progresses. The pressure symptoms and signs constituting the "mediastinal syndrome" comprise—

1. *Pressure on the air passages*, giving rise to dyspnœa, cough and expectoration. The dyspnœa may be inspiratory and associated with stridor, or expiratory and paroxysmal. The cough is harsh and may be "brassy"; it is often associated with mucoid, blood-stained, or even "prune juice" sputum. Bronchiectasis may result in some cases.

2. *Pressure on or infiltration of the lung*, leading to collapse and sometimes breaking down of lung tissue. If the pleura is reached or invaded, pleural effusion, often blood-stained, may result.

3. *Pressure on arteries.*—Compression of branches of the pulmonary artery may lead to local gangrene, or in other cases the growth may ulcerate into a larger vessel and cause fatal hæmorrhage. Pressure on the subclavian artery may cause inequality of the radial pulses, and according to Ekgren this may only be present when the patient is lying and not when he is standing.

4. *Pressure on veins.*—Dilated tortuous veins may be seen over the front of the chest and abdomen, or in the neck. The flow of blood in these superficial veins may be reversed, owing to the obstruction of the superior vena cava or its main radicles. The current then runs from above downwards, instead of from below upwards, as normally. There may be œdema of the chest-wall or of the face and neck from the same cause.

5. *Pressure on nerves.*—The vagus may be compressed, causing paroxysmal dyspnœa and cough. Laryngeal paralysis or spasm may result from involvement of the recurrent laryngeal nerve. Dilatation of the pupil, followed later by constriction, drooping of the upper lid and enophthalmos, occurs when the sympathetic is involved. Paralysis of the diaphragm on one side from compression of the phrenic nerve, and pain from involvement of the intercostal nerves, may be present.

6. *Pressure on the œsophagus* may lead to dysphagia of increasing degree.

In addition to the signs afforded by these various conditions, there may be glandular enlargements in the neck, the suprasternal notch, or in the axillæ. The growth may invade the chest-wall at any spot, and in rare cases it may pulsate. The pulmonary physical signs are dyspnœa, sometimes orthopnœa and cyanosis. In some instances the patient prefers to lean forward; this is said to be due to the fact that in this position the antero-posterior diameter

of the mediastinum is increased, and the tension caused by the growth is thereby lessened. There may be dullness over the sternum or over the upper thoracic spines, and over any part of the lung invaded or compressed by the growth. The breath-sounds heard over the dull area may be harsh, bronchial, tubular, weak or absent. The signs due to any secondary condition, such as bronchitis, bronchiectasis or a pleural effusion may be found in addition.

Complications.—These include the secondary conditions just mentioned. Others are due to ulceration of the growth through the chest-wall, into the trachea, bronchi, œsophagus or aorta. Pericarditis may occur if the growth invades the pericardium, and hæmopericardium may result from ulceration of a vessel.

Course.—The growth enlarges progressively and the course is often rapid, particularly in lympho-sarcoma. Fulminating cases lasting only a few weeks occur, more commonly the patients live from 6 months to 2 years from the onset, rarely more.

Diagnosis.—When signs of mediastinal pressure become apparent, new-growth should be suspected, in common with aneurysm, mediastinal abscess or cyst, enlarged mediastinal glands and pericardial effusion. The history, the general condition of the patient, the physical signs, blood examination, and the X-rays may all help in distinguishing between these conditions. The evidence afforded by the X-ray may be of the utmost value. The pulsating shadow of an aneurysm, the large area of a pericardial effusion, the indefinite edge of an infiltrating growth extending into the lung, may be shown clearly, but the appearances should always be interpreted in the light of the other clinical features, and a diagnosis should not be made on X-ray findings alone, since a growth may pulsate, or may give rise to an effusion, while a mediastinal abscess or cyst may give a sharp shadow. An œsophageal new growth can sometimes be differentiated by the œsophagoscope, but this should only be employed when aneurysm can be excluded. Diagnosis from pulmonary new growth may be almost impossible. Before the onset of pressure symptoms, growth may be suspected from the cough and emaciation, and here again the X-rays may give valuable indications. Chronic tuberculous disease should always be excluded by repeated sputum examinations. The diagnosis of mediastinal growth may sometimes be obscured by some of the complications it induces, notably pleural effusion and bronchiectasis. The rapid onset and progress of these conditions and the bloodstained character of an effusion may all suggest the possibility of a malignant cause. The presence of enlarged glands in the neck or axillæ, or of nodular growth in the chest-wall or episternal notch, may afford almost conclusive evidence of malignancy.

Prognosis.—This is practically hopeless and death occurs from exhaustion, starvation, toxæmia, asphyxia or hæmorrhage.

Treatment.—The treatment is that of inoperable malignant disease elsewhere. X-ray applications, or radium treatment in some form may be tried. Otherwise treatment is symptomatic and palliative. Pain may be relieved by aspirin, pyramidon, codeine or morphine. Sleep may be induced, if there is insomnia, by chloral hydrate, omnopon or other hypnotics. If effusion is causing dyspnœa it may be tapped, but the fluid usually collects again rapidly.

CYSTS OF THE MEDIASTINUM

SIMPLE CYSTS.—These are usually small and of no clinical importance.

DERMOID CYSTS AND TERATOMATA.—These are very rare and become apparent generally in young adult life. They may enlarge, giving rise to symptoms and signs similar to those of a mediastinal tumour, or they may lead to empyema. They usually contain pultaceous material, and sometimes hairs, muscle, cartilage, bone and teeth. Such cases are almost certainly teratomatous in nature and derived from included embryos. This condition may sometimes be diagnosed during life by the expectoration of hair, teeth, bone or cartilage. The prognosis is, as a rule, serious, but some cases recover under appropriate surgical treatment.

HYDATID CYSTS.—A hydatid cyst may be primary in the mediastinum and may give rise to signs of mediastinal pressure, but the condition is extremely rare. Its presence may be shown by X-rays and its nature demonstrated by the blood reactions or by paracentesis. Such cysts have been successfully treated surgically.

Other rare mediastinal conditions are hernia of the stomach or colon through the diaphragm into the mediastinum. A retro-sternal goitre may also form a mediastinal swelling.

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SECTION XV

DISEASES OF THE KIDNEYS

THE CHARACTERS OF NORMAL URINE

The amount of urine normally secreted in 24 hours is 50 ounces or 1500 c.c. The specific gravity of the total should lie between 1015 and 1025, though individual specimens will vary considerably more, according to the amount of fluid imbibed or the quantity excreted by the skin and bowels. The reaction should be acid, due to the presence of acid sodium phosphate, NaH_2PO_4. The total acidity should be such that about 650 c.c. of decinormal caustic soda will neutralise the daily output. This is equivalent to 82 grains of $NaHCO_3$, but it requires a rather larger quantity (120 grains according to Spriggs) of bicarbonate of soda by the mouth to effect this neutralisation. The total acidity of the urine rises very considerably in acidæmia, and may be more than doubled despite large doses of alkalis. Normally, urine is more acid during fasting than during absorption of food, the acid and alkaline tides being thus produced. The alkaline tide is often explained as due to the gastric juice withdrawing hydrogen ions from the blood, but this must be balanced by the pancreatic secretion of hydroxyl ions. More probably the alkaline tide is due to the absorption of alkaline vegetable salts, as it is more marked in herbivora. On decomposition, either in the bladder or after excretion, the urine becomes alkaline, from the conversion of urea into ammonium carbonate.

The constituents of urine are partly derived from the food (exogenous) and partly from the katabolism of the tissues (endogenous). We may briefly consider the source and significance of the principal constituents.

Nitrogenous constituents.—The total nitrogen excreted each day on an ordinary mixed diet is about 18 grammes or 270 grains. Of the various nitrogenous constituents urea is by far the most abundant, its output being 33 grammes, which contains 15·4 grammes of nitrogen, or 85 per cent. of the total. As so much of the urea comes directly from the food, the amount of urea falls both absolutely and relatively in starvation; the total nitrogen drops to 5 grammes or even less, of which urea nitrogen forms about 60 per cent. On a diet rich in carbohydrates and fat, but containing hardly any nitrogen, these figures may fall still lower, as the assimilation of other foodstuffs reduces the waste of tissue nitrogen to a minimum. This is often forgotten, and in nephritis undue importance is attached to a drop in the output of urea, which is simply due to the diet prescribed being poor in nitrogen, whereas the urea excreted depends mainly on the quantity of protein ingested.

Next in importance come the purin bodies. Purins contain the group C_5N_4, and the best known is tri-oxy-purin or uric acid $C_5N_4H_4O_3$. A small quantity of the less oxidised purins, xanthin and hypoxanthin is also excreted. Exogenous purins come mainly from meat juices, from the nuclei of cellular organs (such as liver and sweetbread), and from tea, coffee or cocoa. Only from one-tenth to one-half of the ingested purins are excreted as such, the remainder being destroyed by the liver, ultimately appearing as urea. The alkaloids of tea, coffee and cocoa give rise chiefly to xanthin and hypoxanthin, the rest to uric acid. On a diet rich in meat the daily output of purins amounts to 0·34 gramme of nitrogen, and on a purin-free diet to 0·202 gramme. This endogenous purin, which forms the larger part, comes mainly from the leucocytes and muscles. Anything increasing the leucocytes in the circulation increases the output of endogenous purins, and in leukæmia the excretion of uric acid may rise to 5 grammes a day. Unaccustomed exercise diminishes the output of uric acid, while increasing that of the less oxidised xanthin and hypoxanthin, the total purin excretion remaining the same. Uric acid is only excreted as such when the urine is highly acid: normally it appears as acid sodium urate. (See also Urinary Deposits.)

Creatinin is, according to Folin, the most constant of the nitrogenous constituents on a meat-free diet, and serves as a measure of endogenous nitrogenous metabolism. In a healthy young man on a diet consisting entirely of bread, about 0·9 gramme is excreted daily, while on a diet containing meat extracts more than 2 grammes may be passed. During muscular wasting its output is increased, while in a subject already wasted it is diminished. All this suggests that it is derived from the creatin of muscle—both of the body and of the food. It may be recognised in urine by Weyl's test; with sodium nitroprusside and caustic soda it gives a ruby-red colour, which, unlike that given by acetone, is at once destroyed by glacial acetic acid. Jaffe's test depends upon the deep orange colour, given by even dilute solutions of creatinin on the addition of a saturated solution of picric acid and some 10 per cent. solution of caustic soda: this has been utilised for the colorimetric estimation of creatinin by Folin.

Creatinin can be obtained from creatin by dilute boiling mineral acids. Creatin, which is abundantly present in muscles, is not normally present in the urine. It has been claimed that it appears in urine during starvation, but Graham and Poulton have shown that the presence of diacetic acid, which is invariable in starvation, vitiates the methods ordinarily employed to show it. It is said that its presence in the urine is of value in the diagnosis of carcinoma of the liver; but this is doubtful. It is recognised by the increase in the creatinin which follows treatment of the urine with hydrochloric acid.

Ammonia is normally excreted to the extent of about 1 gramme a day. An increase in this amount is not, as was formerly thought, a sign of incapacity on the part of the liver to form urea, but a sign of acidæmia. The body protects itself against acids in the circulation by forming ammonia from the proteins of the tissues. The increased excretion of ammonia is, therefore, a measure of the degree of acidæmia, and it is estimated by the amount of acid set free from the urine on the addition of formalin, which combines with the ammonia to form hexamine. In the acidæmia of diabetes, the output of ammonia may rise to 4 grammes a day, or even more.

Hippuric acid is not an important nitrogenous constituent of urine, but it is of interest as being made by the kidney itself by the combination of benzoic acid with glycocoll. It is, therefore, increased by a diet of green vegetables, and is diminished when there is conspicuous degeneration of the renal tubules.

The pigments of urine are nitrogenous. The principal one, urochrome, to which urine normally owes its colour, though closely related to urobilin, has an independent origin from hæmoglobin. Even when all the bile escapes from the body through a biliary fistula the excretion of urochrome is unaltered. Urobilin, on the other hand, is a reduction product of bile pigment. The reduction is effected by bacterial action in the bowel, whence it is reabsorbed by the blood and excreted by the kidney. Normally it is not excreted as such, but as a colourless chromogen. The appearance of preformed urobilin is evidence either of increased hæmolysis, or of increased intestinal putrefaction, or of increased time for reabsorption, as in intestinal obstruction. It can be recognised with the spectroscope by the absorption band it gives in the blue, or by the green fluorescence it shows on the addition of zinc chloride and ammonia. Very little is known of uroerythrin; it is an unstable body and is readily carried down by urates, to which it imparts the characteristic pink colour. A trace of hæmatoporphyrin is also normally present in the urine; but an obvious amount is an abnormality, which will be considered later.

Non-nitrogenous constituents.—These are principally salts. Chlorides are the most abundant, averaging about 10 to 13 grammes of sodium chloride a day. During the exudative stage of pneumonia this is much reduced, and it may be also considerably diminished in nephritis. The phosphates are partly excreted as acid phosphates of sodium and potassium, partly as earthy phosphates of calcium and magnesium. The former are not precipitated on neutralisation, while the latter are. A phosphatic deposit, as stellar crystals of calcium phosphate or tables of magnesium phosphate, is no proof of a real increase in the output of phosphates, but is usually merely an indication of diminished acidity. Ammonio-magnesium phosphate, on the other hand, is evidence of ammoniacal decomposition. It forms a deposit of "coffin-lid" or "knife-rest" crystals. The amount of phosphoric acid excreted daily amounts to about 2·5 to 3·5 grammes, of which the earthy phosphates form half. Sulphates are present in the urine to the extent of 1·5 to 3 grammes of SO_3 a day. Very little sulphate is taken in the food, and most of that which is taken either as food or medicine is excreted by the bowel, so that the urinary sulphates come almost entirely from the oxidation of the sulphur in the protein molecule. About nine-tenths are excreted as sulphates of the alkalis, and the remaining one-tenth as ethereal sulphates, formed by conjugation with putrefactive products from the tyrosin and tryptophan of the protein molecule. Of these, the most striking is indican, or indoxyl-sulphate of potash. It is best detected by adding an equal quantity of strong hydrochloric acid to some urine, then a few drops of hydrogen peroxide, and shaking up the mixture with some chloroform. The indican is oxidised to indigo, which imparts a blue colour to the chloroform. It should not be found in the urine of children, but is normally present during middle or later life in those living a sedentary life, if meat be taken freely. Herter described those from whose urine it is absent as "candidates for old age." Its presence in excessive

amount is some evidence of excessive intestinal putrefaction or of intestinal stasis; but Mackenzie Wallis believed it was sometimes synthetically produced. It is important that it should be looked for when the urine is fresh, as it tends to disappear on standing. It is not, however, an accurate guide to the total amount of ethereal sulphates, which may be definitely increased even though the amount of indican is small. A rise in the proportion of the total sulphates which are excreted in ethereal combination is better evidence of intestinal intoxication than a well-marked indican reaction. The cherry-red colour sometimes given by this test is due to indol-acetic acid; its presence is usually associated with definite symptoms of intestinal intoxication. All the sulphur in the urine is not excreted as sulphates; some 6 per cent. appears as neutral sulphur, derived from the sulphocyanide of the saliva, the taurine of the bile salts and substances allied to cystin. The neutral sulphur is diminished in insanity.

Many other substances are normally present in traces in the urine, but except diastase, they are of little clinical importance. Ten to 30 units of diastase are normally present, but less will be found in some forms of impaired renal capacity and a great deal more in most pancreatic diseases. The presence of 50 units suggest a pancreatic lesion, while 100 or more make this certain. In severe pancreatitis 300 to 500 may be found.

THE ESTIMATION OF RENAL FUNCTION

It may be necessary to determine (1) the total renal capacity, or (2) the adequacy of either kidney separately. Generally speaking, the first is more the concern of the physician, and the second that of the surgeon. Estimation of the latter is of vital importance before nephrectomy is considered, lest the remaining kidney should prove inadequate to maintain life. Estimation of the former is an assistance both to diagnosis and prognosis. Some of the tests under the first heading have for their object the determination of the part of the kidney involved. These will be considered first.

A.—Estimation of Capacity of both Kidneys

1. *Examination of the blood.*—The damaged kidney will fail to excrete substances which it should, and examination of the blood may reveal their presence in undue amount. The quantity of urea in the blood throws important light on renal capacity; normally this ranges from 0·02 to 0·05 gramme per cent., but is raised in various kidney diseases. According to Widal, patients with more than 0·2 per cent. of urea in the blood cannot live more than a few months. As pointed out under Uræmia, a rise in the percentage of urea in the cerebro-spinal fluid above 0·1 is of ill omen, and if it rises above 0·3 the case will almost certainly be fatal. The amount of sodium chloride in the blood may be raised from the normal 0·45 to 0·5 gramme per cent. to 0·6 or higher. When there is extreme renal failure there may be an increase in the H-ion concentration, the uric acid and the indican of the blood, while the calcium content may fall from the normal 10 mgm. per cent. to 6.

2. *The urea concentration test.*—MacLean has recently introduced this

simple and helpful method. Although ordinary estimation of the percentage of urea in urine gives no information of value, the response of the kidney to a given dose of urea does. Fifteen grammes of urea dissolved in a 100 c.c. of water, and flavoured with a little tincture of orange, are given to a patient just after he has emptied his bladder. The urea in the urine passed 1 and 2 hours afterwards is estimated by the hypobromite method. If this amounts to 2 per cent. or more in the first specimen the kidney is efficient, and the second specimen need not be examined. But sometimes the diuretic action of the urea leads to dilution of the urine. This will have passed off by the end of the first hour, so the second specimen will act as a control. Some observers prefer to rely upon the specimen passed at the end of the third hour, and regard a figure below 2·5 per cent. as an unfavourable indication when operation on the urinary tract is under consideration. A moderately efficient kidney may show a concentration of 1·5 per cent., while a very bad one may excrete a urine with 1 per cent., or even less urea. This is one of the best means of estimating renal efficiency.

3. Various tests have been elaborated to try and differentiate between tubular and glomerular damage, but they have not proved very satisfactory. Schlayer has attempted to do this by studying the reaction of the kidneys to the excretion of chlorides, iodides and lactose. He claims that a healthy kidney can get rid of 5 grammes of salt by merely increasing the concentration of the urine, but that if the tubules are damaged it cannot excrete urine of the requisite concentration. A delay in the excretion of iodide is also taken to indicate tubular damage. On the other hand, lactose injected intravenously is believed to be excreted by the glomeruli. But these last two tests are not free from risk.

4. *The specific gravity test.*—This is a simplification of Schlayer's concentration test. After an ordinary breakfast, the patient drinks no fluid and eats no juicy fruit for 24 hours. The sp. gr. of all the urine passed during the second half of this period is determined. A reading of 1020 or less indicates some failure of concentration.

5. *The phenol-sulphone-phthalein (phenol-red) test.*—One c.c. of sterile salt solution containing 0·006 gramme of the drug is injected hypodermically. The urine is collected 1 hour and 10 minutes afterwards, and again an hour later. On the addition of some 25 per cent. caustic potash to the urine, it should turn pink when the drug has percolated. Normally 40 to 60 per cent. should appear in the first hour, and 60 to 85 per cent. in the first 2 hours. According to Rowntree and Fitz this is the best test to distinguish functional incapacity due to nephritis from that due to chronic passive congestion, the failure to excrete the drug being prominent in the former, and only occurring in the latter when the congestion is very severe. Some other observers have not been so favourably impressed by this test.

B.—Estimation of Capacity of each Kidney

It is generally agreed that the introduction of a separator into the bladder and the collection of urine from either side is fallacious as a guide to the activity of the two kidneys. Catheterisation of each ureter under the direct view of the cystoscope is the only reliable method. Several of the tests

previously described may be adopted for this purpose, such as the injection of phenol-red. The urine should be collected for 2 to 2½ hours. It is usual to encourage secretion during examination by giving some tea or simple diuretic. Afterwards, hexamine should be given as a precautionary measure, and the patient kept in bed for 36 hours. The amount of sugar with the first test or of colouring matter with the second is compared on the two sides. Another drug frequently used for this purpose is methylene-blue; 15 minims of a 5 per cent. aqueous sterilised solution are injected into the buttock. It is first excreted as a colourless chromogen and, later, as methylene-blue itself. The chromogen turns blue when boiled with acetic acid, and should appear in the urine in from 15 to 20 minutes, after which the excretion of unaltered methylene-blue should begin. It should reach its maximum in from 4 to 5 hours, and should have disappeared in from 40 to 50 hours. Obviously, catheterisation of the ureters cannot be continued all this time, so that observation is directed towards a marked delay in the appearance of blue on one side as compared with the other. As in acute or subacute nephritis the rate of methylene-blue excretion is entirely unaffected, the utility of this test is confined to unilateral chronic disease.

Indigo-carmine may be used for a similar purpose; 0·16 gramme of the drug is dissolved in sterilised water and injected hypodermically. The urine should be coloured in about 10 minutes, first appearing green and then blue. Excretion reaches its maximum in about an hour, so that this test has advantages over the methylene-blue method. Delay in the appearance of the dye and a feeble staining of the urine may be taken as evidence of disease. For fuller details of these methods the writings of Thomson-Walker should be consulted.

Pyelography is a valuable method of detecting hydronephrosis, pyonephrosis, etc. Four to 10 c.c. of 15 per cent. solution of sodium bromide are injected very slowly through a fine needle into either ureteric catheter and an X-ray photograph taken. In this way, the bromide being opaque to the rays, a beautiful picture of the ureter and pelvis of the kidney may be obtained.

ABNORMALITIES OF THE URINARY SECRETION

Polyuria

Polyuria may be due to—

1. Increase in the quantity of fluid imbibed.

2. Increase in the molecular concentration of the urine as in diabetes mellitus, or after saline diuretics. More water is thereby attracted into the blood stream by osmotic pressure.

3. Incapacity of the kidney to excrete a concentrated urine, as in chronic interstitial nephritis.

4. High blood-pressure, which tends to force more blood through the renal vessels.

5. Dilatation of the kidney vessels, as produced by stimulating diuretics of the caffeine group.

"Diabetes insipidus" is frequently due to disease of the pituitary gland

or of the overlying hypothalamus, or to damage in this neighbourhood by specific meningitis of the base of the brain. It is also probable that hysterical polyuria is due to a temporary effect on the pituitary through the sympathetic (Cushing). This alteration of the pituitary secretion appears to affect the renal vessels directly, since pituitrin will check diuresis, even in the denervated kidney.

Anuria

Suppression, as opposed to retention of urine, may be due to—

1. Acute nephritis with intense congestion and nephrosis, whether the result of an infection or of drugs, such as turpentine, cantharides or carbolic acid.

2. Bilateral obstruction to the ureters.

3. Reflex causes, such as operations on the kidney or trigone of the bladder.

4. Vasomotor conditions, as collapse, shock or irritation of the vasomotor centre. Probably the anuria in diphtheria is due to the last of these (Garratt). In cholera there is not only collapse, but depletion of water by other channels.

5. Hysterical. This condition has been described by Charcot. It is, however, rare, and the element of fraud must be eliminated. Thus in one case I found urea abundantly present in the contents of the washing bowl, and this explained how the urine was disposed of.

Albuminuria

Albuminuria should be more correctly termed proteinuria—since blood serum contains two proteins—albumin and globulin—and either may appear in the urine, though search is seldom made for the latter. The ordinary tests of heat coagulation, nitric acid or salicyl-sulphonic acid give positive results with either. Mackenzie Wallis recommended the following tests for globulin in the urine. If dilute acetic acid (33 per cent.) be added to a urine containing it, a white precipitate is produced without the aid of heat. This may be confirmed by filling a tall cylinder with distilled water and adding urine drop by drop from a pipette. As the drops descend in the water, white rings form when globulin is present in large amounts. The globulin can be precipitated for quantitative examination by making the urine alkaline with ammonia, and then half saturating it with ammonium sulphate.

Proteinuria may be classified thus—

(A) Without Organic Diseases of the Kidneys, as in—

1. *Functional or orthostatic proteinuria.*—This is common in males between puberty and adolescence; it is much less common in females of the same age. Dukes found it in 16 per cent. of all boys entering Rugby School. Protein appears only in the urine secreted in the upright posture, and is absent from the urine passed on first rising. There is no evidence that the amount of protein in the food influences it, though some constituent of raw eggs may excite a transient albuminuria by a toxic action on the kidneys. Severe physical exercise will excite proteinuria in most healthy young adults. Collier

found it present in every one of the Oxford crew of 1906 after rowing a course; to such a condition the term "physiological" proteinuria may fairly be applied. When the protein appears apart from exertion, the subject is often an anæmic weedy youth with a dull heavy aspect and a tendency to fainting. The heart is irritable, and the blood-pressure unstable, and fluctuates with change of posture. There may also be a few hyaline casts, and frequently calcium oxalate crystals. In any case of proteinuria in a boy or young man the diagnosis of a kidney lesion should not be made unless casts other than hyaline are discovered, unless the tension of the pulse is definitely and permanently raised, and unless there are signs of cardiac hypertrophy. In the absence of such evidence, the urine passed on first rising should be examined. If this is free from protein, the condition is almost certainly functional. Then 15 grains of calcium lactate should be given three times a day for 3 days, after which the urine should be examined again. If this checks the proteinuria no further anxiety need be felt. Some milder forms of toxæmic kidney may simulate functional proteinuria, so that a search should be made for toxic foci, such as septic tonsils, tuberculous glands, or chronic appendix trouble, in all cases. A holiday is advisable if the patient has been doing hard mental work, as the condition is apt to appear under the strain of competitive examinations. A tepid bath, with cold sponging down the spine, and followed by vigorous towelling, is advantageous, and a general tonic such as strychnine, with iron if there is anæmia, should be prescribed. The condition soon rectifies itself when adolescence is past, and any case of proteinuria in a patient approaching thirty probably does not fall into this category.

2. *Febrile.*—Any acute specific fever may be accompanied by proteinuria due to cloudy swelling of the kidney. It should subside soon after the temperature falls to normal.

3. *Congestive.*—In failing heart there is usually proteinuria from venous congestion of the kidneys. Hyaline casts may also be found. Unlike the urine of nephritis the urine is loaded with urates. After an epileptic fit there is often a transitory proteinuria, probably due to the congested condition of the veins during the fit. For a similar reason protein is apt to be present in the urine of any unconscious person.

4. *Toxic.*—This forms an intermediate group between those with and those without organic disease of the kidney, for if the action of the toxin be prolonged a definite nephritis may be established. Thus the proteinuria of pregnancy is generally regarded as toxæmic in origin, and may clear up completely. The proteinuria sometimes seen in jaundice is also toxic in character.

(B) With Organic Diseases of the Kidneys.

1. *Nephritis, acute and chronic.*

2. *Leaky kidney*, by which is meant a condition in which the kidney leaks, allowing some of the blood proteins to escape; but is not the subject of a progressive lesion, as in nephritis. This is considered further under the diagnosis of Bright's disease.

3. *Amyloid disease of the kidneys.*

4. *Tumours and infarcts in the kidney* may cause proteinuria, but more usually simple hæmaturia.

Albumosuria

Albumose, or more correctly proteose, is the name applied to the disintegration product of protein, which on further breakdown yields peptone. Proteose is found in urine during autolysis of the tissues, such as occurs during reabsorption of a pneumonic exudate, in involution of the uterus or in acute yellow atrophy of the liver. It is not of great clinical importance. Proteose can be recognised by the fact that although it is precipitated by saturation with ammonium sulphate it is not coagulated by heat. Proteose precipitates disappear on heating and reappear on cooling. It can be separated from albumin by saturating the urine with crystals of ammonium sulphate, boiling and filtering. The precipitate on the filter paper is washed with water, when any proteose will be redissolved and carried through the filter paper. It can then be detected by the pink colour it gives on the addition of strong caustic soda and a drop of dilute solution of copper sulphate. With these reagents native proteins give a violet colour. The Bence-Jones protein, which is found in considerable amounts in the urine of sufferers from multiple myelomata, is not a true proteose though possessing similar solubilities. On treatment as above it yields a violet colour, showing that it has affinities with native proteins. It begins to be precipitated at 50° C., but on approaching boiling-point most of the precipitate is redissolved. This is probably due to the influence of certain salts in the urine, and is not a property of the isolated protein. As Bradshaw showed, it also gives a ring of coagulum on contact with strong hydrochloric acid. Its recognition is of great diagnostic value, as it is pathognomonic of multiple tumours of the bone marrow, and enables them to be detected before there is any external sign, but only pain and tenderness in the bones. At a later stage the tumours may break through the investing bone and give rise to palpable swellings. Sometimes the Bence-Jones protein is spontaneously precipitated, causing the urine to appear milky. In one such case I found considerable excess of phosphates in this milky precipitate, probably derived from the autolysis of the surrounding bone.

True peptone is exceptionally found in the urine in pneumonia and phthisis, but is of no clinical importance.

Hæmaturia

When blood is intimately mixed with the urine it is held to be in favour of its renal origin. Bleeding from the bladder is more apt to occur into the last part of the urine voided, while urethral bleeding is said to occur chiefly into the first part. When the quantity of renal bleeding is not great, it imparts a smoky appearance to the urine, owing to the conversion of some of the hæmoglobin into methæmoglobin, which gives an absorption band in the red on spectroscopic examination. The chief causes of hæmaturia may be classified, more conveniently than scientifically, as follows:

1. *Prerenal.*—The altered condition of the blood which occurs, for instance, in scurvy, purpura hæmorrhagica and certain hæmorrhagic fevers, leads to the escape of some of the blood through the kidney without any evidence of a definite kidney lesion.

2. *Inflammations of the kidney,* due to (*a*) Bright's disease, both acute

and chronic. Hæmaturia is a constant feature of acute nephritis and of exacerbations of chronic nephritis. It may also occur in the course of chronic interstitial nephritis, without any acute symptoms. "Renal epistaxis" is usually an early sign of an interstitial change, which is sometimes, as shown by Hurry Fenwick, confined to a single papilla where the vessels are dilated.

(*b*) Tuberculosis or a *Bacillus coli* infection. The latter more usually affects only the pelvis of the kidney.

(*c*) Certain drugs, such as turpentine, cantharides and carbolic acid, or occasionally hexamine.

3. *Irritation of the kidney by foreign bodies*, such as

(*a*) New-growth.
(*b*) Infarcts.
(*c*) Crystals, such as oxalates or uric acid, and calculi.
(*d*) Parasites, such as Bilharzia.

Traumatic, vesical and prostatic causes are not considered here.

Hæmoglobinuria

This is due to some hæmolytic agent. It may be

1. *Paroxysmal*, as in Raynaud's disease and in syphilis. In many cases the cause is obscure, but Wassermann's reaction will probably show that most of these are syphilitic. It would appear that in such persons there is always present a hæmolysin which is set free in the serum on exposure to cold, and which is absorbed by the red corpuscles. On return to warmth this hæmolysin is activated by a complement present in normal serum and leads to destruction of red corpuscles (Donath and Landsteiner). Thus, if the patient's finger with a string tied firmly round it be immersed in ice-cold water for a few minutes, some of the red corpuscles will be found to have hæmolysed.

2. *Continuous*, or, rather, for as long as the hæmolytic agent is at work. The real distinction is that in this second group the agent can produce the hæmoglobinuria without an additional factor. Sometimes the agent is a drug like potassium chlorate or arseniuretted hydrogen, sometimes it is an organism like the malarial parasite, and sometimes it is an unidentified toxin, such as is developed by extensive burns. In this connection it may be observed that potassium chlorate appears to be less frequently the cause than formerly (perhaps because it is given in smaller doses or is prepared in a purer state), and that some observers believe black-water fever, a variety of malaria in which hæmoglobinuria is a leading symptom, is due to the large doses of quinine. The chemical tests for hæmoglobinuria are the same as for hæmaturia, but the microscope will fail to reveal red corpuscles. Some of the pigment may be excreted as methæmoglobin, especially after drugs of the aniline group, nitrites, or potassium chlorate.

Hæmatoporphyrinuria

Sometimes the hæmoglobin molecule is broken down in the blood stream and the pigmentary portion is excreted apart from the protein and iron. This is usually due to poisoning by sulphonal or trional, particularly when

the drug has been taken regularly for a long time. It is then of grave prognosis; large doses of alkalis should be given. It is commoner in females than in males. Occasionally hæmatoporphyrinuria occurs apart from these drugs, when it is not of grave import. It has been met with in cirrhosis of the liver, gastric ulcer and as a congenital abnormality of metabolism, when it may be associated with hydroa æstivale. Exceptionally toxic symptoms occur even when it is not associated with sulphonal or trional, as in two cases recorded by Ranking and Pardington, and by one of us. In these, some intestinal toxin with a reducing action appeared to be at work. Hæmatoporphyrin sometimes imparts a port-wine colour to the urine, but sometimes it is excreted in combination with a metal. In the latter case the urine is brown, from the admixture of some unknown pigment, and the spectroscope shows two bands closely resembling those of oxyhæmoglobin. On the addition of an acid, however, the characteristic bands of acid hæmatoporphyrin appear.

Choluria

Another derivative of hæmoglobin, bile pigment, appears in all forms of jaundice due to obstruction of the main or intrahepatic ducts. In a true hæmolytic jaundice, such as acholuric family jaundice, as the name implies, bile does not appear in the urine. Bile pigment can often be recognised by noting the tinging of the froth caused by shaking the urine, but is best detected by the addition of a drop of fuming nitric acid to filter paper dipped in the urine, when rings of colour appear, green being the essential one. The green colour given on addition of a solution of iodine to the urine is a less delicate test. Bile-salts are often absent from the urine when bile pigment is present. Matthew Hay's test is the only reliable one for their presence there. On putting flowers of sulphur on the surface of the urine, they sink to the bottom, owing to the lowering of surface tension by the bile-salts.

Melanuria

Melanin only appears in the urine in melanotic sarcoma. Garrod has shown that in all other diseases in which melanuria has been recorded the test employed has been unsatisfactory. The melanin is excreted as melanogen which darkens on standing, and gives a black precipitate on addition of ferric chloride, which is soluble in excess of the reagent, yielding a black solution. A more delicate test is made by the addition of sodium nitroprusside and sufficient caustic soda to render the urine alkaline. The ordinary ruby-red colour, due to creatinin, is developed. The urine is now made acid with acetic acid, and if melanin is present a prussian-blue colour appears.

Alkaptonuria

This is not the manifestation of a disease, but is rather of the nature of an alternative course of metabolism, harmless and usually congenital and lifelong (Garrod). The individual is incapable of completely breaking down the tyrosin in the protein molecule, so that the intermediate product, homo-

gentisic acid, appears in the urine. The urine reduces Fehling solution on boiling, but it does not ferment, and it darkens on standing, or at once on the addition of alkalis. It may stain the linen brown. When a dilute solution of ferric chloride is allowed to fall drop by drop into the urine, each drop produces a transitory deep blue colour. The urine reduces ammoniacal silver nitrate in the cold, giving a silver mirror on the sides of the test tube. Ochronosis—a blackening of the cartilages and ligaments, and sometimes of the conjunctivæ—may occur, and usually there is also a chronic arthritis, which may lead to a curious "goose-gait."

[For other reducing substances in the urine, including sugar, see article on Diabetes.]

Ketonuria

Ketonuria is a term used loosely to include the appearance in the urine of diacetic acid and its derivatives, acetone and β-oxybutyric acid. The former is merely a decomposition product of diacetic acid, and, being only present in traces in the urine, is unimportant. The latter, formerly regarded as the source of diacetic acid, is a more saturated and less toxic fatty acid, which has been shown by Hurtley to be formed out of diacetic acid by the liver, as an attempt at detoxication. Diacetic acid is derived from the incomplete oxidation of fats or of the fatty acid groups in protein. It is probably always made in small quantities, but when there is an abundant consumption of carbohydrate, it is completely oxidised. One molecule of carbohydrate must be metabolised for every two molecules of fat if oxidation of the latter is to be complete. In starvation the store of glycogen is quickly exhausted and the body chiefly lives on its fats; hence acetonuria. Persistent vomiting, advanced carcinoma of the digestive tract and rectal "feeding" also are equivalent to starvation, and will excite ketonuria, though without such a degree of acidæmia as to cause toxic symptoms. In conditions where the liver is thrown out of gear, such as post-anæsthetic poisoning, ketonuria may occur with toxic symptoms, because of the severe disturbance of all metabolic processes. But there are other agents at work besides diacetic acid which may be responsible for those symptoms. Only in advanced diabetes do we find toxic symptoms directly due to diacetic acid. Here there may be complete inability to utilise carbohydrates, so that the body, perforce, lives on protein and fats. If these are freely given in the food the amount of diacetic acid produced may be very large. But if a diabetic be fasted there is a great drop in ketonuria, showing that most of this is exogenous in origin (see Diabetes). The test formerly used for diacetic acid was the mahogany red colour given on the addition of ferric chloride. This has the disadvantage of being masked if the patient is taking any salicyl body. The nitro-prusside test was formerly regarded as showing the presence of acetone, but Hurtley has demonstrated that it is really a much more sensitive test than ferric chloride for diacetic acid. A crystal of nitroprusside of soda is dissolved in the urine, and then a strong solution of ammonia is poured on the top. A ring, the colour of Condy's fluid, speedily develops at the junction of the liquids and spreads upwards. The intensity of colour is a rough measure of the degree of ketonuria. The reaction is made still more sensitive by previous addition of crystals of ammonium sulphate to saturation.

Drugs which Alter the Colour of Urine

Methylene-blue is used as a colouring matter of sweets and also as an ingredient of certain proprietary pills. It is also given sometimes for gonorrhœa and bilharzia, or less commonly as an analgesic in rheumatism, sciatica and migraine. In small quantities it imparts a green colour to the urine, when it may be precipitated with the mucin. In larger doses it turns the urine blue. It can be recognised by its presence in suspension, so that it can be removed by simple filtration. It can be dissolved from the filter paper by chloroform, and is turned pink by the addition of alkalis. Eosin may be used in sweets and turns the urine a fluorescent pink. Pyramidon may give rise to a reddish orange colour in the urine. Rhubarb and senna may turn the urine reddish brown from the chrysophanic acid they contain. The urine turns pink on the addition of an alkali. Santonin turns the urine a vivid yellow, which becomes rose pink with alkalis. Carbolic acid may turn the urine greenish-black on standing, from the formation of hydroquinone. In one case of carbolic acid poisoning under my care the urine withdrawn by a catheter was olive-green without exposure to the air. Other drugs which may have this effect are salol, creosote, naphthalene and uva ursi. In chronic carboluria, ochronosis may occur as in alkaptonuria.

Certain drugs can readily be recognised in the urine by some colour reaction. Thus, salicylates are excreted as salicyluric acid, which gives a violet colour on the addition of ferric chloride. Copaiba, which is precipitated by nitric acid, can be distinguished from albumin by the solubility of the precipitate in alcohol. On the addition of hydrochloric acid a urine containing copaiba turns cloudy, the cloud soon becoming rose pink. Iodides in urine give a blue colour with guaiacum, and on the addition of hydrochloric acid impart a violet colour to chloroform shaken up with the urine.

Pyuria

Pus may come from the urethra, prostate, bladder or kidney. The diagnosis of the source is discussed under septic diseases of the kidney. The best test for pus in the urine is the microscope. If the amount of pus be considerable it will yield a ropy mass on the addition of liquor potassæ. If ozonic ether be shaken with the urine, bubbles of oxygen are evolved. With tincture of guaiacum a blue colour may be given even without the addition of ozonic ether.

Chyluria

True chyluria is due to blocking of the thoracic duct by the *Filaria sanguinis hominis*, with consequent rupture of lymphatics of the bladder through back pressure. Fat may be found in the urine in the lipæmia of diabetes, in growths of the kidney, and after fracture of long bones, when fat may be liberated into the circulation. Accidental contamination by an oily lubricant for a catheter and fraudulent addition of milk to the urine must be excluded. Pseudo-chyluria is due to a lecithin compound of globulin, and is sometimes found in non-nephritic proteinuria. Unlike true fat, this substance is not extracted by shaking up with ether.

Pneumaturia

Osler gives the following causes for gas in the urine: (1) Mechanical introduction of air in vesical irrigation or cystoscopic examination in the knee elbow position. (2) Infection of the urine as by the ***Bacillus aerogenes capsulatus***. (3) Vesico-enteric fistula.

Crystalline Deposits in Urine

These may be:

1. *Uric acid*, which is characterised by multiplicity of forms and the yellow colour due to the urinary pigment they absorb. The chief varieties found are derived from the barrel and the whetstone types. Thus with a small whetstone stuck at either end of a barrel we get the lemon-shaped crystal. If the whetstones at the end of the barrel are larger, we obtain the "bicycle-handle" crystal. A very characteristic form is that derived from two whetstones with their broader ends apposed. The rosette crystal is a group of whetstones joined by their bases. The factors in the excretion of uric acid are considered under renal calculi; the chief factors in the deposit of uric acid crystals as such are, according to Sir Wm. Roberts, high acidity, high percentage of uric acid, poverty in mineral salts, and low pigmentation. The first two are the most important, especially the first. Poverty in salts or pigments is not considered important to-day. Deposits of urates are usually amorphous, but ammonium biurate may crystallise out as spheres with projecting spines.

2. *Oxalate of lime* is found in the urine, usually as small regular tetrahedra, which under the microscope appear as "envelope" crystals. They may arise from (*a*) ingested oxalates. Rhubarb, spinach, strawberries, and sorrel are the only things likely to produce oxaluria sufficient to excite symptoms, though many other articles of diet contain some oxalates. (*b*) In achlorhydria, from gastric fermentation of the carbohydrates. (*c*) In chronic pancreatitis, according to Mayo Robson and Cammidge. Here there is more usually hyperchlorhydria, and the fermentation of the carbohydrates must be intestinal. (*d*) In crises in neurasthenics, with irritability, lassitude and neuralgic pains, without discoverable cause.

Oxaluria may cause smarting on micturition and may excite both albuminuria and hæmaturia. Its importance as a starting-point for renal calculi is considered later.

3. *Phosphates*. See Characters of Normal Urine (p. 1177).

4. *Cystin* is an amino-acid containing sulphur, and is contained in many proteins, being especially abundant in hair. Its presence in more than minute traces in the urine appears to be due to an inborn error of metabolism, affecting only the endogenous protein, since it is not increased by the administration of cystin by the mouth (Garrod). It is deposited as hexagonal plates, and is often accompanied by a variable amount of diamines, such as putrescin and cadaverin, pointing again to an incomplete breakdown of the tissue proteins. If the urine becomes infected, these cystin crystals may aggregate to form a calculus.

5. *Tyrosin* rarely appears in the urine as sheaves of fine glistening crystals. It is then generally accompanied by *Leucin*, which does not appear until the urine is concentrated by evaporation, when it forms spheres with

concentric rings. The presence of these substances is sometimes regarded as pathognomonic of acute yellow atrophy of the liver, but they are occasionally seen in other severe disintegrations of the liver, such as cirrhosis.

Organised Deposits

of red blood corpuscles, pus, epithelium, casts and spermatozoa do not call for detailed description here. The first two have already been referred to. For Epithelium and Casts see sections on Inflammatory Diseases of the Kidney.

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Geoffrey Evans.

CIRCULATORY DISTURBANCES

1. *Active congestion.*—There is no distinction to be drawn between active congestion of the kidney and the early stage of acute nephritis.

2. *Passive congestion.*—Anything which raises the pressure in the renal vein must produce a passive congestion of the kidney. Failing compensation in valvular disease of the heart is the commonest cause of this; but it may also be brought about by respiratory diseases or by pressure on the renal vein by abdominal tumours or ascites. A transient congestion may result from an epileptic fit.

The cardiac kidney, as it is called, is the most typical example of passive congestion. The organ is firm and dark in colour, especially the pyramids. The capsule strips normally. The stellate veins are engorged. The kidney may drip with blood, and if placed in a dish after section soon exudes œdematous fluid.

The urine is scanty, high-coloured and of high specific gravity. Unlike the urine of chronic nephritis it is loaded with urates. It contains a variable amount of albumin and hyaline casts, with a few red blood corpuscles, if the congestion is at all considerable. With increasing grades of congestion, glomerular secretion is first impaired, as shown by the lactose test, and then tubular secretion, as shown by delay in excreting chlorides and iodides. But renal inadequacy never reaches the high grade seen in true nephritis, nor is death from uræmia likely. The prognosis and treatment are those of the cardiac condition causing it. Stimulating diuretics are of much more service than in nephritis, since there is no primary disease of the secreting structures.

3. *Infarction.*—This, which is a common complication of infective endocarditis, may take two forms—(*a*) Multiple small hæmorrhagic infarcts, producing the "flea-bitten" kidney, which may lead to foci of embolic nephritis with fibrinous exudate and much leucocytic infiltration. (*b*) Larger anæmic infarcts, "map-like" areas of coagulation necrosis, roughly wedge-shaped, but with irregular edges and with the base reaching the surface of the organ. Their formation may cause a sudden pain in the loins, if they are large. Either of these conditions will cause both albuminuria and hæmaturia.

4. *Thrombosis of the renal vein.*—This is rare, and is usually significant of a terminal infection, as in a marasmic infant. In thrombosis of the

inferior vena cava the process may reach as high as and spread into the renal vein. This would produce the same effects as the cardiac kidney, but in a much more intense form.

NEPHRITIS

Bright described an acute inflammation of the kidney accompanied by dropsy and albuminuria, and a chronic form in which dropsy is absent. There has been much controversy as to what should be included in the category of "Bright's disease." Some forms of nephritis are degenerative rather than inflammatory in origin, and these are included under the description of toxæmic kidney. It may be said that all nephritis tends to be diffuse in its distribution, though the different elements in the kidney may be involved in very varying degree. Thus the occasional occurrence of an *acute interstitial nephritis* is described in the earlier stages of scarlet fever and other infections, especially syphilis; it is characterised by much infiltration with plasma cells and lymphocytes in the boundary zone of the pyramids, around the glomeruli and beneath the capsule. But here, too, there may sometimes be degenerative changes in the tubular epithelium and glomeruli. Again, in the changes induced by corrosive sublimate poisoning the tubules alone may be involved. Diphtheria toxin, cantharides and phosphorus may have a similar effect. The toxæmia of pregnancy may affect the kidney in the same way. Williamson says of this: "The histological picture is essentially that of a necrosis, as though a virulent toxin in the process of its excretion had killed the cells of the convoluted tubules, affected to a less extent those of the loop of Henle, and spared altogether the glomerular epithelium." Similar changes may occur in acute yellow atrophy of the liver.

Febrile albuminuria is a mild degree of the same thing. If the poisoning is recovered from, a complete regeneration of the tubular epithelium may take place, and the recovery of function be complete. This tubular degeneration can be distinguished from the typical glomerulo-tubular inflammation during life by certain features described under Toxæmic Kidney. But it is difficult to draw a hard-and-fast line between these different forms, as they shade off into one another. Clearly, whether the actual infecting agent reaches the kidney, or only its toxic products, must often depend upon the severity of the infection. The classification which in our opinion harmonises, as far as possible, the pathological, anatomical and clinical phenomena is as follows:

I. Degenerative Group. *Toxæmic kidney.*

II. Inflammatory Group:

(A) *Glomerulo-tubular.*—1. Acute nephritis. 2. Subacute or reparative stage, commonly called chronic parenchymatous nephritis or large white kidney. 3. Chronic or sclerotic, commonly called secondarily contracted kidney or small white kidney.

(B) *Embolic focal nephritis* set up by infective endocarditis.

(C) *Chronic interstitial nephritis*, commonly called granular kidney or small red kidney.

III. Vascular Group:
(A) *Hyperpietic kidney.*
(B) *Senile or atheromatous kidney.*

TOXÆMIC KIDNEY

Definition.—Certain toxic substances may excite degenerative rather than inflammatory lesions in the kidneys, which are nevertheless capable of complete recovery. To such conditions the name of toxæmic kidney has been given.

Ætiology.—The commonest cause is bacterial toxæmia. As fever in itself does not necessarily cause albuminuria, all the so-called "febrile albuminurias" should be referred to this group. Thus the acute specific fevers—pneumonia, typhoid fever, diphtheria, small-pox, tonsillitis and scarlet fever (notwithstanding the fact that the two last often cause a true nephritis)—are common causes of the slighter degrees of toxæmic kidney. More potent are exogenous and endogenous poisons. Mercurial salts, arsenic and cantharides are important causes clinically, while uranium and bichromate salts are frequently used in the experimental production of the condition. Jaundice and diabetes mellitus are not uncommon causes, but the outstanding example of the endogenous group is the toxæmia of pregnancy.

Pathology.—The post-mortem appearances are not distinctive. When œdema is present it may be diffuse, as in nephritis, or limited to the lower extremities. There is no cardiac hypertrophy or gross arterial disease. Hæmorrhages are rare. The organs are pale and swollen. The kidneys are pale and increased in size and weight; the parenchyma tends to bulge through the capsule when the latter is incised. The capsule is not thickened; it strips readily and leaves a smooth polished pale surface, on which engorged stellate veins may be seen. The cut surface of the cortex is pale, in contrast to the congested pyramids; it is increased in thickness and its structure is blurred. On microscopical examination, the parenchyma shows degenerative changes, particularly affecting the convoluted tubules. There is cloudy swelling, vacuolation and desquamation of the secreting cells, there may be fatty degeneration, and in more severe cases focal or diffuse necrosis. These changes result from the action of the poison on the parenchyma in the process of its excretion. Apart from the presence of some swelling of the glomerular tufts and the presence of an albuminous exudate in the intercapsular space, the glomeruli show little damage. The loops of Henle and the collecting tubes are also relatively little affected. The venules are congested and there may be thrombosis with extravasation of blood; unless the degenerative process has gone on to necrosis the arteries and arterioles show little significant change. There is œdema of the interstitial tissue, but there is no small cell infiltration except as a secondary reaction to necrosis. The absence of tissue reaction that is undoubtedly inflammatory and the presence of tissue changes that are certainly degenerative are the distinctive features of the histological picture. Similar changes are to be found in other organs of the body, and especially in the liver, which may show various degrees of damage, namely, cloudy swelling, fatty degeneration and focal or diffuse necrosis.

Symptoms.—When due to bacterial toxæmia the condition does not give

rise to symptoms. It is recognised by the presence of a trace or cloud of albumin in the urine on boiling, and by the presence, in the centrifugalised deposit, of granular, hyaline and epithelial casts. In addition, there may be a few white blood corpuscles; when red blood corpuscles are present, or when there is frank hæmaturia, the differential diagnosis from an acute nephritis cannot be made with certainty. In the severer types with insidious onset, as in mercurial poisoning or in the kidney of pregnancy, the first symptom is often malaise, disturbance of digestion and constipation, accompanied by albuminuria and oliguria. Headache is a prominent symptom, and is often persistent. Œdema is commonly present and may be the initial sign; it is either a general œdema of the renal type, or it appears first in the lower extremities, as in cardiac œdema. Eye symptoms are important; there may be dimness of vision and flashes of light before the eyes, or rarely sudden blindness. On examination of the fundus oculi the disc may appear normal, or there may be œdema of the disc or partial detachment of the retina. The vessels are normal and hæmorrhages are rare. These symptoms may be followed by fits, as in ordinary uræmia, but sometimes the fits occur without previous warning. In general, the symptoms of a fully developed case are clinically indistinguishable from those occurring in the uræmia of true nephritis. The urine contains up to 3 or even 4 per cent. protein. Hyaline, granular and epithelial casts may be present, and may be very numerous; white blood corpuscles may be present, though few in number. In severe cases, the urine contains blood-cell casts, the result of capillary thrombosis and extravasation of blood.

NEPHROSIS.—This term has been used in various ways. We propose to limit it to those cases which, like toxæmic kidney in general, present merely degenerative tubular lesions without inflammatory reaction. The condition is characterised by marked œdema, cholesterolæmia and massive albuminuria. On the other hand, there is an absence of cardio-vascular changes, hæmaturia or cylindruria. The urea of the blood remains normal, as does the globulin of the plasma, while its albumin content falls as the disease progresses. Nephrosis is probably part of a general toxæmia, for when experimentally produced, the first protein to appear in the urine may be hepatic in origin. At the necropsy, a large amount of cholesterol may be found in the kidney tubules—the so-called "myelin" kidney.

Diagnosis.—The diagnosis depends on the recognition of the signs and symptoms of kidney disease in a patient affected by one of the known causes of toxæmic kidney, and on certain biochemical tests by which a true nephritis can be reasonably excluded. In milder cases, the possibility of the symptoms being due to heart failure must be excluded. Complete recovery is in favour of the diagnosis of toxæmic kidney. Exacerbation of a chronic nephritis can be recognised by a history of previous nephritis and the presence of definite cardiac hypertrophy and arterial changes. The difficulties are sometimes considerable, however, since a marked rise of blood-pressure may occur in a toxæmic kidney, while advanced degrees of chronic nephritis may occur without cardiac hypertrophy, increased blood-pressure or clinical evidence of arterial disease. The blood urea is normal or only slightly increased in the toxæmic kidney; whereas in chronic nephritis the blood urea tends to rise, and may reach 300 mgm. or even more. In the toxæmia of pregnancy, the appearance of albuminuria in the early months of pregnancy is in favour

of the condition being one of chronic nephritis, whereas the albuminuria due to toxæmia generally makes its first appearance in the later months.

Prognosis.—The importance of recognising the toxæmic kidney is that both the immediate and ultimate outlook are better than in nephritis of apparently equal severity. The prognosis in the single case depends on the nature of the cause, the degree of its severity, and the possibility of its early and complete removal. Recovery, when it occurs, is complete, but in the severe cases and in some cases of nephrosis, chronic nephritis may supervene and there is doubt as to recovery.

Treatment.—If not already in bed on account of the condition responsible for the toxæmic kidney, the patient should be immediately confined to bed. Treatment is directed towards eliminating the toxins and resting the kidneys. Barley water and milk and soda should be given. A free evacuation of the bowels must be secured daily by the use of magnesium sulphate, or by the use of jalap in severe cases. An alkaline diuretic, such as potassium citrate, should be given in ½ drachm doses 4-hourly, to which may be added sufficient sodium bicarbonate to render the urine neutral to litmus paper, for it has been shown that there is an increased acidity of the blood in these cases. The diet should be limited in quantity. At the same time, since there is little or no retention of urea in the blood, it is unnecessary strictly to limit the intake of protein. Indeed, in nephrosis the Epstein diet described under chronic parenchymatous nephritis has been advocated. Soups, meat extractives and condiments are to be withheld. The action of the skin should be stimulated with hot packs or hot baths. The above outline of treatment is for the severer cases; for the febrile albuminurias special treatment for the renal condition is not required.

ACUTE NEPHRITIS

The classical form of acute nephritis is hæmatogenous in origin and essentially glomerulo-tubular in distribution. Such a definition would exclude an ascending infection of the tubules from the pelvis of the kidney, such as occurs in pyelonephritis. It would also exclude the embolic nephritis of infective endocarditis, where inflammatory foci are set up in the kidney as the result of septic emboli reaching it from the heart. These produce marked fibrinous exudation and infiltration with leucocytes; but only some capillaries in some of the glomeruli are affected.

Ætiology. Acute nephritis was formerly not a common disease. Herringham found, at St. Bartholomew's Hospital, where the average number of medical cases is 7000 a year, that there were, in a period of 9 years, only 166 cases, 120 being in males. On the other hand, a large number of cases occurred in the epidemic of acute nephritis in the Great War, 1500 being recorded in Flanders alone during 1915. Since the Great War it would appear to have become more frequent.

The causes usually given for acute nephritis are as follows:

1. Acute Specific Fevers.—Scarlatina is undoubtedly the commonest specific fever to produce it. Goodall found nephritis in 8·4 per cent. of all cases of scarlatina.

Nephritis is an occasional complication of typhus, small-pox, chicken-

pox and mumps. Syphilis, malaria and yellow fever may also cause it. It will be noted that, in most of these, the infecting agent is an animal parasite or of unknown nature. In some of the latter, evidence is accumulating that an ultra-microscopic, filter-passing organism may be responsible, and that filter-passing organisms can produce acute nephritis. Thus acute nephritis occurred in the 1918 epidemic of influenza, and opinion tends to the view that a filter-passer, and not Pfeiffer's bacillus, was responsible for this outbreak.

Many cases of nephritis are preceded by tonsillitis, or otitis media, and it is probable that the throat is often the door of entry for the infection.

2. Diseases of the Respiratory Tract.—It may also occur as a complication of other acute infections of the respiratory tract. The commonest bacterial agent is the streptococcus.

3. Diseases of the Skin.—The frequency with which acute nephritis may follow burns or extensive skin diseases is interesting, in view of the physiological connection between the kidney and the skin. Thus, it is a not infrequent complication of erysipelas, impetigo, boils, pemphigus and dermatitis. It must be remembered, also, that children who have been burnt are very liable to develop true scarlatina as well as a mere septic rash, and that streptococcal infection may be the responsible agent.

4. Diseases of Other Systems.—Acute nephritis may also be a complication of acute infections of other systems. Purpura, which is probably toxic in origin, may be accompanied by a true nephritis.

5. Epidemic Type.—In the American Civil War and in the Great War acute nephritis occurred as a primary disease in an epidemic form, characterised by dyspnœa at the onset, and in general by a benign course. In the fatal cases, inflammatory and thrombotic lesions were found in the lungs and spleen.

It is a very common idea that cold or chill is a cause of acute nephritis. The statistics of the army epidemic go far to disprove this. For, during the first winter, when there was much wet weather, and the men were much exposed, cases were few and far between, and not until the weather was better did the disease assume epidemic proportions. On the other hand, a patient who has nephritis is more susceptible to cold, which may provoke an exacerbation. Where exposure seems to be responsible for acute nephritis, examination will generally reveal some definite evidence of an old-standing lesion of the kidneys. Conformably with that, after the first winter of the war, there was an agreement between the incidence of nephritis in the army and low temperature.

Pathology.—The kidney is swollen, with punctiform hæmorrhages over a pale, reddish-grey surface. The cortex is increased and, on section, the kidney drips with blood or with œdematous fluid. Microscopically, the glomeruli are swollen, becoming pear-shaped and protruding into the first part of the convoluted tubules, with Bowman's capsule tightly stretched over them. In these glomeruli the nuclei are less distinct, and the capillaries show fatty changes in their walls. Blood may be extravasated between the layers of Bowman's capsule. The convoluted tubules have their lumen blocked either by the swelling of their epithelium or by débris, casts and blood. The interstitial tissue is swollen and œdematous, with hæmorrhages here and there, and sometimes lymphocytic infiltration. The arteries of the

kidney show little alteration except that some of the afferent arteries share in the glomerular changes.

Symptoms.—The onset is usually acute, though occasionally it may be rather insidious. In the latter instance the patient may complain of biliousness, nausea, vomiting and abdominal pain, with headache and sometimes diarrhœa before the onset of renal symptoms. In the cases with acute onset, he may have more or less severe pain in the back, and œdema soon develops. It usually starts in the face; the legs and scrotum are generally involved next, and the swelling soon spreads all over the body. Occasionally the dropsy is curiously localised and fugitive. Though dyspnœa is not regarded as a common feature of acute nephritis apart from uræmia or cardiac failure, in the army epidemic it was almost invariable at the onset. As a rule, shortness of breath started at the same time as the dropsy, but did not last so long, having ceased at the end of 2 or 3 days. There is usually only slight fever, though occasionally a temperature of 102° or 103° may be reached. Some irregularity of temperature, however, is common in the first week or 10 days. The pulse may be raised in tension and the blood-pressure is generally raised. The blood is hydræmic and contains excess of chlorides. Occasionally the serum is milky, as was pointed out by Bright. The skin may be dry and itching, with occasionally a papular or erythematous eruption. Retinal hæmorrhages and œdema of the discs may occasionally occur.

The urine is greatly reduced in volume, and may be entirely suppressed. Eight to 12 ounces would be an ordinary figure. It is dark in colour and usually obviously contains blood. This may render the urine as dark as porter, but it may be bright red or merely smoky. Sometimes the blood forms a flocculent, reddish-brown precipitate. The urine is usually loaded with albumin, and casts will be found on microscopical examination. At first blood casts and epithelial casts will alone be found; but, at a later stage, granular and hyaline casts will appear. Fatty casts are not found in the first attack of acute nephritis. Their presence suggests a recrudescence of a chronic disease. Isolated renal cells, transitional epithelium and squamous cells from the lower urinary tract are also commonly found. Micro-organisms are not usually observed, and their presence in any number would suggest that the case is more probably one of pyelonephritis. A sudden rise in the secretion of water after a few days is usually a sign of definite improvement.

Complications may be due to three main causes.

1. *Renal failure*, *i.e.* uræmia may develop. Some slight uræmic symptoms are common in acute nephritis, such as headache, dizziness, nausea and vomiting. But any of the forms of uræmia described later may assert themselves. Convulsions are the most common of the severe symptoms, but are not as grave in significance as in chronic nephritis. If treated promptly, recovery may follow.

2. *Extension of the œdema.*—Water-logging of the lungs may occur, producing serious dyspnœa; but this is sometimes chiefly due to cardiac failure. In any case it is serious. A milder degree of bronchial catarrh is quite common. A rare but very dangerous complication is œdema of the glottis, which calls for prompt treatment.

3. *Secondary infections.*—The subjects of nephritis are always liable to secondary infection, and these are particularly apt to affect the serous mem-

branes; therefore pleurisy, pericarditis, and peritonitis are not uncommon complications. The last two are very dangerous.

Sequelæ.—If complete resolution does not occur, the patient may be left with a "leaky kidney" or else with a more serious condition of chronic nephritis. These are discussed later.

Diagnosis.—The combination of dropsy, albuminuria, hæmaturia, casts and scanty urine usually makes the diagnosis quite easy. The most difficult point is to distinguish it from an exacerbation of chronic nephritis. Definite evidence of cardiac hypertrophy and arterial changes would be in favour of the latter. The presence of granular casts at the outset, or of fatty casts at any time, is suggestive of chronic disease. An infarct in the kidney which causes a pain in the back and hæmaturia may simulate nephritis, but general dropsy is not likely to occur, nor are casts present in the early stages. Great reduction in the volume of urine is not usual. It must be remembered, however, that infarcts may start foci of nephritis. Signs of infective endocarditis would suggest infarction. In chronic interstitial nephritis there may be a smart hæmorrhage, but the abundant urine of low specific gravity and the cardio-vascular signs would lead to a correct diagnosis. The renal hæmorrhage in the early stage of new-growth of the kidney is so profuse that confusion with acute nephritis is not likely to occur. Moreover, epithelial casts would not be found, though a large blood cast from the pelvis of the kidney is a very characteristic feature. Pyelitis may give rise to some confusion, as there may be small hæmorrhages, especially at the beginning. The presence of micro-organisms in a catheter specimen and abundant blood corpuscles, with only a haze of albumin, in the absence of casts, will generally make the diagnosis clear. Moreover, general dropsy does not occur in pyelitis unless it sets up severe nephritis as a sequel.

Prognosis.—The prognosis naturally depends on the severity of the disease. It is better in those cases where there is a discoverable cause, an acute onset, and where the patient comes under treatment promptly. Recovery is usually slow, requiring two to four months, and the criterion of the cessation of the acute stage is the disappearance of red corpuscles from the urine. The patient may die from uræmia, secondary infections, or extension of the œdema to vital structures. If the urine becomes free from albumin in one month, the chances of complete recovery are good. In the army epidemic a large number of cases cleared up within a few days; of the remainder, the course was very variable. Recovery occurred in anything between 2 and 16 weeks, although some continued to pass albumin, blood and casts at the end of 6 months. The longer the duration of the acute stage, the more probably will there be permanent damage to the kidney.

Treatment.—(*a*) *Prophylactic.*—The best prophylactic measure is prompt and efficient treatment of any infective process liable to set up nephritis. There is evidence to show that the routine administration of alkalis in scarlet fever diminishes the incidence of acute nephritis.

(*b*) *Curative.*—The indications are to remove, if possible, the microbic or toxic cause at work and to ensure such physiological rest for the kidney as is practicable; to promote elimination of nitrogenous and saline waste by other channels; to treat complications as they may arise and to correct the resulting anæmia. In this way much may be done to steer the patient towards recovery, although we can do little to control the course of the

inflammatory process. The patient is naturally kept recumbent in bed. To counteract the congestive effects of gravity, it is well to move him from side to side, and occasionally to put him on to his chest. He should be clad in a flannel nightgown, and be placed between blankets to guard against chills and to encourage free action of the skin. The room should be warm and well ventilated. If suppression of urine threatens, dry cups or poultices should be applied over the loins. This measure is sometimes successfully adopted to diminish hæmaturia.

Diet.—In acute nephritis, the danger of overloading the inflamed kidney with nitrogenous substances is hardly sufficiently recognised; whilst in chronic nephritis the dietetic restrictions are apt to be too severe. The dictum that "in acute affections we concentrate our attention on the diseased organ, whilst in chronic cases we keep the general condition of the patient more in view," applies particularly to the treatment of nephritis. Nitrogen retention is common and a source of danger, so that the free administration of milk usually recommended is open to objection, since cow's milk contains 4 per cent. of protein, which equals 0·56 per cent. of nitrogen. It will do little harm to deprive the patient of nitrogen for a time, and von Noorden advises restriction of the diet at the outset to fruit juice, water and sugar. Where there is no nausea, toffee is allowed, which, being composed of butter and sugar, throws no work upon the kidney. It is generally appreciated by children and allays hunger. Barley water, with a little milk added, may also be given, and as the patient improves the proportion of milk may be increased. It is quite unnecessary to give anything else for a few days, and the relatives' fear of starvation may be allayed by explaining the rationale of the treatment. The excretion of nitrogen is reduced to its lowest level by giving a diet of fats and carbohydrates, when it may fall below that of a fasting person, as was shown by Folin; but excess of fat is inadvisable for reasons given under chronic parenchymatous nephritis. It is well to avoid salt in any form as it is often badly excreted, and its retention increases œdema by raising the osmotic pressure of the tissues.

It is usual to try and flush out the kidneys, and to this end the patient is directed to drink a large quantity of water; but often the inflamed kidney is incapable of excreting water readily, so that attempts at flushing it out will fail and only increase the œdema. The total amount of fluid allowed in the day should not exceed 3 pints for an adult or 1½ pints for a child of 12. It is true that there may be a sudden diuresis after some days; this, however, is not the result of treatment, but the first and surest sign of convalescence. It may be termed a "critical diuresis," and, after its occurrence, the quantity of water and milk taken may be safely increased. A drink prepared by adding 1 pint of boiling water to 1 drachm of acid tartrate of potash, half a lemon, and some sugar, stirred occasionally until cold and then strained, may be allowed throughout in moderate quantities. The citric acid and the tartrate become bicarbonates in the blood and may render the urine less irritating by making it less acid; apparently it is not as easy to render urine alkaline in a severe case of acute nephritis as it is in the normal individual. Beef-tea, broth, and meat juices are all to be condemned as imposing work on the kidney with very little corresponding nutritive advantage.

Elimination by other channels.—Of these, the simplest and best method

is purgation. A drachm of pulv. jalapæ co. followed by 1 drachm each of sulphate of magnesia and sulphate of soda in as concentrated a solution as possible should be given at the outset and repeated as occasion arises. Diaphoresis is not nearly so satisfactory and may depress the heart if carried to excess. Sponging the patient well with hot water, followed by friction with warm dry towels, will do good and is usually sufficient. The warm room, the blankets, and the flannel nightgown also tend to induce perspiration. More drastic measures are seldom called for in acute nephritis unless uræmia is impending, when the hot-air bath may be a distinct service.

All stimulating diuretics, such as the caffeine group of drugs, are to be avoided. When acute symptoms have quite subsided, 2 grains of theocin sodium acetate in 1 ounce of water, twice a day, may increase the permeability of the kidney. The method is not free from risk, as it may cause a return of hæmaturia if given too soon. A simple guide is the occurrence of diuresis. Unless this occurs, the drug is doing no good and may do harm. Saline diuretics, such as potassium citrate, are safer. In so far as they produce diuresis, they do it by raising the osmotic pressure of the blood and thus drawing water from the œdematous tissues. The following prescription is mildly diaphoretic and diuretic:

Pot. cit., grs. xv.
Liq. ammon. acetatis, ℥i.
Sp. æth. nitr., ℥ xv.
Aq. camph. ad ℥i. To be taken every 6 hours.

The addition of 5 minims of tincture of digitalis is advisable if the heart's action becomes weak.

Treatment of complications.—For the treatment of renal failure, see Uræmia. Pleurisy, pericarditis, or peritonitis should be treated on ordinary lines. Œdema of the glottis may call for scarification of the larynx or even tracheotomy.

After-treatment.—Bed is imperative until blood has disappeared from the urine and is advisable until albuminuria has ceased altogether. This may be impossible, since acute nephritis may go on to chronic nephritis, but there is a considerable advantage in prolonging the rest as much as possible. Bread, butter, vegetables, puddings, eggs and then fish may be gradually added to the diet, according to the scale given under chronic nephritis, as the hæmaturia and albuminuria diminish, but abstention from meat is advisable for some time, and meat extracts had better be altogether avoided. If anæmia result, 15 minims of the liquor ferri acetatis should be given, with 1 drm. of liquor ammon. acetatis in camphor water three times a day. Chills should be guarded against in every possible way, and the loins may be protected by wearing a well-fitting cholera belt.

CHRONIC PARENCHYMATOUS NEPHRITIS

It is generally agreed that all chronic nephritis involving the parenchyma of the kidney is diffuse from the first, though naturally the interstitial changes take longer to manifest themselves. It is certain that when parenchymatous nephritis has existed for any length of time, there will be interstitial change as well. On the view here adopted, chronic parenchymatous nephritis or

large white kidney is the subacute stage of a glomerulo-tubular inflammation. If the patient lives long enough, the kidney will pass into the sclerotic or secondarily contracted stage, often called small white kidney. Dalton believes that this later stage is more often seen than it was, because improved treatment enables more patients to reach it.

Ætiology.—It is most frequently the sequel of acute nephritis, though the initial attack may have been so mild as to have escaped notice. The kidney of pregnancy may develop chronic parenchymatous change. Alcohol, syphilis and malaria are all credited with being able to cause it.

Pathology.—The kidney is large and swollen; the capsule strips easily, leaving a smooth white surface on which the engorged stellate veins are prominent. On section the cortex is increased and pale, while the pyramids are engorged. Microscopically, the glomeruli are large and irregular, with disorganisation of structure and thickening of the fibrous tissue of the capsule. The tubular epithelium shows swelling, fatty degeneration and desquamation. Casts of different kinds are seen in the lumen of the tubules. The interstitial tissue is diffusely increased by new fibrous tissue. The vessels do not show any alteration except for some fatty changes in or close to the glomeruli. The heart may show some hypertrophy of the left ventricle, though not nearly so much as in the later stages of secondarily contracted kidney

Pathology of œdema in chronic parenchymatous nephritis.—Dropsy is one of the most characteristic features of the disease. Various explanations have been given of its causation. One of the earliest was that it was due to hydræmia from retention of water which the kidney could not excrete. But marked hydræmia may occur without œdema, and even total anuria need not cause dropsy. The next hypothesis was that the capillary endothelium was damaged by toxins and, therefore, became unduly permeable (Cohnheim). But it has been shown experimentally that such damage actually hinders the passage of fluid from the blood to the tissues. There is more in favour of Widal's view that defective elimination of salt by the kidney leads to accumulation of water by raising the osmotic pressure of the tissues. The chief difficulty in this view is that salt retention does not always cause œdema. M'Lean and Russell point out that if water is not eliminated its retention would lower salt concentration, which would lead to retention of salt until the balance was restored. It is obvious, therefore, that the same effect will be produced whether the primary defect in the kidney relates to elimination of salt or water. Yet another explanation that has been advanced is Martin Fischer's, that there is an acidæmia which increases the permeability of the tissues; but this has not been confirmed. An important advance was made when Epstein showed that a feature peculiar to nephrosis and to chronic parenchymatous nephritis was a great reduction in the protein content of the blood and exudates, almost entirely affecting the albumin, so that the amount of globulin is always increased relatively and sometimes absolutely. In chronic interstitial nephritis, on the other hand, while the residual nitrogen fluctuates considerably, there is no change in the protein composition of the serum. In chronic parenchymatous nephritis the daily drain on the protein may even amount to 10 per cent. of the total protein in the blood. This causes a fall in the osmotic pressure of the blood, giving the tissues the controlling power to absorb and retain fluid. In support of this view it may be mentioned that the œdema produced in per-

fusion experiments with normal saline or Ringer's solution is prevented by the addition to the perfusing fluid of colloids which are in osmotic equilibrium with the colloids of the lymph and tissues. A weak point in this hypothesis is its failure to explain the dropsy of acute nephritis, which comes on long before any depletion of the proteins of the blood can occur.

The tissue starvation in chronic parenchymatous nephritis is also shown by the high cholesterol content of the blood, comparable to that observed in advanced diabetes. That the blood serum in nephritis may be milky was noted by Bright, and subsequent observers have called attention to pseudo chylous ascites in this disease. This cholesterol seems further to damage the kidney, while the abstraction of lipoids from tissue cells allows of imbibition of fluid, with consequent swelling of cells.

To sum up, salt retention and protein depletion are probably the most important causes of œdema in this disease. But at the present time the œdema is regarded mainly as a result of damage to the extra-renal tissues by the same agent that damaged the kidneys, rather than as a consequence of the failure of renal function.

Symptoms.—These may be continued from those of acute nephritis. More usually there is an interval of apparently normal health. Then the patient begins to suffer from languor and digestive disturbances, followed by the combination of anæmia and dropsy, which gives rise to a very characteristic aspect. Hence the saying "large white kidney, large white man" The dropsy may extend to the serous sacs. The urine is scanty, probably 20 ounces or less in the day; its specific gravity is high, but urates are not so abundant as in the urine of the cardiac kidney. It contains a large amount of protein, usually about 0·5 per cent., as measured by Esbach's method. Numerous tube casts will be found on sedimenting the urine, epithelial, fatty, granular and hyaline forms all being present. Red blood corpuscles may be found from time to time. Examination of the blood may show a rise in the chlorides, while, on the other hand, there need be no increase in the blood urea.

Vomiting and diarrhœa are common and troublesome. Ulceration of the colon, probably due to the vicarious elimination of toxins by the bowel, is an occasional and dangerous complication. Areas of exudate, known as "cotton-wool" patches, and œdema of the discs—constituting one form of albuminuric retinitis—may be found in severe cases. There may be dyspnœa, due to acidæmia, the result of diminished excretion of acid sodium phosphate. Secondary infections of the lung, pleura, pericardium or peritoneum may occur.

If hypertrophy of the heart and a rise of blood-pressure fail to take place, the outlook is very grave, and death from uræmia or secondary infection is likely to close the scene. If, on the other hand, the blood-pressure rises and the heart hypertrophies, while the amount of urinary secretion may increase considerably over normal, and the dropsy subsides, the stage has been reached of

SECONDARY CONTRACTED KIDNEY

Pathology.—The kidney is small and its capsule is adherent. On stripping it a coarsely granular, mottled surface is exposed. The term

small white kidney is therefore a misnomer. On section the mottled appearance is seen to extend throughout the cortex, some areas being red, the others yellow or white. Microscopically, the affected glomeruli are seen to form rather large homogeneous nodules. Other glomeruli are preserved to a greater or less extent, and regeneration of epithelium has occurred in some places, covering the remains of the capsular space. To a great extent the tubules are destroyed; those which remain are dilated and lined by a flat epithelium. The interstitial increase is chiefly round the destroyed glomeruli and tubules. The whole arterial system of the kidney usually shows hypertrophy of the media and hyperplasia of the intima.

The heart is hypertrophied, especially the left ventricle. The aorta is thickened, and ordinary atheromatous changes may occur at an unusually early age.

Symptoms.—This stage takes at least a year to develop after the onset of chronic parenchymatous nephritis. The urine is increased, probably to 80 ounces or more. The quantity of albumin is very variable, but is always more than that of chronic interstitial nephritis. Epithelial, fatty, granular and hyaline casts are present. Renal permeability to solids is lowered so that the output of water has to remain at a raised level if dropsy is to be avoided. Towards the end the secretion of urine is sure to fail, and uræmia is likely to follow. Signs of cardiac hypertrophy can be detected, and the blood-pressure is generally raised to something between 160 and 220. Albuminuric retinitis, of the form described on p. 1202, is not uncommon. Later, silver-wire arteries, retinal hæmorrhages, which are often flame-shaped, and even glistening white patches (see p. 1208) are sometimes to be noted. Infarction of the lung may occur, causing pain, dyspnœa, hæmoptysis with signs of consolidation, and perhaps a pleural friction. It results from detachment of a clot in the right auricular appendix, and, being generally due to a secondary infection, marks a definite step downwards. There may be other signs of infection, such as pericarditis or peritonitis. But in the absence of complications life may be prolonged for several years. In children contracted kidney may cause a remarkable condition of infantilism and dwarfism. Puberty does not occur at the recognised time. Bone deformities resembling rickets often develop, associated with a low calcium content of the blood.

Diagnosis.—The combination of dropsy, anæmia, albuminuria and cylindruria generally makes the diagnosis of chronic parenchymatous nephritis easy. In the dropsy with albuminuria of failing heart the œdema first occurs in the most dependent parts, while in nephritis the eyelids are first affected. In cardiac dropsy the liver will probably be enlarged and tender, and the urine will only contain hyaline casts; the permeability of the kidney for dyes is not seriously impaired. Amyloid kidney may be accompanied by cachectic dropsy; but the heart will not be hypertrophied and the blood-pressure is not raised. Moreover, a cause for amyloid disease, and the presence of amyloid disease elsewhere, are usually obvious.

If there is no œdema the diagnosis has to be made from functional albuminuria, leaky kidney and chronic interstitial nephritis. Functional albuminuria only occurs between puberty and thirty, albumin is absent from the urine secreted in the recumbent posture, casts are absent, with the possible exception of the hyaline variety, and calcium lactate may clear up the

albuminuria for a time. A "leaky" kidney is the result of some old damage, and is not an indication of a progressive disease. The albuminuria is detected accidentally, there being no symptoms. The blood-pressure may, however, be slightly raised. There are no cells in the centrifuged deposit of urine. In chronic interstitial nephritis the specific gravity of the urine is very low, and the albumin does not amount to more than a trace. Unless the heart is failing there will be no œdema. In extreme secondary contracted kidney the picture may approximate closely to chronic interstitial nephritis. Fatty casts are not found in the latter. The estimation of blood urea should be carried out whenever there is a question as to renal efficiency.

Prognosis.—The outlook in chronic parenchymatous nephritis is always very serious. It is essentially a progressive disease, leading to secondary contraction. Death may occur from uræmia, heart failure or secondary infections. If there is secondary contraction of the kidney, the outlook is still serious; but with care life may be prolonged for several years. Death may be brought about in the same ways as in the parenchymatous stage. Retinal changes make the prognosis more serious, and "woolly" exudate with swelling of the optic disc generally foretell death within two years. Retinal hæmorrhages and discrete white patches of degeneration in the retina are, however, of less serious significance.

Treatment.—It is essential, as a prophylactic measure, that the treatment of all cases of acute nephritis should be thorough and prolonged. Septic foci, especially in the tonsils, should be looked for and thoroughly treated, as also should any syphilitic or malarial infection. Confinement to bed is only advisable during exacerbations, when dropsy is extreme, or when uræmia is threatening. The skin should always receive attention, and patients should sleep between blankets and be careful to avoid exposure to cold and wind.

Diet.—There has been a tendency to restrict the protein intake too much, since there is no evidence that the albuminuria is influenced by the amount of protein in the food. Epstein has urged, indeed, that a high protein diet is indicated in order to raise the low protein content of the blood, while fats should be avoided to diminish lipæmia. That such a diet may markedly reduce œdema is true, but not necessarily by raising the protein content of the blood. Probably the diuretic action of the urea formed from the high protein diet is largely responsible. It is, therefore, wise to estimate the blood urea, and if it is not raised to carry out MacLean's urea concentration test (p. 1180), and only to make use of the high protein diet if this test shows at least 2 per cent. of urea. If it is below that figure we can arrive at the appropriate diet in this way. Chittenden has shown that nutrition can be maintained by a normal individual on 50 to 60 grammes of protein a day, which corresponds roughly to 1 gramme of protein per kilogram of body weight. The minimum protein allowance for a chronic nephritic should be this plus the amount of protein which he is losing in the urine, which, in a case of ordinary severity, will be about 6 grammes a day, or about the same as that contained in one egg. It may rise, however, as high as 25 grammes. Von Noorden has shown that nitrogen can be excreted in chronic nephritis satisfactorily, so long as not more than 94 grammes of protein are taken in a day. Above this amount, elimination may become irregular and un-

certain. We may say, therefore, that the theoretical minimum is 56 grammes and the practical maximum 94. There is not a wide difference between these figures, and it may be added that a pint of milk, one egg, a quarter of a pound of fish, and 2 ounces of meat contain altogether 63 grammes of protein. Allowing for the protein in bread and vegetables, it will be seen that the amount of nitrogen in this diet is sufficient, unless the urea concentration test indicates a capacity to excrete more than 2 per cent. of urea, and the blood urea is not raised, when proteins may be given freely. Naturally meat extracts and cellular organs, such as liver, kidney and sweetbread, should be avoided, because they contain a large amount of purin; that has to be excreted by the damaged kidney, which eliminates uric acid with difficulty. This is contrary to the principles of physiological rest but, equally, such restrictions of diet must be avoided as would lead to failure of appetite and consequent wasting, while incapable of diminishing the albuminuria. A much greater variety of diet than is usually allowed might be permitted; cooked eggs and dishes made from eggs may certainly be taken. Raw eggs, however, contain certain indeterminate substances which may irritate the kidney. The distinction drawn between red and white meat is fallacious. Red meat is assumed to be more injurious, presumably because it is supposed to contain more purin, whereas the reddest meat contains far less than sweetbread. Chronic nephritics should not be restricted to milk, which is too dilute a form of food for them, and may increase the dropsy. Salt should be moderately restricted, since it is often badly eliminated, and if it accumulates in the tissues will increase œdema. It can be replaced by lemon juice. In this way we can avoid increasing the miseries of an incurable disease by unnecessary restrictions. If nitrogen retention exists, as shown by estimations of blood urea, a diet poor in protein should be taken on one day in each week. Indeed, a day when the diet is restricted to fruit and sugar is often as useful in chronic nephritis as is the day of vegetable and egg diet in diabetes. But prolonged nitrogen starvation is as bad for the nephritic as for any one else, and in some cases increases the water-logging of the tissues.

Generally speaking, alcohol is inadvisable in any form, and should never be ordered to those unaccustomed to it. In those who have been taking it regularly, deprivation may interfere with appetite, in which case a little well-diluted whisky is probably as innocuous as any form of alcohol can be. But the strictest moderation must be enjoined. Tea and coffee used to be forbidden, because of the methyl-purins they contain, but in our opinion this restriction is unnecessary.

Diuretics.—It is generally considered well to flush out the kidney in chronic nephritis; but, before attempting this, we should consider what method of diuresis is to be used, how far it is desirable in an individual case, and how far it can achieve the end desired.

Diuresis can be produced (*a*) by *vaso-dilatation of the kidney*, as by caffeine, theobromine, theocin or diuretin. These are direct stimulants to the renal epithelium, the vascular change being secondary. (*b*) By *vaso-constriction elsewhere*, which raises the blood-pressure and forces more blood through the kidney. (*c*) *Increase in the quantity of circulating fluid.*—(1) By absorption of water from the intestines, as by giving the patient large quantities of fluid to drink. (2) By increasing the osmotic pressure of the

blood. Urea and the saline diuretics, citrates, acetates, etc., act in this way, drawing water from the tissues into the blood stream.

The first group are usually unsuitable in chronic nephritis, since it is unwise to stimulate a damaged structure. Any of this class may cause an exacerbation with hæmaturia. The same applies to juniper and scoparium. Theocin sodium acetate in doses of 2 grains twice a day renders the kidney more permeable, and may be followed by an improvement. But, unless it is followed by a prompt diuresis, its use should be discontinued. In general, it may be said that the stimulating group should be reserved for those cases where an increased flow is required and the kidneys are not organically diseased, as in failing heart.

As to the second method of diuresis, since the blood-pressure is generally raised in chronic nephritis, it seems unnecessary to raise it further. Digitalis is the drug usually employed for this purpose; but it is now known not to raise the blood-pressure, its diuretic action being secondary to its effect on the heart. Therefore, it should be used as a diuretic when the heart is failing, as it is liable to do at some stage in the course of this disease. Even here, it may fail if the blood-pressure is already high.

A marked feature of chronic nephritis is the defective adjustment of the kidneys to varying water supply. Von Noorden found that whereas a normal individual, with an average hourly diuresis of 52 c.c., excreted 723 c.c. for 3 hours after drinking 1800 c.c. of Salvator water, the nephritic hardly showed any response. As in acute nephritis, the drinking of large amounts of fluid may, therefore, merely increase the œdema. The reaction to drinking a pint of water may be determined; unless this definitely increases the quantity of urine it is no use persisting with attempts to flush out the kidney.

As explained under Acute Nephritis, the saline diuretics are the least open to objection; since they draw the extra water from the tissues they cannot increase and may diminish the œdema. Urea as the natural diuretic of the body is often given in doses of 45–60 grains three times a day, when there is no nitrogen retention. Some of the newer diuretics, such as euphyllin and novasurol, appear to act by liberating water from extra-renal tissues. In this way they would come under heading (*c*), but they do not seem suitable in chronic nephritis. One to 2 drachms of ammonium chloride is given on each of two days before giving ½–1 c.c. of novasurol, this treatment being repeated at intervals of 3 to 9 days.

Diaphoretics. — The arguments for and against diaphoretic measures will be found under uræmia. Diaphoretic drugs are not suitable for the routine treatment of chronic nephritis, as a moist perspiring skin renders the patient more liable to chills—always a danger in this disease. A course of hot-air baths may sometimes be helpful when there is retention of salt, which increases the œdema. If they are followed by diuresis they are doing good.

Purgation.—Free elimination by the bowel is here, as in other forms of nephritis, a prime requisite. The special liability to mercurialism renders calomel unsuitable for routine treatment.

Paracentesis.—Removal of the œdematous fluid by Southey's tubes is seldom practised now, though occasionally simple incisions are made. But the wounds are likely to suppurate, and the fluid will reaccumulate as

long as conditions remain unfavourable. Ewart prefers to drain the fluid into the legs by adopting the upright posture. In this way the fluid, which is presumably loaded with toxic substances, is removed from the vital organs.

Transfusion.—Epstein has advised transfusion of healthy blood, accompanied by removal of an equal quantity of blood from the patient, with the object of increasing the protein content while removing toxins.

Decapsulation.—This procedure was recommended by Edelbols in 1900; but in many of the recorded cases it was evidently unnecessary, and in some others unsuitable. The operation, therefore, fell into disrepute, and in spite of a recent revival has not stood the test of experience.

Climate is a valuable help. In this country, Ventnor or anywhere on the south coast from Bournemouth westward is the most suitable climate that can be obtained. Egypt generally suits such patients particularly well. Madeira or California is also quite suitable. The wind and the more violent fluctuations of temperature on the Riviera render it much less advisable.

Treatment of complications. — These are uræmia, heart failure and secondary infections, such as pericarditis, pleurisy, colitis and peritonitis. Their treatment is discussed under those headings.

In conclusion, it must be recognised that the kidney, once damaged by chronic nephritis, cannot completely recover, and the main thing is to attune the mode of life to a low key, subjecting the patient to as little strain as possible. He may have a considerable variety of food, provided that the intake of protein is regulated in the way described above, and that he takes very little purin and salt. He can be helped by saline diuretics and unirritating preparations of iron, such as liquor ferri acetatis. He will do all the better if his medical man realises that many of the methods recommended in the treatment of this disease are impotent, where not actually harmful.

CHRONIC INTERSTITIAL NEPHRITIS

Synonym.—Granular Kidney.

In chronic interstitial nephritis there is an insidious inflammatory condition. It is impossible in the present state of knowledge to give even a general definition of this form of kidney disease, but in the description which follows, the distinction from secondary contracted kidney on the one hand, and from hyperpiesia on the other hand, will be clearly made.

Ætiology.—The disease is commoner in men than in women, and occurs more frequently as the fiftieth year is approached and passed. It is rarely found in young children. Poisons circulating in the blood are the most important cause. Such may occur in alimentary toxæmia, in which case diamines are absorbed, and in focal sepsis. Gout, lead poisoning and alcohol are accredited with special power of damaging the kidneys. Syphilis is not a cause.

Pathology.—The kidney tends to be reduced in size, and is tough. The capsule is adherent, leaving a finely granular surface on stripping. Sometimes the capsule is thickened and splits on attempting to strip it, thus giving an erroneous impression of a smooth surface. Retention cysts may be seen, both on the outside and the inside of the organ. On section the

cortex is reduced; not only is it shrunk from without inwards, making the organ smaller, but the increase of intrapelvic fat shows that it has also shrunk from within outwards. The vessels are unduly prominent. The glomeruli show signs of inflammatory reaction, and the interstitial tissue in their neighbourhood is increased and infiltrated with small cells, generally of the mononuclear type. These areas of disease are patchy, and form wedge-shaped areas, with their base on the cortico-medullary zone. The intervening areas of renal tissue show little or no change. The histological lesions in the arteriæ interlobulares and vasa afferentia, as also the patchy small cell-infiltration in the kidneys and evidence in some glomeruli of proliferation of the cells of Bowman's capsules, provide evidence of inflammatory reaction, and this is a primary event in the pathology of the disease. The distribution of the renal lesion in chronic interstitial nephritis is distinct from that in secondary contracted kidney, for in the latter the lesion is diffuse and every glomerulus is more or less altered in structure. In advanced cases of chronic interstitial nephritis, however, the extent of structural alteration extends and becomes more diffuse, so that it may be as difficult to make the differential diagnosis from secondary contracted kidney histologically as it is clinically.

On account of the toxæmia resulting in chronic inflammatory changes in the kidney, cardio-vascular hypertrophy occurs. The suprarenal glands are often enlarged, and this, like the cardio-vascular hypertrophy, is to be regarded as an expression of physiological response to persistent hypertension.

Symptoms.—The subject of chronic interstitial nephritis often fails to seek medical advice until the condition has become well advanced. The symptoms of which he complains are protean in character. Thus, he may complain of polyuria, but the passage of a larger amount of urine is often a source of pride rather than of anxiety. Nocturnal frequency of micturition may be the initial symptom. If the patient has to pass water more than once during the night there is probably polyuria. On the other hand, the symptoms of hyperpiesia, such as headaches, a sense of fullness in the head, giddiness, and tinnitus aurium, may be first apparent. Thickening, with retraction of the ear-drum, may be found. The patient may complain of migraine or neuralgia. "Dead fingers" and muscular cramps may result from the peripheral vaso-constriction. Failing vision, due to albuminuric retinitis, may lead the patient to seek advice from an ophthalmologist. The so-called "silver-wire" arteries and retinal hæmorrhages, which are often flame-shaped, are often present. Glistening white patches, probably degenerative, and œdema of the discs—constituting another form of albuminuric retinitis (see p. 1202)—are more common and are very characteristic. Sudden amaurosis is evidence of uræmia. Detachment of the retina may occur. Hæmorrhages are quite common, and epistaxis, sub-conjunctival, gastric or renal hæmorrhage, and even apoplexy may be an early event. Instead of the plethora of hyperpiesia, with a well-nourished body and high colour, there is a sallow tinge in the complexion, and loss of weight. Gastric disturbance is more often hypochlorhydria than is the dyspepsia of hyperpiesia; indeed, there may be loss of appetite and even distaste for food and nausea, indicating the presence of a definite, though low-grade, toxæmia. On closer examination, the signs of renal disease are more apparent. The urine is increased in quantity, and its specific gravity is low,

usually lying between 1008 and 1012. It generally contains a trace or cloud of albumin, though this may be lacking in the urine passed on rising. The protein constituents of the blood are not altered, but there are marked fluctuations in its non-protein or residual nitrogen, corresponding to the degree of functional deficiency of the kidneys, and in later stages of the disease non-protein nitrogen may reach the figures reached in secondary contracted kidney. Physical signs of cardio-vascular hypertrophy, described elsewhere, are often present. Œdema of the ankles only occurs when the heart begins to fail. Indications of cardiac dilatation may be met with. Cheyne-Stokes respiration may occur, especially if the heart begins to fail. "Asthma" is cardiac or uræmic in origin. Emphysema is not uncommon in chronic interstitial nephritis, for loss of elasticity is a factor in both. Consequently there may be bronchitis, and intercurrent pulmonary diseases, such as pneumonia, are more frequent and more dangerous. A furred tongue, urinous smell in the breath, anorexia and dyspepsia are common. Vomiting and diarrhœa are suggestive of chronic uræmia.

Complications.—The principal complications are due to failure of the pump, the tubing, or the filter. In other words, the heart may fail, causing venous congestion; the artery may give way, as in cerebral hæmorrhage; or the renal excretion become so inadequate as to lead to uræmia. Glycosuria is sometimes found. This may be due to alcoholic excess, a factor in the causation of the interstitial nephritis; or to the damaged kidney leaking sugar, in which case the blood sugar will be subnormal; or possibly to over-action of the suprarenals.

Diagnosis.—This rests on the combination of urinary and cardio-vascular signs. The differential diagnosis from hyperpiesia is discussed on p. 970, and that from secondary contracted kidney on p. 1204.

Prognosis.—If the condition be recognised early, there may be a satisfactory response to treatment. In so far as there is a structural change in the kidney it is permanent, but when it is not advanced it is compatible with many years of useful life if the patient takes care. The tests for renal permeability afford useful prognostic evidence. Any evidence of cardiac dilatation, or of uræmia, even of the chronic variety, makes the outlook much less satisfactory. Retinal changes are of ill omen. The prognosis is better in hyperpiesia than in chronic interstitial nephritis, and better in chronic interstitial nephritis than in secondary contracted kidney.

Treatment.—*Prophylactic and general.*—The timely discovery of a trace of albumin and casts in the urine should act as a danger signal, enabling the brake to be applied before disaster occurs. If a rise of pressure be discovered before this stage is reached the opportunities for successful treatment are all the greater. Late hours, evening meetings in stuffy rooms, especially when accompanied by heated political discussions, are to be condemned. In few conditions are both the dish of herbs and contentment more essential, and the stalled ox and strife more injurious.

Exercise in the open air, without strain, and not sufficient to affect the pulse or respiration, is a great help in the early cases. Golf seems to be the best form of exercise for those liable to these degenerative changes. Baths may be a valuable aid. A cold bath is inadvisable, but a warm one, either at night or on rising, is beneficial. The advantage of the effervescing Nauheim bath is not so certain, as it lowers blood-pressure by direct vaso-dilatation

and may be followed by faintness. Plombières douches are recommended when there is a suspicion of intestinal intoxication. They should not be given more than three times a week for 3 weeks at a time; the pressure employed should not be more than 18 inches. An annual course of balneological treatment is often helpful; regulation of life, freedom from worry and change of surroundings are of more importance than the chemical ingredients of the water. Climatic treatment should be on the same lines as in chronic diffuse nephritis. The Riviera and high altitudes are specially unsuitable.

Dietetic.—The bulk and the number of the meals should be reduced; roasted meats should be partaken of sparingly, while animal soups, gravies and internal organs should be avoided altogether. On the other hand, fruits, green vegetables, farinaceous and non-nitrogenous foods may be taken freely. The salt added at table should be stopped, and in severe cases a salt-free diet may be advisable for a time. If the pressure show a continued tendency to rise, a few days' rest in bed on a milk diet are advisable. Coffee, tea and tobacco should be limited and in some cases excluded; thus, tobacco should be forbidden if it cause cardiac pain or distress. Alcohol is usually bad, except when the heart is weak or the appetite poor, when a small quantity may be allowed with food. Moderate restriction of fluids does not diminish nitrogenous excretion and spares the heart.

Drug treatment.—The bowels should be kept freely open, to eliminate both toxins from the body and pressor diamines from the bowel. Sodium or magnesium sulphate are specially useful for this purpose, as they combine with the putrefactive substances and render them inactive. A weekly dose of calomel or mercurial pill will help; but, as in other forms of nephritis, there is a risk of mercurialism if they are given more frequently. Indiscriminate attempts to lower arterial tension by vaso-dilator drugs are to be condemned. We do not know what is the correct pressure for a particular degree of interstitial nephritis, but we do know that some elevation of pressure is necessary. Sometimes it may be necessary to lower pressure directly, just as it is compulsory to lower temperature in hyperpyrexia. In that case, those drugs should be selected which have a slow and prolonged action. The fall of pressure produced by amyl nitrite is quite transitory, while nitro-glycerine only acts for 40 minutes. Their usefulness is therefore confined to anginal attacks. Erythrol tetranitrate in half-grain doses, on the other hand, produces a fall lasting 6 hours. It may, however, occasionally produce severe headache. The action of mannitol is also prolonged. A tablet composed of sodium nitrite, gr. $\frac{1}{2}$, erythrol tetranitrate, gr. $\frac{1}{4}$, mannitol nitrite, gr. $\frac{1}{4}$, ammonium hippurate, gr. i, may be given once or twice a day for a time. But the usefulness of vaso-dilator drugs is very limited, and they may be dangerous. Thus, coronary thrombosis is more likely to occur with a falling pressure. Moreover, the inability of the kidney to excrete a concentrated urine demands a rise of pressure to enable it to excrete sufficient dilute urine for adequate elimination. Potassium iodide is more useful, because it does not act by direct vaso-dilatation, but probably aids in the elimination of the toxins concerned, just as it does in the case of mercury, lead and the syphilitic poison. One to 3 drachms of the 1 in 500 solution of collosol iodine may be given in water three times a day if there be intolerance to potassium iodide. The tinct. iodi of the French Codex in doses of 3 to 5 minims is sometimes helpful, as are small doses (gr. $\frac{1}{2}$ to 1) of thyroid extract. It is probably

in hyperpiesia mistaken for chronic interstitial nephritis that iodine is of most value. Venesection is to be looked upon rather as an aid in an emergency arising from high pressure than as a routine treatment. Patients who are nervous about themselves should not be told the reading of the manometer, and they should never be allowed to read the index themselves, as this may easily send up the pressure 10 mm.

Treatment of complications.—Dyspnœa is due to uræmia or failing heart, and should be treated by the measures appropriate to those conditions. Complete rest is indicated if the heart begin to fail, and 2 minims of tincture of strophanthus with 5 grains of potassium iodide should be given every 4 hours. Nitrites given on the plan already described may help to tide over a difficulty, and oxygen will spare the work of the right heart. Venesection may be tried. Although morphine is risky in diseases of the kidney, it may afford great relief in cardiac distress, and may be cautiously tried. Full doses of sodium bicarbonate may help if there be any acidæmia. But cardiac symptoms indicate a downward step in granular kidney. Henceforward, we are on the horns of a dilemma ; if the pressure be allowed to become too high, there is danger of either cerebral hæmorrhage or cardiac failure, while if it be lowered too much, the urinary excretion becomes inadequate. Epistaxis is a safety-valve and should not be checked too soon, and hæmaturia is similar in character. Digestive disturbances are due to a mild chronic uræmia, and should be treated by free purgation and limitation of the nitrogen intake. Insomnia is due to high tension, and may yield to 20 minims each of sp. æth. nitrosi, sp. æth. co. and sp. ammon. aromat., well diluted. Another remedy is 20 grains each of bromide and chloralamide. It may be occasionally necessary to resort to morphine to break the sequence of restless nights which are exhausting the patient, but, as stated in the article on uræmia, its use is not free from risk.

HYPERPIETIC KIDNEY

In this form of renal disease the vascular changes are of greater importance than the renal, and it will only be necessary to make a brief reference to it here.

Ætiology.—The ætiology is the same as that described under Arterial Hypertrophy (pp. 943, 944) and Supernormal Blood-pressure (p. 970).

Pathology.—The renal changes consist of hypertrophy of the arterioles, which, sooner or later, is followed by fatty degeneration. The latter results in an ischæmic fibrosis of the organs. Thus, the changes are largely degenerative in character, rather than inflammatory changes seen in chronic interstitial nephritis. The kidney is slightly reduced in size, and is somewhat firmer than normal. On section, the fine radial striation in the cortex is preserved, and throughout the organ the small arteries are prominent. Histologically the essential lesion is an increase in the muscular fibres of the media and the musculo-elastic layer of the intima. The hypertrophied tissue becomes fatty, and obliteration of the lumen takes place, and ultimately the renal tissue supplied by the affected arteries undergoes hyaline degeneration due to fibrosis ; the fibrous connective tissue in the immediate neighbourhood is thickened, but there is no glomerulitis and little or no small-

celled infiltration, in contrast to the inflammatory reaction found in chronic interstitial nephritis. The condition is one of ischæmic fibrosis. There is cardio-vascular hypertrophy.

Symptoms and Diagnosis.—The patient is generally plethoric, with high colour, and is usually well nourished. His symptoms are described under Supernormal Blood-pressure and Arterial Hypertrophy.

Treatment. This will be found under Supernormal Blood-pressure and Arterial Hypertrophy.

SENILE OR ATHEROMATOUS KIDNEY

In this form of kidney disease also the vascular changes are of greater importance than the renal, and it will only be necessary to deal briefly with the affection.

Pathology.—The kidneys show depressed red areas, which are due to contraction of fibrous tissue along the distribution of particular interlobular arteries, and, therefore, tend to be conical in form, with their base to the surface of the organ. There is an absence of cardiac hypertrophy; the pressure in the diseased arteries falls below that necessary for glomerular excretion. The affected glomeruli accordingly shrink, and the connective tissue around them becomes condensed and thickened. The degenerate glomerulus and its capsule fuse together, and undergo fatty and granular changes. The atheromatous kidney is, therefore, generally due to atrophy following insufficient circulation, with consequent fibrosis.

Symptoms and Diagnosis.—There may be gradual failure of the physical and mental powers—described by Allbutt as "contraction of the spheres of bodily and mental activity"—rather than the more dramatic events of chronic interstitial nephritis. There is a trace of albumin in the urine. The vessel wall is thickened and tortuous. The blood-pressure is not high, and there is an absence of cardiac hypertrophy. Death by cardiac failure or intercurrent affections is the commonest ending, while cerebral hæmorrhage and even uræmia are unlikely.

URÆMIA

When renal incapacity is sufficiently pronounced it leads to a metabolic disaster to which the name of uræmia is given. That this disaster is due to an intoxication is generally agreed,—the mechanical explanations of Traube are no longer accepted,—but it is still doubtful what the poison is, or whether the various clinical manifestations which are grouped as uræmic are all due to the same poison, or indeed if they are all toxic in origin.

A damaged kidney not only allows materials to escape which it should retain, but retains those which it should excrete. In uræmia the retention of crystalloid substances in the blood is shown by the rise in its molecular concentration, as determined by lowering of the freezing-point.

In support of the retention theory, Bouchard sought to prove that the urine of a uræmic patient is less toxic for animals than that of a healthy person. But the methods at his disposal did not exclude the serious dis-

turbances set up by osmotic currents following the injection into the circulation of urine or of its solid ingredients. According to some observers, Bouchard's results can be explained as due to the poisonous effect of the potassium salts in concentrated normal urine.

In trying to identify some special constituent of the urine as responsible, attention was naturally first paid to urea as the most abundant. Reduction in urea excretion was easily demonstrated in uræmia. But the interpretation of this fact as bearing on uræmia falls to the ground now that it is known that the greater part of the urea comes directly from the protein of the food. A nephritic patient is usually given very little nitrogenous food, especially if uræmia be impending. Moreover, he frequently vomits and thus further reduces his intake. There is no doubt, however, as to the retention of urea in uræmia, both in the blood and in the cerebro-spinal fluid, and to precisely the same extent. According to Canti, patients with more than 0·2 per cent. of urea in the cerebro-spinal fluid are suffering from uræmia. The reading may rise to 0·7 per cent., and even if it is above 0·3 per cent. the case will be fatal. It should be pointed out that as the hypobromite method was used other nitrogenous bodies in the fluid would also react, so that it would be better to say that in uræmia the non-protein nitrogenous content of the cerebro-spinal fluid is increased. The urease method would give the amount of urea only, so that the difference between the results obtained by the two methods is an indication of the amount of amine bodies other than urea, to which the toxic effects are probably due. Urea is also found in the sweat and other secretions when it is eliminated with difficulty by the kidney.

Another reason against attributing uræmia simply to retention of urea is that urea is not toxic. Some years ago large amounts of urea were given for tuberculosis. There was no evidence that it was of benefit, but it certainly was harmless. Retention of uric acid, creatinin, the pigments and the salts of urine have each in turn been invoked to explain uræmia but without satisfactory evidence. In fact, when we compare the symptoms of complete obstructive suppression of urine, or urinæmia, with those of uræmia they are so different as to suggest a different origin. Ascoli says: "Severe urinæmia in man is chiefly manifested by bodily weakness and languor which often appear before any other symptoms, but generally lead to progressive mental weakness and exhaustion, often terminating with great suddenness. The greater part of the most prominent symptoms of uræmia are, however, lacking, especially the severe and acute mental disturbances, the sudden amaurosis, and the epileptic phenomena in general. Only in occasional cases do the symptoms resemble uræmia." The name of *latent uræmia* is sometimes given to this condition, but this is hardly suitable.

If, then, we abandon the view that uræmia is due to retention of one or more of the normal constituents we are thrown back on one of three explanations if uræmia is a toxic process. It might be due to: (1) Some precursor or derivative of urea. (2) Loss or alteration of an internal secretion of the kidneys. (3) Some product of abnormal metabolism.

The immediate precursor of urea is ammonium carbamate, from which it can be formed by simple dehydration. As the liver is the site of this change, hepatic insufficiency would lead to carbamate in the circulation, and this has been invoked to explain uræmia. In puerperal eclampsia

and acute yellow atrophy the toxic symptoms may be thus produced, as there is extensive destruction of liver cells. But in uræmia definite changes in the liver are unusual, and a relatively small amount of hepatic tissue is sufficient to convert enough ammonium carbamate into urea. Frerichs put forward the opposite view, that retention of urea in the body was followed by a reversal of this change, and he produced symptoms similar to those of uræmia by intravenous injections of ammonium carbamate. But the amount of ammonia in uræmic blood is not so great as in the blood of some diabetics in whom symptoms of uræmia are lacking.

Before uræmia can be referred to loss of the internal secretion of the kidney, the existence of such secretion must be proved. The evidence usually quoted is Rose Bradford's observation on the effect of partial nephrectomy in dogs. When the amount of kidney substance was largely reduced he found that the excretion of urea was increased. He suggested that the internal secretion of the kidney regulated nitrogenous katabolism, which in its absence went on unchecked. But Beddard and Bainbridge found that the increased output of urea occurred only as a terminal event when the animal was so ill that it was unable to take food and was starving. And it has long been known that after starvation for some time there is a rise of urea excretion—when the reserve of fat has been exhausted and the animal is reduced to living on its tissue protein alone, a condition under which life cannot be long supported.

Allied to this view is the hypothesis that the autolytic products of the kidney are the cause of uræmia. But in chronic interstitial nephritis the lesion is so slowly progressive that the amount of such products in the circulation at any one time must be infinitesimal, and yet the fatal issue may be due to uræmia.

We are therefore thrown back on the third hypothesis, that the defective excretion leads to the formation of abnormal products from perverted metabolism. It may be that there is one specific substance or a number of abnormal bodies responsible. The fact that the clinical manifestations are so various does not in itself prove the existence of different toxins. Alcohol can produce delirium tremens, peripheral neuritis, cirrhosis of the liver or cardiac enlargement under different conditions. But the demonstration by Lewis and Barcroft that there is a non-volatile acidæmia in uræmic dyspnœa is a strong point in favour of multiplicity of toxins, for this acidæmia will not produce the other manifestations of uræmia. Marriott and Howland attribute this acidæmia to the failure of the kidney to excrete acid phosphates. As to the nature of any other toxins we are still in doubt. Choline, a substitution product of ammonia formed from breaking down of the complicated fat of the nervous system, has been suggested, but this is unlikely, as it is a body of comparatively feeble toxicity and lowers blood-pressure, which usually remains high in this condition. A more promising suggestion is trimethylamine, another substituted ammonia. The so-called urinous smell in uræmia is due to this body, and the smell is absent in the urinæmia of simple suppression. Golla found that it was present in traces in normal urine and blood, but that it was increased tenfold in the blood of uræmic patients. In complete obstructive suppression, on the other hand, it was normal in amount. Experimentally trimethylamine has induced severe epileptiform convulsions.

We may conclude that at any rate some of the symptoms of uræmia are due to a toxæmia acting on the nervous system caused by the abnormal metabolic products resulting from inadequate excretion by a diseased kidney.

Symptoms.—A convenient clinical classification of the types of uræmia is: (1) *Cerebral* in the fulminating and acute cases; (2) *Respiratory* in the subacute cases; and (3) *Gastro-intestinal* in the chronic cases. The terms acute and chronic apply to the uræmia and not to the disease responsible for it. But each of these types is really nervous in origin. Usually the first type begins with severe headache. Drowsiness and twitchings of the face and hands follow. The twitchings may become aggravated into epileptiform convulsions, and the drowsiness may deepen into coma, ending in death. But several important departures from this course may occur. Sudden loss of vision, amaurosis, is not infrequent, although the fundi may not show the changes characteristic of albuminuric retinitis. Local palsies, hemiplegia or monoplegia, may come on spontaneously or after a convulsion, and are frequently due to small vascular lesions. Intense itching of the skin, tingling and numbness of the extremities, muscular cramps or insomnia may usher in the more serious symptoms. Sudden mania or delusional insanity may be the first and a very misleading symptom. Generally the cerebral type is rapidly fatal, but convulsions and amaurosis, though more striking, are less grave than the other symptoms. In the epidemic of war nephritis we saw seven instances of uræmic convulsions with complete recovery from the nephritis.

The commonest respiratory symptom is the paroxysmal dyspnœa, to which the name of uræmic asthma is given. It is associated with a fall in the CO_2 of the alveolar air from the normal 5 per cent. to 3 per cent. or lower. There is diminished alkalinity of the blood, from the presence of some non-volatile acid. Addison called attention to the hissing character of the respirations in this condition. In all types of uræmia there is a tendency to stomatitis, and this is perhaps particularly so in uræmic asthma. Rose Bradford says that the combination of dyspnœa of a hissing character in a drowsy patient with bleeding gums is very typical of the uræmic state. At first there may be no signs in the chest except the ordinary cardio-vascular signs of chronic nephritis, but as the attack proceeds there are usually abundant moist sounds from the onset of œdema of the lungs. The heart fails, the patient becomes steadily waterlogged, slipping down into the bed from the orthopnœic position as he becomes more and more drowsy. The fatal issue may not occur in this way, however, but from development of some of the more acute nervous symptoms.

Less common than this paroxysmal dyspnœa is Cheyne-Stokes respiration. The whole of the cerebral functions may then show a curious periodicity; thus the pulse quickens during the noisy breathing, the pupil dilates, the patient becomes more conscious and restless. As the apnœic pause succeeds the pulse slows down again, the pupil contracts and the patient becomes quieter or even comatose.

The gastro-intestinal symptoms are nausea, hiccough, vomiting and diarrhœa. The gastric part of these symptoms may be very chronic. Any practitioner who neglects systematic examination of the urine will sooner or later treat a case of uræmia as one of simple dyspepsia. Apart from

the urine, there is, however, one significant point: the dyspepsia may improve under treatment while the vomiting persists. In simple dyspepsia vomiting is never the last symptom to clear up. It is stated that this vomiting has no relation to meals, but this is far from being invariably true. Vomiting may occur only then, and so the mistake is made. In severer cases the vomiting may be quite uncontrollable, when the prognosis becomes correspondingly grave.

Attacks of diarrhœa are not uncommon in chronic nephritis and are not in themselves significant of uræmia. The amount of nitrogenous excretion occurring by the bowel, when urinary elimination is inadequate, irritates the intestine and leads to the so-called albuminuric ulceration. Another explanation of this condition is that hæmorrhages which occur here as elsewhere in chronic nephritis are the precursors of the ulceration. There may also be an intense catarrhal or even "diphtheritic" colitis. Here, therefore, there are local lesions sufficient to account for symptoms usually referred to uræmia, for such lesions are conspicuously absent at least in the asthmatic and gastric symptoms. It is accordingly inadvisable to call these symptoms uræmic, as is generally done. At any rate the term should be confined to those violent choleraic attacks which are out of all proportion to the local lesions. Both the vomiting and diarrhœa are sometimes regarded as an attempt at vicarious elimination of toxins. The fact that the vomit may contain a higher percentage of amines than the blood certainly suggests this.

In this way all the symptoms of uræmia could be regarded as due to toxins acting on the central nervous system, though sometimes manifesting themselves by local action on the medullary centres controlling respiration and vomiting. It is in accordance with what we find in other diseases, *e.g.* diphtheria, syphilis and lead poisoning, for a circulating toxin to exhibit this selective action on the nervous system. Evidence is, however, accumulating that vascular lesions in the brain play a larger part in the production of the uræmic syndrome than was previously thought, while terminal infections are frequently responsible for some of the symptoms.

Diagnosis.—This brief account of the symptoms of uræmia will indicate also some of the pitfalls besetting diagnosis. The greatest difficulty arises in distinguishing between hemiplegia due to uræmia and to cerebral hæmorrhage. In both there may be chronic interstitial nephritis with its urinary and cardio-vascular signs. In both the blood-pressure may be high and rising. But coma usually comes on sooner in hæmorrhage and becomes profound more rapidly. Ophthalmoscopic examination may be of great assistance, the existence of albuminuric retinitis pointing to uræmia. Some cases of cerebral tumour without localising signs, but with the classical symptoms of headache, vomiting and optic neuritis may be very difficult to distinguish from uræmia, if there is chronic nephritis as well,—a not very uncommon complication in syphilitic tumours of the brain. But such cases are more chronic in their course than uræmia. If the cerebral type of uræmia be accompanied by pyrexia, as it sometimes is, the question of meningitis must be considered. Lumbar puncture may then throw light on the case by the cytology, bacteriology and urea content of the fluid.

Cases of cardio-vascular disease in which the left side of the heart is failing may simulate uræmia. The urine is loaded with urates, twitchings do not occur, and the urea content of the cerebro-spinal fluid is low. Accord-

ing to Canti such cases occur after 45, while true uræmia is commoner before that age.

Other causes of coma must be taken into account,—alcohol, status epilepticus, trauma, opium, diabetes and the apoplectiform onset of general paralysis. The urinous smell of the breath may be a help. The fact that there is a fair quantity of urine may be misleading, for in chronic interstitial nephritis and contracted white kidney the daily excretion of water must be in excess of normal to maintain adequate elimination of solids. The presence of albumin is not sufficient, for any comatose person may have albuminuria. The presence of casts, other than hyaline, must also be established. For reasons already given, estimation of the urea in the urine is not likely to be of service, while an estimation of the blood urea is most helpful.

In the respiratory type the absence of adequate cardiac or pulmonary signs to account for the dyspnœa in a person not previously the subject of asthma will generally lead to a correct diagnosis, especially if the drowsiness and the condition of the mouth are duly considered. In the gastro-intestinal type once attention is directed to the urine the condition will probably be recognised. The danger lies in the renal symptoms being overlooked because they may be trivial. Moreover, comparatively slight renal inadequacy may lead to toxic symptoms by the retention of some poison which would otherwise have been promptly eliminated. Thus salicylates, opium and mercury are badly excreted by the nephritic. Sometimes a patient who dies with symptoms resembling uræmia is found at the necropsy to have a very slight kidney lesion,—merely an adherent capsule and some diminution of the cortex. Then usually some other chronic intoxication such as pyorrhœa alveolaris will be found to have been at work as well.

Treatment.—This is unsatisfactory, as the underlying lesion is usually incurable and progressive. Only in acute nephritis can we expect to do more than stave off the fatal issue for a short time. When uræmia depends on an acute congestive nephritis the engorgement of the kidney may be relieved by the application of 4 dry cups to the loins. For the relief of vomiting, a minim of carbolic acid with 3 minims of dilute hydrocyanic acid and 10 minims of liquor adrenalin. hydrochlorid. in half an ounce of water every 3 or 4 hours sometimes affords relief. For the headache, a mixture of bromide and chloral hydrate is the best remedy, and doses of 20 to 80 grains of each may be required. But the main indication in the treatment of uræmia is the rapid elimination of the accumulating toxins in every possible way.

1. *Elimination by the bowels.*—Of all the routes available this is the simplest and one of the most effective. We should therefore never be in a hurry to check the diarrhœa which may be present, as it is nature's effort to get rid of toxins. According to von Noorden, 8 grammes of nitrogen can be excreted by the bowel in the day, while not more than 3 grammes can be excreted by the skin. Croton oil, elaterium and gamboge are open to the objection that they are very irritant to an already irritated intestine. A drachm of pulv. jalapæ co. or 5 grains of calomel, followed by ½ an ounce of magnesium sulphate, should be tried. In milder cases of chronic uræmia a colocynth and hyoscyamus pill every other night may be sufficient. If not, 1 oz. of mist. sennæ co. should be given without delay.

2. *Elimination by the kidney.*—As uræmia is a manifestation of the failure of the kidney to do its work, but little response can be expected to diuretics. The action of diuretics is considered under chronic nephritis.

3. *Elimination by the skin.*—Not very much nitrogen can be got rid of in this way, and the method is open to the objection that the removal of so much fluid without a corresponding amount of organic solids concentrates the toxins in the circulation, while giving the kidney a more concentrated and therefore a more irritating urine to excrete. Diaphoresis, moreover, may be exhausting to the heart. One of the factors in the production of œdema in nephritis is the retention of salt, which raises the osmotic pressure of the tissues with a consequent retention of fluid which contains toxins. The elimination of salt by the skin may therefore be of service by making excretion by the kidney easier. In such cases we have found diaphoresis followed by diuresis, which is not the normal effect of sweating. The vapour bath or hot pack is more trying to the heart than the hot-air bath. None of these measures should be continued more than a quarter of an hour after sweating has begun, and a careful watch must be kept on the pulse; the procedure should be stopped at once if there are any signs of collapse, and stimulants should be at hand. If the treatment is having a good effect, sweating will begin at a lower temperature with successive baths. A nightly hot bath, containing 4 tablespoonsful of mustard, followed by wrapping in hot blankets until sweating has ceased is useful in some chronic cases, even when there is no œdema. Pilocarpine is profoundly depressing to the heart, and may lead to a drowsy patient being drowned in his own pulmonary and bronchial exudates. It is not often given now that the risks are more fully appreciated.

After diaphoresis the temperature may fall dangerously low in spite of hot bottles and blankets. The temporary improvement may sometimes, in our opinion, be too dearly purchased at the expense of the subsequent exhaustion.

4. *Elimination by bleeding.*—This is the most effective treatment. A spontaneous epistaxis has been noticed to avert a threatened attack of uræmia, and venesection is a rapid way of removing some of the toxins. It may be advantageously combined with the infusion of normal saline solution or of 1 per cent. of sodium acetate, which has been advocated as more easily excreted. With infusion a larger amount of blood can be safely abstracted and the toxins diluted. As the vascular tension is usually high the volume of fluid infused should be less than that of the blood removed. Thus 20 oz. of blood can be withdrawn and 10 oz. of fluid infused. In our experience this treatment is most applicable to cases of convulsions and amaurosis. Removal of cerebro-spinal fluid by lumbar puncture is a rational procedure, and is useful for the control of headache and of convulsions.

Since uræmic asthma is due to an acidæmia, a drachm of sodæ bicarb. should be given every 3 or 4 hours in this condition. Inhalations of oxygen have been recommended, but any benefit derived from them is probably due to their cardiac effect. Inhalations of chloroform may be useful in uræmic convulsions. Osler strongly recommends morphine, considering it indispensable for the restlessness and delirium. We have certainly known it to do good, but we are inclined to agree with Burney Yeo that, if it be used freely

for this purpose, the restlessness of uræmia may be relieved by the repose of death.

LARDACEOUS DISEASE

Synonyms.—Amyloid or Waxy Kidney.

Definition.—A pathological condition in which the blood vessels of the kidney, in more advanced cases the tunica of the tubules and the interstitial tissue also, are the seat of waxy degeneration.

Ætiology.—The affection is commoner in men than in women, and although occasionally seen in children it is more likely to occur in adolescence and earlier adult life, being uncommon after fifty years of age. It is usually due to chronic suppuration and syphilis. The influence of tuberculosis and diseases of the bones and joints is merely due to the obstinate suppuration which they excite. It is doubtful whether it ever occurs, apart from such conditions.

Pathology.—Amyloid material or lardacein is a product of protein degeneration, containing nitrogen, sulphur and chondroitin-sulphuric acid. In uncomplicated cases, the affected kidney has the appearance of a large white kidney with a smooth surface and a capsule that strips easily. The organ is firmer than it otherwise would be. On section, the cortex is thicker than normal and has a yellowish white appearance; the glomeruli may be visible as minute translucent spots. The pyramids are dark red, in contrast to the pale cortex. If a solution of iodine in potassium iodide is poured over the surface, some of the glomeruli stand out as mahogany-brown spots and the vasa recta as brown streaks. In histological preparations stained with methyl-violet, amyloid material takes a pink colour. The disease tends to appear first in the capillaries of some glomeruli, while others are normal, and its incidence is often partial within a single glomerulus. The afferent arterioles, vasa recta and capillary plexus are next affected; in more advanced cases there is amyloid degeneration of the tunica propria of the tubules with amyloid deposits in the interstitial tissue. In most cases there is an associated nephritis, interstitial rather than parenchymatous. The kidney lesion is generally the most striking part of a widespread lardaceous degeneration which also involves the liver, spleen and intestine; less commonly the blood vessels of the thyroid, suprarenals, pancreas, heart and brain may be affected as well. Occasionally only the kidney is implicated.

Symptoms.—The symptoms are not likely to occur unless chronic suppuration has existed for at least 3 months, and the onset is insidious.

The urine is copious, of low specific gravity (1003 to 1010). The amount of albumin is variable; when abundant there is probably coincident nephritis. The amount of urine and its specific gravity may also be affected by the presence and degree of coincident nephritis, and the state of the heart. Hyaline and granular casts are present in the urine; casts staining brown with iodine are not evidence of amyloid disease, and may occur in other diseases of the kidneys. True waxy casts are not found. In later stages there is œdema, with diminished excretion of urine. The blood-pressure is not raised, nor is the left ventricle hypertrophied, unless there is coexistent chronic nephritis.

Diagnosis.—The diagnosis is indicated by the nature of the urine. It is made (1) when there is a sufficient cause in the past history or present condition, namely, chronic suppuration or syphilis; (2) on the general condition of the patient, namely, a secondary anæmia, which may reach an extreme grade, with a pale or "alabaster" facies and cachexia; (3) on signs of lardaceous disease in other organs, such as enlargement of the liver or spleen and diarrhœa.

Course and Prognosis.—This depends on that of the primary cause. If the latter is unchecked, the disease is slowly progressive and death occurs from exhaustion due to the original disease, less often from uræmia. Where the original disease can be cured, recovery may occur. Complete recovery of the kidneys is less likely than is recovery of the liver, spleen and intestines.

Treatment.—The treatment is that of the original disease. In suppuration of the bones or joints, empyema, etc., it is surgical; but it must be recognised that in advanced cases surgical treatment may be too late, even though it is successful in eradicating the septic focus. In all cases fresh air and sunlight and a nourishing diet are essential. Iron, arsenic and cod-liver oil should be given. Cases of syphilitic origin should be treated with potassium iodide, in combination with iron and arsenic.

BACILLURIA

Synonym.—Bacteriuria.

Definition.—Bacilluria is a condition in which bacteria are present in the urine in such numbers as to render it hazy to the naked eye, without a corresponding reaction in any part of the urinary tract to their presence.

Ætiology.—Predisposing causes are constipation and obstruction to the outflow of urine, as in the bacilluria that may complicate pregnancy. The condition is found at all ages from infancy onwards, and is more common in females than in males. The infecting organism is *Bacillus coli* in the great majority of cases; less frequently *B. typhosus*, paratyphoid A and B, staphylococcus, streptococcus, and *B. proteus* are found.

Pathology.—There are three main paths of infection: (1) by the blood stream, (2) by lymphatics, and (3) by the urethra. In the first two of these a focus may be found, as in the bacilluria following typhoid fever or appendicitis, but sometimes post-mortem examination has shown a complete absence of any lesion. There is little reaction in the urinary tract to the infection; the mucous membrane of any part of it may show a mild degree of hyperæmia.

Symptoms.—The urine, immediately it is passed, has a hazy appearance; if it is poured into a test-tube, and the test-tube rotated, the urine has a characteristic "satiny" appearance or shimmer; it is not cleared by filtration. Its odour is often characteristic, being sometimes fishy in cases of *B. coli* infection and highly ammoniacal in *B. proteus* cases. Its reaction is acid, unless due to staphylococcal or *B. proteus* infection. It generally contains a trace of albumin, and often may contain a few white blood corpuscles and epithelial cells. A catheter specimen grown in broth, in dilutions of 1 c.c., $\frac{1}{10}$ c.c. and $\frac{1}{100}$ c.c. urine in 10 c.c. broth, gives a growth in all dilutions, and in *B. coli* infections there is generally a growth in more extreme dilutions.

There may be no other symptoms. On the other hand, there may be indefinite malaise, fever, gastro-intestinal disturbance, especially indigestion, constipation and abdominal pain; in other cases headaches, rigors and even meningism may occur. There may be local symptoms, such as enuresis in children and frequency of micturition in adults. When the symptoms point to inflammatory reaction in one part of the genito-urinary tract, such as pyelitis, cystitis, prostatitis, urethritis, or epididymitis, the condition is better diagnosed accordingly; even though bacilluria may be the primary condition.

Course and Prognosis.—The course varies greatly. The condition may be transient; more frequently it persists for weeks or months and shows a tendency to relapse. The prognosis should be guarded, in view of the possibility of complications and resistance to treatment, but in general it is good.

Treatment.—*Prophylaxis* is important in nurseries and children's hospitals, since there is evidence of spread of infection *via* the urethra, at any rate in females. Here it is a question of cleanliness. Having excluded as far as possible a focus of infection elsewhere, the main indications are rest, emptying of the bowel and flushing out of the kidney. In the initial stages at any rate, particularly if there are any general or local symptoms, the patient should rest in bed. The diet consists chiefly of carbohydrates, fruit and vegetables. Five pints or more fluid in the 24 hours are advisable, in the form of water, Malvern water, Vichy water, lemon drink, Imperial drink, barley water, weak tea and thin soups. Milk as such is unsuitable, though junket, butter-milk, whey and cream are food. Alcohol should be avoided. The bowels should be first emptied with castor oil and then kept open with salines or senna. Grey powder is also a useful laxative in such cases.

Urinary antiseptics are of value. The best plan appears to be to give enough potassium citrate in 20-grain doses every 4 hours in order to render the urine thoroughly alkaline for 10 days after the acute symptoms have subsided; then to give acid sodium phosphate in 30-grain doses three times a day, adding 10 grains of hexamine as soon as the urine again becomes acid. Sodium benzoate, 10 grains three times a day, may be useful, either by itself or with hexamine. It should be noted that hexamine is inert in an alkaline urine. Cystopurin (15 grains three times a day) or hexyl-resorcinol (2-grain capsules—one to three thrice daily) should be tried if hexamine proves ineffective or irritating. A change of antiseptic is sometimes advisable. Intestinal antiseptics are sometimes more efficacious, such as salol, 30 grains daily, or combined with boric acid, 15 grains daily. Boric acid is given in 5-grain keratin-coated capsules, to avoid gastric irritation. Sandal-wood oil is the most reliable antiseptic if the urine is alkaline from the first. In cases of delayed recovery, vaccines are a useful adjuvant; they do not replace other treatment, but are sometimes undoubtedly beneficial. *B. coli* vaccines are given in doses of 5 to 500 millions at 7 to 10 days' intervals, the dosage and interval depending on the particular case. It is important to bear in mind that bacilluria is often merely a complication of some other affection or disease of the urinary tract, such as renal calculus, tuberculosis of the kidney, pelvic abscess or neoplasm.

PYELITIS

Definition.—Pyelitis is inflammation of the renal pelvis. There is commonly some coincident inflammation of the renal parenchyma, but it is only when nephritis complicates the clinical picture that the condition is termed pyelo-nephritis.

Ætiology.—Most cases are due to a blood-borne infection of the renal pelvis, and it may be noted in this connection that it is a normal function of the kidney to excrete micro-organisms present in the blood stream; whether the renal parenchyma is, or is not, of necessity damaged in the process is a point on which there is not as yet exact information. The pelvis may also be involved by ascending infections—(*a*) via the lumen of the ureter when there is ureteral obstruction; it is probable that infection does not spread by this channel when the lumen is normally patent. (*b*) By way of the peri-ureteral lymphatics from local foci in lower parts of the urinary tract, such as the bladder, urethra, prostate, seminal vesicles and epididymis. Lastly, there is the possibility of direct spread of infection from the bowel, and by cross lymphatic channels from one kidney to the other. In those cases in which a pyelitis occurs secondary to appendicitis, cholecystitis, ulcerative colitis, etc., the spread of infection may be by the lymphatics or the blood stream.

In general, pyelitis is more common in females than in males. Its age incidence depends on the determining cause. Thus, it is common in female infants, as a result perhaps of urethral infection, to which they are more liable than male infants. It is not an uncommon complication of pregnancy, occurring especially in the fifth month of gestation. It is common in males at a later age, associated with enlarged prostate and cystitis.

Other ætiological factors which affect both sexes are stone in the kidney, tuberculosis of the kidney, the presence of any tumour pressing on the ureter and causing ureteral obstruction, such as pelvic tumours, cystitis from any cause, and urethral stricture.

Pathology.—The mucous membrane of the pelvis is swollen, œdematous and hyperæmic, and the submucous venules are engorged. Where there is obstruction, the pelvis is dilated and contains a slightly turbid or opalescent fluid. In these circumstances the ureter above the obstruction is dilated and tortuous and its walls are thickened. The kidney is swollen and pale, from cloudy swelling, and in severe cases there may be multiple small abscesses in the renal parenchyma.

Bacillus coli is by far the most common infecting micro-organism. Streptococci, staphylococci, gonococci and bacilli of the proteus and typhoid groups may be found. The infecting micro-organism is readily recovered from the urine.

Symptoms.—The clinical types of pyelitis differ greatly from one another, and the condition may be responsible for an acute fulminating illness or for a chronic malaise of indefinite nature.

Local Symptoms.—**Pain** is the most important, especially as a diagnostic indication in acute cases. It is of the nature of a dull ache in the loin or flank, at first slight and intermittent, later, or in other cases at once, constant

and sometimes intense. Occasionally it is like renal colic; there may be strangury. Increased frequency of micturition is a common symptom.

General Symptoms.—In acute cases there may be sudden onset with rigors, vomiting, headache and the general constitutional disturbance of profound toxæmia. These cases may simulate septicæmia (in fact there may be septicæmia), appendicitis, or, when associated with abdominal distension, constipation and vomiting may even simulate intestinal obstruction. In other cases, with cerebral symptoms, meningitis may at first be difficult to exclude.

In subacute cases, without marked pain or rigors, there is general malaise, fever, anorexia, wasting and a secondary anæmia associated with some degree of polymorpho-nuclear leucocytosis (W.B.C. = 10 to 15,000).

In relapsing cases there are periods of exacerbation with acute symptoms, and intervening periods of fair health or general malaise. Fever is commonly present; in acute cases with rigors it may rise to 105° or 106° F. In general the temperature is irregular, remittent or intermittent, varying between 102° and 104° F. in acute cases, and 100° and 102° F. in subacute cases. The pulse is raised in proportion to the temperature, and there is a corresponding slight increase in the respiration rate. Of other general symptoms constipation or diarrhœa frequently precedes the disease, and constipation generally accompanies it. Toxæmia is often marked.

Deep tenderness on palpation of the renal region is the most important sign to determine. There is some degree of abdominal rigidity, and it may be possible to determine enlargement and tenderness of the kidney. The urine is characteristically turbid; it is at first febrile in character; later, chiefly as the result of treatment, it is pale and of diminished specific gravity. The turbidity is not entirely removed by filtration, and is of the character described under Bacilluria. Examination of the deposit (catheter specimen in women) shows pus cells and epithelial cells from the urinary tract. There may be hæmaturia. In all cases a rectal examination should be made to determine the condition of the prostate and seminal vesicles. Stones in the lower part of the ureter may be palpated.

Diagnosis. — In cases with fever and constitutional disturbance the differential diagnosis is from those diseases which come in their early phases under the category of indeterminate fever. The diagnosis is made on the examination of the urine. Pyonephrosis is diagnosed by the presence of a tumour. Calculus is recognised by its clinical features and by X-ray photograph. Perinephric abscess in its early stages is not accompanied by pyuria or frequency of micturition. Cystitis is generally afebrile; and it is accompanied by suprapubic discomfort and pain, particularly at the end of micturition. The diagnosis can be established by cystoscopy. Urethritis is recognised by local tenderness, urethral discharge and urethroscopy, and prostatitis by swelling and tenderness on rectal examination.

Prognosis.—The natural course in the majority of cases is to recovery in a few weeks. A longer interval generally elapses before the urine is free of bacteria. In a proportion of cases the complaint tends to become chronic, and among these are included cases that relapse, for in these the recovery has generally been incomplete. The disease may progress to pyelo-nephritis, suppurative nephritis, pyonephrosis or perinephric abscess. A fatal termination is rare, except when the condition complicates other disease,

such as paraplegia, or in elderly persons with obstruction to the outflow of urine.

Treatment.—Complete rest in bed is of first importance. Especial care must be taken to guard against chill. Otherwise the general treatment is that of a febrile illness. The bowels should be kept freely open with saline, after an initial dose of castor oil followed by an enema. The diet should be limited to fluids while there is fever, and in general is similar to that described under Bacilluria. If there is vomiting, fluid is given per rectum—half a pint 4-hourly. So long as there is toxæmia and fever, alkalis are given in sufficient dosage to render the urine alkaline; potassium citrate either alone, or combined with the bicarbonates of potassium and sodium, is given 2-hourly at first, then 3-hourly and 4-hourly so long as the urine is kept alkaline. After the temperature has been normal for some days and toxic symptoms are past, the medicinal treatment follows the lines advised under Bacilluria.

Chronic cases.—A short course of the treatment outlined for an acute case is advisable. Following this, every effort is to be made to build up the patient's resistance by living in fresh air, avoiding chill and over-fatigue, a generous and nourishing diet, and by so arranging the diet that the bowels are open regularly without taking purgatives other than a simple saline in the morning, or paraffin and agar. At the same time hexamine and acid sodium phosphate may be given, or an intestinal antiseptic, such as salol or izal. Vaccine treatment has proved efficacious in some cases, especially if given over long periods. F. Kidd has obtained good results by renal lavage with 5 per cent. colloid silver. In all cases a local focus of infection must be excluded by careful examination, since its removal is the first line in treatment, and its neglect is the cause of many chronic cases. In the rare fulminating cases, with suppurative nephritis, nephrectomy may save the patient's life.

PERINEPHRITIS AND PERINEPHRIC ABSCESS

1. Perinephritis without suppuration is really a part of some cases of chronic nephritis. Its clinical importance is not generally recognised, but it may be the sole cause of lumbar pain in that disease. The capsule of the kidney is thickened and adherent to the perirenal tissues, many of the adhesions being vascular.

2. Perinephritis proceeding to suppuration may be primary or secondary.

Ætiology and Pathology.—The primary form may follow injury, but more frequently it results from boils, carbuncles and tonsillitis, or complicates an acute specific fever. Soon after the Great War, cases were so common as to be described under the name of *epidemic perinephric suppuration.* The infecting organism is *Staphylococcus pyogenes.* J. Koch has shown experimentally that intravenous injection of staphylococci is followed by their excretion in the urine after an interval of 4 to 6 hours. In the process of excretion, according to Koch, they may give rise to multiple cortical abscesses, cylindrical medullary abscesses, or, passing along the cortical lymphatics, may gain access to the perinephric tissues and there cause abscess formation. In these circumstances perinephric abscess is an example of the

mildest form of staphylococcal pyæmia with single metastatic abscess formation. The secondary form may complicate suppuration in the neighbouring organs, such as the kidney, liver, gall-bladder or appendix. It may be secondary to caries of the spine. In other cases the infection may be carried by lymphatics from a focus in or around the bladder, rectum or female pelvic organs.

Such is the ordinary terminology, but it will be observed that the "primary" form is really due to infection from a distant focus through the blood stream, while the "secondary" is due to direct extension or infection through the lymphatics from some focus in the neighbourhood of the kidney.

Symptoms.—The general symptoms are fever of a hectic type, malaise, pallor and a toxic appearance; there may be rigors, sweats and vomiting. Seven to 14 days generally elapse before localising symptoms appear, such as abdominal pain, and slight fullness and resistance, with deep tenderness, in the affected loin. As the abscess forms, pain and tenderness increase, there is induration and, later, redness of the skin and œdema in the lumbar region. The tumour first tends to spread backwards, obliterating the normal hollow in the loin, and then as pus collects it may spread forwards, forming a tender tumour palpable from the front. In its relations to the colon it resembles a renal tumour, but does not move with respiration. There is resistance or rigidity of the abdominal wall on the affected side. There is an increasing polymorphonuclear leucocytosis. The urine is febrile in character, containing a trace of albumin and perhaps a few white blood corpuscles; it does not contain pus, unless the kidney itself is involved, but hæmaturia may occur.

Course.—When the condition is simply associated with chronic nephritis it has no separate significance. When it proceeds to suppuration the abscess may rupture into the peritoneum, colon or pleura, or on to the surface, unless the abscess is opened and drained.

Diagnosis.—Before localising signs appear the condition may be mistaken for typhoid fever, malaria or infective endocarditis. The blood examination is important for the purpose of excluding malarial parasites; leucocytosis is against typhoid fever, and when above 15,000 is in general against infective endocarditis. Absence of agglutination of micro-organisms of the typhoid group is further evidence.

When the tumour exists it has to be distinguished from a renal tumour or pyonephrosis. Renal and adrenal growths may be accompanied by fever, but do not usually give the general symptoms of suppuration; they tend to extend forwards rather than backwards, and induration of the tissues is absent. Pyonephrosis causes symptoms of suppuration and a tender swelling, but the tumour is circumscribed, moves with respiration, and does not cause any bulging in the lumbar region. Pyuria is usually present.

The diagnosis of caries of the spine, hip disease, and even of myositis as distinct from perinephritis may be difficult. Since perinephritis in itself induces lumbar rigidity and some degree of scoliosis, X-ray examination may be required to exclude caries of the spine. Hip-joint disease is excluded by absence of local tenderness and by the freedom of flexion and rotation of the thigh.

Treatment.—In the early stages, before there is evidence of suppuration, and when the chief symptom is lumbar pain, the treatment is that of a patient acutely ill with a general toxæmia. The bowels should be kept well open, and fomentations or poultices applied to the lumbar region. Aspirin may be given to relieve pain, and the local application of belladonna is of assistance. Early operation is important, and should be performed as soon as there are reasonable grounds for suspecting suppuration.

TUBERCULOSIS OF THE KIDNEYS

Small grey tubercles are frequently found scattered through the kidneys in persons who die of acute miliary tuberculosis; the kidney disease, however, scarcely affects the clinical aspect of the case, and this form of renal tuberculosis will not be considered here. Further, in patients who die of pulmonary tuberculosis it is not uncommon to find tuberculous foci in the kidneys post mortem, although there was no indication of their presence during life.

Clinical renal tuberculosis is either the fibro-caseating form of the disease, or it is tuberculous hydronephrosis. In either case, the tuberculous infection is generally primary in the kidney in so far as its clinical expression is concerned.

Ætiology.—The sexes are equally affected. The maximum age incidence is in the third and fourth decades; the disease is uncommon in the young and rare in the old. At an early stage the disease is unilateral. In the majority of cases the tubercle bacilli are carried to the kidney by the blood stream from a tuberculous focus, such as a caseating lymph gland. Recent experimental work has shown that bacteria do not ascend in the lumen of the ureter unless it is diseased, when the infection may spread by direct extension in its walls Infection may also reach the kidney via the lymphatics in a proportion of cases. The path of infection is by way of the ureteric lymphatics, and it is probable that pelvic tuberculosis, for example, tuberculous prostatitis, may spread to the kidney by this route. There is also reason to think that tubercle bacilli from a diseased kidney may infect the opposite healthy kidney by the same lymphatic path, the bacilli first travelling in the urine and walls of the ureter from the diseased kidney and causing disease of the bladder, and then travelling from the bladder by way of the ureteric lymphatics to the sound kidney. On the other hand, there is a shorter path for infection from one kidney to another by the para-aortic lymphatic system. Since the disease in the other kidney takes the same anatomical form as it originally had in the kidney first affected, it is probable that, if the first is due to a blood-borne infection, so is the second. Vesical tuberculosis is, as a rule, secondary to infection elsewhere in the urino-genital system, and the primary disease is commonly renal.

Pathology.—The initial lesion is in the cortex, or one of the pyramids, and it consists of one or more tubercles. The morbid process spreads by destruction of kidney tissue; there is caseation in the centre of the lesion, inflammatory reaction, with intense small-cell infiltration, giant-cell formation and more or less fibrosis at the periphery. The lesion also spreads by the deposition of tubercles at a distance; these are scattered through the

cortex, singly or in groups. Extension through the capsule is uncommon, but extension to the renal pelvis is frequent. Complete destruction of one or more pyramids may occur, or the disease may spread and involve one or more calyces or the entire pelvis. The resulting infiltration and cicatricial contraction may lead to hydro- or pyo-nephrosis. The disease tends to extend down the ureter, and the bladder is commonly infected at an early stage. Secondary infections may lead to metastatic abscesses in the kidneys and ultimately to destruction of the whole organ.

Symptoms.—Frequency of micturition is often the earliest symptom; it is first noticed by day and later at night. Urgency and painful micturition develop next. The urine may show no other abnormality than a trace of albumin at an early stage; characteristically it is pale and a little turbid from the presence of pus; it is acid in reaction, it may contain a few renal cells, and it is sterile on culture. By appropriate staining tubercle bacilli may be demonstrated in the centrifuged deposit. Hæmaturia may be the first symptom, or the disease may develop insidiously with lumbar pain. On examination, the kidney is sometimes enlarged, and it may be hard and irregular; it is often tender. Tenderness along the course of the ureter or thickening of the ureter, as determined by abdominal or rectal examination, is of great importance. The rest of the urino-genital system requires close examination; this should include cystoscopy and in some cases ureteral catheterisation. X-ray examination of the abdomen may reveal calcified tuberculosis of the kidneys or lymph glands, and it may be required in the differential diagnosis from renal calculus. Finally, a careful review of the patient's history and present condition for evidence of a chronic bacterial toxæmia or of tuberculous infection elsewhere must be made.

Diagnosis.—The presence of tubercle bacilli in the urine, whether determined by microscopic examination of the stained deposit or by guinea-pig inoculation, is not absolute proof of renal tuberculosis, because the bacilli may be excreted by a healthy kidney or they may come from some other part of the urinary tract. Nevertheless, the demonstration of tubercle bacilli in the urine is of the first importance in a doubtful case, and the diagnosis may be established by cystoscopy. The cases which require most careful examination are those with an atypical onset, such as massive hæmaturia, and those in which there is a gross secondary infection when first seen. The possibility of renal tuberculosis must always be borne in mind in hydro- and pyo-nephrosis. The differential diagnosis from simple albuminuria and the several forms of Bright's disease is made on the presence of pyuria and the absence of signs and symptoms of chronic nephritis. Patients with pulmonary tuberculosis are perhaps more prone than others to chronic nephritis on account of the secondary infections which complicate their disease.

Course and Prognosis.—The onset is insidious and the course progressive. Natural recovery is hardly known, though occasionally an unsuspected caseous kidney may be found at autopsy on patients dying of other conditions. The disease runs an uncertain course, having a duration of a few years up to ten or even twelve years from the date of diagnosis. Death results from tuberculous toxæmia, secondary infection, or failure of renal function.

Treatment.—When the disease is unilateral the kidney should be

removed. Nephrectomy is rarely justified in bilateral disease. In any case the patient's health and resistance should be raised to the utmost by rest, fresh air and good food, on the general lines of treatment of tuberculosis of the lungs. Cautious tuberculin treatment may be indicated when the disease cannot be treated surgically.

RENAL CALCULI

Renal calculi may be composed of calcium oxalate, uric acid, urates, phosphates, cystin, or of a mixture of these.

Ætiology.—Two factors are required to form a renal calculus: crystals derived from the urine and some colloidal material to bind them together. Hence, as Benjamin Moore pointed out, the commonest nucleus of a stone is calcium oxalate, since oxaluria excites albuminuria and even hæmaturia, thus providing the necessary colloid. Infection of the urinary tract, such as pyelitis, will also act in this way by producing an inflammatory exudate. This is well seen in cystinuria, which will not lead to a calculus unless the urine becomes infected. Pure uric-acid stones may occur in quite young children, because in them a definite deposit of uric-acid crystals in the pyramids and pelvis of the kidney is almost a normal event. Milk is usually sufficiently diuretic to remove them; but if it is not, they irritate the epithelial lining of the pelvis, producing an outpouring of thick mucus which may cause the crystals to cohere. The former comparative frequency of uric-acid stones in the children of the poor in London was probably related to the scarcity of fresh vegetables in the diet, which leads to high acidity of the urine and consequent precipitation of uric-acid crystals. Such stones were also common in Norfolk, for some obscure reason. The factors leading to the deposits of various crystals in the urine have already been discussed (see Abnormalities of the Urinary Secretion). From this it will be noted that phosphatic stones will only occur in alkaline urine, so that they are generally accretions round a nucleus of some other material which has excited an ammoniacal decomposition.

Calculi may occur at any age, but are very rare in the old. They are commoner in males than in females. Those of sedentary habit are more liable to them. Alcohol and lead are said to predispose to renal calculi.

Pathology.—The pure oxalate stone is very hard, mulberry-shaped, stained by altered blood, and varies in size from that of a pea to that of a walnut. If it is encrusted with uric acid it becomes brown, and in form a coral-shaped mass, representing a cast of the renal pelvis and calices. Phosphatic stones are generally smooth and white. A cystin stone is hard, oval, light amber or greenish in colour, with a glistening surface. Other forms are rare. If the stone remains in the renal pelvis it may (1) by gradually increasing in size lead to the atrophy of the renal tissue; (2) by eroding the capsule of the kidney produce a fistula into the perinephric tissues, resulting in a perinephric abscess; (3) by obstructing the outflow of urine cause hydronephrosis or, more frequently, pyonephrosis. If it passes into the ureter it may become impacted, in this way again exciting hydronephrosis or pyonephrosis, or if it obstructs the ureter completely, may produce atrophy of the

kidney. If it causes ulceration of the ureter, this may be followed by a stenosis. If it passes into the bladder it is very likely to excite ammoniacal decomposition, and thus become encrusted with phosphates.

Symptoms.—A stone may remain latent in the kidney without causing any symptoms. More usually it causes pain, particularly on any jolting movement. This is occasionally referred to the opposite side, a point to be borne in mind when considering operation. A bout of pain may be accompanied by hæmaturia, and there may be albuminuria for some days afterwards. A small oxalate stone may produce more pain than a large uratic stone, because of its hardness and roughness. A large, branched uratic stone occasionally causes profuse hæmaturia without any pain. The results of renal calculi may be classified as (*a*) mechanical, (*b*) septic. Under the first heading come colic, hæmaturia, anuria, hydronephrosis; under the second, pyelitis, perinephric abscess, pyonephrosis. The frequency of septic complications can be understood when the importance of sepsis in the production of calculi is realised.

Renal colic is the most severe and distressing manifestation of calculus. It is particularly likely to be started by riding on a horse or in a train or omnibus, which causes the calculus to engage in the entrance to the ureter. Violent paroxysms of pain then occur, radiating along the course of the genito-crural nerve down into the groin and testis, which becomes retracted in the scrotum. The pain is also felt in the loin, and the muscles overlying the kidney become rigid. Vomiting and sweating are common. The patient is unable to keep still, and rolls about or gets on to his hand and knees, calling out with each paroxysm. He becomes pale and his pulse increases in frequency, and the temperature is apt to rise. During or after the attack there is usually some hæmaturia, and crystals may be found in the urine. The attack may last several hours and then end as abruptly as it began. Anuria is a serious symptom and implies that the ureter is completely blocked, and the other kidney is either diseased or its secretion reflexly inhibited. Occasionally both ureters may be blocked by calculi. Symptoms referred to the bladder, prostate or seminal vesicles do not occur until the stone reaches the bladder or the lower end of the ureter.

Diagnosis.—The occurrence of renal colic and hæmaturia suggests stone, but these symptoms may be produced by the passage of a blood clot from renal neoplasm or by acute pyelitis especially in a movable kidney. Ordinary examination of the abdomen reveals nothing beyond lumbar tenderness in uncomplicated cases. X-ray examination is of great value. Oxalate stones are the easiest to detect by that method, as even when small they throw a dense shadow. This is fortunate, since oxalate stones are the commonest. Pure uratic stones may not be detected unless they are large. Cystin stones throw very little shadow. Calcareous abdominal glands and phleboliths may be mistaken for calculi on X-ray examination. It may be necessary to fill the ureter with bromide through a ureteric catheter to prove whether the shadow seen is in the ureter. A skiagram of the pelvis should never be omitted, since a stone may have passed down to this region. Attacks of pain and hæmaturia with the presence of calcium oxalate crystals in the urine, but with a negative X-ray examination, are probably due to crises of oxaluria (see p. 1190). Appendicular colic may simulate renal colic, but the point of maximum tenderness is different.

Prognosis.—As long as there is no serious destruction of kidney substance or septic complication the outlook as to life is good, if treatment be adequate. Attacks of renal colic may occur from time to time, with great suffering, and even after stones have been removed by operation they may form again, though this is exceptional. Occasionally stones may be followed by a true chronic nephritis with its usual consequences.

Treatment.—The methods which should be employed when crystals likely to form stones are found in the urine have been described under urinary deposits. Disinfection of the urine should be carried out as described under bacilluria and pyelitis. It is well, however, not to render the urine alkaline when a stone is suspected, since this would lead to a deposit of phosphates upon it. A book of litmus papers should be given to the patient with instructions to place blue and red strips in the morning urine, which is likely to be the most acid. Enough citrate of potash should be given to render the urine amphoteric but not alkaline. Probably 20 grains at night will be sufficient for this purpose. The urine should be kept dilute by taking water freely. Mineral waters, such as Contrexéville and Evian, are helpful, the former particularly for uric acid, the latter for oxalates. Whey is also helpful when uric acid crystals are present. If a renal calculus is present, and this is confirmed by X-rays, removal by operation is indicated. The following points, however, are generally contra-indications for operation: (i) Large-branched stones, (ii) large bilateral stones, (iii) stones which are only the size of a pea or smaller, unless there is severe pain, extensive absorption of renal substance causing toxic symptoms, or obstruction to the outflow of urine. If the diagnosis is uncertain, or operation is refused or postponed or considered inadvisable because of the patient's general condition, the treatment appropriate to the deposit found in the urine should be continued. Violent exercise and jolting movements should be avoided. Small stones can often be got rid of by giving the patient 10 minims of tincture of belladonna with 10 grains of citrate of potash every 4 hours for a few days, and directing that 5 pints of water should be taken in the 24 hours. For the symptomatic relief of pain, aspirin in 10-grain doses, hot baths and antiphlogistine may be of service. Morphine should be avoided in the treatment of chronic renal pain, on account of the danger of establishing a habit.

For an attack of renal colic $\frac{1}{6}$th to $\frac{1}{4}$th of a grain of morphine tartrate together with $\frac{1}{100}$th of a grain of atropine sulphate, should be given hypodermically. The anti-spasmodic effect of the atropine aids the onward passage of the stone, while the morphine relieves the pain. If morphine be given alone, the pain is apt to recur as soon as its anodyne effect passes off. Ten minims of tincture of belladonna should then be given in an ounce of water every 3 or 4 hours, with abundant fluids, as described above, until the pupils are dilated and the face rather flushed. Inhalations of chloroform may be necessary at the onset, until the drugs have had time to act. Hot applications to the loins or hot baths may help to relax spasm. Inversion of the patient has been advised, to attempt to disengage the stone from the ureter. After the paroxysm is over, the aid of X-rays should again be invoked to locate the stone if it has not been passed.

HYDRONEPHROSIS

Definition.—A condition in which the pelvis and calices of the kidney are distended by the accumulation of non-infected urine due to ureteral or urethral obstruction.

Ætiology.—CONGENITAL.—The condition may be congenital, due to an abnormality of the ureter or urethra; other congenital defects may be present. The ureteral stricture is commonly found at the exit of the ureter from the pelvis of the kidney, or near its entrance into the bladder. Other congenital causes are a faulty connection of the ureter to the pelvis of the kidney, or an aberrant renal artery. Hydronephrosis is sometimes found post mortem in infants and children without evidence of obstruction to the outflow of urine. In these cases the condition is presumed to be due to a neuro-muscular inco-ordination comparable to congenital hypertrophic stenosis of the pylorus.

ACQUIRED.—It is more common in females than in males, and the maximum age incidence in 74 cases collected by Herringham was between the third and sixth decade.

(*a*) *Bilateral* hydronephrosis results from stricture of the urethra, phimosis, enlarged prostate, obstruction within the bladder, or from a pelvic tumour; the last named is the commonest cause.

(*b*) *Unilateral* hydronephrosis is due to ureteral obstruction from—

1. Blocking of the outlet from the pelvis of the kidney by a stone, or by papillomatous growth, or by extension of a renal neoplasm or tuberculosis.
2. Stricture of the ureter following an acquired ureteritis.
3. Pressure on the ureter from without, particularly by tumours of the uterus and ovaries; peritoneal adhesions are an occasional cause.
4. Torsion of the ureter by displacement of a movable kidney.

Pathology.—The pelvis and calyces are dilated, and the renal parenchyma is flattened and atrophied. The whole organ in the early stages is not enlarged. In its later stages the pelvis may be greatly enlarged, and the renal parenchyma reduced to a thin-walled sac. When the kidney, as distinct from the pelvis, is chiefly affected, first the pyramids, and then the cortex, become hollowed out into large sacculi lined with a smooth white membrane, separated by septa of condensed renal tissue. These sacculi open into the pelvis, which may be relatively little dilated; they project as bosses on the surface of the organ. There is an associated chronic nephritis.

It is generally held that hydronephrosis results from intermittent obstruction. It has been produced experimentally, however, by ligature of the ureter causing complete obstruction. But complete obstruction is more usually followed by atrophy of the kidney.

Symptoms.—Many cases are latent, and give rise to no symptoms. The tumour may be discovered accidentally, or there may be complaint of pain in the flank or back. The onset is insidious.

The symptoms by which a hydronephrosis is indicated are the presence of a renal tumour and complaint of an aching pain in the flank or back, and sometimes polyuria or hæmaturia. In intermittent hydronephrosis, the tumour suddenly disappears with the passage of a large quantity of watery fluid; after an interval the tumour gradually reappears and finally empties

suddenly as before. This sequence may be repeated at intervals. Where true polyuria or hæmaturia occurs it is due to a coincident nephritis or pyelitis. There may be acute exacerbations of the chronic pain, with vomiting and collapse; such attacks may accompany emptying of the hydronephrotic sac.

Course.—When unilateral, hydronephrosis may never cause serious trouble, and intermittent cases may persist for years and finally disappear. In bilateral cases uræmia may supervene. Infection of the kidney is not uncommon, and may lead to acute pyonephrosis. The sac may discharge spontaneously through the ureter, and the fluid never reaccumulate. The sac may rupture into the peritoneum, or rarely through the diaphragm into the lung. Cases have occurred in which the ureter of the sound kidney has been blocked by a calculus.

Diagnosis.—The condition, especially when bilateral and unaccompanied by symptoms, is generally overlooked. In its most characteristic form, where the hydronephrosis is intermittent, the diagnosis is readily made. When the condition is apparent simply as a renal tumour the diagnosis from renal neoplasm (or retro-peritoneal glands in a child) is difficult. When the tumour is large it may be mistaken for an ovarian tumour. An examination with X-rays should be made, aided in difficult cases by filling the distended pelvis of the kidney with bromide through a ureteral catheter. In skilled hands this will definitely demonstrate the presence of hydronephrosis. Aspiration of the sac is occasionally practised for diagnostic purposes; but surgical exploration is a safer measure. Fluid from a hydronephrotic kidney is clear or slightly turbid, it contains albumin, and traces of urea and other urinary constituents; in the deposits are epithelial cells.

Prognosis.—This depends on the cause of the hydronephrosis and the condition of the opposite kidney.

Treatment.—The first indication is to remove the cause. Cases of intermittent hydronephrosis that do not cause serious symptoms should be treated on general lines. An abdominal belt to support a hydronephrotic mobile kidney may be of service.

In unilateral hydronephrosis causing serious symptoms, or of large size, nephrectomy is advisable. Since the state and function of the opposite kidney can be fairly accurately ascertained by pyelography and examination of a sample of urine obtained by ureteral catheterisation, nephrectomy is a less serious risk than it was before these exact methods of diagnosis were available.

In bilateral hydronephrosis the main indication is to remove the cause when possible, and to adopt every measure that may aid in preventing infection of the urinary tract.

PYONEPHROSIS

Definition.—Distention of the renal pelvis with pus, to an extent sufficient to cause a renal tumour.

Ætiology.—The affection is a sequela of pyelitis or hydronephrosis. There are two main types, namely, tuberculous and pyogenic pyonephrosis. The latter, which is the commoner, is most frequently due to an impacted calculus.

Symptoms.—The patient is wasted, toxic and febrile. Rigors are common. There is a renal tumour, which is tender on palpation, and moves to some extent with respiration. Pyuria is present, unless the ureter is completely obstructed.

Diagnosis.—The differential diagnosis from hydronephrosis is made from the presence of pyuria and of local and general symptoms of bacterial infection. Perinephric abscess gives signs of a more diffuse swelling, usually with œdema and redness of the surrounding skin, and does not move with respiration.

Treatment.—In bilateral cases the treatment is palliative. In unilateral cases nephrectomy is indicated, if tests show that the other kidney is adequate.

TUMOURS OF THE KIDNEY

Benign Growths

These are of relatively slight importance.

ADENOMATA are the most common, occurring in the cortex or under the capsule. They may be single or multiple; multiple nodules commonly occur in sclerotic kidneys in old age. They seldom attain any size.

FIBROMATA are not uncommon as nodules, sometimes multiple, in the cortex or medulla. LIPOMATA and ANGIOMATA are rare.

Malignant Tumours

SARCOMA.—Sarcoma occurs most commonly in infancy, in the first 3 years. On this account, according to Herringham, more malignant growths of the kidney are to be found in the first 5 years than in any 10 years during the rest of life. The tumours are congenital and are one of the most characteristic types of renal neoplasm.

Two forms are recognised—(*a*) *Sarcoma*, more often bilateral than carcinoma, may arise from the capsule or substance of the kidney. The structure is often alveolar and spindle- or round-celled.

(*b*) *Embryonal adeno-myosarcoma.*—These remarkable tumours contain glandular, fibrous, muscular and embryonal tissue. Such tumours lie within a distended renal capsule, and are solid and opaque. Large tumours tend to undergo cystic degeneration.

The prominent features of sarcomata are their frequent occurrence in infants, their rapid growth to a very large size, and fatal course. Metastases are exceptional; the liver is most frequently involved.

HYPERNEPHROMA.—These tumours arise from adrenal rests under the capsule of the kidney. They are single, large and well circumscribed. They are yellowish, fatty and vascular tumours, and are prone to hæmorrhage, necrosis and cystic degeneration. Typically there is a central fibrous core, surrounded by a more cellular cortical portion. They are more solid than adeno-carcinoma, and not lobulated as is the embryonal adeno-myosarcoma.

More recently the origin of these tumours has been disputed. If all tumours with distinct lumina are excluded from this category, and if it is recognised that the cells of adeno-carcinoma may show marked fatty change,

the number of true hypernephromata is considerably reduced. Since adrenal rests are relatively seldom found, it is probable that the number of hypernephromata has been overestimated in the past. It must be remembered that the kidney is also liable to invasion by a growth from the adrenal body.

ADENO-CARCINOMA.—It is difficult to determine the frequency of these tumours, on account of their confusion with hypernephromata. They occur as single, large, yellowish encapsuled tumours, or as small multiple growths in sclerotic kidneys. The tumours tend to spread along the renal veins into the inferior vena cava, and to the pelvis of the kidney and perinephric tissues. Metastatic deposits occur in the lymph glands along the aorta, lungs, liver, bones and brain. The suprarenal gland is frequently involved.

Symptoms.—1. Hæmaturia is the first symptom in more than 50 per cent. of the cases. It is much less frequent in children. The blood is fluid or clotted, and moulds of the pelvis or ureter may be passed. The hæmaturia is spontaneous, profuse and intermittent; it is little influenced by rest, nor is it provoked by exertion. It may be the only evidence of a neoplasm, and after lasting for a week or 14 days may cease, leaving no further evidence of the growth until at some later date a tumour is felt. The urine frequently contains albumin at intervals.

2. Pain is uncertain. It may be a dragging feeling, or a constant ache. The passage of clots may give rise to renal colic; otherwise the hæmaturia is not accompanied by pain.

3. The presence of a tumour is a most important sign. It is felt on deep palpation bimanually. It is first palpable below the ribs, outside the rectus muscle, as a solid swelling, with rounded borders, that moves with respiration. It may be possible to define its upper border. As the tumour increases, it tends to go forward. It may fill the hollow below the twelfth rib behind, but does not cause a swelling in the back. Large renal tumours cause asymmetry and bulging of the abdominal wall and marked displacement of neighbouring abdominal viscera. On the right side, the ascending colon lies in front, on the left the last part of the transverse colon and descending colon; the tumour is, therefore, resonant on percussion in front. When the tumour is highly vascular, pulsation is felt in it, and a systolic bruit may be heard over it. In later stages, the tumour is liable to become fixed by adhesions.

4. Progressive emaciation is generally late. It may be absent although the tumour is large.

5. Metastases are sometimes the first sign of a renal neoplasm, occurring in the lungs, bones or brain. Secondary deposits in the para-aortic lymph glands may cause obstruction to the inferior vena cava, or this may result from pressure of the tumour itself.

Diagnosis.—The diagnosis is made on the presence of hæmaturia, with a tumour. When hæmaturia occurs alone, cystoscopy will indicate the affected kidney; other causes of hæmaturia must be excluded by careful clinical, bacteriological and X-ray examination. When a tumour is the only sign an exploratory laparotomy is advised. The tumour requires to be distinguished from splenomegaly, hepatomegaly and Riedel's lobe. A renal tumour has not the definite edge characteristic of splenomegaly and enlargement of the liver. Enlargement of the liver is not often a source of difficulty. Splenic tumours are recognised by the fact that they tend to

occupy an oblique position in the abdominal wall, by the presence of a notch and of a sharp inner margin, free movement with respiration, and dullness to percussion. A Riedel's lobe is continuous with the liver, does not extend back into the loin, and is dull on percussion.

A differential diagnosis from retroperitoneal tumours, including those of the suprarenal, is not always possible, though the suprarenal growths may sometimes be recognised by certain characteristic features. Thus, there is the medullary sarcoma type described by Hutchison, generally occurring in children, characterised by metastases in the skull, ecchymotic swelling of the eyelids, papillœdema and severe anæmia, and the "infant Hercules" type of tumour of the adrenal cortex.

Prognosis.—The average duration is 4 to 5 years (Herringham), but it varies with the degree of malignancy. Recovery is rare.

Treatment.—Surgical treatment alone holds out a prospect of cure. Symptomatic treatment includes the use of drugs for the relief of pain and the control of hæmaturia; for the latter 20 to 60 minims of the tincture of hamamelis, or gr. ½ of hydrastine hydrochloride, may be given every 4 hours for a few doses.

CYSTS OF THE KIDNEY

Solitary Cysts

These may occur in an otherwise normal organ. They vary in size from very small cysts to tumours of considerable bulk. They result from dilatation of an obstructed tubule, and they may be congenital.

Multiple Cysts

Multiple cysts of small size are commonly met with in sclerotic kidneys. They result from chronic inflammatory changes that lead to obstruction of the tubules with subsequent dilatation. There are also rare cases of multiple cysts, of large size, whose ætiology and course are little known.

Polycystic Disease of the Kidneys

Definition.—Polycystic kidneys appear as a massive conglomeration of cysts, varying in size from a pin's head to a marble, separated by dense strands of fibrous tissue, in which little or no renal tissue is evident on naked-eye examination.

Ætiology and Pathology.—The commonest age incidence is between 40 and 50 years; they are relatively common in the decades preceding and following; they may occur in infancy and childhood, and of these a large proportion are in still-born infants. Those occurring in infants are congenital, and other congenital abnormalities may be present. Those occurring in adults may also be congenital; if that is the case, the condition must be progressive, for the lesion found on post-mortem examination is too severe to admit of its having had a long duration. It has been held that

polycystic kidneys are aberrant forms of chronic nephritis, with unusually large and numerous retention cysts. Intermediate forms, however, do not occur. It is alternatively suggested that the condition is a result of maldevelopment or a form of neoplasm.

The organs are enlarged in size, and weigh 20 to 30 ounces each, or even 3 to 4 lb. They have been compared to a bunch of grapes in appearance. The cysts project from the surface and form the mass of the organ. They are lined by a layer of flattened cells, and are filled with fluid. This fluid is clear or turbid, limpid or viscid, colourless or yellowish ; it is sometimes blood-stained, giving it a red, purple or green colour. Urea has been found in the fluid, which may also contain fat globules, cellular débris, cholesterol and triple phosphate crystals. On microscopic examination more or less renal parenchyma is found in the septa between the cysts ; the tubules are distorted, and exhibit varying degrees of atrophy, degeneration and dilatation, while the glomeruli show changes characteristic of chronic interstitial nephritis. The blood vessels of the kidney undergo sclerotic changes ; there is increased fibrous connective tissue and small cell infiltration. In some cases cysts are also found in the liver, ovaries, broad ligament, uterus, pancreas and spleen ; but they are rare in any other organ than the liver. More than one member of a family may be affected.

Symptoms.—The affection is nearly always bilateral. When the tumours develop to large size in the fœtus, difficulty in labour may result. In the adult there may be no symptoms, or any of the symptoms of chronic nephritis may develop and may terminate in uræmia, cerebral hæmorrhage or cardiac failure. General arterial disease, with raised blood-pressure and cardiac hypertrophy, is commonly present ; on the other hand, the condition may reach an advanced stage and fatal termination without appreciable cardiac hypertrophy. In a third group the bilateral renal tumours are the most striking features, associated with general malaise, dull aching pain in the loins, and recurrent hæmaturia. The tumours are not tender, and present the ordinary signs of renal tumours (*q.v.*). The urine is of low specific gravity, and commonly contains a trace of albumin ; there may be polyuria.

Course.—This usually follows that of chronic interstitial nephritis.

Diagnosis.—A condition of chronic interstitial nephritis with large palpable kidneys should suggest polycystic disease. Renal neoplasms other than sarcomata are nearly always unilateral. The absence of fever and pyuria excludes bilateral pyonephrosis.

Treatment.—The treatment is that of chronic nephritis. Operation is rarely indicated, since both kidneys are nearly always equally affected.

Other Forms of Cystic Disease

Echinococcus cysts may occur in the kidney, and the discharge of the daughter cysts has produced attacks of renal colic. *Cystic degeneration of renal neoplasms* is described elsewhere.

MOVABLE KIDNEY

The kidney is normally held in place by the perirenal fat, the renal vessels and the peritoneum stretched over it. But this does not prevent a certain

amount of respiratory excursion, as may be seen either by X-ray examination or in the operating theatre. The range of movement varies between 1 and 2 inches, and is more marked on the right than the left side. The term movable kidney should therefore only be applied to cases where there is an excessive respiratory descent, so that the upper as well as the lower pole can be felt, or where the kidney can be moved about by external manipulation. As the kidney slips downwards, the lower pole gradually passes towards the middle line, while the organ rotates slightly, causing the hilum to look somewhat forwards.

Ætiology.—Movable kidney is about seven times more common on the right than on the left side. On the right side, the liver is thought to exercise some downward pressure during its inspiratory descent—though this is doubtful, according to Christopher Addison. Moreover, the ascending colon and the hepatic flexure lie on the inner aspect of the right kidney, thus tending to drag it down when the bowel is loaded or dropped. On the left side, on the other hand, the strong costo-colic fold suspends the splenic flexure much more securely, while the descending colon lies to the outer side of the left kidney. Consequently this kidney is not nearly so exposed to downward pressure.

The condition is much commoner in women than in men. Of 667 cases collected by Kuttner, nearly 88 per cent. were in women. The principal reason for this difference is again an anatomical one. In men the kidney pouches are deep, narrow and rapidly diminish in breadth from above downwards, while in women they are much shallower and broader, and diminish only slightly in breadth from above downwards. This natural difference is accentuated in the spare long-waisted women with narrow loins, who are recognised as specially liable to floating kidney. The greater liability of women to chronic constipation further helps to induce dropping on the right side. Tight-lacing may formerly have been a contributory cause, but, before this can operate, it is necessary that the kidney should be lower than normal. Then, undoubtedly, tight-lacing can aggravate the condition.

Pathology.—Many reasons have been given for the occurrence of movable kidney; but few will stand investigation. The existence of a congenital mesonephron has been described in some cases. Wilson and Howell consider this a myth. They point out that, if the perirenal fat be absorbed, the kidney may become almost completely invested by peritoneum, or may slip into the mesocolon. The relaxation of the abdominal walls is frequently given as a cause; but the condition is quite frequent in nulliparæ. Wilson and Howell drew attention to the fact that if diminution in intra-abdominal tension played a large part in the production of a movable kidney, we should expect to find it occurring after the removal of large tumours from the abdomen. This would be the more likely since Nature provides no compensating mechanism in such cases as she does after parturition. But movable kidney is not a common sequel to such operations.

The wasting of fat around the kidney is also given as a cause, but, like tight-lacing, is probably only a contributory factor. Occasionally trauma would appear to be responsible. Glénard emphasised the frequency with which movable kidney is associated with a general visceroptosis. To-day, we may go further and assert that, except in rare traumatic cases, movable

kidney never occurs without visceroptosis, and that in women marked visceroptosis seldom occurs without rendering the kidneys unduly mobile. It is rare to see a case of movable kidney on the X-ray screen without finding definite gastroptosis. Naturally, if there is general visceroptosis, the kidney is its most obvious sign. It is a firm organ which can be readily grasped, while the other dropped viscera would elude palpation. As Landau says, "Pleased with his discovery, the physician may impute all subsequent symptoms to the movable kidney." Most of these are really due to visceroptosis.

The unduly mobile kidney may show certain changes. In the acute stage, the kidney may be large, gorged with blood and dull red, even purplish. In the chronic stage, the kidney is somewhat small and light, rather pale in colour and flabby. Local patches of chronic interstitial nephritis have been described by Hurry Fenwick; but these are certainly not common. A more serious sequel is the occasional occurrence of hydronephrosis produced by torsion of the ureter during the forward rotation of the organ or by its becoming kinked over the renal vessels. If hydronephrosis occurs, a subsequent infection may convert it into a pyonephrosis.

Symptoms.—There may be no symptoms at all and, if the movable kidney is only discovered in the course of routine examination, it is better not to tell the patient of its existence. It may be well, however, to inform a reliable relation, if such can be found, in order to protect one's self against a less discreet medical attendant subsequently revealing the fact to the patient. The commonest symptom is a constant dragging pain owing to traction on the renal plexus. This most frequently first declares itself between 25 and 35 years of age. A zone of hyperæsthesia corresponding to the distribution of the tenth thoracic segment may also be present. More serious symptoms directly due to movable kidney are Dietl's crises; but these are not common. The attacks are characterised by intense pain radiating down the ureter and through the back, shivering, nausea, vomiting, fever and collapse. The urine is scanty, and may contain blood. Sometimes the pelvis of the kidney may become distended, giving rise to an obvious increase in the size of the organ. This may pass off later, with abundant discharge of urine, showing that the crises are due to kinking and consequent partial obstruction of the ureter. If repeated, they may lead to hydronephrosis.

The other symptoms which have been attributed to floating kidney are really due to the associated visceroptosis. According to Bartels, dilatation of the stomach may occur from pressure of the dislocated kidney upon the duodenum. This is improbable and, where real dilatation of the stomach is found, it is usually atonic, or else there is kinking of the pylorus from marked gastroptosis. Gastroptosis, as already said, is the rule, and without an X-ray examination it is by no means easy to discriminate between a dilated and a dropped stomach. Constipation is very common, as it is in all cases of visceroptosis. Jaundice is certainly not due to pressure of the movable kidney on the bile-duct, as has been asserted, but is merely a complication of visceroptosis which permits of a more ready infection of the biliary passages. Neurasthenic and digestive symptoms, so commonly present, are the outcome of intestinal stasis from visceroptosis, and are not due directly to movable kidney. Naturally, if the patient is constantly in pain, she is likely to

develop nervous symptoms. But, apart from this, there is no reason to attribute far-reaching nervous consequences to movable kidney, yet, for some enthusiasts, hysteria in women, hypochondriasis in men, and even insanity, are common outcomes. There is little doubt that far too much stress has been laid upon this condition as a cause of manifold complaints.

To detect a movable kidney on the right side, the left hand should be placed under the loin while the patient is recumbent, though some authorities prefer a semi-recumbent posture. The patient should then be told to take a deep breath while the right hand is placed just under the edge of the liver in the nipple line. The kidney may then be felt to slip between the fingers. Usually, this does not cause the patient a definite pain, but a dull, sickening sensation. In the more advanced degree of the condition, the organ may be felt far from its normal position, even to the left of the middle line or nearly down to Poupart's ligament. In examining on the left side, the observer should stand on the patient's left, placing his right hand behind the loin and palpating in front with his left. It is a mistake to examine the left kidney for mobility by reaching over the patient.

A movable kidney usually feels larger than the normal excised organ. This is because of the surrounding investments through which it is felt.

Diagnosis.—Usually this is obvious, as the shape and mobility of the organ are so characteristic. Occasionally, a Riedel's lobe has been taken for movable kidney; but the continuity of the former with the liver should prevent this mistake being made. In the same way, a distended gall-bladder is continuous with the liver, and cannot be separated from it. Moreover, it is not nearly so movable, and curves characteristically towards the umbilicus. Carcinoma of the pylorus has offered difficulties in some cases; examination of the stools for occult blood, a test-meal and X-ray examination would clear up the diagnosis. Scybala near the flexures of the colon may be mistaken for floating kidney; but their indefinite shape and inelasticity generally help to distinguish them. Their disappearance after a series of enemata would settle the question. In one case a mesenteric cyst appeared closely to resemble a floating kidney.

Prognosis.—Apart from the development of hydronephrosis, movable kidney does not tend to shorten life in any way. It is doubtful whether a kidney once prolapsed can ever maintain the normal position unaided.

Treatment.—Some cases call for no local treatment, though the associated visceroptosis and neurasthenia will require attention. If pain is felt, the adoption, for a short time, of the knee-elbow position will help to replace the kidney and relieve the tension on the renal plexus. If pain is at all frequent, some form of abdominal support should be worn. Hurst has urged that the support should be designed to increase the general intra-abdominal pressure, and not to replace any one viscus. We are convinced that this is sound and that, in many cases, a "kidney belt" is worse than useless, while the addition of ingeniously placed pads only increases the discomfort. Curtis' support for visceroptosis is, in our opinion, much more satisfactory, while a specially designed corset for visceroptosis suits some cases better still. Whatever the form of the support it need only be worn while the patient is in the erect posture, and it is best fitted while she is recumbent, preferably with the pelvis raised on a pillow so as to aid the replacement of

the kidney. Often, when a support of this kind has been worn for a year or two, it is possible to give it up without recurrence of symptoms. Breathing exercises to develop the extension of the lower thorax, with exercises to improve the tone of the abdominal wall have in many cases proved more efficacious than a passive support. Operation should never be advised simply for pain, as it is rarely successful in relieving this symptom for more than a few weeks. On the other hand, if there is any evidence of hydronephrosis developing, the operation of nephropexy is advisable. But, even then, it may not be successful. In one case of Dietl's crises, followed by hydronephrosis, nephropexy had to be followed a year later by nephrectomy.

Treatment of Dietl's crises.—The patient must be put to bed and hot fomentations or antiphlogistine applied to the affected side. A hypodermic injection of a quarter to half a grain of morphine may be required if the pain is severe. Usually this is sufficient but, should the attack last more than a few hours, an attempt must be made, under an anæsthetic, to rectify the position of the kidney by manipulation. Naturally conditions are unfavourable for nephropexy during or immediately after a crisis, because of the congested state of the organ.

W. Langdon Brown.
Geoffrey Evans.

SECTION XVI

DISEASES OF THE JOINTS AND INFLAMMATORY DISEASES OF THE FIBROUS TISSUES AND MUSCLES

ARTHRITIS

INFLAMMATION of one or more joints occurs in many pathological conditions, and the following classification of the various forms is based upon their ætiology: (A) arthritis of known causation; and (B) varieties of arthritis in which the ætiology is at present somewhat obscure or indefinite.

(A) *Arthritis of known causation.*—1. Traumatic arthritis. 2. Specific infective arthritis, where the cause is definitely due to infection with the specific bacteria of known diseases, *e.g.*, gonococcal, dysenteric, pneumococcal, and tubercular arthritis; and the arthritis of known specific diseases, such as scarlet fever, Malta fever, dengue fever, typhoid and paratyphoid fever, syphilis, glanders, and acute septicæmia and pyæmia from blood infections with streptococci or other organisms. An infective arthritis may occur as the result of the blood infection in almost all the known infectious diseases, *e.g.* measles and mumps. Acute rheumatism or rheumatic fever will probably with advance of knowledge of its pathology come to be included in the "specific infective arthritis" group, for the evidence that its cause is due to infection by a specific organism is very strong. 3. Gout. 4. Arthritis following the injection of animal sera, *e.g.* anti-dysenteric, anti-diphtheritic, anti-tetanic, anti-meningococcus and anti-streptococcal sera. 5. Arthritis of neuropathic type due to disease of the nervous system, *e.g.* tabes dorsalis and syringomyelia. 6. Arthritis due to abnormal blood conditions, such as hæmophilia and purpura. 7. Arthritis associated with "Deficiency Diseases," *e.g.* scurvy and rickets.

(B) *Arthritis of obscure causation.*—In this group are included acute rheumatism or rheumatic fever, non-specific infective arthritis, intermittent hydrarthrosis, and hypertrophic osteo-arthropathy. In all probability most, if not all, of these forms of arthritis are due to an infective cause; and as our knowledge of their pathology extends, the types included in this group will become transferred to group (A) of arthritis of known causation.

(A) ARTHRITIS OF KNOWN CAUSATION

I. TRAUMATIC ARTHRITIS AND TRAUMATISM

Injury to a joint causes damage to its various structures, and hæmorrhagic or serous effusion results, with consequent inflammatory changes, such as pain and swelling. This is a surgical condition which is dealt with in works on surgery. Simple traumatic arthritis is non-progressive, and when the injured structures have healed under appropriate surgical treatment the arthritis should disappear. It must be remembered, however, that traumatism is frequently the cause of the development of a progressive arthritis of another type. Thus, in a tubercular subject the injury may be followed by the development of tubercular arthritis, and similarly an injury to a joint may start a progressive osteo-arthritis; this is commonly seen in osteo-arthritis of the hip-joint. In such cases there is a complex of ætiological factors present which predispose the patient to a particular form of arthritis and the injury to a joint determines the site of development.

II. SPECIFIC INFECTIVE ARTHRITIS

Gonococcal Arthritis or Gonorrhœal Rheumatism

This is one of the most serious complications of gonorrhœa. In a general blood infection with gonococci the fibrous tissues of the body are very liable to be affected: thus, the synovial membranes of the joints or tendon sheaths, the ligaments, fasciæ, aponeuroses, bursæ and the connective tissues generally may be involved.

Ætiology.—Gonococcal arthritis commonly occurs during an acute attack of gonorrhœa, but it may develop during the subsidence of an attack or in its chronic stages. Often strain or injury, exposure to cold, over-exertion and lack of care in the treatment of an attack of gonorrhœa lead to the development of arthritis. The complication occurs more frequently in men than in women.

Pathology.—The structures round the joint often show involvement, the tendon sheaths and bursæ being inflamed and swollen with effusion. The affected joints may be swollen, owing to exuded fluid. The effusion is usually turbid, and contains polynuclear leucocytes and synovial cells. Organisms may be found in the exudate of the joint or tendon sheath, and in such cases are usually found in the leucocytes present, but frequently the effusion is sterile. The fibrous tissues affected may contain gonococci. The plantar ligaments at their insertion into the heel may be the seat of a gonococcal infection, giving rise to the "painful heel of gonorrhœa," and organisms have been found in this situation. In an affected joint the organisms may disappear and the joint become normal. In other cases, however, fibrous adhesions may form in and around the joint, leading to fibrous ankylosis, and the involvement of the periosteum may cause a local osteitis, with formation of osteophytes. Wasting of the muscles above and below an affected joint rapidly occurs if the arthritis is long continued, and deformities

of the feet may result from contraction or weakening of the ligaments. In some advanced cases the structures of the joints involved may undergo marked degenerative changes, such as are found in advanced osteo-arthritis, and permanent crippling results.

Symptoms.—The onset is often acute, with high temperature, general pains in joints and fibrous tissues, and the development of arthritis in one or more joints, usually the latter. The pyrexia may last for several weeks, and an examination of the joints shows often definite thickening and structural changes. The tendon sheaths and fibrous tissues may show signs of inflammation. Other complications may occur as the result of the gonorrhœal infection. Thus, in the eye, gonococcal conjunctivitis, iritis, scleritis and keratitis may occur. The skin may show a condition known as "keratodermia blennorrhagica," in which red patches, about half an inch in diameter, occur, which become keratosed, forming hard dry yellowish elevations. They commonly occur on the soles of the feet. Endocarditis, pericarditis or pleurisy may develop during an attack.

Diagnosis.—Attention should always be paid to the existence of a gonorrhœal urethritis and a special examination of the urogenital tract is advisable. Bacteriological examinations should be made of the urethral discharge, especially after prostatic massage, and also of the urine. The fluid from an affected joint should be bacteriologically examined for gonococci. While the illness resembles rheumatic fever in its acute symptoms, it differs in the fact that the arthritis when once developed in a joint lasts longer and does not quickly disappear under treatment with salicylates; the arthritis does not clear up in one joint and fly to another, as in acute rheumatism; and in gonorrhœal arthritis the sterno-clavicular, temporo-maxillary, intervertebral and sacro-iliac joints are not uncommonly attacked, while these joints are rarely affected in rheumatic fever.

Treatment.—The most important part of the treatment is to cure the primary infection, and this should be treated by appropriate measures. Removal of the primary cause is usually followed in early cases by a rapid clearing up of the arthritis. Complete rest in bed and milk diet are necessary in the acute stage. The affected joints should be kept at rest, and local treatment, such as hot fomentations or iodine poultices, gives relief. Radiant heat is of value. Diathermy has given good results; also ionisation may be used with advantage after radiant heat treatment. Bier's method of treatment, by inducing hyperæmia of the affected joint, is sometimes beneficial. Drugs are of little use; but for relief of pain, aspirin phenacetin, or pyramidon may be useful.

Vaccine treatment is of value, and the best results are obtained from an autogenous vaccine. At first small doses of 1 to 2 millions, at intervals of about 4 days, should be given, and the dosage and the interval between them may be gradually increased. Serum treatment with anti-streptococcal or anti-gonococcal serum has been employed, but is inferior to vaccine treatment and is not to be recommended.

As the acute symptoms subside, care must be taken by careful passive movements, splints and bandaging, to prevent the formation of adhesions or contractures. In severe cases, where a large joint like the knee is involved, surgical treatment, such as tapping or incision and irrigation has given good results.

Dysenteric Arthritis

Ætiology and Pathology.—Arthritis is a not uncommon complication of bacillary dysentery and occurs in from 1 to 2 per cent. of cases. It is very rare in amœbic dysentery, but a few cases have been observed late in the disease, and may have been due to secondary infection. Dysenteric arthritis occurs usually after the acute intestinal symptoms have subsided, and may develop in any period up to 3 months from the onset of the dysenteric attack. There is some evidence to show that a cessation of the diarrhœa, such as may occur after the administration of opium or other drugs, acts as a predisposing cause. Dysenteric arthritis is not due to the serum used in the treatment of dysentery, for it occurs in cases in which no serum has been given. Moreover, the arthritis following anti-dysenteric serum is simply a very transient synovial effusion occurring about 8 days after its administration, whereas dysenteric arthritis is a condition lasting some weeks, and if not carefully treated may lead to permanent joint changes. Bacteriological examination of the fluid from the affected joints is usually negative, but in a few cases dysentery bacilli, usually of the Shiga type, have been found. It must be remembered that one of the common sequelæ of dysentery is a post-dysenteric colitis due to a streptococcal or other intestinal infection. Cases of arthritis occurring in dysentery long after the specific organisms are present in the stools are probably due to these secondary infections, which are well known to be causes of infective arthritis.

Symptoms.—Usually more than one joint is affected. The knees are most frequently attacked, the ankles and elbows coming next in frequency; the finger, shoulder and wrist-joints are sometimes involved, and occasionally the temporo-maxillary and sterno-clavicular joints. Clinically the disease closely resembles gonorrhœal rheumatism, and in addition to the joints, the fibrous tissues, the ligaments and the tendon sheaths are frequently involved. Dysenteric arthritis usually causes a definite pyrexia, which lasts for a variable period. It may manifest itself as a synovial effusion (hydrarthrosis) into one or more joints, which gradually clears up, or there may be involvement of all the joint structures, with formation of adhesions and limitation of movement. In some cases severe pains occur in one or more joints (arthralgia), without the development of organic changes in the joint; this condition is due to a fibrositis involving the fibrous structure round the joint. Dysenteric arthritis, like gonorrhœal, is commonly complicated by a conjunctivitis affecting the lower and upper lids; this has been found to occur in about 50 per cent. of cases. It usually clears up in a few days, even without treatment. Iritis has been observed in a few cases.

Diagnosis.—The course of dysenteric arthritis is similar to that of the gonococcal variety, from which it is distinguished by the history or presence of a dysenteric infection and the negative evidence of a bacteriological examination for gonococci or history of recent gonorrhœa. It is distinguished from acute rheumatism by the absence of general sweating and cardiac complications.

Treatment.—The general and local treatment of the joints is on similar lines to that of gonorrhœal rheumatism. Specific treatment should be directed towards the intestinal infection. A bacteriological examination of

the stool, and of the material obtained from saline irrigations of the colon should be made, and if pathogenic organisms, such as dysentery bacilli, or abnormal streptococci, or other organisms likely to cause arthritis are found, a vaccine should be prepared and administered. Intestinal toxæmia may be treated with advantage by colon irrigation with normal saline on alternate days, and saline aperients, such as sodium or magnesium sulphate, should be administered by mouth, as well as intestinal antiseptics such as guaiacol carbonate or salol grs. x three times daily. Anti-dysenteric serum is not to be recommended for the treatment of dysenteric arthritis, as in cases where serum had been administered in the acute stage of the intestinal symptoms there would be serious danger of an anaphylactic collapse should further doses of anti-dysenteric serum be given when arthritis developed, for the interval between these events is sufficiently long to produce anaphylaxis.

Pneumococcal Arthritis

Ætiology.—Arthritis is a rare complication of a pneumococcal infection, and is due to the transference of organisms to the joint by the blood stream. It usually occurs during the acute stage of pneumonia, or within a fortnight of the crisis, but it has been observed to precede the lung involvement. In general pneumococcal septicæmia arthritis may occur during the course of the illness, even without involvement of the lungs.

Symptoms.—The joint symptoms are acute, with marked swelling and pain. One or more joints may be involved, but the knee is most commonly affected. The joint may become distended with pus, with much redness and œdema, and rapid disorganisation of the joint.

Treatment.—When the joint becomes purulent it should without delay be treated surgically by incision and drainage. In other cases the joint effusion is serous or sero-purulent, and the inflammation may subside with rest and local treatment similar to that for gonococcal arthritis. It is advisable in pneumococcal arthritis where much fluid is present to aspirate the joint, and the exudation should be bacteriologically examined. When the effusion is sero-purulent and improvement does not occur with rest and local treatment, incision and drainage of the joint should not be delayed. After the acute stage has subsided great care is necessary to prevent the formation of joint adhesions, and prolonged treatment will usually be required to enable the mobility of the joint to be restored.

Tubercular Arthritis

Tubercular arthritis usually occurs in young patients, and as an infection from a primary tubercular focus elsewhere in the body, and frequently signs of tuberculosis in other parts of the body are present. The possibility of an arthritis in a young subject being tubercular must always be borne in mind, and an X-ray examination is of great value in differentiating this type from other varieties. The subject is dealt with fully in surgical works, to which the reader is referred.

Scarlatinal Rheumatism

Arthritis is a fairly common occurrence in the course of scarlet fever. It begins usually about the end of the first week, but may occur quite late in the disease, and some weeks after the temperature has become normal.

In the mild forms the affection is that of an arthralgia rather than an arthritis, severe joint pains without swelling occurring for a few days and then disappearing. In the more severe forms a synovitis with effusion occurs in the joints, and sometimes the peri-articular structures are involved. Scarlatinal rheumatism usually clears up completely with rest and general treatment. Some cases are benefited by salicylates. The resemblance to rheumatic fever is sometimes a close one, and it is possible that in these cases the two diseases may be occurring simultaneously. Since the specific pathogenic organisms of these diseases have not been definitely identified, it is impossible to dogmatise on their relationship.

In the pyæmic form of scarlet fever, suppuration of one or more joints as part of the general septicæmia infection may occur. These cases are usually fatal, and the arthritis should be treated surgically by incision and drainage.

Malta Fever

During the initial stage of the illness, pains in the joints (arthralgia) and muscles and fibrous tissues are common. During the relapses of fever which characterise this disease, effusions occur into one or more joints, associated with swelling and much pain. The arthritic effusions subside as the fever passes away, but may reappear with subsequent relapses. In addition to the joints, the fibrous tissues are often involved, giving rise to a painful fibrositis during the febrile periods. Organic joint changes do not usually result. The treatment consists of rest and local applications to the affected joints. Active treatment of the Malta fever infection is essential.

Dengue Fever (Break-bone Fever, Dandy Fever)

Very severe pains in the joints and bones occur during this disease, and the joints often become red and swollen, owing to arthritic effusion. The arthritic symptoms clear up with subsidence of the fever, though joint pains may persist for some weeks.

Typhoid and Paratyphoid Fevers (Enteric Fever)

In these diseases arthritis is a rare complication, and one or more joints may be involved. It may occur during the later weeks of the acute stage of the illness, but in very protracted cases a multiple suppurative arthritis may form part of a post-typhoid septicæmia and pyæmia.

Arthritis must be carefully distinguished from periostitis, which is a much commoner complication of enteric fever, and is usually suppurative in type, occurring either during the acute stage of the illness or after the general fever has subsided.

The arthritis of enteric fever is treated by rest and local applications. Should the effusion not subside, aspiration of the joint should be performed; and if pus be found, surgical treatment by incision and drainage is advisable.

Syphilitic Arthritis

Acquired.—In the secondary form a joint effusion due to a synovitis may occur. It is associated with little or no pain, and usually clears up quickly with rest and anti-syphilitic treatment.

In the tertiary form the synovial membrane or capsule of the joint may be involved by gummatous thickening, and this, together with the associated effusion, will give rise to an irregular joint swelling, which may be of considerable size. Usually there is little or no pain, and there is fairly good mobility of the joint. In other cases a syphilitic osteitis may spread to a joint, which becomes involved in the inflammatory process, and an arthritic effusion results. A gummatous condition of the peri-articular structures, such as skin or fibrous tissue, may spread to the joint, causing a like result. The irregular swelling, and relative lack of pain, together with other evidence of syphilis and the blood tests, usually enable a diagnosis to be made; but this is more conclusively demonstrated by an X-ray examination, which shows the exact origin of the arthritis.

Congenital.—"Chronic effusion" due to "chronic syphilitic synovitis" occurs usually between the ages of 6 and 15 years, and both sexes are equally affected. It is a painless effusion, affecting nearly always both knees, though the swelling may be more marked in one than the other. The mobility of the joint is not impaired, and thickening of the joint structures does not occur. The malady is associated with interstitial keratitis in about 75 per cent. of cases. The course of the disease is prolonged, and there is a marked tendency to relapse after the effusion has disappeared.

Syphilitic epiphysitis usually occurs in infants under the age of 6 months, and is rarely confined to one joint. It is usually acute in onset, associated with pain and pyrexia, and resulting in a "pseudo-paralysis" of the affected limbs. Suppuration frequently occurs in the region of the epiphysis, owing to infection with pyogenic organisms (generally streptococci or staphylococci), and the inflammatory process may spread to the adjacent joint, causing an arthritis, which may be suppurative in type. The disease is well known, and the diagnosis is usually clear, since at this early age other causes of pseudo-paralysis are uncommon. Other stigmata of syphilis will probably be present, and a Wassermann test of the blood and an X-ray examination of the affected part may be made to confirm the diagnosis.

Surgical treatment will be required where suppuration is present.

All the above forms of syphilitic arthritis require in addition to rest and local measures a complete course of anti-syphilitic treatment, when the joint condition will make a rapid and permanent recovery.

Glanders

In the acute stage arthralgia is a common symptom, and in chronic cases, as a part of the pyæmic process of the disease, suppurative arthritis may occur, due to infection of the joint with the *Bacillus mallei*.

Septicæmic and Pyæmic Arthritis

Blood infections of septicæmic or pyæmic type apart from those already mentioned are frequently accompanied by arthritis. Most commonly the

infecting organism is a streptococcus, but staphylococcal or other infections may be the cause. The arthritis is usually acute, and associated with much pain and swelling. It is commonly, but not always, suppurative in type, the presence of pus being indicated by marked redness and œdema round the joint. In cases of this type the joint effusion should always be bacteriologically examined after withdrawal by an exploring needle, and if pyogenic organisms are found, incision and drainage of the joint by surgical measures are not to be delayed.

Acute Periostitis

Acute periostitis is a common symptom of a streptococcal septico-pyæmia in young persons, and frequently the epiphyseal neighbourhood is affected, so that the joint or bursæ round it become involved by the acute inflammatory process in the proximity.

An examination will reveal the presence of marked tenderness and sometimes swelling, with perhaps redness and œdema over the affected bone, the site of specially marked tenderness being the bone and not the joint. In cases of this kind the suppurative periostitis is of a very acute nature, and will rapidly become an acute osteo-myelitis if not dealt with without delay. The greatest care is necessary in order to differentiate this condition from acute rheumatism or other form of arthritis.

Treatment.—Immediate operation is necessary, and the infected periosteum should be freely opened and drained by appropriate surgical measures, the effusion being examined bacteriologically.

The arthritis associated with acute periostitis is commonly an acute synovitis of simple nature, caused by extension of the inflammation, but not the pyogenic organisms, to the joint, so that the synovial effusion is sterile. Surgical treatment of the periostitis is usually followed by rapid subsidence of the neighbouring arthritis. Should the arthritis not quickly clear up it is advisable to examine the joint effusion bacteriologically, and if this is infected with pyogenic organisms, surgical treatment of the joint should at once be adopted.

III. ARTHRITIS DUE TO GOUT (see p. 421)

IV. ARTHRITIS FOLLOWING THE INJECTION OF ANIMAL SERA

For arthritis following the injection of animal sera, see pp. 30, 39.

V. ARTHRITIS OF NEUROPATHIC TYPE

Lesions of the joints and bones may occur owing to the trophic changes associated with tabes dorsalis and syringomyelia. The knee- and hip-joints are most commonly affected, and in syringomyelia the joints of the upper extremity may be involved. In this condition there is marked swelling and disorganisation of the joint and an almost complete absence of pain. The joint may be distended with fluid, the capsule and ligaments round the joint becoming stretched and weakened. When the knee-joint is affected there is often very marked painless lateral movement.

Fractures of the shaft or portions of the head of a bone in proximity to the joint may occur, and irregular bony outgrowths (osteophytes), similar to those found in osteo-arthritis, may give rise to the irregular outline of the disorganised joint seen in advanced cases of this type. X-ray examination of the joint shows these changes together with marked organic alterations, such as absorption of cartilage and rarefaction of bone. This type of arthritis is easily recognised by the marked organic changes of painless character which have taken place and by the association of organic disease of the nervous system.

VI. ARTHRITIS DUE TO ABNORMAL BLOOD CONDITIONS

HÆMOPHILIA.—In this disease, hæmorrhage into joints and resulting arthritis are very common. The knees are most frequently involved, the ankle- and elbow-joints coming next in frequency, but any large or small joint may be affected. The hæmorrhage may be the result of an injury, but it is frequently apparently spontaneous, when probably some movement or jar acts as the exciting cause. The affected joint becomes distended with blood, and pain and slight rise of temperature may occur. The effused blood may be absorbed quickly without any definite impairment of joint function. In some cases a definite arthritis follows the hæmorrhage, the swollen joint becoming red and hot, and the synovial membranes inflamed. This condition may last some time, and occasionally osteophytic outgrowths may develop. The appearance of the joint may resemble that of tubercular arthritis, but it is really a condition of osteo-arthritis caused by the joint hæmorrhage. The third stage is that in which after absorption of the effusion, adhesions and marked organic changes occur, so that impaired movement and sometimes ankylosis result. An X-ray examination will now reveal changes similar to those of advanced osteo-arthritis. The joint affections of hæmophilia require rest and the general treatment recommended for the disease. Local treatment must be applied with great care, since fresh hæmorrhages are liable to occur into the joint affected.

PURPURA.—Joint affections occur in association with purpura, and these may be classified into the two groups:

(*a*) *Purpura simplex*, in which the eruption may be accompanied by joint pains and sometimes swelling from effusion, which quickly clear up with rest and appropriate general treatment (see p. 726).

(*b*) *Purpura rheumatica*, sometimes called Schönlein's disease. Joint pains are an early symptom, and swelling of the neighbouring joints occurs. The arthritis is caused by synovial effusion, and clears up without any permanent organic changes resulting.

VII. ARTHRITIS ASSOCIATED WITH "DEFICIENCY DISEASES"

Scurvy.—In infantile scurvy periosteal hæmorrhages are common, and sometimes hæmorrhagic effusions into joints occur. In the scurvy of adults, swelling of joints sometimes occurs, the affected joint being tense and distended, with a sero-sanguineous effusion. Other signs of scurvy will probably

be present, such as the characteristic gum changes, palatal hæmorrhages, hæmorrhage into muscles, purpuric skin eruption, or a hard brawny œdema of the legs and feet. Symptoms of this kind only occur after a dietary which for several months has been deficient in fresh vegetables, fruit and fresh meat.

The treatment of scorbutic arthritis consists in rest of the affected parts and dieting with foods of high anti-scorbutic value.

Rickets.—The bones, especially at their epiphyseal junctions, are involved in this condition, and stretching of the ligaments round the joints may occur. Arthritis does not occur primarily in rickets, and any arthritic manifestations are secondary to changes in the bones and ligaments.

(B) ARTHRITIS OF OBSCURE CAUSATION

ACUTE RHEUMATISM OR RHEUMATIC FEVER (see p. 292)

NON-SPECIFIC INFECTIVE ARTHRITIS

This includes the types of arthritis known as rheumatoid arthritis, arthritis deformans, osteo-arthritis, and chronic villous arthritis.

It is a disease of obscure causation, but probably due to an infection which is not uniform in origin. It is characterised by changes in the joint structures, which may involve the synovial membrane, the articular cartilages, the bones and the capsule, and in the peri-articular structures. Typical cases of the above types of arthritis differ in their morbid appearances, but great similarities are present in all, and a case belonging in its early stages to one type may in its later stages develop into another. Thus, a case of so-called rheumatoid arthritis, or of villous arthritis, may in the later stages of the disease develop the typical bone changes of osteo-arthritis.

The terms rheumatic gout and chronic articular rheumatism are also used to describe the above conditions; and since the terminology is so confusing, and also a source of misunderstanding, not only to the medical profession but to the public, it would appear desirable that the term non-specific infective arthritis be used to include them all.

Ætiology.—Much has been written about the causes of chronic rheumatic affections, but the majority of these can only be regarded as predisposing conditions and not as true causes.

Arthritis has a lower incidence rate amongst coloured than white races. Osler and McCrae, in their American statistics, have alluded to the relative immunity of the negro race, and this agrees with the writer's experience amongst large numbers of Indian troops in Mesopotamia. A family history of arthritis is commonly obtained from sufferers. It does not appear that the disease is hereditary, but it seems likely that there is inherited a tendency for the joints or fibrous tissues to be affected when a person is subjected to an exciting infective cause. Thus, a streptococcal infection may in one person give rise to chronic arthritis, while in another a severe anæmia or an infective endocarditis may result.

Sex has been regarded as a predisposing factor, the frequency in females being stated to be something like four times that in males. Age: while

infective arthritis is rare under 10 years, all ages are susceptible. Dr. G. F. Still has described a form of infective arthritis occurring in children of early years, 8 of his first 12 published cases occurring under the age of 3. From the age of 20 years infective arthritis has a relatively large incidence for all ages, and the small numbers given for advanced ages are to be explained by the small population from which they are drawn at these periods of life.

Mental strain and debility, by lowering the general resistance, predispose, if the exciting infective cause is present. Trauma and physical strain may cause an arthritis or fibrositis, but this condition will not be progressive unless some infective cause is present at the time of the injury. It is well known that an injury is often the starting-point of a progressive arthritis, and this is commonly the case in osteo-arthritis of the hip-joint. Exposure to cold, wet and damp, and living in houses without proper damp-proof courses, particularly in districts where the subsoil is damp and the subsoil water high, all act as predisposing causes. Pregnancy and parturition are sometimes followed by a non-specific infective arthritis. It is well known that an existing infection in the body—for example, pulmonary tuberculosis—often undergoes a rapid development as the result of pregnancy, and in a similar way a latent streptococcal or other infection may be set up and cause a non-specific infective arthritis. This is the probable explanation of the ætiological bearing of pregnancy on arthritis. Disease of the nervous system is not associated with infective arthritis or the various forms of fibrositis. The changes seen in the so-called Charcot's joints of tabes or syringomyelia are due to trophic changes from spinal-cord disease, which, together, often with trauma, lead to severe organic changes in the affected joints. For many years dietetic errors in food and drink held sway as supposed exciting causes. Excess of protein in the dietary, drinking alcoholic beverages, such as certain wines and beer, and the taking of acid fruits, were all thought to play an important part, but the modern view is that metabolic factors have little or no influence in the causation of infective arthritis.

The conclusion which forces itself upon one from a close study of cases of non-specific infective arthritis is that the real exciting cause is an infection, the continued absorption of toxic substances giving rise to the inflammatory changes in the joints and fibrous tissues. It has been my experience that in the great majority of these cases a streptococcal infection from some focus in the body is the exciting cause, though in some cases another organism may cause similar effects—for example, the *Bacillus coli communis* group of bacteria. Arthritis from specific infections is well known, and the various examples of this type have been already described.

Pathology.—The disease, when not associated with a general specific infection, is, it is believed, in all cases due to some localised infection of the body, generally of a streptococcal nature. The organism causing the infection cannot usually be obtained from the affected joint or tissues, and in all probability the pathological changes are due to the toxins absorbed. A very large number of bacteriological examinations of the affected joints have been made by numerous skilled observers, but no specific organism has been found, and generally the results have been negative. In a few cases a streptococcus or a bacillus has been found in the affected joints, but proof has generally been wanting that this organism was the primary cause of the

arthritis in question. Poynton and Paine isolated from one case of infective arthritis a streptococcus which caused similar lesions in rabbits. It appears probable that in the majority of cases the affected joints and tissues are devoid of living bacteria. This is not surprising, since the causal infection is often of a relatively low type of virulence, and often far distant from the affected joints. An analogous example is to be found in the pleurisy, with sterile effusion, frequently present over a subphrenic abscess containing pathogenic organisms.

The cause of an infective arthritis should always be sought for. A careful clinical examination of all the organs should be made, but frequently no apparent cause is visible. The commonest cause of infection is to be found in connection with the teeth sockets. Dr. Beddard, in October 1918,[1] placed 90 per cent. of cases of so-called rheumatoid arthritis in this category, and my personal experience agrees with this view. Very commonly the teeth and gums appear healthy, and give rise to little suspicion, even after a close examination; but sometimes there may be visual evidence of caries and gingivitis, and on pressure pus may be expressed from the space between the gum and the teeth. It cannot be too clearly realised that the infection which is most likely to be the cause of an arthritis and allied conditions is often deeply seated near the apex of the tooth and gives rise to no symptoms whatever, and pain, swelling and tenderness may be entirely absent. The only certain method of examination of the tooth sockets is by means of X-rays; this should be done in every case, photographs of the individual teeth being taken. Usually there is definite evidence of osteitis, with rarefaction or destruction of the alveolus, and the most striking evidence of all is the indication of an apical abscess or granuloma shown in the print by the clear white space around the apex of the tooth. This space is invariably filled with pus or granulations heavily infected with pathogenic streptococci, and must serve as a constant supply of virulent toxins, if not of bacteria, into the blood stream. On very many occasions this condition has been associated with infective arthritis and the various forms of fibrositis. Where arthritis is present and a dental origin is discovered, almost always streptococci showing similar bacteriological characters are found in profusion in the fæces, and in cases of progressive arthritis after all the teeth have been removed, there is usually found bacteriological evidence of a marked streptococcal intestinal infection. The streptococci causing arthritis usually belong to the "viridans" group, and sometimes hæmolytic streptococci accompany these. Intestinal infections may, apart from dental infections, give rise to arthritis, but in such cases there is generally evidence of attacks of entero-colitis with diarrhœa and loose stools containing mucus. The causation of dysenteric arthritis by bacillary dysentery has been mentioned. In this country intestinal infections are uncommon primary infective causes of arthritis.

A septic condition of the tonsils and adenoids, of streptococcal type, may give rise to arthritis and allied conditions. A careful examination of the tonsils should always be made, and if unhealthy looking, pressure should be applied to see if pus can be expressed. The maxillary antra and nasal sinuses should be carefully examined by illumination and other methods for a possible source of infection. The uterus and genital organs also should be examined. In my experience infections from these organs, apart from

[1] *Transactions Medical Society of London.*

gonorrhœa, are very rarely the cause of arthritis and allied conditions. Any focus of suppuration may act as the cause of a general infective arthritis; thus, infected wounds or a suppurating joint may give rise to a non-suppurating general arthritis (McCrae).

The morbid changes in the joints in this condition have been described by Strangeways and others. Briefly, they consist of swelling and hyperæmia of the synovial membrane, and in the villous form this may attain a high degree of proliferation. The fluid in the joint is slightly turbid from the presence of small fibrous deposits, and usually contains lymphocytes and a few polynuclear cells. Later, the capsule of the joint becomes involved, and inflammatory processes are set up which may go on to thickening and contraction. The cartilage of the joint becomes affected, the surface being roughened and irregular with small elevations, and may become the seat of a fibrous tissue degeneration, with blood vessels spreading through it. The cartilage becomes thinned and may almost entirely disappear.

Atrophic changes occur in the bones, and the density becomes diminished. At the apposed surfaces absorption occurs in advanced cases, and at the periphery osteophytic outgrowths of softish bone, so that a mushroom appearance may be produced. In the synovial fringes, thickened fibrous nodules, partly calcified, may develop, and these sometimes become dislodged, forming loose bodies in the joint. In extreme cases a fibrous or partly bony ankylosis may result. The changes to be seen in X-ray photographs are rarefaction of the involved bone and a fuzziness of the articular surfaces, as if a very thin layer of fine cotton-wool covered them, due to the irregularity of the surface of the bone in consequence of the changes described. The clear space between the opposed bones is diminished, as a result of cartilage absorption. Loose osteophytes may be seen in some cases. Lipping of the bones or slight outgrowths may be visible.

Symptoms.—It cannot be too strongly insisted upon that the most careful examination must be made to determine exactly what structures are affected. Each joint should be carefully examined for evidence of swelling, pain on movement, and crepitation, creaking or grating. A careful examination should also be made of the bursæ around the joints of the tendons and of the tendon sheaths. The freedom of movement in all directions of each joint should be carefully tested and any limitation noticed.

Some cases begin with an acute onset of pyrexia and general symptoms in addition to the local. Such cases of acute infective arthritis often completely clear up with rest and treatment after an attack of moderate duration. Generally, however, the condition is progressive, and unless the cause of the disease is removed no permanent improvement will result. In the majority of cases, however, the onset is insidious and gradual. The earliest joints involved are often the metacarpo-carpal joints of the thumb and the phalangeal or metacarpal or carpal joints of the hands, but any joint may be primarily affected. The temporo-maxillary joint is involved much more often in infective arthritis, and this is an important point in diagnosis. A localised pain in an affected joint or joints occurs, and this progresses, other joints being involved, usually in a comparatively symmetrical manner. The affected joints show swelling and signs of effusion, and there is pain on movement and usually crepitus; creaking or grating are felt. In advanced cases there may be deformity of the joint, due to the effusion and to the hyper-

trophied synovial membrane and osteophytic outgrowths. The skin over the joints, especially of the hands and feet, shows trophic changes, such as pallor, smoothness, thinning of the skin and a tendency to abnormal sweating and defective circulation. The muscles above and below an affected joint soon show marked wasting if the disease persists. Marked deformity of the joints may occur in chronic cases, and this is seen especially in the hands, feet, knees and elbows, owing to the ankylosis and contracture of tendons round the affected joints. The tendon reflexes over affected joints are usually exaggerated, owing to the excitability of the reflex nervous arc. The involvement of the joints is usually accompanied by general pains, described as rheumatic in nature, and no fever may occur, though malaise, depression, headaches, anæmia and debility are usual. Cardiac complications are absent, as a rule; and beyond the joint affections and the general malaise and ill-health often associated with marked wasting, little is found.

The mono-articular form usually occurs after adult life and often follows an injury. It may affect the hip or shoulders, and is associated with marked impairment of movement in the affected joint. The changes are those of an osteo-arthritis, and the muscles waste. The disease does not usually spread to other joints.

The vertebral form.—Pain and impairment of movement of the cervical joints commonly accompany the ordinary types of non-specific infective arthritis. In some cases the whole vertebræ may be involved, and marked fixation of the spine ensues, sometimes with deformity, resulting in the bowing commonly seen in old people (spondylitis deformans). An X-ray examination will usually reveal osteophytic changes, and the bony outgrowths sometimes involve the nerve roots, so that in these cases the pain may be so severe as to lead to the development of the drug habit.

Infective arthritis in children.—This was first described by Still and is well known. The disease is associated with fever and enlargement of the lymphatic glands and spleen, which are sure evidences of an infective origin.

Prognosis.—In an early case of non-specific infective arthritis, if the cause is discovered by investigations on the lines indicated and is then removed, the treatment adopted will in all probability be followed by marked improvement, and there is reasonable hope of a complete cure. When the active inflammatory processes have subsided, massage and passive movements of joints are likely to improve the impaired mobility resulting from the infective process. It must be admitted that in the very advanced cases, where the primary source of infection has been succeeded by secondary sources, little can be done beyond treatment adopted for relieving the distressing symptoms. In cases of long standing the inflammatory changes are often progressive in nature, and removal of the primary cause may do little good because the infective process is being carried on by a secondary intestinal infection. In an advanced case of infective arthritis, the disease is often progressive in nature, and all that can be hoped for is to arrest the progress of the inflammatory process.

Treatment.—The most important step is first to find out the cause of the infection which has given rise to the arthritis. The measures to be adopted have been already indicated. A careful and complete clinical examination should be made to discover any possible source of infection,

including an X-ray examination of the teeth and accessory nasal sinuses and bacteriological examination of the stools, the urine and naso-pharyngeal swabs.

In acute cases, with pyrexia, absolute rest in bed is essential, and complete rest of the affected joints. Local applications of heat, such as electric-light baths, or fomentations, iodine poultices, are of value. Salicylates, which are of such striking benefit in rheumatic fever, are of little use. Indeed, drugs, except for the relief of pain—such as pyramidon and phenacetin—are not of much account. Intestinal antiseptics—such as guaiacol carbonate, grs. x, t.d.s., or cyllin, ℥ iii—should be given. A new intestinal antiseptic, "dimol," which is said to have fifteen times the disinfecting power of phenol and to be non-toxic, may be taken in doses of 2 to 4 grains in keratin or sugar-coated capsules three times daily. Bier's treatment is of value until the exciting cause has been determined; an elastic bandage is placed round the limb above the affected joint, so as to obstruct the veins but not the arteries, and is left on for 20 minutes daily. In cases without pyrexia, if there are signs of active inflammation in the joint, such as redness, heat, swelling, or pain, rest of the joint is essential, and local and general treatment as above should be prescribed. Iodine is of value. Collosol iodine in doses of 1 to 2 drachms with a wineglassful of water may be given twice daily, and the French tincture of iodine, which contains no potassium iodide, may be given in doses of 6 minims in water three times daily. Iodides, if tolerated, may be given instead.

As soon as the source of infection is found, this should be eradicated, if possible. Where the teeth are implicated or an apical dental infection is present, they should be removed and placed in a sterile vessel for bacteriological examination. In removal of infected teeth it is important where many are implicated that the extractions should be effected gradually. A severe auto-inoculation may follow the extractions, so that it is often safest to remove the affected teeth two or three at a time at different operations, an interval of 2 or 3 weeks being allowed between each. This precaution is particularly necessary in patients over 50 years of age. A satisfactory way of dealing with an apical infection is Gardner's method of sterilising the infected bone area by removal of the alveolar layer over the site of the lesion and curetting the diseased tissue, and sterilisation after removal of the offending tooth. This involves a cutting operation over the gum of the affected part. This method has been used in America, but has not been much employed in this country.

Vaccine treatment is of great value, but it cannot be too strongly insisted upon that it must be accompanied by removal of the causal infection. The affected teeth should be extracted after guarding against possible contamination of the teeth removed with normal streptococcal organisms found in the mouth, and a vaccine prepared. A course of at least 3 months of vaccine treatment is usually required, with weekly and, later, fortnightly doses. It is a wise procedure also to have a bacteriological examination of the fæces made, even if a dental streptococcal infection has been found. Usually an abnormal streptococcal intestinal infection is also present in such cases. It is then an advantage to use for treatment a combined vaccine made with equal proportions of the dental and intestinal streptococci. Overdosage with vaccine should be avoided, by commencing with quite small doses, which are carefully increased. In cases where the teeth have been removed and arthritis still persists, an examination of the fæces or colon

washings will usually indicate a streptococcal infection, and in such cases vaccine treatment may give benefit. For further details, see page 45.

In chronic and subacute cases, electric light or radiant heat treatment should be given daily or on alternate days, and this should be immediately followed by ionisation with iodine ions, a 2 per cent. solution of lithium iodide being placed on the lint of the cathode. In cases where much pain is present, ionisation with salicylic acid ions is of value. Diathermy is of value for relief of pain.

When there are no signs of active inflammation and the infective cause has been removed, massage and movements of the joints are indicated. Where the joint movements are much limited, breaking down of adhesions under an anæsthetic, or suitable surgical measures may be adopted.

In pyrexial cases the diet should be mainly liquid. It must be borne in mind that most cases of non-specific infective arthritis require a diet of high nutritive value, and attention should be directed towards giving a dietary rich in vitamins. Milk, cream, eggs, the unheated juice of fresh lemons or oranges, fresh fruits and vegetables, fish, chicken and meat, may be given according to the digestive capacity of the patient. If tolerated, milk fermented with lactic acid bacilli is of value in controlling intestinal fermentation. Cod-liver oil and malt, or one of its many substitutes now on the market, may also be given with advantage.

In chronic villous synovitis where the above measures fail, opening of the joint surgically and removal of the villous outgrowths has given good results.

Chronic Rheumatism.—The term chronic rheumatism is applied to many chronic affections in which pain occurs, associated with changes in the joints and fibrous structures of the body. So many different affections are loosely denominated "Chronic Rheumatism" that the term conveys no exact meaning, and it would be better abolished

INTERMITTENT HYDRARTHROSIS

This is a remarkable and rare condition in which at periodic intervals pain and stiffness of certain joints occur, rapidly followed by synovial effusion. The swelling of the joints quickly disappears, leaving them in a normal condition, but the symptoms recur periodically after intervals of about 12 days or more. The condition is to be distinguished from infective arthritis during the course of which transient effusions may take place into various joints which clear up quickly, but in infective arthritis some of the joints show signs of a progressive arthritis with organic changes in the joints demonstrable by physical and X-ray examination, and these changes are permanent, not clearing up intermittently.

A very typical case was under the care of Dr. A. P. Luff and myself for many years. The patient, aged 64, at the age of 18 and 22 had attacks of rheumatic fever. At the age of 47 attacks of intermittent hydrarthrosis developed. Suddenly stiffness and pains occurred in the elbow and knee, followed quickly by effusion, which lasted 2 or 3 days, the symptoms entirely disappearing, but recurring after varying intervals. At first, intervals of three months elapsed between the attacks, but the intervals became less, so that recurring synovial effusions occurred, usually into the knees or elbows, at intervals of about 12 days. There was no rise of temperature with the

attacks, and between them the affected joints were perfectly normal. At the age of 53 a very severe attack followed undue exertion, and after this there was a period of freedom for 5 months. Since that time the attacks have regularly occurred at intervals of about 12 days, and have been uninfluenced by the internal administration of remedies, such as salicylates, iodides and intestinal antiseptics, such as guaiacol carbonate, and courses of thyroid extract have had no effect. Autogenous vaccines prepared from the stools and teeth have been useless. It is interesting to note that in this patient at the age of 62 definite signs of arthritis of the cervical vertebræ occurred, with changes demonstrable by X-ray examination; these were found to be associated with a dental infection, and after the removal of the affected teeth and treatment with an autogenous parodontal vaccine and the usual remedies for infective arthritis, the cervical arthritis gradually cleared up, but during this period the attacks of intermittent hydrarthrosis still occurred in the knee-joints, apparently quite independently of the infective arthritis of the neck. The recurrence of attacks of intermittent hydrarthrosis in spite of all kinds of treatment, resembles the similar recurrence of attacks in Quincke's œdema (angio-neurotic œdema), and Sir Archibald Garrod, who has made a special study of intermittent hydrarthrosis, has called attention to the association of the two diseases, one of his cases showing with the joint symptoms accompanying symptoms of angio-neurotic œdema. The prognosis in intermittent hydrarthrosis is not good as regards cure of the recurrent attacks, but these appear to have little effect on the general health, and do not lead to organic changes in the joints, though the necessity of complete rest during the attacks leads to much inconvenience and incapacity for work.

HYPERTROPHIC OSTEO-ARTHROPATHY (see p. 1262)

FIBROSITIS

A condition of chronic inflammation of the fibrous structures of the body, such as the fasciæ, aponeuroses, subcutaneous tissue, ligaments, tendons, periosteum, the sheaths of muscles, nerves and important organs of the body, may occur and give rise to pain and impairment of movement. The general term "Fibrositis" is used to cover these affections, and usually a special term is used to specify the particular part of the body affected. It includes:

Panniculitis—chronic inflammation of the panniculus adiposus, which includes "finger pads" (a localised inflammation of the subcutaneous tissue on the dorsum of the phalangeal joints) and "fibrous nodules" which may form in the subcutaneous tissues in the course of a so-called rheumatic infection, also inflammatory conditions of the fasciæ, aponeuroses, tendons and ligaments (*e.g.* myalgia), and of the palmar and plantar fasciæ.

Inflammation of tendon sheaths—teno-synovitis of various kinds.

Inflammation of bursæ—bursitis.

Inflammation of the nerve sheath, or peri-neuritis, as, for example, sciatica and brachial neuritis (see p. 1653).

Ætiology.—The ætiology of the various forms of fibrositis is in all probability identical with that described under infective arthritis (see pp. 1250, 1251), and a source of infection is to be sought for and eradicated in the same manner as in the case of infective arthritis. Exposure to cold, wet and damp, and the strain of unwonted exercise or undue exertion, are very likely to cause a fibrositis of the fibrous sheaths of the muscles involved. The chronic irritation and over-use of tendons and ligaments is a common exciting cause of a local fibrositis, such as occurs in teno-synovitis and the Dupuytren's contractures so often seen in coachmen and violinists. Disorders of metabolism and dietetic errors appear to play a part in the causation in some cases. Fibrositis is an exceedingly common complaint, and is one of the most frequent causes of bodily pain.

It is important that a very careful physical examination be made, and the exact site of the tender area of fibrous tissue involved should be mapped out by palpation and pressure. Care should be taken not to mistake the pain arising from some deep-seated disease for fibrositis of the overlying structures.

Panniculitis

In this condition the subcutaneous tissue of the panniculus adiposus may be affected in a diffuse form covering fairly large areas, or isolated small areas only may be involved. The subcutaneous tissue covering the back of the neck, the deltoids, and back is frequently affected over large areas in the "diffuse" form, and on palpation and picking up the skin and underlying subcutaneous tissue with the fingers, the thickened and tender area of panniculitis can be discovered. The small fibrous subcutaneous "nodules," sometimes found in chronic rheumatic infections, are isolated forms of panniculitis. The pathology of the rheumatic nodules occurring in acute rheumatism is dealt with elsewhere, and is of a different nature.

"*Finger pads*" are small localised areas of subcutaneous thickening, commonly seen over the dorsum of the proximal interphalangeal joints. They are composed of fibrous tissue, and are important as indicating the presence of some infection giving rise to symptoms of a chronic rheumatic type.

Patchy areas of panniculitis give rise to thickening, and even tumours of a fibro-fatty nature. Sometimes in stout people large, diffuse, painful fatty masses are formed, and a condition known as Dercum's disease or adiposis dolorosa may result (p. 477). The pain associated with the various forms of panniculitis is due to the involvement of the superficial subcutaneous nerves in the inflamed areas.

Treatment.—The treatment of panniculitis consists, firstly, in seeking for a source of chronic infection and eradicating it as far as possible. Attention to the general health is important, and over-fatigue and exposure to cold and damp are to be avoided. Daily massage gives the best results, and it is an advantage to combine it with local radiant heat. Hot baths and electric light baths are of value. Where much pain is present it may be necessary to give aspirin, phenacetin, pyramidon, etc. In "adiposis dolorosa" the above treatment may be combined with thyroid extract in suitable doses.

Fibrositis of Fasciæ, Aponeuroses, Tendons and Ligaments

These conditions are very common, and when occurring in the neighbourhood of joints must be carefully distinguished from arthritis. Close examination will show by the impairment of movement and other signs whether a joint is involved or not. Local tenderness of the affected areas of fibrositis can usually be made out, and often tenderness of the periosteal covering of bones, especially in the pelvis, is marked. Fibrositis of ligaments and tendinous insertions is often seen. When occurring near joints a periarthritis may result, the joint itself being free.

1. Varieties of Myalgia.—1. *Lumbago*, where the muscles of the loins and their tendinous attachments are involved. This condition must be carefully distinguished from arthritis of the spine, from sacro-iliac disease, and from deep-seated abscesses, such as perinephric abscess or those resulting from spinal caries. In addition to the physical examination, X-ray investigation is helpful in cases which do not respond to treatment.

2. *Stiff neck* or *torticollis* affects the muscles of the back of the neck. Care must be taken that deep-seated causes of the stiffness of the neck, such as retro-pharyngeal abscess, cervical caries, or enlarged cervical glands, are not overlooked.

3. The muscles attached to the back of the skull, or those of the scapula and back may be affected, and the names cephalodynia, scapulodynia or omodynia and dorsodynia have been respectively applied.

4. *Pleurodynia*, where the intercostal muscles, and sometimes the pectorals, serratus magnus, latissimus dorsi, or other muscles attached to the ribs, are affected. The condition is usually unilateral, and gives rise to severe pain when the affected muscles are brought into action, as on coughing or deep breathing. Usually local tenderness can be elicited on palpation; but careful examination is needed to exclude such sources of pain as pleurisy or intercostal neuralgia.

5. The muscles and their attachments in any part of the body may be involved, for example, the abdominal muscles, those of the extremities, such as the deltoids or adductor muscles, and even the aryngeal muscles.

Treatment.—The treatment of the above forms of myalgia consists in removal of any possible infecting cause, and local treatment, by means of massage, baths, etc., and when necessary simple remedies for the relief of pain as described.

2. *The palmar fascia* may be involved, and the resulting thickening and contraction give rise to Dupuytren's contracture.

It is rare in females, and is often associated with the chronic irritation of the palmar fascia set up by the local pressure associated with a hobby or occupation. The disease sometimes occurs in families, and may be hereditary; but frequently no apparent cause can be found for its development.

The condition usually commences as a nodular thickening of the palmar fascia opposite one of the metacarpo-phalangeal joints, from which the inflammatory condition spreads. The ring and little fingers are most commonly affected by the resulting contraction, becoming flexed at the metacarpo-phalangeal joints, the other joints usually being left in a position of extension.

Medical treatment is of little value, but removal of an infective cause of fibrositis may arrest the progress of the disease. Surgical treatment has been adopted, but the division of the fibrous bands, though temporarily relieving the contracture, is apt to be followed by a recurrence.

3. *The plantar fascia* may be involved, and this occurs usually at its insertion into the os calcis. The condition known as "painful heel" gives rise to intense pain on pressure, so that the heels cannot be put to the ground without much suffering. In some cases a deposit of bone, which can be shown by X-ray examination, forms in the affected area.

The treatment of this condition should consist, firstly, in removal of a possible cause of the fibrositis, and afterwards local treatment should be adopted. The writer has found that the application of leeches freely applied to the heel over the affected area has given the best results in obstinate cases. Massage, local applications of heat and ionisation may be used. Surgical treatment, especially when spurs of bone have been formed, may be necessary, but should be avoided if possible.

Teno-synovitis

The tendon sheaths may be affected. The condition not infrequently arises from the chronic type of infection associated with fibrositis or chronic rheumatism, and may be quite unassociated with strain or traumatism. It is not an uncommon symptom of gout. Its occurrence in dysenteric and gonorrhœal infections has been described. The flexor tendons of the hands and wrists are the most commonly attacked. Pain, swelling or crepitus results. The treatment consists in removal of a possible infecting cause. Rest, local applications of heat, and ionisation with iodine ions do good.

Bursitis

An inflammation of the bursæ may occur as part of a fibrositis. It is important not to confuse the condition with that of arthritis, but a careful physical examination supplemented by X-ray examination, if necessary, will prevent this.

Sub-deltoid bursitis gives rise to pain round the shoulder joint, increased by movement, and very careful examination is required to distinguish it from arthritis of the joint. Bursitis is not an uncommon symptom of gout. The treatment of bursitis is similar to that of teno-synovitis.

MYOSITIS OR INFLAMMATION OF THE VOLUNTARY MUSCLES

Three forms occur—(1) the suppurative type; (2) the non-suppurative type; and (3) myositis ossificans progressiva.

1. Suppurative Myositis.—In this condition there is a primary inflammation of the affected muscles associated with the local signs of inflammation and the general symptoms of a septic infection. Abscesses form in the affected muscles, which require incision, and in the pus obtained pyogenic

organisms, such as staphylococci, or less commonly streptococci, are usually found.

2. Non-Suppurative Myositis.—It must be remembered that the voluntary muscles are affected in the course of other diseases. Thus, degeneration of the striped muscle, known as Zenker's degeneration, may occur in any acute infection of long duration, and it was first observed in typhoid fever. In scurvy, intra-muscular hæmorrhages are very common, and these are followed by a chronic inflammation, which usually clears up; but in a few of such cases I have seen suppuration occur. Trichinosis is accompanied by a myositis, set up by the encapsulated larvæ of the trichina spiralis deposited in the voluntary muscles.

Dermato-myositis is an acute or subacute inflammation of the muscles of unknown origin, which is associated with dermatitis and œdema. The onset is usually gradual, and ultimately all the muscles of the body may be involved. Pain is an early symptom, and fever of a mild intermittent type occurs. Œdema develops over the affected muscles, and is accompanied by a dermatitis of erythematous or urticarial type. Sweating is common, and enlargement of the spleen usually develops. Owing to involvement of the respiratory muscles broncho-pneumonia is a late complication. The disease is usually progressive, and generally fatal, though some recoveries have been recorded. The treatment adopted has been for the relief of symptoms, and no specific treatment is known at present.

A type of the disease in which hæmorrhages occur in and between the muscles is known as "polymyositis hæmorrhagica."

3. Myositis Ossificans Progressiva.—This is a progressive inflammatory affection of the locomotor system of unknown origin, characterised by the deposition of bony substance in the fasciæ, muscles, aponeuroses, tendons, ligaments and bones, with resulting ankylosis of most of the articulations. The disease is rare. It usually commences in early life, and is commoner in males. Three stages occur in the muscle changes. In the first stage, swelling and infiltration of the affected muscle with embryonic connective tissue occurs. In the second stage, the embryonic connective tissue becomes organised and forms ordinary connective tissue, which retracts to a hard fibrous mass. In the third stage, calcification of the fibrous mass occurs, and this becomes replaced by bone.

The muscles of the back and neck are generally the first involved, and the vertebral ligaments become ossified, so that irregular bony swellings occur, and deformity and fixation of the spine result. The upper and lower limbs are later involved, the muscles contracting and causing fixation of the joints. The muscles of mastication become finally involved and prevent movement of the lower jaw. Ultimately the patient becomes helpless and bedridden, and usually dies from some intercurrent affection, such as pneumonia, or pyæmia resulting from bedsores. The disease is always progressive, but is usually of long duration, and there may be a cessation in its progress for several years. No specific treatment of value is known.

W. H. Willcox.

SECTION XVII

DISEASES OF THE BONES

HYPERTROPHIC PULMONARY OSTEO-ARTHROPATHY

Definition.—A symmetrical enlargement of the bones of the hands and feet, and of the distal ends of the long bones, accompanied by clubbing of the fingers and toes, occurring in association with certain chronic diseases, in which usually the lungs are affected.

Ætiology.—The primary diseases in the course of which hypertrophic osteo-arthropathy may develop are:

1. Diseases of the lungs, such as (*a*) Tuberculosis with cavity formation and fibroid phthisis; (*b*) empyema and bronchiectasis; (*c*) malignant disease of the lung, pleura or mediastinum; and (*d*) chronic pleurisy, consolidation or fibrosis of the lung, non-tuberculous in nature.

2. Congenital heart disease, and sometimes chronic heart disease non-congenital in origin.

3. Chronic diseases associated with toxic conditions, *e.g.* chronic dysentery, chronic cysto-pyelonephritis, chronic alcoholism, chronic jaundice, as in hypertrophic cirrhosis of the liver. Congenital syphilis has been stated to be sometimes a cause; but this is doubtful.

4. Chronic defects in the circulation of vasomotor origin, *e.g.* chronic forms of Raynaud's disease.

5. It is said that a neuritis may lead to clubbing of the fingers and osteo-arthropathy, and pressure on the brachial plexus by a subclavian aneurysm has given rise to clubbing of the fingers on the affected side.

It appears that in the majority of cases a chronic toxæmia, in conjunction with a circulatory defect causing venous congestion, leads to the development of osteo-arthropathy. This combination is found to the greatest degree in the lung diseases above mentioned. In some cases a chronic toxæmia can be excluded, as, for example, in congenital heart disease, where the circulatory defect of itself will lead to marked clubbing of the fingers; in this condition, however, the long bones are not appreciably affected, and the changes are limited to the soft parts of the terminal phalanges, the hypertrophy of which leads to the so-called "clubbing."

The disease is said to be eight times more common in males than females. All ages may be affected. The most striking examples are seen from 30 to 50; but in congenital heart disease and in chronic lung disease in children, such as bronchiectasis and fibroid phthisis, definite signs of the disease often appear in early life.

Pathology.—The bones most frequently affected are the metacarpal bones and the first two rows of phalanges. The lower ends of the radius and ulna may be also attacked, and more rarely the lower end of the humerus and the upper ends of the radius and ulna. In the lower extremities the corresponding bones are affected. X-ray examination shows a thin layer of newly formed bone diffusely spread over the shaft beneath the periosteum, and most marked just above the junction of epiphysis and shaft. The bony changes are the result of a chronic inflammation, and the thickening of the periosteum and new formation of bone beneath it may be accompanied by atrophy and rarefaction of the pre-existing bone. There are no bony changes in the terminal phalanges, the soft tissues and nails alone being affected.

Symptoms.—The onset is usually gradual, and little local pain is experienced, though stiffness and clumsiness of movements occur. Sometimes marked clubbing of the fingers may develop in a few weeks; but usually several months or more elapse before the condition is characteristic. There is a remarkable symmetry in the pathological changes, and the ends of the fingers and toes show blueness from defective circulation. The nails are large and broad and curved, both longitudinally and transversely—the so-called parrot-beak. They show longitudinal striation and are brittle and easily split. The root of the nail is raised above its bed, and if pressure is applied at the root a distinct space between them can be made out. The joints in the neighbourhood of the affected bones show swelling, from effusion and thickening of the synovial membrane. Osteo-arthritic changes in the joints are only present in the severe osteo-arthritic type. The thyroid and pituitary glands are normal.

Three types of cases are seen, but these may be only grades in the development of the extreme form of the disease.

1. *Cases showing only clubbing of the fingers, in addition to the signs of the general primary disease.*—This symptom may disappear if the primary disease is cured, as, for example, empyema.

2. *Cases showing clubbing of the fingers and painful thickening of the bones of the hands and feet, forearms and legs, in addition to symptoms of the primary disease.*

3. *The "osteo-arthritis hypertrophica" type.*—The hands and feet become greatly enlarged, owing to the bony changes and thickening of the soft parts. The forearms and legs are thickened. The pelvis, sternum, ribs and clavicles may be thickened, and the vertebræ may show changes resulting in kyphosis. Osteo-arthritis occurs in the parts involved, so that movement of the joints is painful and difficult. In this type of case the very remarkable changes in the bones and joints overshadow the symptoms of the primary disease.

Diagnosis.—The disease is recognised by the presence of the characteristic changes in the extremities, and by the presence of signs of one of the primary diseases already mentioned.

Infective arthritis (arthritis deformans) is distinguished by the absence of clubbing of the fingers, and by the characteristic changes shown by X-ray examination.

Acromegaly is to be distinguished by the absence of clubbing of the fingers; the kyphosis is more often cervico-dorsal, whereas in hypertrophic pulmonary osteo-arthropathy it is more often dorso-lumbar; the facial

appearance is characteristic; and in this condition symptoms and signs of pituitary disease are usually manifest.

Prognosis.—The prognosis appears to depend on the primary disease. If that can be arrested or cured, there is hope of arrest or improvement in the hypertrophic osteo-arthropathy.

Treatment.—This should be directed towards the cure or improvement of the primary disease. Other treatment is symptomatic and similar to that adopted in the treatment of infective arthritis.

OSTEITIS DEFORMANS

Synonym.—Paget's Disease.

This is a rare disease and was first described by Sir James Paget in 1877.

Definition.—A chronic inflammatory condition, of unknown origin, causing enlargement and deformity of the bones affected. The disease may affect the head, the clavicles, the bones of the thorax, the spine and the long bones, or it may be limited only to one long bone.

Ætiology.—The condition usually commences at an age over 40, but has begun earlier. There are several recorded instances of inheritance of the disease, but this is exceptional. Various causes, such as syphilis, cancer, atheroma and defects of internal secretion, have been suggested; but there is no reliable evidence that these are of any importance in the causation. When the disease is limited to one long bone of the lower extremity there is sometimes a history of injury before the appearance of symptoms.

Pathology.—The changes in the bones are those of a rarefying osteitis, involving the central parts, while *pari passu* there is new bone formation beneath the periosteum, so that thickening occurs. The cause of the osteitis is not known. The bones most often involved in order of frequency are the skull, tibiæ, femora, pelvis, spine, clavicles, ribs and radii. The affected bones become much thickened, and in the case of the bones of the lower extremities the thickening is accompanied by weakness, so that deformities result. The skull becomes much thickened, and the circumference may be considerably increased. The femur is bent with its convexity forwards and the tibiæ are similarly deformed, and there may be outward as well as forward bowing. The spine becomes markedly kyphotic.

Symptoms.—The disease commences usually late in life with rheumatic pains in the legs, which may be severe, if these parts are involved; but if the skull only is affected the first symptom may be a noticeable enlargement in the circumference of the head. When the long bones and spine are affected, there may be a considerable reduction in height due to the deformities produced. The deformities already described may be noted. There is no rise of temperature, and beyond the discomfort caused by the pains and deformity the general health is usually little affected. The disease is generally progressive, but not infrequently it is limited to one long bone of the lower extremity. Death occurs from some intercurrent disease.

Diagnosis.—The disease is readily recognised when there is general involvement of bones. The bowing and thickening of the long bones of the lower extremity, the reduction in stature, and the thickening of the bones of the cranium, causing the face to assume a triangular appearance, make a

characteristic picture. Where, as is not infrequently the case, only one or two long bones of the lower extremities are involved an X-ray examination is necessary before a diagnosis can be established. In such cases careful investigation is necessary by means of clinical observation, *e.g.* the Wassermann reaction for syphilis, to exclude other possible causes of osteitis.

Treatment. The greatest care should be taken to see that the diet is rich in vitamins. Any food infection should be dealt with appropriately. Calcium should be given, in the form of lactate internally, or intramuscular or intravenous injection of 10 c.c. of 1 per cent. solution of the chloride or by other suitable calcium medication. Parathyroid extract is of value in combination with the calcium therapy. Artificial sunlight treatment is of value in raising the immunity and body resistance.

LEONTIASIS OSSEA

This is a very rare condition, in which there is diffuse hypertrophy of the bones of the skull. All the bones of the cranium and face may be affected. In one form of the disease there may be definite bony tumours appearing in the skull, which may cause pressure on the brain and give rise to characteristic cerebral symptoms.

The differentiation of this disease from the type of " osteitis deformans " in which the cranium is affected is difficult, and usually rests on the absence of involvement of other bones and the involvement of the bones of the face, which is uncommon in Paget's disease.

OSTEOGENESIS IMPERFECTA (FRAGILITAS OSSIUM)

This is a rare condition, in which multiple fractures occur in intra-uterine or infantile life. The condition is hereditary in 27 per cent. of cases (Griffith). In newly-born infants numerous fractures may be observed. In early life fractures may occur with very slight provocation, and the union resulting is usually fibrous and not bony, so that marked deformity may result. Osteo-malacia may develop in these cases, and deficient ossification of the bones of the vault of the skull and other developmental defects, such as spina bifida or club foot, may be present. When fractures are present at birth the infant will probably die soon. In cases where fractures occur after some years have elapsed there is little danger to life, but much deformity may result.

OSTEO-PSATHYROSIS (FRAGILITAS OSSIUM)

This is a rare condition, characterised by abnormal brittleness of the bones, which occurs after infantile life, and in either sex. The disease closely resembles osteogenesis imperfecta just described, and when the diseases commence in early life either term may be applied, for the two conditions are identical. It is best to reserve the term " osteo-psathyrosis " for cases in which the condition commences after infantile life. Abnormal

fragility of the bones occurs in old age, and in such diseases as syphilis, cancer and diseases of the nervous system, as tabes dorsalis, general paralysis of the insane, and chronic insanity. Chronic wasting diseases may be accompanied by an abnormal tendency to fracture. These conditions are not examples of the disease under consideration, and they must always be excluded before a diagnosis is made.

Ætiology.—Osteo-psathyrosis occurs equally in both sexes. A history of inheritance from generation to generation is common, and several members of one family may be affected.

Symptoms.—General health of the sufferers is good; but fractures occur from very slight causes, such as a slight blow or fall, or even turning over in bed. Fractures of the jaw may result from the act of chewing. These lesions are not usually accompanied by pain, and union of the fragments occurs with the formation of callus. Owing to faulty positions after union, marked deformities are common.

Prognosis.—The disease does not appear to shorten life, and in some cases the abnormal tendency to fracture greatly diminishes as age advances. Great disability is, of course, experienced by sufferers from this disease.

Treatment.—This is largely precautionary, the utmost care being taken to avoid the occurrence of fractures, and when these occur they should be carefully treated on surgical lines, so that deformity may be prevented. Phosphorus has been recommended internally.

OSTEO-MALACIA (FRAGILITAS OSSIUM, MOLLITIES OSSIUM)

Definition.—A chronic disease, occurring usually in females, characterised by decalcification and weakness of the bones, with resulting bending or fracture and deformity.

Ætiology and Pathology.—*Geographical distribution.*—Osteo-malacia occurs, but rarely, in most parts of the world. In certain districts, however, it is relatively common, for example, in the Olona valley near Milan, and Calabria in South Italy, in the north-western district of Switzerland, and in certain districts of South Germany and Austria endemic areas have been observed. The disease is very much commoner in women, probably occurring at least twenty times as frequently as in males. Heredity plays no part. In the majority of cases the symptoms begin between the twentieth and thirtieth year; but occurrences earlier and later are recorded. Defective hygienic conditions and lack of suitable food are said to predispose; but the disease is not limited to the poorer classes.

There appears to be a definite relationship between the disease and the ovarian function. Its much greater frequency in women bears this out. Fehling asserted that the disease was due to a morbid condition of the ovaries, and on this assumption oöphorectomy has often been performed with, in many cases, beneficial results. The ovarian theory, however, does not explain the rare occurrence of the disease in men, nor the form of osteo-malacia occurring in children.

It has been stated that endocrine insufficiency is an ætiological factor in osteo-malacia and allied conditions, and defective suprarenal function has been said to be a factor in their causation in some cases.

Infective causes have also been stated to predispose, and in some cases a severe attack of puerperal, typhoid or scarlet fever, etc., has preceded the development of osteo-malacia. The occurrence of pregnancy or repeated pregnancies appears to predispose. Morbid conditions of the thyroid and parathyroid glands have been stated to be causative factors; but this is not proven.

The bones affected are soft, and can often be bent or cut without difficulty. The bone tissue is much reduced, and the marrow is yellow or fatty, and may show hyperæmia. The periosteum is thick and hyperæmic, and the surface of the bone beneath is rough, and the bone more porous than normal. Formation of new bone does not occur, and the absorption of the calcium salts in the affected parts leaves the bony framework fibrous and decalcified. The bones most frequently affected are those of the pelvis, and next in order come the vertebræ, the bones of the thorax, those of the lower extremities, those of the upper extremities, and, lastly, the bones of the head. The pelvis may show marked deformity, the sacrum being displaced forwards and the acetabula pressed upwards and inwards. The ribs may show numerous fractures, and the sternum be much bent. The long bones may show deformity and fractures. The muscles are atrophied and may show marked degenerative changes. The joints are not affected. The ovaries have been found to show degenerative changes, but these are not constant.

Symptoms.—The onset may be insidious, so that the disease is not recognised until far advanced. Pain in the pelvic region, back, thorax and extremities occurs early, and is of an aching or neuralgic type. Tenderness on pressure over the affected bones may be present. Deformity of the spine or lower extremities may be observed, and fractures of bones from very trivial causes attract attention. The occurrence of pregnancy and the examination consequent on this lead commonly to the recognition of the pelvic deformity and the disease which has given rise to it. General weakness occurs, and the muscles show atrophy and often fibrillary tremors. The urine contains an excess of phosphates and calcium salts, and there is a tendency to the formation of renal calculi, which give rise to distressing attacks of renal colic.

The course of the disease may be fairly rapid, lasting several months, but usually it extends over several years. The patient is bedridden, and fever, sweats, wasting and cardiac symptoms occur, spontaneous fractures and bedsores adding to her discomfort and to the difficulties of nursing.

Treatment.—Attention to the general hygienic conditions is of importance. The diet should be liberal and comprise foods rich in calcium, salts and phosphorus, such as milk, eggs, fish, sweetbreads and meat. Calcium salts, especially the glycero-phosphates, may be given; but though of value on theoretical grounds, they have been found to be of little benefit. Phosphorus has given the best results of any drug employed, and a course of 3 months or more is advisable. It may be given in solution in almond oil 1 in 1000, in daily doses of one teaspoonful after food, or pil. phosphori of strength 1 in 100 may be given in doses of 1 or 2 grains three times daily after food. Epinephrin and suprarenal preparations are claimed to have given good results in some cases.

Where improvement does not follow medicinal treatment and the disease

is steadily progressing, oöphorectomy is indicated. Should pregnancy occur in a patient suffering from osteomalacia, artificial abortion is justified and advisable, since the changes occurring during pregnancy usually lead to a rapid development of the disease. Lactation should not be permitted.

ACHONDROPLASIA

Synonyms.—Chondro-dystrophia; Micromelia fœtalis.

Definition.—A disease usually of fœtal life characterised by shortness of the long bones, trident hands and large head. It depends on interference with endo-chondral ossification, especially at the epiphyseal junctions of the long bones.

Ætiology.—The disease may be transmitted through the male line, and its occurrence in three generations has been recorded. Delivery in achondroplasic women usually necessitates Cæsarean section, and this tends to prevent transmission of the disease by the female. The disease may occur in several members of the same family. It has been stated that females are more often affected; but Rolleston's series of 100 cases showed an almost equal distribution (53 males and 47 females).

Pathology.—A fibrous tissue invasion takes place from the periosteum into the area between the diaphysis and epiphysis of the long bones, and this more or less completely prevents the endochondral ossification at the epiphyseal junction which is necessary for longitudinal growth. Consequently, growth in length of the long bones is prevented, though increase in thickness can take place from periosteal deposition. The long bones show symmetrical exaggeration of the normal curves and are strongly laid down. The scapula is dwarfed and the glenoid fossa too small for the head of the humerus. The clavicles are not affected. The fibula shows much less shortening than the tibia, so that great bowing of the former results. The pelvis is distorted and ill-shapen, the sacrum being tilted forwards. The development of bones with a membranous matrix is not impaired. The ribs show a well-marked rosary, the prominence at the junction of the rib with its costal cartilage being due to an overgrowth of bone, which surrounds the end of the cartilage in a cup-like manner. The skull is little affected in its total size, since the membrane bones develop normally. At the base of the skull early synostosis of the basisphenoid and occipital bones leads to shortening of the base and to a narrowed funnel-shaped foramen magnum.

The true causation of the above changes is unknown. A relationship to cretinism and rickets is not now accepted, and there is no evidence that tuberculosis or syphilis has any part in the ætiology. Some writers have suggested that achondroplasia is the result of a maternal toxæmia acting on the fœtus, but the nature of this has not been explained.

Symptoms.—The subject of achondroplasia is more or less dwarfed. The head and trunk are about normal in size, but the extremities are much shortened, and with the arms at the sides the fingers reach little below the crest of the ilium. The humerus and femur are relatively more shortened than the other bones of the extremities, so that the proximal segments of the limbs show the most marked shortening. The hands are short and trident-

shaped, the fingers being almost equal in length. Lordosis of the lumbar spine is marked, owing to the tilting forward of the sacrum. The scapulæ are short and the fibulæ curved with the convexity outwards. The contracted pelvis in females may give rise to difficulty of labour or necessitate Cæsarean section. The general health is not affected, and the subjects of achondroplasia are usually strong and of average intelligence.

OXYCEPHALY

Definition.—A cranial deformity in which exophthalmos and optic atrophy develop.

The condition is usually present at birth, but in some instances it may develop from the second to the sixth year. It appears to be caused by premature synostosis of certain of the cranial sutures, especially the coronal and sagittal, but why this should occur is not known ; as a result of the early union of the sutures the growth of the vault of the skull is restricted in its antero-posterior and transverse diameters, the necessary space for the brain being obtained by compensatory increase in the height of the skull. The anterior fontanelle appears to close later than the normal time, and its site is marked by a slight protuberance, over which the bone is thinned. The forehead is much increased in height and the supraorbital ridges are feebly marked, the hairy scalp being much raised up. Owing to the abnormal growth of the cranium and increased intracranial pressure caused by the growing brain, headaches occur, and the eyeballs become pushed forwards, causing exophthalmos. Pressure on the optic nerves and chiasma leads to progressive optic atrophy, with gradual impairment of vision. The sense of smell may be lost, owing to pressure on the olfactory bulb and nerves. The intelligence is usually not affected.

Medicinal treatment is of no value, except for the relief of headache, for which phenacetin, aspirin or pyramidon may be given. When the symptoms of intracranial pressure become marked and optic atrophy is commencing or progressing, a decompression operation is advisable.

W. H. Willcox.

SECTION XVIII

DISEASES OF THE SKIN

I. INTRODUCTORY

In order that the diseases which affect the skin may be understood it is necessary to give a brief account of the anatomy, physiology and general pathology of the skin.

Anatomy.—The skin is a fibrous structure varying considerably in thickness in different parts of the body and covered externally by several layers of epithelial cells. On section its main bulk is seen to be made up of white fibrous tissue bundles running chiefly parallel to the surface and bound together by thin fibres of elastic tissue. The surface of this fibrous mass, which is called the *dermis*, is not level but is surmounted by a number of finger-like projections, called papillæ, which fit into corresponding depressions or pits on the under surface of the epithelial covering which is called the *epidermis*.

In the fibrous stroma of the dermis blood vessels, lymphatics and nerves ramify. The *arteries* form a plexus of large vessels at the junction of the dermis with the subcutaneous fatty layer and from this deep plexus arteries pass upwards, frequently near hair follicles or sweat ducts to which numerous twigs are sent, to another superficial or sub-papillary plexus situated just below the bases of the papillæ. From this smaller vessels pass upwards to end in the papillæ. The *veins* follow a similar course in the opposite direction.

Lymph circulates freely in the spaces between the cells of the epidermis and the fibres of the dermis, but definite lymphatic vessels are also found in the papillæ and in the dermis, accompanying the blood vessels.

The *nerves* of the skin are both medullated and non-medullated. They also follow the course of the blood vessels and are distributed to the hair-follicles, sweat and sebaceous glands, blood vessels, arrectores pili muscles and to the connective tissue bundles in their passage through the dermis. Losing their medullary sheath in the sub-papillary layer some fibres pass up and are distributed to the papillæ and to the basal and mucous layers of the epidermis, while other medullated fibres end in curious whorls in the papillæ, which are called the touch corpuscles of Meissner ; a few end in small ovoid bodies, known as Pacinian bodies, in the subcutaneous tissue.

The *epidermis* consists of several layers of cells, varying considerably in thickness in various parts of the body. The layer nearest the dermis consists of regular cubical cells to which it is intimately attached, and it is from this layer that the rest of the epidermis is developed ; it is spoken of as the *stratum germinativum* or *basal layer*. The layers above this consist

of cells in various phases of transformation into horn cells, which are seen in their final form in the outermost layers. Above the basal layer there are several layers of large polyhedral cells with large nuclei and a spongy cell substance; they are bound to one another by fine fibrils from which they have obtained the name "prickle" cells; this is the *mucous* or *Malpighian layer*. Above this are one or two layers of lozenge-shaped cells, lying parallel to the surface of the skin, whose protoplasm contains large deeply staining granules, giving to it the name *granular layer*. Then comes a thin transparent layer, the *stratum lucidum*, and above this the *horny layer*. Here the cells have lost their nuclei and protoplasm, and consist only of a cell capsule which has been converted into a highly resisting substance called keratin; the cells are intimately bound together and can only be separated with great difficulty. Thus a strong protective layer is produced which can only be destroyed by strong acids or alkalis or by violence.

Dipping down from the epidermis into the dermis are certain epithelial structures, the hair follicles with their sebaceous glands, and the sweat glands.

The *hair follicles* are pockets of epithelium which contain in their walls all the layers of the epidermis in a modified form. They penetrate the whole thickness of the dermis and often pass into the subcutaneous tissue for some distance. The *hairs* grow from enlarged papillæ at the bottom of the pits and also consist of modified epidermis, so modified that the cellular structure is only visible on the outer layers formed of superimposed scale-like cells, the cuticle of the hair; the remainder of the hair structure consists of an outer fibrous part, the cortex, and a more succulent centre, the medulla. Hairs are present all over the skin except on the palms and soles, and vary very much in size. Their ordinary characteristics need no description. The hair follicle is inserted obliquely in the skin, and on the aspect where it forms an obtuse angle with the surface, a small band of unstriated muscle, the arrector pili, is found, attached below to the hair follicle near the papilla and above to the fibrous tissue underlying the surface epidermis. This muscle on contraction erects the hair.

From the same side of the hair-follicle, and lying between it and the muscle, so that it is compressed when the muscle contracts, is found a sacculated gland growing out of the follicle; this is the *sebaceous gland*. It secretes an oily substance which lubricates the hair and the skin surrounding the follicle. The secretion is produced by fatty degeneration of the cells of the gland itself, and is expressed by contraction of the arrector pili muscle. These glands vary much in size and in some cases far exceed that of the hair follicle; in this case they often open directly on the surface of the skin in common with the hair follicle. They are most developed on the face, back, chest and scrotum.

The other epithelial appendages are the *sweat glands*, which are found everywhere in the skin. They are tubular structures which pass down to the lowest part of the dermis or into the subcutaneous tissue and end in a coil, the *sweat or coil gland*, the straight portion passing to the surface being the *sweat duct*. Both the duct and gland consist of a single layer of cubical cells which becomes continuous with the basal layer of the epidermis. The duct has no special epithelial lining through the epidermis. Involuntary muscular fibres, which expel the secretion of the gland and are under the control of special pilo-motor centres, are present among the coils of the glands. The

secretion of the gland is a true secretion and is not produced by degeneration of its cells, as in the case of the sebaceous glands. Certain large sweat glands, called *apocrine glands*, occur in the axillæ, nipples and pubic region, which do, however, show breaking up of the cell protoplasm during activity.

The only other skin structures that require mention are the *nails*. These are simply modifications of the horny layer of the skin. The nail grows from that portion of the nail bed which is partly hidden by the nail fold and partly seen as the lunula of the nail, which forms a pale half-moon shaped area above that structure; this area is called the *matrix*.

PHYSIOLOGY AND PATHOLOGY.—The functions of the skin are four in number—(1) It forms a protective covering over the whole body; (2) it is an organ of secretion; (3) it is the seat of tactile sensation; and (4) it plays an important part in regulating the temperature of the body. The skin also allows of absorption, though this can scarcely be considered one of its primary functions. From the point of view of dermatology the two first functions are the most important.

The protective function is a double one, firstly the skin as a whole lying on a loose connective tissue pad, protects the deeper structures from damage by acting as a buffer; secondly, the resistant characters of the horny layer protect from irritants, not only the deeper structures, but also the layers of the skin lying beneath it, for the moist cells of the body unprotected by these dry keratinised cells would perish if exposed even to the ordinary atmosphere. Damage to the horny layer is responsible for a very large group of inflammations of the skin.

The horny layer, however, does not act quite alone: it is made more impermeable to simple external irritants by the presence of a thin layer of oil on its surface which is provided by the secretion of the sebaceous and sweat glands. As will be shown later absence or deficiency of this oily secretion renders the skin much more susceptible to external irritants. On the other hand, excessive sweat secretion from the large amount of water it contains may make the horny layer sodden, and therefore more liable to damage. Similarly, an excessive sebaceous secretion tends to make the horny layer thicker and is an excellent medium for the growth of organisms.

It must further be remembered that the horny layer does not form a complete sheet, but that innumerable invaginations which form the hair follicles and sweat ducts are present. These considerably weaken the protective power of the horny layer, and it will be found that at these spots inflammatory reactions, due to damage of this layer, are most likely to occur. It is also practically certain that absorption takes place at these follicular openings.

The secretions of the skin are the sweat and the sebum, the latter of which is the secretion of the sebaceous glands. The former is a watery fluid which contains traces of sodium chloride and other mineral salts, extractives, and a very small quantity of urea and fats. It varies very much in quantity, but normally about equals the quantity of urine voided and, therefore, is responsible for the removal of nearly 50 per cent. of the total water excreted by the body. The main function of this excretion of water is to maintain the temperature balance of the body and, therefore, in hot weather the amount of sweat is increased in order to cope with more rapid evaporation and so keep the body surface cool, the quantity of urine being correspondingly

diminished unless larger quantities of water are imbibed. In cold weather the reverse is the case.

The sweat has special interest to the dermatologist not only from its lubricating effect on the horny layer, but also from the fact that certain drugs are sometimes excreted by it, and it is possible that some of the eruptions caused by the ingestion of these drugs may be produced by their irritating action during the process of excretion by the sweat.

The sebum is an oily secretion whose function appears to be entirely that of lubricating the hairs and surface of the skin: it not only helps to protect the skin from chemical irritants, but also from the actinic rays of the sun.

The other two functions of the skin, namely, the *tactile sense* and the *regulation of temperature*, will have been dealt with elsewhere, and as they affect the dermatologist but little, they will not be further considered here.

GENERAL DESCRIPTION OF SKIN DISEASES

The bulk of skin diseases fall into two great classes, inflammations and new growths. There are in addition certain conditions which cannot be included under either of these headings, and will require special mention, namely, the disorders of secretion, of sensation, of the circulation, and of pigmentation; atrophies of the skin and certain congenital abnormalities. It will also be necessary to describe the diseases of the hair separately. As so many of the inflammations depend upon disorders of secretion, sensation and circulation, it is proposed to deal with these first. Before proceeding, however, to deal with pathological conditions of the skin, it will be useful to define the terms used in describing clinical manifestations. It must be realised, however, that these terms are used very loosely, and are only a convenient form of nomenclature.

A *macule* is a spot which is not raised above the skin; it may be vascular or pigmentary. The term is usually applied to small lesions up to the size of a pea, a larger lesion being called a "plaque" or "tâche." Large sheets of redness are generally called an "erythema."

A *papule* is a solid elevation usually not exceeding the size of a pea. If the surface is flat and smooth it is called a "plane" papule; if pointed an "acuminate" papule.

A *tubercle* or *nodule* is an elevation usually between a pea and a hazel nut in size. The term nodule is also used for small solid swellings in the substance of the skin and subcutaneous tissue which do not necessarily project above the surface.

A *tumour* is a swelling exceeding a hazel nut in size. It need not necessarily be solid, but this term is not usually applied to thin-walled superficial fluid swellings.

A *wheal* is a circumscribed elevation of the skin of a transitory character in which œdema is so marked as to force the blood out of the superficial capillaries and so produce a dead white elevation.

A *vesicle* is an elevation not larger than a pea containing clear fluid.

A *bulla* is a similar lesion of larger size; in other words, a *blister* or a *bleb*.

A *pustule* is a similar lesion to a vesicle, but contains pus instead of clear fluid.

A *scale* is a lamella of the horny layer of the skin.
A *crust* is a mass produced by the drying of exudates on the skin.
An *excoriation* is an abrasion of the superficial layers of the epidermis.
A *fissure* is a crack in the skin.
An *ulcer* is a circumscribed loss of tissue involving the whole thickness of the epidermis.

A. M. H. GRAY.

II. CONDITIONS PREDISPOSING TO SKIN DISEASES

A.—DISORDERS OF SECRETION

Under this heading are included deficiency or absence of sweat and sebaceous secretion, and also excessive secretion.

ANIDROSIS OR DIMINUTION OF SWEAT SECRETION

This occurs in many diseases, but is seen in its most marked form in xerodermia and ichthyosis. It also is seen in hypo-thyroidism and in its more marked form myxœdema, in the degenerating skin of old people, and in poisoning by certain drugs, of which arsenic is one of the most frequent examples.

The milder cases of hypo-thyroidism show dryness of the skin, dryness, brittleness and thinning of the hair. They improve rapidly under the judicious administration of thyroid extract.

XERODERMIA AND ICHTHYOSIS

These two names are applied to the mild and severe types of the same disease. The condition is one of abnormal dryness of the skin owing to the almost complete absence of sweat and sebaceous secretion accompanied by an overgrowth of the horny layer of the epidermis (hyperkeratosis).

Ætiology and Pathology.—The disease is inherited and often occurs in several members of the same family. It attacks both sexes equally. The disease is usually noticed about the second year of life, but some children are born with a condition closely resembling it (*ichthyosis congenita*): these children are frequently premature and generally stillborn. There is no very definite evidence as to whether the changes in the epidermis follow the absence of secretions, or vice versa, or whether both are dependent on a common cause; possibly the overgrowth of the horny layer is an attempt on the part of Nature to compensate for the protection usually supplied by the oily secretions. Histological examination shows very marked increase in the thickness of the horny layer, which is irregular and grows directly from the mucous layer, the granular layer being absent. The sweat glands are apparently normal histologically, although they do not function, but the sebaceous glands are atrophied.

Symptoms.—In the milder cases (*xerodermia*) the skin is dry and rough,

and there may be a certain amount of branny scaling on the surface. On the extensor aspect of the limbs the hair follicles are prominent and contain small horny spines The palms and soles are more lined than normal, while the flexures of the body show little change. The hair is dry and lustreless, and occasionally stunted and brittle, while in a few cases only down grows on the scalp.

In the more marked cases (*ichthyosis*) the body is covered with large fish-like scales which are firmly adherent. They may be thin, transparent and colourless, or thick and dark in colour (the so-called alligator skin). In these cases the trunk and extensor aspect of the limbs are most involved, the face and scalp often showing little change, though the changes mentioned above may be present. This dry skin is particularly liable to become inflamed on account of alteration in its protective mechanism.

There is another form in which the disease develops in localised sheets, lines or bands (*ichthyosis hystrix*), but this condition is closely related to the linear nævi and will be dealt with under that heading.

Prognosis.—The disease persists throughout life, and although it can be relieved by appropriate treatment it never really gets well.

Diagnosis.—The dryness of the skin, the origin of the disease in early life, and its persistence, and the presence of fine or coarse scaling with the absence of inflammation renders the diagnosis easy.

Treatment.—This consists in an attempt to replace the natural oil of the skin. Frequent warm baths, followed by the application of some oily preparation, is usually sufficient. One of the most useful preparations is glycerin. amyli, adip. lanæ hydros. āā ptes. æq., to which may be added 2 per cent. or 3 per cent. of salicylic acid if desired. Too vigorous use of soap is to be discouraged.

Some authorities recommend thyroid extract internally, on the grounds that the condition is due to deficient thyroid activity, but the results obtained have been scarcely sufficient to confirm this view.

HYPERIDROSIS

Definition.—This is a condition of over-activity of the sweat glands. It may be general or local.

Ætiology and Pathology.—Sweating in febrile illnesses is not included under this heading. The generalised forms are usually seen in adults, while the localised varieties are not infrequently seen in younger people. They are both probably due to disturbances of the nervous system, though it is difficult to say that they always occur in neurotic individuals. There is no doubt, however, that hyperidrosis is very liable to produce a neurotic condition.

Symptoms.—*Generalised hyperidrosis.*—In this condition the patient sweats excessively, often on the least exertion or excitement. The sweating may be so severe that the patient has to change his clothes several times a day—even in cool weather.

Localised hyperidrosis.—There are certain regions of the body particularly liable to excessive sweating, namely, the palms and soles, the axillæ, and the genital region and perineum. The sweating is often very excessive, and may last for a very long time; there is, however, a tendency for the

condition to diminish with age, it being most marked in the latter half of the second and the third decades of life.

The sweat allows certain saprophytic organisms to grow freely, with the result that decomposition takes place, and an extremely offensive odour develops. This is chiefly noticed in the feet, and is spoken of as *bromidrosis*. Occasionally the sweat is coloured (*chromidrosis*), due in most cases to bacterial activity.

The skin constantly soaked in sweat is subject to attacks by irritants, bacterial and otherwise, and various forms of dermatitis are frequent complications of hyperidrosis, especially the forms spoken of as *miliaria rubra* and *dysidrosis* (see p. 1289).

Prognosis.—Localised cases will generally respond to treatment; but the more severe generalised cases are apt to be very persistent.

Treatment.—For the *generalised cases* frequent warm baths are required to keep the skin clean. Dabbing on a weak formalin lotion (1 per cent.) is often useful; but care must be taken not to use it too freely, as a dermatitis may be set up. The general health should be looked to, and all dietetic errors and habits liable to cause sweating rectified. Some cases benefit by the internal administration of bromides and belladonna.

The *localised cases*, when extreme, are best dealt with by X-rays. Ten or twelve doses, each of $\frac{1}{3}$ Sabouraud pastille, given in groups of four doses at weekly intervals, with intervals of one or two months between the groups, usually give a satisfactory result. Bromidrosis of the feet is best dealt with by frequent washing and change of socks, by bathing in weak formalin solution, or by washing with lysoform, or other formalin soap. The feet should then be freely dusted with a powder of talc containing 3 per cent. salicylic acid.

SEBORRHŒA

Definition.—By the term seborrhœa is meant an over-activity of the sebaceous glands, resulting in an abnormally greasy skin.

Ætiology.—This condition occurs from the time of puberty onwards, gradually diminishing as age increases. It tends to affect certain races and families, but is also influenced by the habits of individuals. Gastric disturbance, constipation, anæmia, uterine trouble and the like all tend to exaggerate the condition.

Pathology.—The condition appears to be due to some disturbance of metabolism not yet fully determined. Some authorities consider that infection by certain organisms play a part, but the evidence is inconclusive.

Symptoms.—The regions affected are the face—especially the nose, naso-labial folds—the scalp, chest and back. In the milder cases the skin is greasy; in the more severe cases it is thickened—giving rise to a muddy appearance—and the follicles are patulous. This condition Darier has labelled "la kerose." In other cases the sebaceous follicles are plugged with semi-solid sebaceous material.

Complications.—Seborrhœa is the underlying cause of many skin affections. Acne vulgaris is merely a more marked stage of the follicular plugging noted above. Infection by certain organisms producing seborrhœic dermatitis is very common, while the skin is especially liable to

ordinary eczema and impetigo contagiosa. Acne rosacea is particularly liable to occur in seborrhœic individuals.

Treatment.—The general health must receive attention. Diet should be regulated to get rid of dyspepsia and constipation; especially should excess of sugars and starches be avoided. Iron and arsenic are indicated in anæmia, and uterine troubles should be appropriately treated. Sodium-bicarbonate in full doses is recommended as a specific by Barber.

Frequent washing with soap and water is necessary. Sulphur has a marked effect in diminishing the secretion, and especially in preventing organisms from growing in it; it may be used as a powder—sulphur. precip. 5 parts, pulv. talc to 100 parts; or as a lotion, potass. sulphurat. ℥i; sp. vin. rect. ℥ij, aquam ad ℥viij.

B.—DISORDERS OF SENSATION

The disorders of sensation comprise hyperæsthesia, anæsthesia and paræsthesia.

Hyperæsthesia is generally symptomatic of some organic or functional disease of the nervous system, and has little or no importance in dermatology.

Anæsthesia also is usually symptomatic; but one form occasionally comes under the notice of the dermatologist first, namely, that associated with syringomyelia. The individuals affected show anæsthesia with trophic changes in the skin of the fingers, often with whitlows and other signs of skin sepsis. Further investigation shows the lesions to be only part of a more general disease of the nervous system. This type is spoken of as Morvan's disease, and is dealt with elsewhere (p. 1606). Localised areas of anæsthesia, with redness, are frequently an early sign of leprosy (see p. 117).

Paræsthesia forms the most important group from the dermatological point of view, as it includes itching or pruritus.

PRURITUS

Under this heading are included those cases of itching of the skin in which there is no other obvious dermatosis. It may be general or local.

Generalised Pruritus

Ætiology and Pathology.—The causes of general pruritus may roughly be classified as follows:

1. The presence of toxic substances circulating in the blood. For instance, in diabetes and jaundice from the presence of sugar and bile-salts in the blood. Similarly certain ingested drugs, such as opium, will cause it. It also occurs in gout and nephritis.
2. As a symptom of some blood diseases, such as leukæmia and lymphadenoma, before any skin lesions are present.
3. In atrophy of the skin in old people, the so-called senile atrophy.

4. In a large group of cases in which no cause can be found, and which are considered of functional origin.

Symptoms.—In the majority of cases itching is the only or main symptom, but others, such as tingling and burning, may be present. It may vary very much in intensity, and may be intermittent. Some people suffer most in hot weather; but it is more frequent on exposure to cold. Hot baths sometimes bring on attacks. In the more severe types the condition is most distressing, the patient rarely has any peace, but is constantly scratching, it keeps him awake at night, and as a consequence his general health suffers and he becomes a nervous wreck. In spite of this, it is extraordinary how little sign there is of scratching on the skin; some cases show a certain number of linear excoriations, but the scratch lesions are rarely as marked as they are in the localised forms and in parasitic affections. Sepsis of the skin is rarely seen.

Diagnosis.—It is essential to try and find the cause. Parasitic infection should be excluded in the first place, and then internal ailments, including the blood diseases. The presence of marked scratch lesions, especially with sepsis, suggests a parasitic origin; the special distribution of parasitic lesions will be considered under their appropriate headings (p. 1315 *et seq.*).

Treatment.—In the cases in which no definite cause can be assigned it is necessary to attend to the general hygiene of the patient. Diet requires careful regulation; alcohol, strong tea and coffee should be forbidden, as should all substances likely to produce urticaria, *e.g.* shell-fish, strawberries, etc.; hot and highly seasoned dishes and excess of nitrogenous food are better avoided. Any disturbance of digestion, especially constipation, should be treated. In bad cases sedative drugs may be required, of which bromides, belladonna, cannabis indica and valerian are the most useful. Injections of pilocarpine are recommended in dry skins. In cases of sleeplessness trional or sulphonal is useful. Opium should be avoided, as, apart from other reasons, it may increase the itching.

Local treatment depends on the conditions which excite the pruritus: for instance, in some cases baths are advantageous, while in others they increase the itching. If the skin is dry, as in senile pruritus or when associated with xerodermia, oily preparations are beneficial: glycerine of starch and lanolin in equal parts, or cocoa-nut oil with a little soft paraffin, are useful preparations, especially if 1 or 2 per cent. menthol or carbolic acid is added. Liq. carbonis detergens and liq. plumb. subacet. fort. aa ℥ij, and milk to ℥viij is often satisfactory. Most cases, however, get most relief from alkaline baths and lotions: for the latter liq. potass. ℥i, sp. coloniensis ℥i, aquam ad ℥viij answers well.

It is very important to see that the patient changes his undervest at night. Many patients do not do so, and this undoubtedly predisposes to pediculosis. Even, however, in cases where no pediculosis appears to be present, cases are often cured by attention to this detail.

Localised Pruritus

Certain parts of the body are liable to pruritus: these are the anus, vulva, and scrotum. Other local areas, however, may be attacked, such as the front of the ankle, lower part of the leg, thighs, back of neck and scalp.

There is a curious itchy condition, the cause of which is still obscure, which attacks the flexures of the body, axilla, elbows, groins and knees, and in severe cases the neck and face. This latter condition is very common in young children, but it may be seen, generally in a more severe form, in young adults, chiefly females.

Ætiology and Pathology.—Most of these localised cases probably start from some transitory cause, which gets better; but a vicious circle has been started, the scratching bringing on itching, and this causing scratching again. In the case of the anus, piles are a frequent cause. Vaginal discharge frequently starts a vulval pruritus, as do sugar and other irritating substances in the urine. Sweating and friction of clothes, and possibly some parasitic condition, such as dhobie itch, may start a scrotal pruritus.

For the other cases it is generally difficult to find a cause, and it is usually necessary to treat symptoms.

Symptoms.—The localised itching is often followed by marked changes in the skin from rubbing and scratching. The usual change noted is that called *lichenification*, in which the skin becomes thick and rigid, the lines of the skin deeper, and the area assumes a dull purplish colour, and on clearing up often leaves deep brown pigmentation. This is well seen in the patches in the flexures and on the limbs, but is modified in the moist parts, where it usually takes on a white sodden and swollen appearance, surrounded by a bright red inflammatory zone. The surface is often covered by numerous excoriations or blood-stained crusts. Occasionally these excoriations may become septic, and ulceration may occur. The symptoms are often so severe as to affect the patient's health by sleeplessness and worry.

Treatment.—The treatment recommended for generalised pruritus is often indicated in the localised cases, such as that directed towards obtaining sleep.

The first thing to do is to remove any local cause; *e.g.* vaginal discharges may require treatment. The bowels should be made to act freely by paraffin, saline aperients or enemata; aloes is better avoided. Irritating food, especially coffee, alcohol, curries, etc., should be interdicted. Piles may require surgical treatment, and any rectal discharge, fistula or worms should be dealt with. All the parts should be carefully washed, mild alkaline lotions or weak antiseptics being useful, and afterwards dried thoroughly and a talc or zinc oxide powder applied. Further relief may be obtained by the application of 1 per cent. ac. carbol. and camphor cream, or 5 per cent. oleinatum cocainæ (B.P.C.). If these milder measures fail, the parts may be painted with silver nitrate, grs. x, sp. æther. nit. ʒi, twice or three times a week, and a bland cream or mild alkaline lotion applied.

The most radical results, however, are obtained by X-rays. Three or four doses of ⅓ Sabouraud pastille given at weekly intervals to the affected area will nearly always remove the itching completely, and the secondary changes in the skin will disappear. For localised body pruritus, excellent results are obtained by painting the affected parts with crude coal tar, which is allowed to dry, and a talc powder applied. This method should not be used if sepsis is present. Further, much relief is often given by exposures to the ultra-violet rays of the mercury-vapour lamp.

C.—DISORDERS OF CIRCULATION

Only certain circulatory disorders have any bearing on skin diseases, if we do not include those disturbances associated with inflammation. Those which are referred to below usually come to the dermatologist on account of secondary changes produced in the skin.

ACROCYANOSIS

This is a condition, most frequently met with in young women, though by no means confined to them, characterised by persistent blueness of the extremities, including the hands and feet, the nose and the ears. Since the introduction of the short skirt, in the case of women the lower half of the legs is also frequently affected. The skin of the affected areas is distinctly colder than the surrounding skin. Patients are particularly liable to chilblains, and to certain types of eruption associated with the embolism of organisms in the peripheral capillaries, such as the tuberculides. The condition is apparently due to contraction of the arteries supplying the part. The causative factor is, however, unknown, but has been variously attributed to deficiency of blood calcium or to endocrine disturbance.

Treatment.—This consists in protecting the affected parts from extremes of heat and cold, massage, galvanic and faradic baths, medical diathermy and general light baths. Some cases improve by the internal administration of calcium salts, with or without parathyroid, or thyroid, and pituitary extracts, and on cod-liver oil.

CHRONIC VASCULAR STASIS OF THE LOWER LIMBS

This condition occurs in almost all individuals approaching middle life, and progresses with age. In individuals suffering from varicose veins it commences earlier. As a rule no special symptoms are produced, but if the skin of the lower part of the leg is damaged—and it is particularly prone to injury—it does not heal well, and there is a great tendency for a dermatitis to be set up. In some cases, however, the venous congestion causes itching, and if the skin in this region is scratched a moist dermatitis is liable to arise, which becomes septic, and healing does not readily occur. In these ways we have the well-known "eczema of the leg" produced. These cases frequently go on to ulceration, and the familiar chronic *varicose ulcer* of the leg is the result.

ROSACEA (*ACNE ROSACEA*)

Definition.—This is a chronic vascular congestion of the nose and central part of the face, resulting from dyspepsia and other internal conditions, and followed by secondary inflammatory changes in the skin.

Ætiology and Pathology.—The disease is common in both sexes, but rather more so in women. It begins usually after 30, but is occasionally

seen before that age. It is generally associated with dyspepsia, usually of the flatulent type, though in many cases there is no very obvious gastric disorder. Cases have been recorded in which complete achylia gastrica was present, or in which there was considerable diminution in the hydrochloric acid in the gastric juice. Uterine disturbance and the menopause are responsible for some cases. Alcohol and strong tea drinking are potent causes.

The mechanism of this vascular dilatation is not quite clear. It is generally assumed that some toxic substance is absorbed, and acts on the vasomotor system; but it is more probably a neurosis. The follicular lesions are the result of the congestion and of the increased sebaceous secretion which the hyperæmia causes, as well as of increased activity of the skin cocci.

Symptoms.—The early symptoms are either those of transitory flushing of the face, or the nose gradually becomes red. Examination shows the presence of dilated vessels on the alæ of the nose. Later the congestion becomes more marked and not only affects the nose but the adjoining parts of the cheeks, the chin and the centre of the forehead. The redness may be persistent or remittent; it is worse after meals. There is usually an increase in sebaceous secretion so that the skin becomes abnormally greasy. Scattered red papules now appear at the follicular openings, and often a bead of pus is seen in them, but no sebaceous plug or comedo. This is the typical "acne" rosacea. If the skin is very dry, this papular rash may be absent; but the whole affected area may become dry and scaly, especially if exposed to the weather, showing that the congestion renders the skin more susceptible to mild external irritants. In other cases, these inflammatory conditions are absent; but the vessels become very dilated, and much disfigurement results. In the most severe cases there occurs an overgrowth of skin and subcutaneous tissue which converts the nose into a lobulated tumour—*rhinophyma*. A number of cases show a persistent type of conjunctivitis, sometimes associated with a keratitis and corneal ulceration. The severity of the eye symptoms does not, however, appear to correspond with that of the skin lesions.

The patients complain of few symptoms except dyspepsia and flushing of the face; but the unsightliness of the condition brings them for relief.

Diagnosis.—The "acne" variety must be distinguished from acne vulgaris, by the limitation of the lesions on the centre of the face, by the underlying congestion and vascular dilatation, and by the absence of the comedo. The age is also a help, as acne vulgaris is commonest between 15 to 30. It must be remembered that sometimes the two conditions occur together. In dry "eczemas" of the face, the possibility of an underlying rosacea should not be overlooked.

Treatment.—The cause must first be dealt with. A fractional test meal will give useful information as to digestive function. Easily digested food, with a minimum of carbohydrates and green vegetables, should be ordered, little or no fluid should be taken with meals, and alcohol and strong infusions forbidden. Sod. bicarb. grs. xv to xx with a bitter three times a day after food is of great help. Dilute hydrochloric acid, ℥ xx thrice daily, may be given in achlorhydric cases. The non-dyspeptic cases often do

well on bromides and belladonna. Ichthyol grs. iij to v (in capsules), or menthol, gr. i, t.d.s., is often useful. The bowels should be regulated.

Local treatment should be sedative in the main. In the acneiform cases, calamine lotion with 1 or 2 per cent. sulphur applied two or three times a day should suffice. In the dryer forms, ceratum galeni (B.P.C.) should be applied night and morning. When the veins are much dilated and unpleasantly prominent they may be destroyed by electrolysis or a fine pointed cautery. In the cases with much hypertrophy it may be advisable to remove some of the overgrown tissue with a knife. This can be done without leaving much scarring.

Of the other disorders of circulation which occasionally come under the notice of the dermatologist may be mentioned *Raynaud's disease* and *erythromelalgia*; but these are dealt with in other sections of this work (see pp. 974, 979).

A. M. H. GRAY.

III. INFLAMMATIONS OF THE SKIN

Having dealt with some of those disorders which predispose to inflammatory changes, it is now possible to consider the Inflammatory Diseases of the Skin. These may be divided roughly into two great classes: (1) The superficial inflammatory dermatoses, due mainly to irritants applied externally; and (2) the deep inflammatory dermatoses, due mainly to toxic substances circulating in the blood. This division is not quite so definite as one might suppose, but it is a good basis on which to work. There are, however, a certain number of inflammatory dermatoses which cannot easily be placed in either group; these will have to be considered separately.

A.—THE SUPERFICIAL INFLAMMATORY DERMATOSES

These are produced as a rule by the application of external irritants to the skin, but there are a certain number of cases in which the external irritant cannot be traced, and in which the general symptoms suggest an internal toxin. External irritants may also cause deep-seated inflammatory dermatoses, but only when they are introduced through the epidermis; thus, the puncture of the bristles of the nettle may produce an urticaria, the infection of a crack an erysipelas, a syphilitic chancre or a patch of lupus vulgaris. Nevertheless, the general rule is that a superficially applied irritant produces a superficial dermatosis.

External irritants may be classified into the following groups: (*a*) chemical; (*b*) heat and cold; (*c*) actinic; (*d*) bacterial; and (*e*) mechanical. This order is chosen because the clinical types can best be explained in this way. The reaction of the skin to these different irritants is generally of the catarrhal type, which is known as "eczema." This term has, therefore, been used freely to label lesions, but, as will be explained later, is used more rigidly in describing cases.

Ætiology and Pathology.—Chemical irritants applied to the skin may cause immediate, or primary, local necrosis, but only those reactions of the skin to irritants which do not cause local death of the tissues are dealt with in this section. Secondary local necrosis does, however, sometimes result from such reactions, as in the case of chronic leg ulcer following a varicose "eczema."

Chemical irritants applied to the skin produce different forms of reaction according to the intensity of the irritant. The reactions also vary considerably in degree according to the sensitiveness or susceptibility of the subject to varying irritants. If an intense irritant, such as a mustard plaster, is applied to the skin, the whole area to which it is applied becomes intensely red, owing to congestion of the papillary vessels; the epidermis becomes œdematous, and if the action is prolonged, small vesicles or even large bullæ develop under the horny layer. Lesions of this type are spoken of as *erythematous eczema*.

If a milder irritant is applied it may only attack the follicles, which are the most vulnerable part of the protective mechanism of the skin. In this case small follicular papules are produced, which in the more acute cases are surmounted by a small vesicle. These papules tend to group together on an erythematous base forming circumscribed patches. These are the *papular* and *vesiculo-papular eczemas*. With some irritants—croton oil, for example—follicular pustulation may also occur. The pus in this case is sterile, and the lesions dry up when the irritant is removed. This constitutes *pustular eczema*.

Lastly, there is a type in which the primary lesion appears to be produced by cracking of the horny layer. It is seen, for instance, on the face in children who dribble, and on the hands of those who use soap and water to excess. Under these conditions the horny layer becomes sodden with water, and this takes place more readily if alkalis, such as soap, are present. Then the skin dries quickly, especially when exposed to the wind, hot sun or a fire, and the horny cells tend to separate from one another, exposing the delicate mucous layer. In this type scaling first appears, followed rapidly by erythema. This is one form of *squamous* or *erythemato-squamous eczema*.

All these primary reactions are liable to undergo secondary changes. Thus, fluid may exude from the surface from rupture of the vesicles and bullæ, producing a weeping eruption (*eczema rubrum*). Or, in the drier types, scaling may occur from irregular formation of the horny layer (this is the secondary type of *squamous eczema*). The moist cases may become infected with pus organisms, and the exudate may dry in the form of crusts (*eczema crustosum*). Thickening of the horny layer may occur, especially when the palms and soles are attacked, and this leads to cracking in the deeper folds of the skin (*eczema rimosum*). Occasionally in the lower extremities lymphatic obstruction and an overgrowth of the epidermis is produced (*eczema verrucosum*), or even elephantiasis may occur.

In order to classify these eczematous lesions a little more usefully, it is advisable not to speak of a superficial inflammation produced by a known external irritant as an "eczema," but to call it a "dermatitis," qualified by the name of the irritant which causes it, as, for example, "formalin dermatitis." To use the word dermatitis without qualification is meaningless, and not so informing as to use the word "eczema."

For a large group of cases in which the external irritant cannot be traced, or in which it is one of those mild irritants to which every one is exposed, such as the air, or the friction of clothes, and also for certain cases in which the lesions are disseminated over the body, the term "eczema" is still used for want of further ætiological knowledge.

DERMATITIS FROM CHEMICAL IRRITANTS

These irritants are so numerous that it is impossible in a work such as this to attempt to give a complete description of them. They may, however, roughly be divided into the following classes: (1) Due to animal poisons; (2) due to plants; (3) due to chemical agents used in medicine; (4) due to chemical agents used in trades; and (5) due to decomposition of body secretions.

1. Superficial dermatitis due to ANIMAL POISONS is rare, most of the reactions being of the deep type, as they are injected by the stings and bites of insects. Some forms of caterpillar, *e.g.* the woolly-bear, however, occasionally produce an eczematous reaction.

2. PLANTS are probably responsible for more cases than are diagnosed. The *Rhus toxicodendron* or poison ivy produces the most marked symptoms, but this plant is rarely found in this country. The symptoms are an acute erythematous dermatitis, usually with much bullous formation, attacking chiefly the exposed parts, face and hands, but also affecting the moist parts of the body, the genitals, axillæ and flexures. Japanese lacquer, which is made from one of the *Rhus* family, may also give rise to a dermatitis in susceptible individuals. The commonest plant in this country to produce a dermatitis is the *Primula obconica*, but other species of the primula may attack susceptible individuals. The lesions are similar to those mentioned above, but much less severe. Among other plants which may produce a dermatitis are *Daphne mezereon*, oleander, rue, parsnip, daffodil, and chrysanthemum, while handling certain woods, such as teak, satin-wood and ebony, may produce similar effects. In all doubtful cases of "eczema" it is well to look for the presence of one of these irritating plants.

3. Of the CHEMICAL AGENTS USED IN MEDICINE some, such as cantharides, mustard, croton oil, chrysarobin and iodine, are used to produce varying degrees of dermatitis. Others may produce it unintentionally, among these being boric acid, iodoform, sulphur, carbolic acid and perchloride of mercury. Fromalin, much used in pathological laboratories, produces a damaging effect on the horny layer, followed by a squamous and fissuring dermatitis. Sulphur, used in the treatment of scabies, is a common cause of an erythemato-squamous dermatitis on the flexor aspects of the limbs, on the abdomen and back, and is associated with intense irritation. Further, surgeons, students and nurses are apt to develop a dermatitis of the hands from the use of various antiseptics.

4. TRADE DERMATITIS.—This is very common and the lesions produced are often specific. They are very numerous, for a description of the majority of which special works should be consulted. Among the more common are the soap and water dermatitis seen in washerwomen and in those engaged in household duties. This may take the form of a dry fissuring dermatitis on the

back of the hands and forearms, or a papulo-vesicular dermatitis in the same situation. Its ætiology has already been discussed. Grocers and bakers are subject to a vesicular dermatitis of the hands, from handling sugar and dough: the so-called grocer's and baker's itch. French polishers, photographers, leather workers, etc., are frequently subject to dermatitis from articles used in their trades. These affections are usually of the papulo-vesicular type.

An acute erythematous dermatitis affecting the exposed parts of the body has been seen in those engaged in making explosives, while a more acute form caused by "mustard gas" will be familiar to those who served in France during the late war. The lesions in this case closely resemble those produced by poison ivy, the same distribution being observed.

Tar and oil acne.—Tar and various oils commonly give rise to a folliculitis, with a central keratotic plug like a comedo, associated with perifollicular inflammatory papules and pustules, and found on those parts of the body which come into contact with the irritants.

Grouped comedones.—In infants who have been rubbed with camphorated oil an eruption often occurs about the chest, neck and chin. The lesions are small black follicular plugs, closely placed, and are often associated with troublesome inflammatory complications.

Hair dyes.—An acute dermatitis of the face, particularly affecting the eyelids, is seen in persons who use certain hair dyes, especially those containing paraphenylene diamine.

Fur dyes.—Certain cheap furs, chiefly rabbit skin dyed with some of the phenylene diamine group of dyes, are responsible for a dermatitis involving the neck and chin. There is often a considerable latent period between the first wearing of the fur and the appearance of the eruption.

5. INTERTRIGO.—Decomposition of sweat and other body discharges may set up a dermatitis, usually of the erythematous type. This is best seen in fat women who are not too cleanly in their habits, the lesions being found under the breasts, in the folds of the abdomen and groins, and on the genitalia. A similar condition is often seen about the napkin region of infants. An erythema first appears, the horny layer of the skin becomes sodden and is removed by friction of the parts, and a raw oozing surface results.

Jacquet's erythema infantum.—In some children an eruption consisting of pea-sized papules occurs about the prominences of the buttocks, thighs and abdomen under the napkin; the depths of the folds escape. Occasionally these lesions spread beyond the napkin area and frequently they are capped by a vesicle or crust. It is not clear whether this is a bacterial infection or due simply to chemical irritation, but it has to be carefully distinguished from congenital syphilis. The condition is spoken of as "infantile erythema of Jacquet."

DERMATITIS FROM HEAT AND COLD

The erythema, followed often by blistering, as a result of a burn or scald, is well known. Similar but usually milder and more transient erythema may follow exposure to cold. The application of carbon-dioxide snow to the skin for purposes of treatment is a good example of the effects of extreme cold.

Erythema ab igne.—Frequent exposure to the fire produces a curious reticular erythema, followed by pigmentation.

Erythema pernio (Chilblains).—Chilblains are frequently seen after exposure to cold. They occur chiefly in children and old people, and particularly in those whose peripheral circulation is sluggish. The lesions are salmon-pink to purplish, ill-defined swellings, which occur chiefly on the fingers and toes, and which itch intensely. The lesions may ulcerate and produce extremely indolent sores. When the helices of the ears are attacked, as they sometimes are in old people, considerable loss of tissue may result. The treatment for this condition is the same as for "Acrocyanosis" (see p. 1280).

Trench foot.—A somewhat analogous condition was met with in the trenches in France during the Great War, in men who had to stand for long periods in the wet and cold. The feet became swollen and painful, the skin was reddened and blistering, and even necrosis occurred. The condition took a long time to subside.

DERMATITIS FROM ACTINIC RAYS

Erythema solare.—Light, whether from the direct rays of the sun or from artificial sources, produces marked inflammatory changes in the skin. The sun's rays produce first a transient erythema which subsides, leaving pigmentation; but in other cases a more persistent erythematous dermatitis occurs, associated with œdema and thickening of the skin and scaling or blistering: this is the so-called "erythema solare."

Tropical skin.—Exposure to tropical sun for many years may lead to atrophy of the skin with pigmentation and warty formation.

Prurigo æstivale.—A rather rare condition occurs in some children in which it appears that the sun's rays are an exciting cause. It consists of the appearance on the face and hands of small very itchy papules which appear during the summer and disappear in the winter. They are not always limited to exposed areas, but these regions are always the most severely attacked. The condition is a very persistent one, and any treatment, except protection from the sun's rays, has little or no effect.

Hydroa æstivale.—This is a much rarer condition than the preceding one and occurs in children suffering from hæmatoporphyria congenita, though not in these cases only. The lesions are blisters, which appear on the parts exposed to the sun's rays, and scars are left when the blisters disappear.

X-ray and radium dermatitis.—X-rays produce much more persistent forms of dermatitis than the sun's rays. If a slight overdose of X-rays is given, an erythema develops in the course of 1 to 3 weeks, which then gradually subsides. If a larger dose is given, the erythema may come on earlier and blistering may occur, which takes weeks to get well. Finally, in the still more intense burns, necrosis of the skin, with the formation of an extremely indolent ulcer, develops. In other cases, atrophy of the skin, with telangiectases and pigmentation, occurs, which may, after many years, break down into an indolent and painful ulcer, and this may in turn become epitheliomatous.

Radium may produce a similar series of changes.

ECZEMA

A description of the more specialised superficial dermatosis produced by mechanical and bacterial irritants will be left until those eruptions for which we reserve the term "eczema" have been discussed. The diagnosis and treatment of the dermatoses dealt with in the preceding paragraphs, together with that of eczema, will be considered at the end of this section. The reason for this is because it is probable that the lesions of eczema are produced, in part at least, by chemical, thermal and actinic irritants, and that pathogenic bacteria do not play an active part. Mechanical irritants do play a secondary rôle, and irritating chemical substances produced by saprophytic organisms are also concerned, but the latter are really chemical and not bacterial irritants.

Under the term "eczema" are included—(1) Certain cases of dermatitis, probably due to chemical irritants, the identity or nature of which has not been discovered. (2) Cases in which individuals are so susceptible to irritants that they react to mild stimuli that would not ordinarily be classed as irritants, such as a slight exposure to the sun, a cold wind, the warmth of a fire, or even to the friction of the clothes. (3) Cases which, having commenced with a simple dermatitis caused by an irritant, fail to get well on its removal and the patient becomes hypersensitive, so that fresh patches are produced, either in the neighbourhood of the original lesion or in other parts of the body. In fact, apart from class (1) another factor is present of which little or nothing is known, and which is spoken of as "susceptibility."

Ætiology.—Many views are held as to the causes of this "susceptibility." First there is the possibility of an inherited susceptibility or diathesis. This may be nothing more than some congenital peculiarity of the skin of which a recognisable form is xerodermia, already discussed. Abnormalities of secretion and of circulation alter the resisting power of the skin. So, probably, do certain toxic states, such as gout and rheumatism; deficient elimination, as occurring in nephritis; chronic infections, as in pyorrhœa and tonsillar sepsis; digestive disturbances and alcoholism. Disturbances of the nervous system, such as teething in infants, uterine troubles and the neuroses, may play a part.

More important, however, is the possible absorption of toxins from a local focus of dermatitis producing a hypersensitiveness or an anaphylactic condition, so that a violent local reaction occurs in the skin if the secretions from the original focus are brought in contact with other areas.

Pathology.—In eczema and superficial dermatitis the anatomical changes are most marked in the epidermis and papillary layers. There is congestion of the papillary vessels, with œdema of the mucous layer, and wandering cells may be present throughout the epidermis. Ballooning of the cell of the mucous layer occurs and minute vesicles appear. The horny layer is improperly formed, the cells retaining their protoplasm and nuclei, with the result that they shrink up on reaching the surface, from evaporation of water in the protoplasm, and so scaling is produced. This pathological condition is called *parakeratosis*.

Symptoms.—The general type of lesion found in eczema has already been described (p. 1273). It now remains to describe some of the common

types of case met with, and this is conveniently done by referring to the regions of the body affected.

Face and scalp.—Eczema of the face of a very definite type is frequently met with in infants. It usually occurs in the first year of life. It begins with a red irritable spot on one or both cheeks, and spreads fairly rapidly, so as to involve the whole face and often the scalp. In the more severe cases lesions are found on other parts of the body. The initial lesion is a red swollen patch or a group of follicular papules which later develop into an eczema of a scaly or weeping type. Itching is always intense but paroxysmal, the child rubbing the parts violently with the hands or against the pillow. In the moist variety septic infection may occur and thick yellow-green crusts form on the surface. Infantile eczema is often very resistant to treatment and may last from six months to a year, even under careful treatment; it usually dies out, however, during the second year of life.

In slightly older children a generalised eczematous condition of similar distribution, but of a septic type, is seen in association with nasal and aural discharge. Small follicular pustules are often present, and blepharitis is common. This is really an eczematised impetigo—that is, a direct bacterial infection, and not of the same nature as the foregoing, which is non-bacterial in origin.

Another common form of eczema met with on the face in children consists of sharply circumscribed scaly patches, always dry and with a surface like crêpe. These patches occur in the region of the mouth and nose, and can generally be traced to dribbling, running at the nose, the habit of licking the lip or smearing the face with a wet finger, or to the use of strong soaps. Some cases, however, are of streptococcal origin. It is produced by rapid drying of a sodden horny layer as described above, and goes by the name of "pityriasis simplex."

In adult life, especially in oldish people, an acute erythematous eczema of the face is apt to develop. It usually appears quite suddenly. The whole face becomes acutely red and swollen; the œdema of the eyelids often being so great as completely to close the eyes. In severe cases blistering may occur; but usually the acute œdema subsides and scaling ensues. This stage may either clear up completely or a chronic eczema characterised by redness, thickening of the skin, and scaling may follow. These acute cases are often associated with a similar condition of the hands and forearms, in fact the parts exposed to the air are most likely to be affected, and this condition is particularly prone to occur in cold weather. In some cases also a history can be obtained of a coexisting septic dermatitis elsewhere, frequently on the leg, and in these cases it is possible that some absorption from this has rendered the patient susceptible. Once a patient has had an attack he is always liable to recurrences, and great care must be taken to avoid exposure to extremes of temperature. Cases of this type may be limited to the eyelids, and a troublesome and chronic condition develop.

Occasionally the papulo-vesicular type of eczema is met with on the face; it is not infrequent on the forehead, generally in men under the hat-band, and often occurs in those who perspire freely.

True eczema of the scalp, except by extension from the face, is rare, most forms of dermatitis in this region being of bacterial origin. This also applies to the ears.

Upper limbs.—The hands and forearms also being exposed to the weather, are subject to eczemas of the same type. The erythematous type frequently complicates that of the face, and runs a similar course.

Papulo-vesicular eczema of the backs of the hands and the forearms is very frequent. It is generally produced by external irritants, whose nature can often not be determined. The lesions usually consist of rather sharply circumscribed red patches covered with numerous vesicles which rupture and leave oozing, pitted raw areas of the size of a pin's head. Sometimes the whole patch is considerably swollen with œdema. There is a great tendency in this type for fresh patches to appear in the neighbourhood, and even on distant parts.

A chronic form is sometimes met with in the palm, chiefly along the deeper folds. It begins as an ill-defined red patch, and subsequently marked thickening of the horny layer takes place. Owing to its inelastic nature the skin cracks and deep fissures are produced, which are very painful and very chronic. This type is spoken of as *eczema rimosum*.

An acute vesicular form is also seen on the hands, chiefly on the palms and sides of the fingers, especially in people whose hands perspire freely. Owing to the thickness of the horny layer on the palm, these vesicles are very deep-seated, and appear like sago-grains in the skin. At first they do not rupture, but run together and form large blebs which can often be seen to be septic. The attacks usually come on quite suddenly, and the feet are often attacked simultaneously; they occur chiefly in the hot weather when sweating is profuse. This condition is called *dysidrosis* or *cheiropompholyx*, and was originally thought to be due to obstruction of the sweat ducts, with the formation of retention cysts. This is now known not to be the case, and that the vesicles are produced by an inflammatory exudate. It is probable that the skin is made sodden by excessive sweating, and this renders it susceptible to the attack of some external irritant. A similar condition has been observed from handling exploded aeroplane bombs, which shows that the condition may be produced by an external irritant.

A chronic erythematous eczema sometimes develops in the flexures of the limbs—particularly the axilla. This has been thought by some to be seborrhœic in origin, and though this has not been proved it is probably of streptococcal origin.

Trunk.—Eczema on the trunk is nearly always secondary to patches starting elsewhere, if seborrhœic dermatitis and dermatitis due to irritants such as sulphur are excluded. There is, however, one type to which reference should be made. In people who sweat much, and especially in infants, an eruption of small vesicles, each surrounded by an inflammatory zone, sometimes appears on the trunk. The lesions appear to be formed around the sweat duct openings. This condition is called *miliaria rubra*, or *prickly heat*, and is probably of the same nature as the vesicular eczema of the hands, the mouths of the sweat follicles being softened by the sweat and some irritant, possibly a bacterial irritant, causing an inflammation.

The nipples are sometimes the seat of an eczema; but this is nearly always of external origin, either from careless treatment during suckling, or from injury from stays.

Genitals and anus.—The moist areas of the genital and anal regions are liable to be attacked. These are not infrequently secondary to a pruritus,

a traumatic dermatitis being produced. On the anus and vulva, thickening of the skin, called *lichenification*, is most common, and has been already mentioned. The scrotum is occasionally the seat of an erythematous dermatitis very distressing to the patient, and very intractable.

Lower limbs.—A special form of eczema is very common on the lower part of the legs. It is associated with chronic vascular stasis. It is generally met with in middle-aged or old people, but is frequently seen in younger persons who suffer from varicose veins, hence its designation *varicose eczema*. It begins either from an infected abrasion which does not heal, or from scratching an itchy leg. Once started the inflammation spreads, as the condition of the skin does not favour resolution. The extension is often due to ill-devised dressings which further lower the resisting power of the skin and favour the retention of discharges. An extensive weeping or crusted dermatitis, therefore, follows, and this is rarely confined to the leg on which it starts, the other soon becoming infected, probably from contact in bed. Owing to the poorly nourished condition of the skin, ulceration is very prone to occur, and thus the chronic varicose ulcer, so familiar to the out-patient department of any hospital, develops. These cases are particularly prone to spread to other parts of the body by the mechanism referred to above.

The feet are subject to the same type of acute vesicular eczema as the hands.

The nails.—The matrix of the nails may be involved in an eczematous process affecting the hands and feet, and may either show a marked irregularity of growth, with roughening of the surface of the nail, or the nail-plate may be pushed up from the nail-bed by parakeratosis beneath.

Diagnosis.—Keeping in view the types of eczema already described, the diagnosis of the lesions should present little difficulty; to determine the cause, however, is not so easy. Efforts must, however, first be directed to try and discover an irritant, and if it cannot be found, or if it appears to be one of those mild irritants which do not normally produce a skin reaction, the cause of the patient's susceptibility must be investigated. These causes have already been discussed and require no repetition. As to the nature of the irritant, some help is obtained by the type of reaction and by its distribution; for instance, in an acute eczema affecting the face and hands, exposure to the wind or sun or to some irritant, as the primula, is suggested. With trades certain parts of the body tend to be especially exposed. Lesions affecting the exposed parts and the moist parts of the body suggest some strong volatile irritant, such as rhus poisoning.

Acute erythematous eczema has occasionally been mistaken for erysipelas; but the absence of a sharp line of demarcation, a slowly spreading edge and high fever, should render the diagnosis simple. Acute giant urticaria of the face is unassociated with redness or vesication. The lesions of erythema multiforme are smaller, more sharply defined, and deeper-seated.

The squamous forms have to be distinguished from seborrhœic dermatitis; this is often difficult, but the characteristic features of this latter disease will be considered later.

Ringworm of the glabrous skin tends to occur in circumscribed circular patches or rings, and the fungus can easily be found under the microscope. A special form occurring in the groins is characterised by its bilateral symmetry, its sharp spreading edge, and the presence of fungus in the scales.

Pityriasis rosea in extreme forms may lead to confusion, but the acute generalised onset, and the presence of some of the typical oval lesions, with a collarette of scales attached about a millimetre from the free edge, will usually settle the diagnosis.

Psoriasis is rarely confused, owing to its characteristic distribution on the extensor aspects of the limbs, its usual sharply defined patches, and the dry silvery scaling, seen even in the smallest papules. A few cases, however, of isolated patches made up of small aggregated psoriasis papules may be very difficult to distinguish from localised patches of squamous eczema.

The moist forms have to be distinguished from impetigo contagiosa. In this disease, however, the vesicles are larger and rarely seen, while the presence of isolated crusted lesions of varying size, with little or no inflammatory zone surrounding them, is characteristic.

The vesicular eczemas of the hands and feet may be caused by a ringworm fungus. This should always be suspected in the chronic spreading cases, and must also be looked for in the acute cases. The diagnosis is made by finding the mycelium of the fungus in the walls of the vesicles—a task not always easy. A curious type of fissuring eczema between the toes is almost invariably caused by a ringworm fungus.

The eczemas found in the course of animal parasitic affections, such as pediculosis and scabies, will be dealt with later.

Prognosis.—This is always uncertain. Most cases of dermatitis due to an external irritant applied on a single occasion get well readily when the irritant is removed. Those caused by the repeated application of the same irritant, as in trade dermatitis, are apt to be more persistent, while recurrent attacks may be extremely troublesome. Once the skin has been damaged subsequent attacks are more common and more resistant to treatment.

Those cases in which some underlying susceptibility exists are always apt to be resistant to treatment.

Treatment.—*Prophylactic.*—This depends on the search for the irritant, and its removal. The latter is not always possible in case of trades; but much can be done to insist on scrupulous cleanliness. It must not, however, be forgotten that the use of strong soaps, soda and turpentine to remove traces of a man's occupation are often the cause of the dermatitis. In cases where these substances have to be used, by washerwomen, etc., the use of a cold cream or some glycerine preparation to replace the grease of the skin will prevent a good deal of trouble.

Eczematous subjects should protect themselves from the sun, cold wind, and heat of the fire.

Local treatment.—This applies equally to the cases of dermatitis due to known irritants, and to those we have labelled "eczema." The main treatment in the early stages, after removing the cause, is to protect the skin and to provide soothing application to allay the inflammation. The use of soap and water will generally have to be forbidden.

In the early and acute stages lotions are most suitable, grease in any form being badly tolerated. Calamine lotion can be applied frequently and allowed to dry on the skin, the powder it contains forming a protective dressing over the surface; it is best used in the acute erythematous and papulo-vesicular form in which there is not much oozing. In the weeping cases, lead lotion applied on linen and kept moist is more suitable; it forms

an insoluble albuminate of lead which acts as a protective layer. If, however, much sepsis is present, it is well first to use a mild antiseptic, baths of 1 in 4000 permanganate of potash, or lotions of 1 in 4000 perchloride of mercury, or 1 in 1000 acriflavine being very suitable. If these lotions dry the skin too much 3 per cent. glycerine may be added.

As soon as the acute stage has subsided oily preparations are better. It is well to begin with one containing a considerable percentage of water, the lin. calaminæ (B.P.C.) or linimentum calcis being the type. Ichthyol, 5 per cent., may with advantage be added in most cases, and if the itching is severe 1 per cent. to 2 per cent. ac. carbolic. Later the water can be given up and either pure oily preparations as lin. calaminæ co. (B.P.C.), or ointments used. These latter are not satisfactory if there is much discharge; but this can be checked by painting the surface once every second or third day with 2 per cent. to 3 per cent. silver nitrate in sp. æther. nit.

Once the chronic stage has been reached pastes are the best means of applying medicaments. Zinc paste consists of zinc oxide, 25; pulv. amyl., 25; paraff. moll., 50 parts, and makes a firm dressing when spread on linen or lint. It not only affords good protection, but allows a certain amount of absorption to take place.

If the chronic cases do not respond to treatment stimulating preparations are required, and can be incorporated in the zinc paste. Ac. pyrogallic., 1 per cent. to 2 per cent.; coal tar, 1 per cent. to 5 per cent.; or oil of cade, 5 per cent. to 10 per cent., are useful, and where there is thickening of the horny layer 1 per cent. to 3 per cent. ac. salicylic. should be added. Chronic dry cases, and even moist ones, if not septic, often do well if painted with crude coal tar which is allowed to dry on. X-rays, ⅓rd of a Sabouraud pastille dose, repeated 3 or 4 times at weekly intervals, are extremely valuable in resistant cases, and cause rapid disappearance of the lesions.

In septic cases the crusts should be removed by warm oil or starch poultices, and a weak mercurial or flavine lotion first applied, and afterwards a zinc paste containing 3 per cent. ammoniated or yellow oxide of mercury.

The gelatine paste of Unna is very useful in the chronic eczemas of the leg, after any sepsis has been removed by antiseptic dressings.

For facial eczema of infants, 3 per cent. crude coal tar in zinc paste, spread on a mask and continuously applied, is of great value; or the special tar paste devised by White of Boston, U.S.A., may be employed.

General treatment.—The patient must be examined for any conditions liable to lower his general resistance. Septic foci, such as pyorrhœa, or tonsillar sepsis, should be removed. In the more acute cases it is advisable to put the patient on milk diet, and to keep him in bed. In the less severe cases a light diet, the avoidance of alcohol, strong coffee and tea, hot and highly seasoned dishes, shell-fish, salted meats and cheese, should be prescribed. Constipation should be dealt with, while intestinal fermentation may be met by the exhibition of salol or salicylate of bismuth, grs. x to xv; ichthyol, ℥ij to v; or menthol, gr. i in capsules three times a day. In gouty subjects alkaline waters and colchicum are indicated.

In the infantile facial cases, the children are usually overfed and some reduction in diet is often required.

In debilitated cases cod-liver oil is of value, while arsenic and iron are

helpful when anæmia is present. In acute cases vin. antimoniale, ℥ v, t.d.s., has been much recommended.

Sleep is often disturbed, and will require sedative drugs to allay itching, and in the worst cases hypnotics: bromides are useful for the former, while for the latter sulphonal, trional and chloral hydrate are among the best. Morphine should be avoided, owing to the prolonged nature of the cases and to its tendency to increase itching.

DERMATITIS FROM MECHANICAL IRRITANTS

Acute dermatitis due to mechanical irritation is best seen in the redness and blisters found on the hands after rowing or on the seat after riding, in those unused to these exercises. The chronic form shows itself as a thickening of the horny layer as seen in the callosities on the hands and feet. The form of dermatitis of mechanical origin, however, which requires special attention here is that produced by the fingers and finger-nails.

Scratch Eruption

Constant friction applied to a localised area produces changes in the skin of a characteristic type. The skin becomes thickened and loses its elasticity; the folds and lines are much exaggerated, and the angular areas of skin intervening become prominent and shiny, resembling the papules of lichen planus; the colour may be the same as the normal skin, or red, but generally purplish, and sometimes the surface is finely scaly or warty. In old-standing cases much brown pigmentation may be present. This condition is spoken of as "*lichenification*," and is seen at its best in localised pruritus, already described on p. 1278.

When general irritation is present the scratch lesions are more diffuse. The finger passing over the skin causes contraction of the arrectores pili muscles and the follicles are erected; the next sweep of the finger-nail scrapes the top off the erected follicle and a spot of blood appears, which dries as a blood-stained crust. In bad cases, linear excoriations are produced, consisting of a line of blood-stained crusts. If sepsis supervenes, typical impetigo contagiosa lesions are produced, and these are particularly common in children; in other cases "eczematisation" occurs—that is, the inflamed papules group together to form a patch or patches, which may be dry and scaly or may weep. Patches of lichenification may also be found mixed with other scratch lesions, while in the most severe cases, ecthymatous lesions, boils and linear ulcers may occur.

Callosities and Corns

These are localised overgrowths of the horny layer, the result of local mechanical irritation. A corn differs from a callosity in that the central portion shows a much greater degree of overgrowth than the periphery, and forms an inverted horny cone which presses on the sensitive dermis, producing much pain. A corn may develop from a callosity, but frequently arises independently.

Symptoms.—*Callosities* are seen as a painless thickening of the horny layer over the ball of the foot and on the palms of the hands, in the latter situation especially in manual workers. They may also occur in other situations.

Corns may be of two kinds—(1) the hard, and (2) the soft. The former are painful, horny elevations, chiefly seen on the feet, and especially in people who wear badly fitting boots. The common sites are on the dorsal surface of the little toes and on the plantar surface of the great toe and over the head of the first metatarsal bone. If the surface layers are removed with a razor a central "core," often stained black or dark brown from hæmorrhage, will be seen.

Soft corns are found on the lateral aspects of the toes in the interdigital spaces. They are usually lentil-sized raised swellings, covered with sodden epidermis and intensely painful. When this superficial epidermis is removed the horny plug can be demonstrated. It is well to remember that soft corns are frequently found in association with interdigital ringworm.

Treatment.—Callosities require no treatment. The principal point in the treatment of corns is to remove injurious pressure; this can be done firstly by fitting suitable boots, and secondly by taking pressure off the corn by wearing a ring of spongiopiline around it. The surface horny layer should be pared down with a sharp knife or razor and 10 per cent. salicylic acid plaster applied or salicylic-acid collodion painted on, the softened horny layer being removed daily. Soft corns are treated by the application of 10 per cent. salicylic collodion, followed by bandaging the affected toe to prevent friction with its neighbours. Frequent washing of the feet is necessary, and the interdigital spaces should be kept dry by powdering freely with talc powder, to which 3 per cent. salicylic acid may be added if sweating is a marked feature.

DERMATITIS ARTEFACTA

This is the name given to self-inflicted lesions of the skin. These are usually found in hysterical individuals, who produce them in order to induce sympathy, or in persons who are endeavouring to exact compensation or to avoid some unpleasant duty.

Symptoms.—The lesions are produced by various means, such as friction the application of strong acids, or alkalis, or of blistering fluid, by heat or by the aid of some sharp instrument. All stages from simple erythema to actual destruction of the skin may occur. They may be single or multiple, but are found on parts of the body easily accessible to the hands, and especially to the right hand (in left-handed people to the left hand). The lesions are very characteristic, especially those in which a liquid agent has been used. They have very sharp edges and the outline is angular, unlike that seen in any ordinary skin eruption; and not infrequently irregular patches near the main lesions have the appearance of having been produced by a spilt liquid. In addition, it may be noted that in the case of the malingerer the artefact may simply consist of keeping open an already existing lesion.

In hysterical cases anæsthesia of the palate has been frequently noted.

Treatment.—For effective cure the patient must be kept under observation, and caught in the act of producing the lesions. This may put a stop

to further activities. Otherwise, occlusive dressing and mental treatment are required.

DERMATITIS FROM BACTERIAL IRRITANTS

Many different organisms are capable of producing dermatitis of external origin, and the eruptions produced are usually characteristic of the organism causing them. These will be described under the organisms concerned.

STREPTOCOCCAL INFECTIONS

The streptococcus tends to produce a serous exudate into the skin. If it is introduced into the dermis through a crack or puncture, a serous and cellular exudate is produced, which is known as *erysipelas*. If the attack is more superficial, the effusion takes place under the horny layer and blisters are produced. The most common of these superficial infections is Impetigo contagiosa.

Impetigo Contagiosa

Symptoms.—This is an affection chiefly seen in children. It affects mainly the exposed parts, such as the face and hands. The initial lesion is a small pea-sized clear vesicle, which, owing to its superficial position between the horny and mucous layers, has an extremely thin wall and ruptures very easily. Before rupture, however, the fluid often becomes turbid, and if cultured in this condition contains both streptococci and staphylococci. If cultured, however, in the very early stages, pure growths of streptococci may be obtained. Once ruptured, fluid exudes freely from the base of the blister and dries as a crust. The crusts vary in thickness and character according to the amount of secondary infection, being thin and amber-coloured if little secondary infection is present, but thick and greenish if it is considerable. Usually the lesions are numerous; they are asymmetrical and obviously spread by local inoculation.

When the lesions occur in folds, such as at the angles of the mouth or nose and behind the ears, a troublesome fissure is likely to form and generally crusting is absent, the fissure being surrounded by a moist, sodden, red area.

The disease is very contagious and children inoculate one another freely, any slight abrasion being sufficient to allow the entrance of the infecting organism. One particularly common cause is pediculosis capitis, and in this case the scalp is usually first affected. In all cases of impetigo of the scalp or back of the neck, search should be made for pediculi.

Occasionally the blisters do not rupture early, but spread centrifugally, flattening down in the centre as they progress, and leaving a ring-like bullous margin (*impetigo circinata*). In other cases a large number of bullous lesions appear very rapidly, with little or no crust formation (*impetigo bullosa*).

Any of these varieties may occur in adults, but the crusted form has generally smaller crusts than in children. One of the most frequent areas to be affected in adults is the beard region, and impetigo contagiosa is one of the forms of so-called "barber's rash."

Diagnosis.—This is usually easy. The presence of scattered crusts, with little or no surrounding erythema, and the occasional small, very thin-walled blister, and an asymmetrical distribution chiefly on the exposed parts, is unlike any other condition.

Treatment.—In most cases the treatment is easy. The crusts should be removed by bathing in warm water or by warm olive-oil compresses, or in bad cases by starch poultices, and the raw surface covered with 2·5 per cent. ammoniated mercury ointment. In the more resistant cases, it is advisable to incorporate the ammoniated mercury in Lassar's paste and spread this on lint and tie it on. The acutely spreading bullous form is best treated in the first instance by pricking the blisters and fomenting with 1 in 1000 acriflavine lotion. In very resistant cases, injections of mixed strepto- and staphylococcal vaccine have proved useful, but are rarely required.

Pemphigus Neonatorum

This is a form of bullous impetigo seen in newly-born infants and is characterised by the presence of varying-sized blisters on the skin.

Ætiology and Pathology.—Pemphigus neonatorum has precisely the same cause as impetigo contagiosa, but produces its characteristic features on account of the ease with which the horny layer separates from the underlying mucous layer in small infants. Infection is usually conveyed on the fingers of the mother or nurse. Pure cultures of streptoccoci can often be obtained from the bullæ in their early stages, though in some cases the *Staphylococcus aureus* appears to be the causative agent.

Symptoms.—The eruption usually appears in the first few days of life. A clear blister appears, which rapidly increases in size, and others soon occur in the neighbourhood. There is little or no tendency to crust formation, though the blisters frequently rupture, the raw surface being protected by the loose blister wall which lies over it. Blisters vary in size from a pea up to a florin or larger, and in severe cases may be very numerous, covering practically the whole surface of the body. The lesions may commence on any part of the body, but are frequent about the napkin area. In the most severe forms the horny layer is so rapidly separated over large areas of the body that blister formation is not an obvious feature. This variety is known as *dermatitis exfoliativa infantum* or "Ritter's disease," and ends fatally in a large proportion of cases

Diagnosis.—The pemphigoid syphilide must be distinguished from pemphigus neonatorum. In the former condition the eruption is symmetrical, is chiefly found on the prominences of the buttocks, on the palms and soles; other symptoms of syphilis are present, such as wasting, snuffles, fissures at the angles of the mouth, and other syphilitic skin eruptions. A Wassermann reaction will in doubtful cases settle the diagnosis.

Prognosis.—Mild cases respond rapidly to treatment, but in the more rapidly spreading cases the prognosis is always grave.

Treatment.—The bullæ should be opened and their contents absorbed with cotton-wool. Strips of lint soaked in liniment. calaminæ (B.P.C.), to which 1 or 2 per cent. of ammoniated mercury has been added, should be applied, and changed three times a day or more often if necessary. The child should be well wrapped up, to prevent loss of heat.

Ecthyma

In this condition local gangrene of the skin occurs and an ulcer, surrounded by a deep inflammatory zone and covered by a crust, is produced. The lesions are not always of streptococcal origin, but may be brought about in various ways; but as they have some resemblance to impetigo contagiosa, it will be well to describe them here.

Ætiology and Pathology.—The type seen in children is often of streptococcal origin and begins as an impetigo. Scratching or a debilitated condition of the patient allows of a more violent reaction, and necrosis occurs. The frequency with which ecthyma is associated with urticaria papulosa, scabies and pediculosis points to trauma as an ætiological factor. The large round adult type, referred to below, is nearly always preceded by a boil, which is a staphylococcal infection, while the linear type can be shown to be produced by violent scratching, to which is added secondary pus infection.

Symptoms.—All varieties are most often seen on the legs and buttocks. The lesions are usually discrete and few in number, but there are exceptions. They have the appearance of impetigo contagiosa lesions, but there is a wide congested area around the crusts, and these latter are not "stuck on" but firmly fixed. On removal an ulcer the size of the crust is found. This type is usually found in children. Another variety is seen in adults especially, in association with pediculosis vestimentorum, and was seen very frequently during the late war. Two types are seen: the large circular type, which has the characters of those mentioned above, but the individual lesions are larger, and the linear or gutter-shaped type, in which long ulcers, often 2 or 3 inches in length and covered with a thick crust, are present.

Diagnosis.—This has to be made from the ecthymatous syphilide, usually a late tertiary manifestation. In this condition there is a tendency to grouping of the lesions, and they are of a more chronic type. Other syphilitic manifestations, a positive Wassermann reaction, and rapid response to anti-syphilitic remedies will settle the diagnosis.

Treatment.—Local treatment is similar to that of impetigo contagiosa. The crusts should be removed by baths or starch poultices, and a Lassar's paste with 3 per cent. ammoniated mercury tied on. In the adult cases, after the sepsis has been removed by 1 in 4000 perchloride of mercury or 1 in 1000 acriflavine dressings, Unna's paste should be applied and changed every 2 or 3 days until healing takes place. Where debility and malnutrition are present, suitable internal treatment must be resorted to, cod-liver oil and malt, and the preparations of iron, arsenic and the phosphates being most useful

Superficial Streptococcal Dermatitis

Certain forms of circumscribed, dry, superficial dermatitis, with fine branny scales, are sometimes seen in association with impetigo contagiosa and appear to have the same origin. In fact, all stages between the two conditions can be traced. In other cases dry scaly patches are found without any impetigo contagiosa lesions, and streptococci have been isolated from them. These cases are sometimes indistinguishable from the scaly patches which occur on the faces of children, and which are described in the section

on Eczema (p. 1288), where it is suggested that moisture and soap play the chief part in their production. It would thus appear that the streptococcus may produce lesions clinically identical with those produced by these physical and chemical causes. It has been thought also that some forms of circumscribed scaly dermatitis found about the neck and trunk, and also in the flexures of the limbs, and which have in the past been loosely grouped as seborrhœic dermatitis, are probably of streptococcal origin, but further investigation is necessary in order to group them clearly.

These lesions are often resistant to treatment. They are frequently associated with a good deal of itching, and are often followed by secondary changes due to friction, namely, "lichenification" and "eczematisation."

Treatment.—The early cases sometimes respond well to applications of dilute ammoniated mercury ointment; others, however, do best on ac. salicyl., grs. xv; liq. picis carbonis, ℥xv; past. zinci ad ℥i. Once a condition of lichenification is established, the treatment should be on the lines laid down for local pruritus (p. 1279).

STAPHYLOCOCCAL INFECTIONS

Staphylococcal inflammations differ from streptococcal in that they tend to occur in the neighbourhood of the hair follicles, and are accompanied by a purulent exudate from the start, and not a serous exudate, as is the rule with the latter. Several varieties of pustular folliculitis occur.

Bockhart's Impetigo

This is the name given to a superficial pustular eruption of staphylococcal origin seen in connection with the hair follicles.

Symptoms.—The lesions consist of small beads of pus situated quite superficially at the mouths of the hair follicles, each being surrounded by a narrow red zone. Generally the hair can be seen penetrating the centre of the pustule. There is no tendency for the lesions to run into one another, each remaining quite distinct. Usually groups of them occur in localised areas, but sometimes their distribution is very extensive, cases occurring in which almost every stout hair is surrounded by a pustule. The most frequent sites are the fronts of the thighs, the legs, the genitals and the backs of the forearms. A very troublesome variety is seen on the scalp of children between the ages of 2 to 5, the infection being usually derived from a discharging ear or nose. The whole scalp is affected, and the condition is combined with a superficial septic dermatitis which affects also the face, and often spreads to other parts of the body. Ciliary blepharitis is a frequent complication. This is the condition which was formerly described as *pustular eczema*. The majority of localised cases occur in conjunction with other forms of pyodermia; they are seen in scabies and pediculosis, and also in people suffering from boils.

Treatment.—The general health of the patient must be attended to, and all local foci of sepsis dealt with on surgical lines. A search for parasitic infestation must be made and appropriate measures adopted. In the localised cases, the pustules should be punctured, and 1 in 1000 acriflavine lotion applied; if this proves too irritating, lead or calamine lotion should be used, the accumulation of powder from the latter being bathed away daily with a

weak alkaline lotion. Mercury lotions are better avoided, as they tend themselves to produce follicular pustulation.

The more extensive cases are very resistant to treatment. Shaving the affected areas, followed by the application of mild antiseptic lotions or sedative lotions and alkaline baths, is sometimes effective. Staphylococcal vaccines should be tried in addition, and in some cases stannoxyl (an oxide of tin) and injections of collosol manganese have given good results. In the pustular eczema of the scalp, the crusts should be removed with warm oil or starch poultices, and the lotions indicated above or acriflavine 1 in 1000 in liniment. calcis applied. At the same time nasal and ear discharges must be appropriately treated. These cases take a considerable time to cure, but the results repay the attention necessary.

Furuncle

Boils or furuncles are deep-seated infections of the hair follicles with the *Staphylococcus aureus*.

Ætiology and Pathology.—The exciting cause of a boil appears to be the presence of virulent staphylococci in the hair follicles which occasion an intense reaction sufficient to cause local necrosis. This is the more liable to occur where the skin is thick, owing to the pressure exerted on the dense fibrous-tissue bundles and the consequent obstruction to the circulation. Scratching, which conveys the causative organism to the follicles and damages their orifices, predisposes to boils, as is seen by their frequent occurrence in parasitic affections. Lowering of tissue resistance, such as occurs in diabetes and in other conditions of lowered vitality, is also a predisposing cause. In other cases it is possible that a condition of allergy and hypersensitiveness to the staphylococcus is present, and this probably accounts for the constant recurrences which occur.

Symptoms.—Boils may attack any part of the body where hair follicles are present, but are most commonly seen on the neck, back and buttocks, regions where the skin is thick and exposed to pressure and friction. The lesions are usually single or few in number, but they tend to recur with great persistence, and recurrences may continue for a long period. The patients attacked are often in a low state of health. Boils are particularly liable to occur in diabetics, and the urine of patients should always be examined for sugar. A boil commences as a deep, tender infiltration, which rapidly increases in size so as to form a painful red swelling, up to an inch in diameter, which projects above the surface of the skin. Later, a small pustule appears in the centre of the swelling and this eventually bursts, exuding a small quantity of pus, which relieves the pain. Later still, a small slough separates from the centre of the swelling, and when this has come away the boil heals, leaving a pitted scar. Some boils, however, subside without bursting. Sometimes the earliest lesion is a superficial pustule, which is followed by the rapid formation of an inflammatory zone. Later, infiltration of the deeper tissues follows, and a slough forms and is discharged, as in the first-mentioned type.

Treatment.—The general condition of the patient must first be dealt with on general lines. Certain internal remedies, such as yeast and calcium sulphide, have occasionally proved of value, but are generally useless.

Vaccines of *Staphylococcus aureus* produce excellent results in some cases, but cannot be looked on as a specific. Stock vaccines seem to be as successful as autogenous. Injection of collosol manganese, suggested by McDonagh, beginning with 0·5 c.c. and repeated twice a week, in slightly increasing doses, for 3 to 4 injections, produces the most dramatic results in certain cases; others, however, are completely resistant. McDonagh has recommended alternation with intramine, but the results do not appear to be materially altered by this routine. Stannoxyl, given by the mouth 2 to 3 tablets t.d.s., has also been claimed to produce excellent results. Local measures are of great importance. The skin should be cleaned up with baths, medicated or otherwise, and the affected areas dressed with 1 in 4000 perchloride of mercury, picric acid, or 1 in 1000 acriflavine. Boric acid fomentations should be avoided, as they spread the infection. Boils should be opened early—as this reduces the amount of necrosis—and treated on surgical principles.

Carbuncle

A carbuncle is a boil or group of boils in which the subcutaneous tissue has become involved in the infective and necrotic process.

Symptoms.—Usually only a single lesion is present. It may at the commencement appear like an ordinary boil, but the spread is rapid, and soon a large, red, indurated, painful area is produced. The lesion may attain a diameter of many inches. After a few days numerous points of pus appear on the surface of the swelling, and these burst and exude pus. The bridges of tissue between these openings may subsequently break down and reveal a large slough, which may take several weeks to separate if not removed by surgical means. Fever and other constitutional symptoms are generally present.

Treatment.—The general treatment is the same as for boils. Local surgical treatment is required, and consists either of complete excision of the carbuncle, with the surrounding inflammatory tissue, or of making a crucial incision and removing the slough, the open wound being packed with bismuth-iodoform-paraffin paste or an appropriate antiseptic dressing.

Sycosis Barbæ

This is a staphylococcal infection of the hair follicles of the beard region, and is one of the three forms of "barber's rash," the other two being impetigo contagiosa of the beard region and ringworm of the beard.

Ætiology and Pathology.—The disease is produced by inoculation of staphylococci into the hair follicles in the beard area, either primarily or as a secondary infection to an impetigo contagiosa. Many cases doubtless start from infection conveyed in the barber's shop, but a considerable number also occur in patients who shave themselves. Scratches from the razor subsequently inoculated by the patient's finger are probably as common as direct infection from a barber's brush or razor.

Symptoms.—The disease usually begins at one spot in the beard or moustache area by the formation of pustules around the hairs. These pustules tend to occur in groups, and become surrounded by an inflammatory zone. As the deeper parts of the follicles become infected, nodules form and

the whole affected area becomes swollen and œdematous. Pus discharging from the ruptured pustules dries and forms crusts. Subsequently some of the hairs loosen and can be pulled out without pain. Each hair on removal is seen to be surrounded by a swollen and transparent root-sheath, and often a bead of pus escapes from the follicle. The disease is progressive, and eventually the whole beard and moustache area, and not infrequently the eyebrows and eyelashes, may be attacked. It tends to become chronic, and in old-standing cases a large number of the hairs are lost, leaving a smooth, red, atrophied patch, not unlike lupus vulgaris, and to which the name *lupoid sycosis* has been given. The presence of some follicular pustules and the absence of lupus nodules is, however, sufficient to separate the two conditions.

Diagnosis.—In addition to the diagnosis from lupus vulgaris just mentioned, sycosis has to be differentiated from impetigo contagiosa, and from ringworm. From the former the diagnosis is made by the involvement of the deeper structures of the skin and the presence of pus in the hair follicles; from ringworm by the absence of fungus in the scales and hairs (see Tinea barbæ, p. 1310).

Treatment.—The acute cases should be treated much in the same way as other acute inflammations of the skin, without any attempt being made directly to attack the organism responsible for the disease. Frequent bathing in warm water or oil should be used to remove crusts, or boric-starch poultices may be used. Lead lotion, or 1 in 1000 acriflavine lotion, should be applied on lint and changed frequently. When the acute stage has subsided the parts should, if possible, be shaved and should be kept shaved, the razor being of the sharpest, and both it and the shaving-brush soaked in 1 in 40 carbolic acid after use. Loose hairs should be epilated and the surface dabbed once a day or more often, if not too painful, with 1 in 1000 biniodide of mercury in 60 per cent. alcohol, and the surface dusted with talc powder. As an adjunct, vaccines may be given. In many cases it is advisable to epilate by X-rays. Provided the inflammation is not too acute, a full Sabouraud pastille dose should be given, and after epilation the area dressed with a 3 per cent. ammoniated mercury ointment.

ANTHRAX INFECTIONS

These lesions, which resemble in some respects those produced by the staphylococcus, are dealt with elsewhere (p. 107).

DIPHTHERIA INFECTIONS

The lesions produced by the diphtheria bacillus are rare, but are seen sufficiently often to require notice. Diphtheritic infection of wounds is a well-known condition, but does not need to be considered here. The surface infection by diphtheria is of two kinds; in children suffering from diphtheria, gangrenous patches occasionally develop, chiefly on the trunk, from which cultures of the organism may be obtained, but the organism may also attack the skin of otherwise healthy persons.

Symptoms.—A single lesion usually occurs, but there may be more than one. It begins as a clear blister, like an impetigo vesicle, and ruptures

very easily; on about the second day a considerable red zone is present around the original lesion, and a central slough has formed, comparable to a small burn. This condition persists for some time, if not treated, and eventually the slough separates and the spot heals. Constitutional symptoms may be present. The writer has recently seen a case of paronychia from which a pure culture of the Klebs-Loeffler bacillus was obtained.

Treatment.—Prompt injection of anti-diphtheritic serum, with the application of a local antiseptic dressing, is all that is required.

INFECTIONS BY THE SEBORRHŒIC ORGANISMS

Three organisms are commonly found in cases of seborrhœic dermatitis, but the part each plays is not yet conclusively proved, so that it will be convenient to group the seborrhœic conditions under one heading. The organisms found are the *acne bacillus*, the *bottle bacillus*, and the *Staphylococcus epidermidis albus*. The first named is a small bacillus which is found chiefly after puberty and is present in very large numbers in the comedo of acne vulgaris. The bottle bacillus is a yeast-like organism which buds and often shows itself as a flask-shaped body, and is found most plentifully in seborrhœic dermatitis of the scalp. The white skin staphylococcus is found pretty universally over the skin.

Seborrhœic Dermatitis

Under this term we include a chronic scaly condition of the scalp, formerly called seborrhœa sicca, and also certain "eczematous" lesions of the face, chest and back, and occasionally on other parts of the body, which are characterised by the presence of more or less circumscribed reddish patches covered by greasy scales.

Ætiology and Pathology.—The histological changes in the skin are those of a chronic superficial dermatitis. The three organisms mentioned above are met with in the scales in all adult cases, but the origin and spread of both seborrhœic dermatitis of the scalp and the figurate type on the body suggest that the views of Sabouraud and Whitfield, that the bottle bacillus is the chief ætiological factor, are correct. Further, the ease with which most lesions clear up under treatment by sulphur supports these views. There is no doubt that an underlying seborrhœa is the main factor in causing the activity of these organisms.

Symptoms.—Seborrhœic dermatitis of the *scalp* is the well-known "scurfy head," and is an extremely common affection, most individuals having it to a greater or less degree. It probably begins in early infancy, and is sometimes seen as a ringed lesion on the scalp of young infants. These lesions have been shown by Whitfield to contain the bottle bacillus in large numbers. These rings may disappear spontaneously, but the infection, which has presumably been conveyed from the mother or nurse, persists and lights up again later in life in certain individuals, especially in those prone to seborrhœa (see p. 1276). In the adult the affection consists of a diffuse branny scaling on the scalp, usually unassociated with any obvious inflammation of the skin. On close examination the scales are seen to be formed around the hairs, indicating that the inflammation is perifollicular.

Varying degrees of scaliness are met with; in some cases it is scarcely perceptible, in others it consists of thick, greasy masses. Symptoms are generally absent, but occasionally a good deal of irritation is present, which leads to scratching, and small crusted lesions are then found among the scales. Sometimes a more acute inflammation supervenes, and the scalp becomes red and hot, and an exudate of fluid may occur, producing crusting. In these cases the inflammation usually extends for a centimetre or so beyond the hairy margin. The persistence of scaly seborrhœic dermatitis is considered by some to be an ætiological factor in producing that form of baldness known as alopecia prematura, which is characterised by the recession of the hair from the forehead and baldness on the crown of the head. It is probable, however, that other factors also play a part in this condition.

The *face* may also be affected, especially the eyebrows, forehead, naso labial folds, beard and mastoid regions. Here the lesions are dry, reddish or pale patches, surmounted by greasy scales or crusts. On close examination it can usually be seen that the lesions are follicular in origin and that the patches are formed by the aggregation of these follicular papules. The ears may be affected, especially the concha, and some forms of blepharitis appear to have a seborrhœic origin. The lesions on the face are very liable to become infected with pus organisms and become thickly crusted. An intractable scaly inflammation of the lips, *cheilitis exfoliativa*, is also considered to be of seborrhœic origin.

On the *chest and back* ringed or figurate lesions are frequently seen, but here follicular papules may occur. The centre of the sternum and the interscapular area are the common sites. Occasionally patches occur among the pubic hairs.

Some authorities include under this heading cases in which circumscribed pinkish or red circular or oval patches, covered by fine branny scales, occur on the trunk and limbs. They are resistant to treatment, especially to the remedies useful in seborrhœic dermatitis, and there is some evidence that they are forms of the streptococcal dermatitis referred to on p. 1297. This type is prone to attack the flexures of the limbs, as are other streptococcal infections.

Diagnosis.—All cases of scurfy head in children should be considered to be ringworm until careful examination has excluded this cause. The presence of stumps and the demonstration of the fungus will settle the diagnosis. In body ringworm the distribution is irregular, the lesions are sharply circular, and the scaling is not greasy. Fungus can be found in the scales.

Impetigo contagiosa of the small crusted type has a close resemblance to seborrhœic dermatitis, especially on the face. The presence of some definite impetigo vesicles and crusts, and the history of its unilateral spread, may help to clear up the diagnosis.

Pityriasis versicolor occurs in the same regions as the body form of seborrhœic dermatitis, but it has a fawn colour and no inflammatory reaction, and the fungus can be found in the scales. Pityriasis rosea can be distinguished by the presence of oval lesions with a collarette of scales within the edge of the lesion, by its acute onset and by its symmetrical distribution.

Prognosis.—The figurate variety on the trunk can always be kept under by appropriate treatment, but frequently recurs. The face is more resistant

to treatment, and when much septic infection has taken place may take a long time to cure. On the scalp constant treatment is necessary, and a permanent cure can scarcely be hoped for, as the organisms invade the follicles. With proper hygiene and appropriate treatment, however, the condition can be kept quiescent.

Treatment.—*Scalp.*—Frequent washing is necessary to remove the scales and accumulated dirt. Unless there is any acute inflammation present, men should wash the scalp two or three times a week or even daily with sp. sapon. kalin. (B.P.C.), or ext. quillaiæ liq. (B.P.C.); sulphur or tar soap may be used. In women the washing should be done once a week. After drying, in severe non-inflammatory cases, an ointment containing 3 per cent. each of ac. salicylic. and precipitated sulphur in a basis of ℥ij soft paraffin and ℥vi cocoa-nut oil should be rubbed into the scalp. Resorcin, thymol, anthrasol, thiol or ammoniated mercury 3 per cent. may be used as alternatives or in various combinations. In the milder cases lotions are preferable. Resorcin or chloral hydrate ℥i, sp. vin. rect. ℥i, aquam ad ℥viij, is a useful lotion. Resorcin should not be used in fair or white-haired patients owing to its staining properties. In the acutely inflamed cases, washing with soap should be avoided, though crusts may be bathed away with warm water. After removal of the crusts, ichthyol ℥ss in ℥i of lin. calcis should be applied, the hair being cut short if necessary.

On the *face*, sulphur and salicylic acid ointment may be used in the chronic cases; if, however, sepsis is present the crusts must be removed and calamine or ichthyol liniment applied.

On the *body*, sulphur and salicylic acid ointment is usually all that is required.

Acne Vulgaris

This condition is characterised by the presence of greasy plugs, known as comedones, in the pilo-sebaceous follicles—particularly those on the face, shoulders, chest and back—often associated with perifollicular inflammation. It is an extremely common affection in its milder forms and by no means rare in its severest types.

Ætiology and Pathology.—The disease occurs chiefly in individuals between 15 and 30 years of age, and is seen in both sexes. The affected individuals suffer from seborrhœa.

If a comedo is examined it is found to consist of epithelial cells, sebaceous material, and the three organisms which are associated with seborrhœic inflammations and, in addition, a small acarus, the demodex folliculorum, is sometimes found. In the greater mass of the comedo, the acne bacillus occurs almost pure, the other organisms being found chiefly near the mouth of the follicle. Accumulated evidence seems to show that the acne bacillus is the chief exciting cause of the comedo, but that secondary suppuration is chiefly due to the activity of staphylococci, though this has recently been denied by Sabouraud. The bottle bacillus and the demodex appear to play no active part in the production of the disease. The excessive oily secretion of the skin, with the patulousness of the follicles which accompanies this condition (the so-called "kerose" of Darier), appears to offer a field for the activities of the acne bacillus, which flourishes in the sebaceous secretion.

The actual comedo is formed by exfoliated epithelial cells—produced by an inflammatory hyperkeratosis of the follicle—mixed with sebum.

Symptoms.—The earliest lesions are the comedones or "blackheads." These are small, black spots which are seen filling the dilated orifices of the pilo-sebaceous follicles, most frequently on the face, but also in the other sites mentioned above. If pressure is exerted on a follicle, a cocoon-like plug can be squeezed out, which is of a cream colour, except for the portion which fills the mouth of the follicle, where it is black. Isolated comedones are extremely common, but when large numbers of them occur the term *acne punctata* is applied to the condition. Frequently, however, the presence of these follicular plugs predisposes to an acute perifollicular inflammation, and the comedo becomes surrounded by a red zone; later, a small pustule may occur in the centre. This lesion is generally painful. When these inflammatory lesions predominate, we speak of the case as one of *acne papulosa*, or *pustulosa*; but it must be noted that all varieties tend to be present together. In some cases the inflammation does not start superficially around the follicular orifice, but deeper, in the region of the sebaceous gland. Here we find first a deep-seated lentil- or pea-sized nodule, often painful, which gradually increases in size, reddening the skin as it pushes upwards, and then sometimes bursts at once and discharges a small quantity of turbid yellow fluid with the remains of the comedo; or it may attain the size of a filbert, and present signs very similar to those of a sebaceous cyst. Sometimes the nodules disappear without rupturing. This type is usually spoken of as *acne nodularis*, and is particularly liable to appear on the back. It is the most persistent type, and often leads to much keloidal scarring.

Diagnosis.—Rosacea, especially the acneiform type, when it occurs in young people may sometimes be mistaken for acne vulgaris, and indeed the two conditions may occur together. In rosacea, vascular congestion is the prominent symptom; the lesions are generally localised to the centre of the forehead, the nose and central portion of the cheeks and the chin—they are painless and the comedo is absent.

Acneiform lesions produced by the internal administration of bromides and iodides may simply be an exaggeration of a pre-existing acne vulgaris; but if not, the lesions tend to be more grouped and to produce tumour-like swellings. Other eruptions characteristic of these drugs may also be present. The acne produced by the irritation of tar and paraffin is usually localised to the forearms and lower limbs.

Prognosis.—The condition tends to die out between the ages of 25 to 30; but the nodular type may often continue till a considerably greater age. Though improvement is sometimes slow, treatment materially hastens a cure. Bad scarring is sometimes left in severe cases.

Treatment.—As the causative organism is situated deeply in the follicle, it cannot be reached by the ordinary anti-parasitic remedies. Treatment must, therefore, be directed to emptying the follicles. In the mildest cases this is best done by frequent washing with spirit soap and hot water, or by steaming. The comedones are then expressed either by a comedo extractor or by pressure with the finger protected by a handkerchief or soft towel. After this a mild sulphur preparation, such as calamine lotion containing 2 per cent. or 3 per cent. of potass. sulphurata or sublimed sulphur should be dabbed on, or if this dries the skin too much 3 per cent. precipitated

sulphur in ung. aquæ rosæ may be used. Ointments, however, should be avoided as far as possible, as they tend to block up the follicles. This treatment must be persisted in for a considerable period. More drastic treatment consists in exfoliating the skin with a resorcin paste.

Vaccines have not given very satisfactory results, though staphylococcal or mixed acne and staphylococcal vaccines have been of some value in the pustular cases.

Of recent years the most rapid cures have been affected by means of X-rays. It must be remembered, however, that atrophy and telangiectasis sometimes occur many years after quite ordinary doses, and although this risk may be taken with impunity on the back, and, in men, on the chest, it is only in the worst cases that it should be used on the face and, in women, on the chest. For the back and chest it is best to give a full pastille dose at a sitting, ½ mm. aluminium filter being used. On the face three ⅓rd pastille doses, at 7 to 10 days' interval, will usually suffice, and a fourth dose can be given later if necessary; but it is well to wait at least 6 weeks before deciding on further treatment.

In addition to local treatment the patient's general health must be attended to, constipation rectified, and such conditions as dyspepsia, anæmia and menstrual disturbances treated.

Acne Varioliformis

Synonym.—Acne Necrotica.

An inflammatory condition of the hair follicles, accompanied by local necrosis, and leaving pitted scars resembling those seen in variola.

Ætiology and Pathology.—The disease is seen chiefly in middle-aged persons of both sexes. It is believed to be of bacterial origin, and is attributed by Sabouraud to the acne bacillus. It occurs in seborrhœic individuals.

Symptoms.—The affection occurs chiefly on the scalp and forehead, but is occasionally seen on the face, neck, chest and back. The lesions usually come out a few at a time, and the attacks may persist for long periods; but there are generally intervals of complete freedom. Often change of residence has the effect of stopping or determining an attack.

The lesions at the commencement are pinhead-sized vesicles situated at the mouth of the hair follicles. These vesicles rapidly dry up without bursting, and scabs are formed. These are seen to be depressed below the surrounding skin. When the scabs fall off after a week or so a small punched-out scar remains. The onset is usually accompanied by a good deal of itching or burning.

Diagnosis.—The condition has to be distinguished from the scattered crusts which occur in seborrhœic dermatitis of the scalp as a result of scratching. The diagnosis can be made by the pre-existing vesicular lesions in the case of acne varioliformis, and by the scarring left.

Treatment.—These cases are often resistant to treatment. The general health should be attended to, and often change of air is very beneficial. Local anti-seborrhœic remedies should be applied, such as salicylic acid and sulphur ointment (3 per cent.), ammoniated mercury ointment (10 per cent.), or lotions of potass. sulphurat. and zinc sulphate.

Acne Keloid

A hypertrophic inflammatory condition occurring on the back of the neck just below the hair margin.

Ætiology and Pathology.—The disease occurs in young adult males. Very little is known of the cause. It occurs at a point where the collar rubs the back of the neck, and friction appears to play a part in its production. The condition has been studied closely by Adamson, who can find no evidence of previous comedo formation. Though he considers that it is produced by a combination of trauma and bacterial infection, he does not consider that the acne bacillus or the *Staphylococcus pyogenes* plays any part in its formation.

Symptoms.—The condition commences with small firm nodules, which gradually increase in size and eventually merge into one continuous mass, closely simulating a keloid.

Treatment.—Adamson recommends large doses of X-rays as the only satisfactory method of treatment.

DERMATITIS DUE TO FUNGI

Ringworm

Ætiology and Pathology.—Tinea or ringworm is the name given to certain inflammatory affections of the skin produced by the growth in it of certain of the hyphomycetes or moulds. These fungi grow for the most part in the horny layer of the epidermis or its appendages, the hairs or nails, and by their growth produce an inflammatory reaction. The fungi which are commonly seen in this country belong, according to Castellani and Chalmers, to four genera—the *microsporon*, the *trichophyton*, the *ectotrichophyton*, and the *epidermophyton*, the latter of which is characterised clinically by not attacking the hairs. To these must be added a fifth, which though of the same family is not usually included under the term "ringworm," namely *favus*, the fungus of which belongs to the genus *Achorion*. The fungus of ringworm is transmitted to man either from another human being or from certain animals, some fungi being only found in man. The types which are common in one country are not necessarily so in another, and in tropical zones a very large variety occur which are not considered here, but are dealt with fully in works on tropical medicine. The microsporon, or small spored ringworm, attacks almost entirely children under the age of about 16, while the epidermophyton is not frequently seen in children. The trichophyton, however, attacks children and adults indiscriminately. The genera can usually be distinguished without difficulty from one another both clinically and by examining the hair or scales under the microscope in liq. potassæ. The different species can, however, only be distinguished by their cultural characteristics. The same ringworm fungus grows differently on different media, and in order to compare cultures the fungus is by tacit agreement grown on what is known as Sabouraud's "proot medium," for the reason that this observer has collected and illustrated in his book, *Les Teignes*, a very large number of the known ringworm fungi. The common nomenclature of the fungi is that adopted in this work.

Ringworm is found chiefly on the scalp, where it almost universally travels along the hairs into the hair follicles, on the beard region, where the hairs are often but not always affected, or on the glabrous skin, where it usually remains confined to the surface horny layer. The nails are also sometimes attacked.

Ringworm of the Scalp

Ætiology and Pathology.—Ringworm of the scalp, *tinea tonsurans*, is essentially a disease of childhood, the adult scalp being so rarely attacked as to be considered a curiosity. In this country about 90 per cent. of cases of scalp ringworm are produced by the microsporon fungus, the large majority of these being produced by a human species, *Microsporon audouini*, the rest (not more than about 5 per cent.) by the microspora of the cat, dog and sometimes other animals. Another 10 per cent. or so of cases are due to trichophyton (or endothrix) and ectotrichophyton (or ectothrix) fungi of each of which there are several species. The microsporon fungus first attacks the horny layer on the surface of the scalp; it reaches the hair shaft at the mouth of the follicle and grows down on and beneath the cuticle of the hair, destroying the cuticle and fibrillating the hair, and finally terminates in a fringe of mycelial processes just above the expansion of the bulb of the hair. The mycelial processes on the surface of the hair break up into small round spores, which are packed so closely together that, when examined in liq. potassæ under a $\frac{1}{6}$-inch objective, they are seen to form a thick mosaic sheath round the hair. As a result of the damage produced, the hairs first lose their elasticity and then fracture. This fracture usually takes place about $\frac{1}{8}$-inch above the mouth of the follicle.

Symptoms.—*Microsporon ringworm.*—In the bulk of cases the disease begins with a small circular scaly patch on the scalp. Very soon the hair on the patch is noticed to be thinning. Several patches may appear simultaneously. On close examination with a lens, these circular patches are found to be covered with fine, branny scales of a greyish colour, the follicles are prominent, giving the patches a nutmeg-grater-like appearance, and numerous broken hairs are seen. At the edge some hairs may be found unbroken but bent at sharp angles, as though a sort of greenstick fracture had occurred. These hairs and the stumps are often covered with a whitish powder, which is the spore sheath referred to above.

On pulling one of the stumps with forceps the former will come away, but usually breaks off above the hair bulb, leaving the latter behind; a great deal of perseverance is necessary to remove the stump intact. The hair thus removed and examined in liq. potass. has the appearances mentioned above, and in addition the fibrillation of the hair will be noted, especially the irregular fracture of the distal end. In old-standing cases the regular circular outline of the patches may be lost, the whole scalp having a moth-eaten appearance, and stumps being scattered irregularly over large areas. The microsporon ringworms contracted from animals have similar appearances.

Endothrix ringworm.—The fungus of this type is not contracted from animals. The clinical appearances may be similar to microsporon ringworm, but two other types are seen. In some cases no patches are present, but a general thick scurfiness of the scalp occurs. On very careful search with a

lens isolated stumps may be found scattered all over the scalp. In other cases sharply defined bald patches occur, which on inspection show no stumps, but every follicular opening is filled with a small black spot. By the careful use of pointed epilation forceps, such as those devised by Whitfield, one or more of these spots may be removed, and on examination the fungus can be demonstrated. This type is called *black-dot ringworm*, and has to be distinguished from alopecia areata.

When the stumps from an endothrix ringworm are examined in liq. potass. under the microscope the spore sheath is found to be absent, the fungus being entirely inside the hair and the cuticle intact. The fungus itself consists of longitudinally running mycelial filaments, which are divided up into small square, round or oval segments, which are called spores, the whole having a ladder- or chain-like appearance.

Ectothrix ringworm.—The fungus which produces this type is of animal origin, and generally produces a much more inflammatory type of lesion than the other varieties. In the majority of cases suppuration occurs, the fungus itself being responsible for pus formation. These suppurating ringworms are spoken of as *kerion celsi*. The affected area is much swollen and red, and often raised considerably from the surrounding skin. The swelling is boggy to the touch, and often gives the sensation of fluctuation, which to the uninitiated suggests abscess formation. On the surface pus is seen to exude from numerous follicular openings, but broken hairs are also seen. These if examined in liq. potass. show fungus, both within and without the hair: the cuticle is destroyed and the mycelium has similar characters to the endothrix fungus, the spores being arranged in chains and not packed together, as in the microsporon type.

Diagnosis.—This is usually simple, the presence of the stumps containing fungus being diagnostic. In cases where stumps are few in number, great help can be obtained by examining the child's scalp under a mercury-vapour lamp, screened by what is known as "Wood's glass." The affected stumps fluoresce brilliantly and can be readily seen. This method is particularly valuable in determining whether a case is cured after treatment. From favus the diagnosis is made by the presence of yellow favus cups. From seborrhœic dermatitis the diagnosis should not be difficult if it is always remembered that a scurfy head in a child must always be considered to be ringworm until this has been excluded. Great care has, however, to be taken to make a thorough search for stumps in the endothrix cases. In alopecia areata a smooth, shiny centre with, perhaps, a row of scattered stumps at the periphery of the patch is found. These stumps, however, are club-shaped, are very thin as they enter the scalp, and when pulled out always come away with a shrunken bulb attached. No fungus can be seen on microscopic examination.

Treatment.—The cardinal fact to remember in the treatment of scalp ringworm is that up to the present no means has been discovered of killing the fungus in the hair follicles. It is, therefore, necessary to epilate the hairs in order to obtain a cure. This can be done by three methods: by X-rays; by producing sufficient inflammation in the affected areas to make the hairs fall out; or by the administration of thallium acetate internally. This second method is the way Nature cures some cases. In kerion the suppuration is sufficient to loosen the hairs, and all that is necessary is to assist this process

by hot fomentations and epilation with forceps. In the ordinary microsporon type, however, the production of the necessary inflammatory reaction is not so easy. Various irritants have been used—the most satisfactory of which is croton oil. The application of this, however, requires great care, and is not suitable for ordinary out-patient practice. Probably the best application available at present is an ointment of equal parts of common salt and soft paraffin. The scalp is shaved and washed daily with soap and water, the healthy portion then smeared with a weak mercurial ointment, such as 2·5 per cent. white precipitate ointment, and the salt ointment rubbed vigorously into the ringworm patches. After a time the patches inflame, and the hairs loosen and fall out. Cure by this method in fairly localised cases takes 2 or 3 months if the treatment is vigorously and conscientiously carried out; otherwise it may take 12 or 18 months to effect a cure. In out-patient practice, and in all extensive cases, X-rays are preferable. The method used is that devised by Adamson and Kienbock, and consists in treating the scalp from five different points with a Sabouraud pastille dose, the points being so arranged that the whole scalp is uniformly irradiated. This should cause all the hair to fall out in 3 to 4 weeks, and a complete cure should take place. There is a risk of permanent alopecia occurring even under the most careful arrangements, but it is very slight; it is well, however, that parents should be fully informed of this risk before the treatment is commenced, in order to avoid any subsequent unpleasantness.

It has recently been shown, chiefly owing to the work of Buschke and his associates, that, if thallium acetate in a single dose of 8 mgrms. per kilo body weight be administered orally, the scalp hair will fall out after about 18 days, leaving the eyebrows and eyelashes unaffected. This method has now been used in a large number of cases of ringworm, and gives satisfactory results. It does, however, often produce well-marked toxic symptoms, chiefly severe joint pains and gastro-intestinal disturbance, and its final beneficial results are probably not equal to those of X-rays. It should only be given to children who are perfectly healthy.

Ringworm of the Beard

Symptoms.—Ringworm of the beard, *tinea barbæ*, occurs in two types: (1) the superficial, scaly type, and (2) the suppurative type. The former begins as a small scurfy patch, which spreads slowly in ring fashion, and resembles the scaly type on the scalp. The hairs are usually attacked, and if removed fungus can be demonstrated in them and also in the scales. The fungus is usually of the endothrix type, and as such is transmitted from man to man. It is not infrequently caught in the barber's shop, and is one of the three forms of "barber's rash."

The suppurative type produces an irregular lumpy swelling of the affected part. The "lumps" are soft and boggy to the feel, and pus may be seen exuding from various follicular openings; the case bears a close resemblance to kerion celsi, but has not the same sharp circular edge, being more irregularly distributed. The hairs are attacked by the fungus, which in this case is generally of the ectothrix type, and is usually transmitted from animals, being frequent among grooms and cattlemen.

Diagnosis.—The scaly variety must be distinguished from seborrhœic

dermatitis and the pityriasiform type of streptococcal infection. This is easily done by the presence of fungus in the hairs and scales of ringworm.

The suppurative type may be confused with the staphylococcal sycosis; but the latter never forms the tumour-like masses which are seen in ringworm, while again the presence of fungus will settle the diagnosis.

Treatment.—The same principles apply as in scalp ringworm. For the scaly type X-rays form the most certain form of treatment; but the risk of atrophy must not be forgotten. If patients decline to take this risk 3 per cent. salicylic and 5 per cent. benzoic acid ointment should be rubbed in daily and the hairs epilated, a few at a time, with forceps. The hair should be kept cut short.

With the suppurative variety hot fomentations and epilation with forceps should be used.

Ringworm of the Glabrous Skin

This can be divided into four types. (1) *Tinea circinata*, the small ring- and disk-like patches seen about the face, neck, body and limbs; (2) *tinea cruris, eczema marginatum* or *dhobie itch*, seen chiefly as sheet-like patches in the inner side of the thighs, and on the perineum and scrotum; (3) the *eczema-toid ringworms* of the hands and feet; and (4) the *pustular body ringworms*.

Symptoms.—1. *Tinea circinata.*—This condition may occur by itself or in combination with scalp ringworm. In the latter condition it usually occurs on the neck or face. In the microsporon cases of human origin the lesions take the form of small disks, usually not larger than a threepenny bit, which show little tendency to grow, and no tendency to clear in the centre or to form rings. The patches are of a pale pink colour, and are covered with branny scales, in which mycelial filaments can be demonstrated by examining them under a $\frac{1}{6}$-inch objective in liq. potassæ. The other varieties of microsporon and the endothrix trichophytons show a much greater tendency to form rings and to attain a larger size. In these cases the earliest spots are similar to those described above, but as they spread the centre loses its scaliness, becomes a paler colour, and eventually the skin resumes its normal character. The spreading edge presents the same branny scaling, and often small pinhead-sized vesicles and pustules. As before, mycelial filaments can be demonstrated in the scales. Itching is often present to a greater or less degree. In rare cases these rings are very numerous, and concentric rings may form. This is well seen in some tropical varieties, such as *tinea imbricata*, where the whole body is covered with concentric ring-formations.

2. *Tinea cruris.*—This condition, also known as *dhobie itch*, is produced by the genus *Epidermophyton*. It is so named because of the commonly held view that clothes are infected by the washerman or dhobie. Originally a tropical type, it is now extremely common in this country, being much more often seen in private than in hospital practice, and almost entirely in males. It is usually seen as a superficial, flat, brownish-red patch situated bilaterally on the inner surface of the thighs in their upper third. The patches usually meet on the perineum, and often involve the whole scrotum, and sometimes spread forward into the groins. The patches, which were formerly known as *eczema marginatum*, have a very sharply defined margin, which is very slightly scaly, but no vesicles are present. Scrapings from the scales show

a chain-like mycelium. The patches, though usually confined to this region, are occasionally seen on the umbilicus and in the axillæ, and are frequently associated with one type of eczematoid ringworm seen between the toes. There is generally intense itching felt in the patches.

3. *Eczematoid ringworms.*—There are several varieties of this type seen. The commonest is that which occurs between the toes, and generally accompanies the type just described. It occurs first between the little and fourth toe, and is generally bilateral. The skin in the web of the toe becomes thickened, whitish and sodden, and fissuring is prone to occur. It may spread to adjoining interdigital spaces, and on to the dorsum and sole of the foot. In severe cases a raw red weeping area, bounded by a sharp margin, is produced. It is not always easy to demonstrate the fungus in the thickened skin between the toes; considerable time must be given to soaking in liq. potassæ the skin removed, and many slides may have to be made before the search is rewarded. This type has been described on the hands, but is very rare.

The most common type seen on the hands consists of rather sharply circumscribed patches of a vesicular dermatitis. They may occur on any part of the hand or fingers, and are generally single and unilateral. They spread slowly, and are itchy. The lesions are usually produced by the endothrix fungus; but others may be found. The demonstration of the fungus is necessary to distinguish them from other forms of localised dermatitis. When the lesions occur on the palm much thickening of the horny layer is produced, and cracking in the deeper folds may take place.

In another form an acute dermatitis, which may involve both hands and feet, is set up, as has been shown by Whitfield. The cases are clinically indistinguishable from the type of acute dermatitis known as dysidrosis or cheiropompholyx, and in all such cases a careful examination must be made for a ringworm fungus.

4. *Pustular body ringworms.*—These occur in sharply defined patches, chiefly on the limbs and neck. The patches are of dull red colour, and sharply raised from the surrounding skin; they have a soft boggy feel, and pus can be seen exuding from the follicles. The fungus in this case is usually of the ectothrix variety.

Diagnosis.—This is only difficult in the acute eczematoid varieties, when it must be distinguished from cheiropompholyx and the localised forms of dermatitis and eczema. This can only be done with certainty by demonstrating the fungus. The circinate patches have to be distinguished from seborrhœic dermatitis and the scaly streptococcal lesions, and on the face from pityriasis simplex. The presence of fungus, and the ease with which patches respond to Whitfield's ointment, as well as the tendency to ring-formation, and asymmetrical distribution, will enable a diagnosis of ringworm to be made.

Treatment.—This is simple in the flat body patches and in tinea cruris. Many antiseptics, such as iodine, sulphurous acid and chrysarobin, will clear up the patches, but the simplest and most easily applied agent is Whitfield's ointment, which consists of 3 per cent. of salicylic acid and 5 per cent. of benzoic acid in a paraffin or paraffin and cocoa-nut oil basis. Most patches will clear up in a week if the ointment be rubbed in once or twice a day; but it is well to continue the application for some days after the patches have subsided, especially in tinea cruris.

Eczematoid ringworm of the toes can be treated with a double strength ointment of the same constituents, the sodden epidermis being removed daily after washing with soap and water; it is well to use this intermittently for 2 weeks at a time, powdering the toes well with a bland powder during the alternate 2 weeks, in order that the keratolytic action of the salicylic acid may subside and give a better indication of the results of treatment. In resistant cases 20 per cent. chrysarobin in spirit may be used in addition. These cases are always resistant to treatment, which requires to be carried on for long periods.

The acute eczematoid ringworms of the hands are often made worse by strong parasiticides, and it is generally better to start treatment with a wet dressing of 1 in 4000 potassium permanganate, subsequently trying small areas tentatively with the stronger ointments. The suppurative type can also be treated with 1 in 1000 acriflavine, or 1 in 4000 perchloride of mercury dressing, and subsequently with Whitfield's ointment, if not cured by the former methods. Resistant cases respond well to X-ray treatment.

Ringworm of the Nails

This is fortunately not a very common affection, but occurs with sufficient frequency to be on the look out for. It may be caused by the endothrix or ectothrix fungus.

Symptoms.—Usually 2 or 3 nails are affected, nearly always those of the fingers—the toe nails being very rarely attacked. The disease usually commences under the free end of the nail, and travels slowly upwards. The nail bed becomes much thickened, and the epithelium sodden, and can be scraped away. As the disease spreads the nail becomes a greenish-grey colour and separated from its bed; the growing edge can be seen as a yellowish line above the discoloured and separated nail. In other cases the nail becomes soft or brittle and breaks up, exposing the underlying sodden nail bed. Very rarely the sides and base of the nail may be primarily affected.

Diagnosis.—The diagnosis has to be made from eczema, psoriasis and syphilis. This can only be done with certainty by finding the fungus. Portions of nail near the growing edge should be taken and soaked for some hours in liq. potassæ. The under surface is then scraped and mounted, and a search made; and this may require several preparations before the mycelium is found. Cultures can often be made direct from pieces of nail; but contamination is very frequent.

Treatment.—The nail must be removed, either surgically or by softening in strong potash and scraping it away. Afterwards one of the stronger anti-trichophytic remedies can be applied. Norman Walker recommends covering the affected nails with lint soaked in Fehling's solution and applying a rubber finger-stall for 24 hours or longer, so as to remove the nail completely. The solution must not be applied to the surrounding skin.

Oidiomycosis

A good deal of attention has recently been paid to lesions closely resembling those produced by the ringworm fungi, but attributable to the growth of yeast-like organisms resembling those found in thrush. The lesions are

chiefly found in moist situations, such as the groins, under the breasts and between the toes. The same fungus has been found to be responsible for a sodden condition between the fingers, to which the name *erosio blastomycetica interdigitalis* had formerly been applied. It has also been found in the nail folds, producing a curious bolster-like swelling of these structures, and has also attacked the nails themselves.

The *treatment* of these conditions is similar to that employed in ringworm.

Favus

Favus is a disease due to the growth of a fungus allied to ringworm, belonging to the genus *Achorion*. It differs from the former in forming thick, yellow, circular cups which cause local scarring and atrophy of the hair follicles. It is a much rarer disease in this country than formerly; but cases are still occasionally seen.

Symptoms.—Favus attacks the *scalp*, the glabrous skin and the nails, and has been recorded on the mucous membranes. On the scalp it appears as a collection of pea-sized or slightly larger circular yellowish crusts standing up from the skin and having a central depression, through the centre of which the hair projects. This is the favus cup or scutulum. Very large areas of the scalp may be involved in the process, the whole having a honeycombed appearance. Where the disease has been cured, scars and permanent alopecia are left. In section the yellow cup is seen to be made up of masses of mycelium radiating from the centre. Favus on the *glabrous skin* shows a somewhat similar appearance, a collection of bright yellow cups forming a massive crust, the whole being surrounded by an inflammatory zone. When seen in this country the lesions are generally very few in number and on the exposed parts, but in some countries where the disease is common the whole body may be covered with great masses of favus scutula. Favus of the glabrous skin in this country is often of mouse origin, and a different species to the scalp favus. Favus of the *nails* has somewhat similar characteristics to that of ringworm of the nails.

Treatment.—The only satisfactory treatment for favus of the *scalp* is X-rays. The risks of alopecia mentioned in the treatment of ringworm need not be considered here, as alopecia will result in any case from the disease. As a preliminary to X-ray treatment the crusts should be removed and the scalp cleaned up with appropriate antiseptic applications.

In *body* favus the scutula must be removed, and the patches treated with either Whitfield's salicylic and benzoic ointment or a 10 per cent. chrysarobin ointment.

Favus of the *nails* is treated in the same way as ringworm of those parts.

Tinea Versicolor

This is a superficial infection of the horny layer with the *Microsporon furfur*, and is frequently seen among hospital out-patients.

Symptoms.—It usually forms very thin, greenish-yellow patches or a continuous sheet over the chest and abdomen; but may cover larger areas of the body. It is said to occur chiefly in people who wear thick woollen underclothing and perspire freely. If the patches are scraped scales can be

removed, and these examined in liq. potassæ show thin mycelial threads with large round spores among them.

Treatment.—The treatment is the same as for other body ringworms, salicylic and benzoic acid ointment or a sulphurous acid lotion causing rapid cure. The underclothing should, however, be sterilised, or reinfection will occur. Precautions against over-clothing should also be taken.

Erythrasma

This is an uncommon disease in this country, and is due to the infection of the horny layer with an extremely small fungus, the *Microsporon minutissimum*.

Symptoms.—The affection occurs as superficial, reddish-yellow patches and plaques, more or less symmetrically arranged, chiefly in the groins and axillæ.

Diagnosis.—The malady is to be distinguished chiefly from tinea cruris, and this can readily be done by noting the size of the mycelial elements under the microscope. In erythrasma they are so small as to require a $\frac{1}{12}$-inch objective, and under it appear as small bead-like chains, with masses of spores intermingled, while in tinea cruris chain-like mycelium can easily be seen under a $\frac{1}{8}$-inch objective.

Treatment.—The treatment is the same as for pityriasis versicolor.

Lepothrix

This is a not very uncommon affection of the axillary hairs in which they become surrounded with dark reddish concretions.

According to Castellani, this affection is caused by a bacillary-like fungus, *nocardia tenuis*, acting in symbiosis with a red pigment-forming coccus, *micrococcus castellanii*.

The treatment consists in dabbing the affected hairs twice daily with alcoholic formalin (2 per cent.), and rubbing in at night a 2 to 5 per cent. sulphur ointment. Calamine lotion may be used to allay any irritation caused by the treatment (Castellani).

DERMATITIS DUE TO ANIMAL PARASITES

The affections of the skin due to animal parasites are of a mixed variety, but for general purposes may be classed under the superficial dermatoses. Animal parasites produce their effects on the skin either by puncturing and injecting an irritating substance or by burrowing in the skin; but what have chiefly to be taken into consideration are the secondary effects produced by the irritation these creatures produce. In tropical countries the number of animal parasites which produce skin lesions is very large; it is proposed here, however, to consider only those seen commonly in this country.

Bites and Stings

The common flea, the bed-bug, gnats and the pediculus family are the common biting insects seen in this country, while of the stinging insects

bees, wasps, hornets and ants may be mentioned. Excluding pediculi, which require more detailed description, the lesions produced by all these insects are wheals of varying size, depending on the particular insect, and also on the susceptibility of the person attacked. The lesions are familiar to all, and require no detailed description.

Treatment.—As most of these stings are due to an acid irritant, the application of weak solution of ammonia and other alkalis gives most relief. In the case of the bee the sting should be removed if still in the skin.

Pediculosis

Three forms of pediculi attack man: the *Pediculus capitis*, the *P. vestimentorum* or *corporis*, and the *Pediculus* or *Phthirius pubis*.

The first two are merely varieties of the same species—the *Pediculus humanus linnæus*.

Pediculosis Capitis.—Ætiology.—This condition is caused by a small insect, 2·5 to 3 mm. long, with an oval body consisting of a narrow thorax and wide abdomen, to the former of which are attached six legs, each being provided with a hook-like extremity, with which it hangs on to the hairs. The head is small, oval and provided with two antennæ, a powerful mandible and a proboscis, with which it punctures the skin in order to suck the host's blood. This variety is found among the scalp hairs, chiefly in female children of the lower classes. Pediculi breed with great rapidity, laying their eggs on the hairs. The eggs are contained in a chitinous, ovoid cell, with a movable lid or operculum, and are known as nits; they are laid from the scalp outwards, and each is stuck on to the hair by a drop of cement extruded by the female as she moves along the hair. Nits can only be removed by unthreading them from the hairs.

Symptoms.—Itching is the only symptom produced by the *P. capitis*, and this is due to an irritating substance injected by the insect when it bites. A large number of infested individuals feel no itching; they are, however, a source of danger, as they infect others. If the itching is severe, scratching follows, and this frequently causes impetigo contagiosa, which is most marked at the back of the scalp, but may spread to the vertex, eventually involving the whole scalp and matting the hair down among thick crusts. Similarly it may spread to the back of the neck and shoulders, and involve large areas of the body. Even when impetigo is absent, the presence of scratch marks on the back of the neck and shoulders is almost diagnostic of *P. capitis*.

Diagnosis.—All cases of impetigo of the scalp, especially in children, should be examined for pediculi. The diagnosis is easily made by finding the pinhead-sized, white, shiny oval bodies attached to the base of the hairs, and in bad cases the transparent little insects themselves can be seen scuttling about among the hairs.

Treatment.—The insects are easy to kill, but the nits are more resistant. The favourite method is to saturate the scalp with paraffin and tie it up for 12 hours; this has the disadvantage of being messy, and is not free from danger if the head is brought too near a naked light. Whitfield's method of saturating the hair with 1 in 40 carbolic acid and then tying the hair up in it for half an hour is very efficacious, especially when much impetigo

is present. After this, the crusts can be removed and the nits combed out, and a weak ammoniated mercury ointment applied.

PEDICULOSIS VESTIMENTORUM.—**Ætiology.**—The causative parasite has exactly the same anatomical character as the preceding, but is usually slightly larger, up to 3 to 4 mm. in length. It is not very common in civil life, being only seen in the habitués of the casual ward and the common lodging-house. In war-time, however, it becomes one of the chief causes of sick wastage of armies, being almost universal in its incidence and causing an enormous amount of skin disease.

The insect lives chiefly in the clothes, coming on to the body in order to feed; it is chiefly found, therefore, in those parts of the clothing which come into most intimate contact with the body. In civil life the *Pediculus vestimentorum* is rarely seen, but its nits may be found in the seams of the underclothing of infected persons. Occasionally in heavily infested people nits may be found on the axillary, pubic and perineal hairs.

Symptoms.—The skin lesions in this condition are mainly those produced by scratching. Closely placed, small, red macules may occasionally be seen, the results of the insect bites, but this is unusual. The scratch eruption has a characteristic distribution and type. In civilians, it is most marked about the back of the shoulders and around the waist and upper part of the buttocks. In soldiers, it is even better marked on the legs and about the knees, owing to wearing the puttee. The lesions in earlier cases are papules, surmounted by hæmorrhagic crusts and linear excoriations. In cases of longer standing, areas of eczematisation and lichenification occur, and the skin becomes irregularly pigmented. Septic complications are not very common in civil life, but in the field are the rule. Boils and linear, gutter-shaped ulcers, described under ecthyma on p. 1297, are extremely common under these latter conditions, chiefly on the legs.

Diagnosis.—This has chiefly to be made from scabies, but the presence of the burrows and the distribution of the rash—described in detail in the article on that disease (p. 1318)—should enable a diagnosis to be made. From senile pruritus the diagnosis can only be made by finding lice or their nits.

Treatment.—Disinfection of the clothing and bedding of the infected person is all that is required, except in those who harbour nits on their hairs, in which case the latter should be cut short or shaved. Most local sanitary authorities will carry out the necessary disinfestation if duly notified; the methods employed scarcely come within the scope of this work. Local lesions can afterwards be treated with sedative lotions and creams, and impetiginous lesions as already described (p. 1296).

PEDICULOSIS PUBIS.—**Ætiology.**—The *Pediculus* or *Phthirius pubis* has a different appearance from that of the above-mentioned varieties; the body is shorter, wider and almost triangular in shape. It is usually about 1·5 mm. long and about the same width, and is provided with six legs, which are more curved than in *Pediculus humanus* and are also provided with hook-like extremities. This louse can move with considerable rapidity along the hairs, but has very limited powers of movement on a flat surface. When found among the hairs it is seen clinging with its legs to two adjacent hairs. Its eggs are laid in the same manner as with other varieties.

The pubic louse is found almost exclusively in the pubic and perineal

hair, but in severe cases the hair in front of the abdomen, chest and thighs may be infested, as may also the axillary hairs, the beard, the eyebrows and eyelashes. It is extremely rare on the scalp. It is usually transmitted during coitus.

Symptoms.—There are two main symptoms, itching and the presence of small bluish stains on the skin. The itching is often intense and may lead to loss of sleep, but is localised to the area attacked. Scratch lesions are not very common, doubtless owing to the protection afforded by the stout pubic hairs; they do, however, occur. The bluish stains found on the skin in regions infested by the crab-louse are now known to be produced by the bites of the insect. They are 4 to 10 mm. in diameter, not raised above the skin, and do not disappear on pressure. They are known as *maculæ cæruleæ*.

Diagnosis.—This is made by finding the louse and its nits attached to the base of the hairs.

Treatment.—The best results are obtained by clipping the hair short and rubbing in 1 per cent. β-naphthol ointment. Ung. hydrarg., carbolic acid lotion (1 in 40), and petrol are also used, but the former of these may set up a severe dermatitis if not carefully used. On the eyelashes, the insects and their nits should be removed with forceps.

Scabies

Ætiology.—Scabies is a disease caused by a spider-like, acarine parasite, the *Sarcoptes scabiei*. The acari form a large group of animal parasites which attack man and the lower animals. The parasite generally found in man (var. *hominis*) is a special variety and is not contracted from animals. Various other acari, however, which attack animals may also attack man, but they do not produce identical symptoms.

The *Sarcoptes scabiei*, commonly spoken of as the acarus, is a minute round body, just visible to the naked eye, and of white shining appearance. The body bears eight legs, which differ in the two sexes. In both sexes the two anterior pairs bear suckers; in the male the third pair bear long bristles and the fourth pair bear suckers, while in the female both hind pairs bear bristles. The female is larger than the male, and burrows in the horny layer of the skin to lay her eggs. If undisturbed the female may live for 2 to 3 weeks and lay up to about 30 eggs. The eggs are laid in the burrow and the young hatch out there, the complete cycle from egg to mature acarus being completed in about 10 days. The larvæ, however, hatch out in 3 to 3½ days.

The female acarus has certain favourite sites for burrowing, namely, the genitals, the fronts of the wrists, the web and sides of the fingers, the ulnar border of the hand, the backs of the elbows, the anterior axillary folds, the nipples in women, the umbilicus, the sides of the gluteal cleft and lower part of buttocks, the front of the knees, the ankles and the dorsum of the feet. In infants the palms and soles are also frequently affected.

Symptoms.—The eruption of scabies is of two kinds—the acarine burrows and the follicular papular eruption. The burrows occupy the sites named above. They are seen most clearly on the hands, where they usually

form thin, sinuous lines, from a millimetre up to a centimetre in length and occasionally even longer. The burrow is generally easily seen, as dirt accumulates in it, but quite often it can only be recognised by a lens. The oldest part of the burrow has a splay mouth, while at the other end the small white body of the acarus, with a black spot in its fore part, can be easily seen with a lens and often with the naked eye. Frequently a clear vesicle or vesicles are seen beneath the burrow, but as a rule on the hands no redness is present unless secondary infection has occurred. When blisters are present, secondary infection is frequent, and pustular, weeping and crusted areas are produced. In other sites vesicles are not common, but a large pea-sized papule usually underlies the burrow, and the burrow itself and its acarus are not so easily seen; these lesions are frequently seen on the penis, scrotum and anterior axillary folds, and are usually diagnostic.

The follicular papular eruption is arranged in smaller or larger circles round the areas where the burrows occur. The main distribution is on the anterior aspect of the body, from the nipples to the knees, and in a semicircle around the anterior axillary fold. The back is free, except in severe cases, down to the top of the gluteal cleft, but scratch lesions occur on the lower part of the buttocks, where ecthyma is often a complication, and on the back and inner parts of the thighs. On the limbs the eruption occupies both front and back of the forearms, up to about the centre of the arm, and also occurs around the ankles. The lesions are first pinkish or whitish elevations of scattered hair follicles, but soon they become covered with bloodstained crusts from scratching. Linear scratch marks are rare in scabies. It is not clear what produces the scratch eruption in scabies, but the work of J. W. Munro suggests very strongly that the follicular lesions are produced by the acarine larvæ, and the distribution of the lesions adds confirmation to this view.

In old-standing cases almost the whole body may be affected, though the face and scalp are practically never attacked in adults; but in small children even these areas may suffer.

Diagnosis.—In well-marked cases no difficulty arises, as the burrows can be seen, but in treated cases the diagnosis may be very difficult and a diagnosis from pediculosis may have to be made. Also the two conditions may occur together. The distribution and character of the rash will usually settle the point, but a careful search with a lens for burrows and acari should always be made.

Treatment.—This depends more on the carrying out of detail than on the actual parasiticides used. Three things are necessary, namely, the opening of the burrows by scrubbing, the subsequent application of a parasiticide to the body, and the disinfestation of clothes and bedding. The body should be soaked in a hot bath, then rubbed with soft soap, and finally scrubbed with a brush, particular attention being paid to areas where burrows occur. After this sulphur ointment (B.P.) is rubbed in all over the body (face and scalp excepted), and the patient again dresses, his clothes having been disinfected in the meanwhile. On the two following days the ointment is again rubbed in, but no bath given (as it tends to increase the liability to sulphur dermatitis), on the fourth day nothing is done, and on the fifth day the patient has a bath—to wash off the ointment—and puts on

clean things, all dirty linen being sent to the wash. If any dermatitis from the sulphur arises, lin. calaminæ, to which 2 per cent. liq. pic. carb. is added, may be smeared on, and if there is much sepsis appropriate treatment can then be applied. Balsam of Peru ointment, 12 per cent., and β-naphthol, 5 per cent., may be used as alternatives to sulphur. Many other methods are in vogue, but the above is generally the most satisfactory.

B.—THE DEEP INFLAMMATORY DERMATOSES

Under this heading are included those inflammatory conditions which start in the dermis or hypoderm, and only involve the epidermis secondarily. It is often easy to decide clinically whether an inflammation starts in the dermis or in the hypoderm, and strictly these conditions should be described separately; but as the same exciting cause may often produce either condition, it is simpler to describe them together.

The causative irritant may reach the point attacked in three ways—namely, (1) through a crack or puncture in the epidermis, (2) by the lymphatics, or (3) by the blood stream. In the first group are included those cases in which certain chemical poisons are introduced into the skin by the bites and stings of insects (already dealt with on p. 1315), and cases in which micro-organisms are introduced into abrasions, as in the case of erysipelas from the streptococcus (p. 55), syphilitic chancre from the *Spirochæta pallida* (p. 190), soft sore from Ducrey's bacillus, lupus vulgaris and lupus verrucosus from the tubercle bacillus (p. 1334), and actinomycosis, sporotrichosis, etc., from certain fungi. The second group includes certain lesions produced by bacterial irritants, such as are seen in the lymphangitic abscess in tuberculosis and the sporotrichial gummata. The third group includes the drug eruptions and other dermatoses, which are labelled toxic eruptions and which are presumably due to chemical poisons circulating in the blood, and also eruptions due to the circulation of micro-organisms, such as are seen in the syphilides and tuberculides. For convenience of description it is proposed to deal with the majority of deep inflammatory dermatoses under two headings—(1) the toxic eruptions, and (2) eruptions produced by living organisms. It must be understood, however, that in the present state of knowledge the ætiology of many of those included in the former group is still very obscure. There is also a third group of dermatoses whose characters make it difficult to place them in either group, and these have, therefore, been described as (3) *dermatoses of unknown origin*.

TOXIC ERUPTIONS

It is practically impossible to produce experimentally in animals any of the toxic eruptions, owing to the fact that no animal has a skin comparable to that of man. Consequently, all our experimental knowledge of toxic eruptions has to be derived from the observed effects of drugs and foodstuffs on the human skin. It is, therefore, proposed to consider first the eruptions produced by these substances.

DRUG ERUPTIONS

These fall into two great classes—those produced by protein-containing and those by non-protein-containing drugs. The latter include all the ordinary galenicals, while the former include serums and vaccines, as well as protein food-stuffs. Extracts of organs given by the mouth rarely, if ever, produce eruptions and are, therefore, not specially considered.

NON-PROTEIN-CONTAINING DRUGS.—Two classes of eruption are produced by these—(*a*) Non-specific eruptions, which may be produced indiscriminately by many different drugs, and (*b*) specific eruptions, which are peculiar to certain drugs.

Symptoms.—NON-SPECIFIC ERUPTIONS.—These are generally erythematous, urticarial or purpuric. The erythematous rashes may be scarlatiniform, morbilliform, or, more rarely, of the erythema multiforme type; sometimes the lesions are vesicular. Urticarial lesions are usually of the simple urticaria type, but occasionally the giant forms are seen. Purpuric lesions are often erythematous at the start and develop hæmorrhages later. It is difficult to classify drugs into any special groups by the reactions they produce, but it may be noted that the under-mentioned types of eruption may be produced by the drugs named:

Erythematous.—Acetanilide, alcohol, antipyrine, arsenic, aspirin, belladonna, benzoic acid, cantharides, capsicum, chloral, chloralamide, chloretone, chloroform, copaiba, cubebs, digitalis, ipecacuanha, mercury, opium, pilocarpine, phenacetin, quinine, rhubarb, salicylic acid and the salicylates, stramonium, strychnine, sulphonal, turpentine and veronal.

Urticarial.—Antimony, arsenic, benzoic acid, chloral, copaiba, digitalis, opium, phenacetin, pilocarpine, quinine, salicylic acid and the salicylates, santonin, turpentine and valerian.

Purpuric.—Arsenic, chloral, chloroform, copaiba, ergot, hyoscyamus, iodoform, mercury, phosphorus, quinine, salicylic acid and the salicylates, stramonium and sulphonal.

SPECIFIC ERUPTIONS.—Certain drugs give rise to eruptions which are characteristic of the drugs. The following are the most important:

Arsenic.—In addition to simple erythematous and urticarial lesions, an acute generalised exfoliative dermatitis may develop. This is especially seen after injections of salvarsan. Herpes zoster also occurs, presumably from the action of arsenic on the posterior root ganglia. Pigmentation, especially about the trunk, though it may be more or less generalised, is seen in chronic arsenical intoxication. It usually presents a fine reticular pattern. Hyperkeratosis occurs chiefly on the palms and soles; it may be diffuse or occur in localised, corn-like projections. Occasionally these localised hyperkeratoses develop into epitheliomata. Excessive sweating of the palms and soles (hyperidrosis) may occur, and the nails may become striated and brittle.

Bromides.—Two main types of specific eruption are seen. Bromide acne is a follicular hyperkeratosis, often closely resembling acne vulgaris and seen in the same situations, but often more extensive, involving the legs and arms, as well as the face, chest and back. It is seen chiefly in epileptics who have taken bromide for some time. The other form is the so-called "anthracoid" form, which is most commonly seen in infants and children;

in the former the drug is often conveyed in the mother's milk. Nodules and tumours varying in size from a pea up to an inch or two in diameter are found, chiefly on the face and legs. The tumours are of a deep red colour and studded with minute pustules; in the larger lesions the surface is often crusted, and in some cases ulceration occurs.

Iodides.—The most typical lesions produced by iodides are papules which look like vesicles and bullæ, but when pricked only blood escapes. They are sometimes spoken of as "pseudo-bullæ." They are common on the face and extremities, and often appear after taking quite small doses of iodides and within a very short time, even as quickly as 24 hours. They are most common in patients suffering from nephritis. These lesions may increase rapidly in size and produce large tumour-like masses, studded with pustules or with a crusted or ulcerated surface, and when occurring in patients who are seriously ill may hasten a fatal termination from septic absorption. In the early stages the cases have been mistaken for small-pox. An acne similar to that produced by bromides is also seen.

Antipyrine.—In addition to producing the more generalised types of eruption, antipyrine may produce large erythematous reddish or purplish patches, situated discretely over the body, of sharply circular outline and giving rise to a sensation of burning. When they subside they leave a very marked pigmentation, which disappears very slowly.

Phenol-phthalein.—This drug, now largely used as an aperient and contained in many proprietary remedies, occasionally produces an eruption similar to the last named. The patches are of dull purplish colour and come out on face and limbs, but often also affect the mucous membrane of the mouth. The lesions belong to the group known as "fixed eruptions," as they tend to recur at the same site if the drug is repeated.

Mercury.—This drug occasionally gives rise to a severe erythema in the groins and axillæ, and also on the palms and soles. There may be also purpuric spots and vesicles. Other symptoms of mercurialism, such as nephritis and ulcerative stomatitis, may also be present.

Silver.—Long-continued ingestion of this drug produces a peculiar slaty-grey pigmentation of the skin, generally universal, but most marked on the exposed parts. It scarcely comes under the heading of inflammations, but is included for the sake of convenience.

Protein-containing Drugs.—These include the antitoxin sera and bacterial vaccines. Vaccines rarely cause marked cutaneous eruptions, but when they occur they are of similar nature to those produced by sera. Serum eruptions form a very interesting group, as it is reasonable to suppose that their method of production is closely analogous to that of those toxic eruptions whose ætiology is obscure. For it has been assumed that these are due either to absorption of poisonous proteins produced by the body or to the toxins of pathogenic bacteria which are present in the body.

Serum eruptions are supposed to be an anaphylactic phenomenon and, though this seems to be a reasonable explanation in those cases where the rashes follow a second injection of a foreign protein given at least 14 days after the first, it does not fit in so well for cases in which the eruption follows the first injection of serum.

Symptoms.—Any of the above-mentioned non-specific eruptions may develop, but there is a greater tendency for the lesions to be of the *erythema*

multiforme type. Often the rash is very extensive, the trunk, face, and limbs being covered with disk-like, sharply circumscribed, infiltrated red lesions; these often become bullous, and hæmorrhages may occur in the centre of the lesions. In other cases ringed lesions occur, which spread peripherally and clear in the centre—*erythema gyratum*. Not infrequently these lesions are associated with fever, and pain and swelling in the joints, and gastro-intestinal disturbances, such as diarrhœa and vomiting, and albuminuria. In other cases the lesions are more of an urticarial nature, with transitory, very itchy wheals and swelling of the skin of the face. These eruptions usually come out about a week or 10 days after the injection of the serum, and clear up in about the same time.

Similar eruptions sometimes develop in persons vaccinated against smallpox, though in addition a true vaccinial eruption, in which the lesions have the characters of the vaccine vesicles, may develop.

Urticarial lesions develop in certain individuals who are sensitive to certain food-stuffs, after ingestion of these substances. They will be considered more fully under Urticaria (p. 1325).

Treatment.—Speaking generally, the first thing is to stop the drug causing the eruption. In the erythematous and urticarial types local soothing lotions are indicated, of which the most useful are lead and opium lotion; or liq. potass., ℥i; sp. vin. rect., ℥i; aq. ros. ad ℥viij; or ac. carbol., ℥i; glycerin., ℥i; aquam ad ℥viij. Alkaline and bran baths are often very useful.

In the serum eruptions, calcium chloride or lactate is recommended and may be given in 10-grain doses three times a day. Quinine, grs. i or ij three or four times a day, is sometimes of value. In the more severe cases the patient must be kept in bed.

THE ERYTHEMATA

The term erythema may be used to signify any transient redness of the skin, such redness being frequently produced by external irritants; and these have already been dealt with under the superficial inflammatory dermatoses. When, however, the term is used to describe a composite clinical picture, two main types have to be considered, namely, the non-infiltrative and the infiltrative.

The Non-infiltrative Erythemata

These include two classes, the congestive and the inflammatory. The congestive type has little or no dermatological importance. It is seen in blushing, which is a pure vasomotor phenomenon, and also in such transitory rashes as that seen during ether administration. The inflammatory type includes the rashes seen in scarlet fever, measles and rötheln, drug eruptions just referred to, and certain other toxic conditions.

Ætiology.—One of the commonest varieties of erythematous rashes is that occurring as the result of septic absorption from a wound, and many of the cases of so-called surgical and puerperal scarlet fever belong to this group. They also occur in ptomaine poisoning and in other infections of the gastro-intestinal tract, but there always remain a number of cases in which no cause can be found.

Symptoms.—Erythematous rashes are usually of either the scarlatiniform, morbilliform or figurate type. The scarlatiniform cases differ from true scarlet fever in the absence of other typical signs, such as high temperature combined with rapid pulse, the date of appearance of the rash, the presence of sore throat and the characteristic appearance of the tongue. The morbilliform erythemata differ from measles in the absence of coryza, conjunctivitis and respiratory catarrh. The temperature is atypical and Koplik spots are not found. The figurate variety consists of patches or groups of disk-like lesions which tend to spread peripherally and clear in the centre so as to leave circinate and gyrate patterns. It is seen most commonly in drug eruptions, and can hardly be confused with anything else. In all these varieties as the eruption subsides there is a tendency to scaling, usually of the fine branny type, and this may often be extensive; the glove-like scaling of the palms and soles, seen in scarlet fever, may also occur in the simple types of erythema.

Hæmorrhage may sometimes take place into the erythematous patches, especially when these occur on the lower limbs. Most cases of simple purpura really belong to the erythema group. The mucous membranes may be affected similarly to the skin, and other general symptoms, such as diarrhœa, vomiting, fever and albuminuria, may be present.

Treatment.—Attempts must be made to find and remove the cause. All possible septic foci, such as pyorrhœa, tonsillar sepsis and chronic appendix trouble, should be dealt with. The bowels should be made to act freely and a light diet ordered. Cases should generally be put to bed, and always when there is fever or any marked constitutional symptoms.

The Infiltrative Erythemata. Erythema Multiforme

Ætiology.—Erythema multiforme may occur as a drug eruption, and especially as a serum eruption, as already noted, but it generally appears without any special cause being determinable. It occurs especially in young adults and may often recur, some cases doing so year after year at regular intervals. Individual attacks may clear up rapidly, but in many cases fresh crops appear, and the disease may go on for weeks or months. The joint swellings which sometimes accompany the skin lesions led to the supposition that the condition was of rheumatic origin, but it is probable that these are only a manifestation of a similar affection of the synovia of the joints.

Pathology.—Microscopic examination shows a dilatation of the vessels of the dermis with a leucocytic exudation. There is much local œdema. The epidermis is œdematous and fluid may accumulate beneath the horny layer or less frequently beneath the epidermis.

Symptoms.—The lesions of erythema multiforme differ from those mentioned in the last section in forming raised infiltrated lesions, which vary in size from a pea to a five-shilling piece or larger, and which have a well-defined distribution. They are usually found on the backs of the hands, wrists, and forearms and on the face, but are not infrequently found on the palms, and may also involve the trunk and lower limbs. In the milder cases they consist of red papules and patches with a sharply-defined border and are usually completely circular in outline. In the more severe forms hæmorrhages occur in the centre, or they become surmounted by bullæ. There

is some tendency to slow peripheral extension, with clearing up of the centre, so that ringed lesions may be formed. In these a play of colours may be noted, the outer red ring surrounding a purple hæmorrhagic ring, which in its turn surrounds a brownish pigmented centre; these lesions are sometimes called *erythema iris*. In rare cases the bullæ so predominate as closely to resemble a pemphigus. The subjective symptoms are often slight, but sometimes itching and burning occur. Lesions may appear on the mucous membranes. Pain and swelling in the joints are not infrequent, and gastro-intestinal disturbance may occur, as may also fever and albuminuria.

Treatment.—Care must first be taken to remove any possible cause. Of the drugs which are of value are calcium lactate, the salicylates and quinine. The former is best given in 5ss. doses on alternate nights. Local treatment is not really necessary, but calamine lotion or liniment may be applied to relieve itching or burning.

Erythema nodosum is closely related to erythema multiforme, and is dealt with on p. 301.

GRANULOMA ANNULARE

This is a very chronic, raised, ringed eruption, of dead white colour, seen chiefly on the dorsum of the hands.

Ætiology and Pathology.—The cause of this condition is unknown, but various intermediate types between it and erythema multiforme have been noticed, and this suggests a relationship with the latter condition. Histologically a dense cellular infiltration, associated with degeneration of the collagen bundles, is found in the deeper layers of the dermis, especially in the neighbourhood of the sweat coils.

Symptoms.—The earliest lesions are lentil-sized white nodules, seen most commonly on the back of the finger joints. Such lesions often occur in groups. They spread slowly, the centre of the group becoming flattened, and surrounded by a raised, dead white festooned margin, which can be seen to be made up of nodules of the same character as those of the original lesions. The disease is very slowly progressive, and may last for months or years if not treated. The lesions are generally localised to the hands and wrists, but are occasionally seen in other parts of the body, such as the nape of the neck, the buttocks, elbows and knees. In some cases subcutaneous fibrous nodules have been described in the neighbourhood of the elbow joints and elsewhere. Subjective symptoms are generally absent.

Treatment.—Internally, quinine and the salicylates may be given. X rays will often cause the lesions to disappear, but no other local treatment has much effect.

THE PURPURAS

The purpuras form a group which are closely related to the erythemata and are very often erythematous at the start. In them, however, the blood vessel walls are damaged and hæmorrhage occurs into the dermis. They may be of toxic or of bacterial origin. They are considered in detail on p. 725.

THE URTICARIAS

The urticarial eruptions are characterised by the presence of wheals, or localised areas of œdema. These are usually transitory in character and are accompanied by severe itching. Several different forms are recognised—

(1) Simple urticaria, (2) factitious urticaria, (3) giant urticaria, (4) papular urticaria, and (5) urticaria pigmentosa.

Ætiology.—As is pointed out above, urticaria can be produced by the ingestion of certain drugs and by injections of foreign sera. It can also be produced by the ingestion of certain food-stuffs in susceptible persons; for example, porridge, strawberries, shell-fish, eggs and milk. It also occurs after the consumption of decomposing food. As far as is known it is never due to the direct attack of any micro-organism. It is clear that it may be produced not only by protein poisons, but by non-protein poisons circulating in the blood. The actual mechanism by which the lesions are produced is not altogether clear. At one time it was thought to be a pure vasomotor neurosis, and that the poisons mentioned acted on the vasomotor centres; but in recent years it has been demonstrated that the lesions are true inflammations, and, therefore, it is probable that the action of the poison concerned is a local one. At the same time external stimuli, such as friction, seem, in many cases, to play a part in determining the points where the poison acts. It must also be noted that urticarial lesions may be directly produced by the injection of poisons into the skin. This is well seen in the bites and stings of insects, and the stings of plants, such as the nettle. In a large number of cases of urticaria, however, it is difficult to find any cause, and these are usually considered to be auto-toxic. The auto-toxin may be generated in the intestinal tract, or in infected foci, such as septic tonsils and teeth and inflammatory trouble in the pelvis. In the giant urticaria cases there is usually a considerable functional element present, and these cases are sometimes considered to be a vasomotor neurosis. Nothing is known of the ætiology of urticaria pigmentosa.

Symptoms.—*Simple urticaria.*—This is the form most frequently met with in adults. It may occur in an acute or in a chronic form. In the former the eruption appears suddenly, is often accompanied by general symptoms, such as fever, diarrhœa and vomiting, and subsides more or less rapidly. In the chronic type the eruption appears in crops; the individual lesions run a more or less rapid course, but fresh crops continue to come out at intervals and the condition may persist for many weeks, months or even years.

The lesions of simple urticaria are in their earliest stages pale pink papules or patches, varying in size from a pea to an inch or two in diameter. In a short time—sometimes a few minutes, at others an hour or so—the central part of the patch becomes a dead white colour, is firm to the touch and raised a millimetre or two from the surrounding skin. The lesions are intensely itchy. They may be few in number or very numerous; sometimes the whole body may be covered with patches of all shapes and sizes, and figurate patches are common. The eruption is most common on the trunk, but any part of the body, including the mucous membranes, may be affected.

Rarely hæmorrhages occur into the patches, and still more rarely do vesicles or bullæ surmount the patches.

Factitious urticaria.—This is a condition of the skin in which the slightest trauma, such as a slight scratch, will bring out a wheal. This condition is often present in simple urticaria, but frequently exists apart from any spontaneous eruption. The condition is sometimes referred to as *dermatographism*, as it is possible to produce letters in urticarial wheals on the patient.

Giant urticaria.—In this condition the lesions are not so much wheals as circumscribed patches of œdema. They are particularly liable to occur about the face—the eyelids, cheeks and lips often swelling up quite suddenly—burning or itching being an accompanying phenomenon. The mucous membranes are not infrequently attacked, and in a few cases sudden œdema of the larynx may produce dangerous asphyxial symptoms. The lesions are very prone to recur, and these recurrences may persist for years. This condition is sometimes spoken of as *angio-neurotic œdema* (see p. 978).

Papular urticaria.—This type is really only a variant of simple urticaria, but is that commonly seen in infants and young children. It is not very commonly seen in breast-fed infants, though it does occur, but otherwise is chiefly seen in the first two years of life; it may in some cases, however, persist, with intermission, up to about 7 years of age. The lesions appear, just like those of the adult form, as pink oval patches, usually about ½ inch in diameter, but instead of the bulk of the whole patch being converted into a wheal only a central pinhead-sized wheal is produced. Itching is intense and often paroxysmal. When the lesion is scratched the central papule becomes inflamed and a bloodstained crust is formed on its summit, and it persists after the surrounding pink zone has disappeared. The cases usually present discrete pinhead-sized papules, covered with bloodstained crusts, suggesting a parasitic origin.

The eruption comes out in crops, especially at night, and chiefly on the lower part of the trunk and thighs, but may occur almost anywhere on the body. The children seem to suffer little in general health, though sleep at night is often lost, its effects being often more obvious in the parents.

Urticaria pigmentosa.—This is a rare condition and it is still a question whether it should be grouped with the other urticarias. It is chiefly a disease of infancy, but a certain number of adult cases are on record. The condition may appear within the first few days of life, and in a few cases lesions are said to have been present at birth.

The lesions usually appear as wheals, ¼ to ½ inch in diameter; and as these disappear a yellowish-brown colour is left, and the lesion may remain raised above the surrounding skin or may flatten down to a pigmentary macule. These pigmented lesions may persist for many months or years. Itching may or may not be present. Sometimes marked factitious urticaria can be elicited. It would appear that occasionally simple urticarial lesions may leave behind pigmentation, but the condition described above is something quite distinct. In true urticaria pigmentosa there is generally a great increase in the mast-cells of the dermis which is absent in ordinary urticaria leaving pigmentation.

Diagnosis.—Simple urticaria may be confused with dermatitis herpetiformis and with the premycosic stage of mycosis fungoides. In the former, small deep-seated vesicles usually occur; but as they are not always present the diagnosis may be difficult. From the latter a diagnosis cannot be made with certainty, though when occurring in old people and persistent, mycosis fungoides must be considered.

The giant forms must be distinguished from erysipelas and acute erythematous eczema. In the former, high temperature is present, the lesion has a sharply defined, slowly spreading margin, and is often blistered. In the latter, the eruption is extensive and symmetrical, the skin is red, and vesicles

are frequently present. Chronic erysipelas of the lip is a persistent, slowly increasing condition and usually arises from a persistent crack in the lip, while urticaria has a sudden onset and disappears again.

Papular urticaria in children is most frequently confused with scabies. The diagnosis can be settled by the presence of burrows and the finding of acari in the latter condition.

Urticaria pigmentosa is not likely to be confused with any other condition.

Treatment.—If a cause can be found it must be removed: articles of diet known to cause the eruption must be avoided and all possible septic foci dealt with. If the cause is not clear, various types of food must be stopped one by one in order to exclude a possible source of trouble. Recently a cuti-reaction to various food-stuffs has been devised to detect the causative agent, and it is possible to desensitise patients from the particular poison to which they are susceptible. Apart from this, mild purgation and the administration of intestinal antiseptics, such as salol, ichthyol, creosote and calomel, can be recommended. Some patients improve on tonic drugs, such as iron, arsenic and quinine. Calcium chloride or lactate given over prolonged periods is efficacious in some cases. In others complete freedom from work and even rest in bed are necessary.

In the papular form in children excessive intake of sugar plays a part in a proportion of cases, and by a rigid cutting down of jams, sweets, etc., relief is often obtained.

In the giant form nerve sedatives, such as valerian and the bromides, are of value.

Locally, anti-pruritic lotions are most useful. Solution of coal tar and subacetate of lead, ℥ij of each to ℥viij of water; or liq. potassæ, ℥i, glycerine ℥i to ℥viij of water, may be used and can be applied frequently; alkaline and bran baths also give considerable relief. In children a teaspoonful of liq. picis carbon. added to a warm bath before going to bed is a valuable remedy, and in some cases sulphur ointment grs. xv to ℥i has proved useful but lotions are usually better tolerated.

There is no known treatment which affects urticaria pigmentosa.

PRURIGO

Prurigo of Hebra is a condition which is rare in this country, but is not uncommon in Eastern Europe. It is apparently closely connected with the urticarias, but some authors consider it a distinct affection. It begins usually in the first or second year of life, by the appearance of intensely itchy, pin-head- to lentil-sized papules on the extensor aspects of the limbs, chiefly on the legs and forearms; these soon become covered with blood-stained crusts, and eventually the whole of the skin of the affected area becomes thickened (lichenified), pigmented and excoriated. The lesions may eventually involve the whole of the limbs, but the flexures usually escape. The trunk, neck and face may become eczematised and lichenified. The glands in the groins and axillæ become much enlarged. The milder cases (prurigo mitis) may eventually respond to treatment and get well about the time of puberty, but the more severe cases (prurigo ferox) persist throughout life, the patient eventually succumbing to the disease.

Treatment.—There is no specific treatment. Baths and sedative lotions

and ointments, together with sedative drugs, to relieve itching and to ensure sleep, should be employed.

DERMATITIS HERPETIFORMIS

Dermatitis herpetiformis or Duhring's disease is a condition characterised by the appearance on the body of crops of erythematous or urticarial papules or patches, usually surmounted by herpetic vesicles or bullæ, and giving rise to intense itching.

The evidence for placing this disease among the toxic eruptions is not conclusive, but is sufficiently suggestive to make it justifiable. In this connection may be mentioned its occurrence as one of the rarer toxæmias of pregnancy (hydroa gestationis), and its close clinical resemblance, in some cases, to the urticarias and the erythemata.

Ætiology and Pathology.—The disease may occur at any time of life; it is rare in infancy and childhood, although cases have been reported; it is fairly common in young adult life, but most cases occur in middle life. Both sexes are pretty equally attacked. A special form occurs in association with pregnancy, and is apt to recur with each pregnancy. The malady does not appear to be associated with the presence of any particular micro-organism in the body, and cultures from vesicles and bullæ are sterile in their early stages. Blood cultures are also negative.

It has been considered by some to be due to some nervous derangement, and it is true that it is sometimes associated with neuroses; it is probable, however, that these are a product rather than a cause of the disease. It is probable that the condition is produced by an unknown toxin.

Microscopically lesions show a dense, cellular infiltration of the superficial part of the dermis, chiefly around the vessels. There is always considerable superficial œdema, which in the vesicular and bullous cases collects under the epidermis, lifting it from the underlying dermis; the fluid and the vesicles contain a large number of eosinophil corpuscles.

Symptoms.—The eruption is essentially polymorphous, that is to say, all the types of lesions mentioned above may be present in the same case at the same time. Most commonly the lesions look like irregularly figurate urticarial wheals which are surmounted by numerous shotty vesicles. In other cases the lesions are more frankly erythematous, while in others larger vesicles or bullæ form, either with or without an underlying erythematous or urticarial patch. In all cases, except when the bullæ are large, there is intense itching in the lesions, with the result that they are scratched, and small bloodstained crusts or excoriations are seen mixed up with the other manifestations of the disease. The limbs and the trunk are most frequently affected, but any part of the cutaneous surface may be involved, though rarely the palms and soles, and the mucosæ are attacked in a considerable percentage of cases. There is a great tendency for the lesions to recur, fresh crops coming out at frequent intervals, and the disease may persist for years; the writer has under his care a case of over 40 years' duration.

The general health usually suffers very little, in spite of the fact that sleep is often disturbed. Gastro-intestinal symptoms, such as diarrhœa and vomiting, may occasionally occur, and in fatal cases lesions have been

found in the gastro-intestinal tract, which possibly account for the above mentioned symptoms. An increase in the eosinophil corpuscles in the blood occurs in the majority of cases.

Diagnosis.—From erythema multiforme it can be distinguished by the irregular distribution, the shape and the polymorphic character of the lesions in conjunction with the intense itching which occurs; from urticaria by the presence of vesicles and bullæ, which are almost unknown in simple urticaria, though not infrequent in the papular variety, and by the persistence and recurrence of the lesions; and from pemphigus by the itching, the polymorphous character of the lesions, and the comparatively slight effect on the general health.

Treatment.—This calls for much patience on the part both of the patient and the physician. In the first place a careful examination, both clinical and bacteriological, must be made to find any focus of disease. Of the internal remedies most reliance has been placed on arsenic, and in some cases the eruption ceases when a certain dose is reached; but this is by no means always the case. Arsenic may be given by the mouth as Fowler's solution or Asiatic pill, or by injection, the cacodylate of soda, enesol and salvarsan being the favourite preparations. The dose should be small to start with, and increased to the limit of tolerance; and the drug should be discontinued if no definite result is obtained. Aperients and saline lavage of the bowel are satisfactory in severe cases; in others quinine, salicin and sodium bicarbonate have proved successful. In any case attempts should be made to check the itching. Alcohol and coffee should be stopped, and also all excess of sugar in the diet. Phenacetin and antipyrine are useful, and trional may be given occasionally at night. The injection of certain non-specific protein substances, such as the patient's own blood, horse serum, sterilised milk or peptone, has occasionally produced a cure.

Local remedies consist mainly of anti-pruritic applications. The most useful is a lotion containing 2 to 3 per cent. carbolic acid, 1 per cent. liq. potassæ, or 2 to 5 per cent. liq. picis carbonis. Alkaline and bran baths are valuable, especially in the bullous cases—in which cases also weak (5 per cent.) sulphur ointment sometimes acts well.

PEMPHIGUS

An inflammatory condition of the skin, characterised by the eruption of blisters usually occurring in crops, and associated with constitutional symptoms.

Four different varieties are recognised: (1) acute pemphigus, (2) chronic (pemphigus vulgaris), (3) pemphigus foliaceus, and (4) pemphigus vegetans. Acute pemphigus is now known to be a definite bacterial infection, and should not strictly be included in this group; but it is placed here for convenience of description. In the other three varieties the cause is unknown, but it is believed that they are of toxic origin.

Acute Pemphigus

Ætiology.—This is a rare condition which occurs almost entirely in butchers, and appears to be due to inoculation of some abrasion with a

pathogenic micro-organism, the diplococcus of Pernet and Bulloch. The lesions are not produced by local spread, as in impetigo contagiosa, but are distributed through the blood stream, and symptoms of acute toxæmia occur simultaneously with (or even before) the appearance of the eruption. The diplococcus can be obtained from the bullæ, as well as from the blood.

Symptoms.—The disease commences acutely with fever, malaise, nausea and vomiting. Bullæ then appear suddenly on the apparently normal skin; they are usually very numerous, and as big as a pigeon's or hen's egg. They may burst, leaving a red oozing surface. The lesions usually involve the mucous membranes of the mouth and throat, and even of the intestinal tract, causing pain and difficulty in swallowing, diarrhœa and vomiting, and secondary bronchitic and broncho-pneumonic complications. In a large proportion of cases a general septicæmic condition supervenes and the patient dies, but in a few milder cases the lesions dry up and the patient recovers. Rarely cases may become chronic.

Treatment.—The cases are so infrequently seen that little can be said on this point. The main principles are to keep the patient in bed, puncture the vesicles, and apply mild antiseptic dressing, *e.g.* 1 in 4000 perchloride of mercury, with a thin layer of paraffin gauze between it and the skin, or some such dressing which will not cause poisonous symptoms by absorption. Quinine is recommended as the best internal remedy. No observations have been made, as far as the writer knows, with regard to specific therapy.

Chronic Pemphigus

Symptoms.—The affection, which is also rare, is characterised by the appearance of crops of bullæ in various parts of the skin and mucous membranes, each bulla appearing on the skin without any pre-existing erythematous or urticarial lesion. The eruption is not associated with itching, but the general health suffers, thus differing from dermatitis herpetiformis. Further, the bullæ are usually sterile in their early stages, though both the *Staphylococcus pyogenes albus* and the *Bacillus pyocyaneus* have been found; but these are almost certainly secondary infections.

The bullæ usually dry up in the course of a week, leaving an erythematous and scaly patch, which subsequently disappears; but fresh crops of blisters constantly come out, and this state of affairs may persist for months and years. The general tendency is for the disease to continue, while the general health steadily deteriorates, and finally death supervenes.

Diagnosis.—This has to be made from dermatitis herpetiformis and from the bullous form of erythema multiforme. The main points in the diagnosis of the former have been considered in a preceding paragraph. In erythema multiforme the lesions are especially distributed on the extremities, and some of them show the definite coin-shaped erythematous patches. The attack usually lasts only a week or two.

Treatment.—This is very unsatisfactory. Arsenic in full doses has given good results, and quinine and salicin are also recommended. Gastro-intestinal antiseptics and colon lavage are useful. Intramuscular injection of horse serum, or of the patient's own serum, may be tried. Local treatment is the same as for acute pemphigus.

Pemphigus Foliaceus

This is probably only an extensive type of chronic pemphigus.

Symptoms.—Bullæ appear frequently and over large areas of the body, and as a result set up a condition resembling generalised exfoliative dermatitis When this stage is reached fresh bullæ are not properly formed, owing to the permeability of the improperly formed horny layer, abortive flaccid lesions constantly appearing on the affected areas. Crusting, scaling and a tendency to warty formations, together with much pigmentation, is present. The trunk, neck, face, scalp and limbs may all be attacked, but usually the hands and feet are much less affected.

The general health is usually much affected; but this is not always so. The writer has at present under his observation a case of 20 years' duration which, apart from the skin condition, is otherwise well. Usually, however, cases end fatally in a year or two.

Diagnosis.—The only condition likely to be confused with this is generalised exfoliative dermatitis; but in this latter condition bullous formation is absent.

Treatment.—This is the same as for chronic pemphigus.

Pemphigus Vegetans

Symptoms.—The lesions in this type frequently first appear in the mucous membrane of the mouth, but may appear on other parts of the body. When fully developed they are chiefly localised to the flexures of the axillæ, elbows, groins, knees and around the anus and vulva. The initial lesion is a flaccid blister, which on rupture develops fungating granulations from its base, which discharge much fœtid secretion. The patient's health suffers rapidly from septic absorption, and he usually succumbs in the course of a few months.

Diagnosis.—The condition when fully established is characteristic, but in the early stages the lesions might be mistaken for syphilitic mucous tubercles. The diagnosis can be settled by the presence of other syphilitic lesions, by finding the spirochæta pallida, and by the Wassermann reaction.

Treatment.—No treatment is known to influence the course of the disease. Local antiseptics are required for the lesions, weak perchloride of mercury and eusol being the most likely to be satisfactory. Otherwise treatment is on the same lines as for pemphigus chronicus.

DERMATITIS EXFOLIATIVA

This is a generalised inflammation of the skin, characterised by redness and profuse scaling. There are many types of this condition, and divers causes. It is customary to divide dermatitis exfoliativa into primary and secondary varieties. The former occurs without any pre-existing dermatosis, while the latter really represents the generalisation of some other skin inflammation, such as eczema, seborrhœic dermatitis or psoriasis. When such diseases generalise there is a tendency for them to take on the character of a primary exfoliative dermatitis, presently to be described.

The primary variety occurs in its most striking form in salvarsan poison-

ing, and may also occur in such diseases as leukæmia and mycosis fungoides—diseases closely related to one another. There still remain, however, a number of cases in which no cause can be found, and which we are probably justified in considering as toxic eruptions.

Symptoms.—The cases due to salvarsan may be taken as typical of the group. In these the eruption usually commences as bright, scarlatiniform patches on the flexor aspect of the forearms and on the abdomen and chest. The rash spreads rapidly, so that in a day or two the whole body is covered. At first it is found to consist of distinct pinhead-sized macules, chiefly around the follicles, but soon it becomes one continuous red sheet. Almost immediately the eruption begins to scale; the scales may be of the fine branny type, or large like fish scales. The amount varies in different cases, but is often very considerable, the bed having to be swept out several times a day. The onset is not always as described; sometimes the initial eruption is an urticaria, or even like an acute erythematous eczema, involving the face and forearms, and in a case recently under the writer's care it was erythemato-vesicular at the commencement. Once the eruption is fully established it usually takes 2 to 3 months to disappear. In an uncomplicated case the rash gradually subsides, scaling ceases, and the skin assumes its normal colour, though some thickening may remain for a considerable time. The flexures of the limb and the neck usually are the last to clear. The hair is frequently completely shed, but grows again later, and the nails may also be lost temporarily, though this is less frequent. An irregular thickening of the nails is, however, more common. At the onset there may be fever, malaise and intestinal disturbance; later, in the course of 3 to 4 weeks, bronchitis and broncho-pneumonia may supervene, and sometimes cause a fatal issue. Nephritis may also occur, and may cause permanent renal changes. If careful nursing is not provided the skin may become infected, and septic absorption may occur. There is always much enlargement of the lymphatic glands, which are soft and spongy, and conjunctivitis is sometimes present.

Most of the idiopathic cases run a similar course; but several different varieties have been described, among which the condition known as pityriasis rubra of Hebra is apt to be associated with visceral complications and with skin atrophy, and runs a very fatal course.

Diagnosis.—The primary cases must be distinguished from those due to leukæmia and mycosis fungoides. In the former the blood picture will probably clear the diagnosis, and in the latter the severe itching, which usually accompanies it, and which is usually absent in the simple exfoliative dermatitis cases.

Prognosis.—This is always uncertain and should be very guarded. Cases may clear up in 2 or 3 weeks, or may persist for years, with gradually increasing prostration ending in death.

Treatment.—In the salvarsan cases sulphur appears to be the best remedy. It may be given as sodium thiosulphate by intravenous injection, or as intramine or contramine, as recommended by McDonagh. The main internal remedies must be directed to maintaining the general health, and to countering complications as they arise. Complete rest in bed is indicated in all cases, however mild they may at first appear, and the warmth of the body must be maintained. Warm bran baths may be given if no fever is

present, and dusting the skin with talc powder makes the patient comfortable. Local septic complications must be dealt with by mild antiseptic creams or pastes.

ERUPTIONS DUE TO BACTERIA AND FUNGI

Having dealt with the deep inflammatory dermatoses produced by toxins circulating in the blood, it is now necessary to consider those which are caused by living organisms reaching the skin by the same channels. Three of these form a very important group of dermatoses, namely, tuberculosis, syphilis and leprosy. The two latter have been dealt with on pp. 190 and 117 respectively. There are, however, certain others which require notice. It is probable that the eruptions of certain specific fevers may be due to the presence of the infecting organisms in the tissues; this is known to be the case in the rose spots of typhoid fever, and is probably the case in variola and varicella. The erythematous and purpuric eruptions sometimes seen in malignant endocarditis and other septicæmic and pyæmic conditions are also probably due to the direct action of the streptococcus, while it will be necessary later to describe the cutaneous manifestations produced by the gonococcus when it enters the blood stream.

TUBERCULOSIS CUTIS

The tubercle bacillus may attack the skin in several different ways. The commonest variety is a superficial granulomatous formation known as lupus vulgaris; this variety can apparently be produced both by local inoculation and through the blood stream. Lupus verrucosus, a variant of this type, is always a local inoculation, and is accompanied by warty overgrowths. Miliary tuberculosis of the skin may accompany general miliary tuberculosis, and local tuberculous ulcers may also form, but are chiefly seen on the mucous membranes. In addition, an infection of the skin may occur when a tuberculous abscess, either from a suppurating lymphatic gland or bone, bursts through the skin, and this is spoken of as scrofulodermia. There are also groups of cutaneous and subcutaneous tuberculous lesions, produced by bacilli circulating in the blood, which are called tuberculides, and include several varieties, the lichenoid or lichen scrofulosorum, the acneiform or acne scrofulosorum, the papulo-necrotic, and the gummatous (erythema induratum or Bazin's disease).

Lupus Vulgaris

Pathology.—The lupus nodule is composed of a group of ordinary miliary tubercles, such as are seen in the lungs and elsewhere. It consists of groups of epithelioid cells, surrounding giant cells, often with peripherally arranged nuclei, the whole being surrounded by a dense mass of round cells. Tubercle bacilli have been demonstrated in the lesions, and inoculation into guinea-pigs will produce tuberculous lesions.

Symptoms.—Lupus vulgaris usually attacks the face; but it is not uncommon to find patches on other parts of the body. In this latter site it may be symmetrical. Usually on the face it is asymmetrical. It is most

frequent on the nose or cheek, and frequently begins in childhood. The earliest lesion is a small, dull red pinhead-sized spot, to which other similar spots are soon added, the whole being surrounded by an erythematous zone. On pressure with a lens, however, these original spots can be distinctly seen as yellowish points or nodules compared in appearance to apple jelly. They are very soft, and if a pointed match is applied to one of them it sinks easily into the nodule. These patches may slowly spread so as to involve considerable areas, and may persist for a long period without ulceration. In other cases, however, ulceration may supervene, and considerable destruction of tissue take place, especially on the nose, which is often completely destroyed up to the edges of the nasal bones. The bone itself is not attacked; but the cartilage may completely disappear. If healing occurs, a soft, superficial scar is produced; but fresh nodules are liable to appear in it. Any part of the face may be attacked; but the scalp usually escapes. The glands in the neck may enlarge and occasionally break down, but this is uncommon. Facial lupus vulgaris is frequently complicated by similar lesions in the mucosa of the nose and mouth, and these situations are sometimes the primary seat of the disease. On the mucous membranes the nodules are not visible, but sharply defined, raised, rather warty-looking patches occur. It is commonly seen on the inner aspects of the cheek, gums, palate and nasal mucosa; but the pharynx and larynx may be involved.

On the body the patches may attain great dimensions; they often spread at the margins and heal in the centre, forming irregular gyrate patterns. As a rule they are of the non-ulcerating type; but in some cases ulceration occurs. In some cases, too, considerable contraction of the skin results, leading to deformity; in others the lymphatic vessels become blocked, and a condition of elephantiasis may supervene.

The disease usually spreads very slowly, and lasts a great number of years. Some cases remain practically stationary almost indefinitely. A few, however, spread rapidly and defy treatment.

In old-standing cases there is a definite tendency to the development of carcinoma. This is of the squamous type, and does not as a rule give rise to secondary carcinomatous glands. It can, therefore, generally be removed locally.

Diagnosis.—Lupus vulgaris is most easily confused with lupus erythematosus (p. 1349). In the former definite nodules are present, and there is a tendency to ulceration; the disease usually begins in childhood and persists for many years. In the latter the disease is non-ulcerative, has a great tendency to be symmetrical, rarely appears before adult life, and is especially liable to occur in the middle-aged. The scalp is often attacked, while this is rare in lupus vulgaris. In lupus erythematosus thick adherent scales, fixed down by epithelial plugs, form, and the scar is often covered with pits of varying size; in lupus vulgaris the scale is of a very superficial type and easily removed, and there are no plugs.

From tertiary syphilis the diagnosis may occasionally be difficult, and the two conditions may be combined. The absence of nodules, the tendency to form sharply cut, rather deep ulcers, the presence of a positive Wassermann reaction, and the rapid response to anti-syphilitic remedies will generally settle the diagnosis.

Rodent ulcer is distinguished by its appearance fairly late in life, by its

firm rolled edges of pearly white colour, and by its tendency to involve the bony structures of the face.

Treatment.—Of prime importance is the general health of the patient. Good ventilation, sunlight, warm clothing and plenty of good food are necessary if cases are to do well. In the absence of a good supply of natural sunlight, excellent results are obtained by exposing the body to the rays of the carbon-arc or mercury-vapour lamps. As to drugs, cod-liver oil, malt, iron and arsenic are often of considerable value.

Local measures should also be taken to destroy the lesions. Small patches may be excised; but this method is only rarely applicable. If the patches are non-ulcerating, and not too extensive, excellent results are obtained by the Finsen light; but this method is rarely available, and is very slow. The nodules may be destroyed by the application of 20 per cent. ac. salicylic plaster with creosote, or 10 per cent. pyrogallic acid ointment rubbed in daily until a violent reaction is produced. Recently Adamson has recommended rubbing acid nitrate of mercury into the patches, and this gives very satisfactory results. In the larger ulcerating patches a preliminary scraping, followed by the application of ac. nitrate of mercury or zinc chloride stick, is usually satisfactory. The use of X-rays and CO_2 snow has nothing to recommend it, and the former is very dangerous if given over prolonged periods.

Lupus Verrucosus

This is due to the local inoculation of the tubercle bacillus, and is chiefly seen in those who handle infected meat, and in those who conduct autopsies. It is also known as *verruca necrogenica* or *post-mortem wart*.

Symptoms.—The lesions usually occur on the hands, chiefly the dorsum and on the knuckles. The earliest lesion is a small, red, firm papule, which spreads slowly. The centre soon becomes raised and warty; but there is always a well-marked inflammatory zone around this warty growth. Serum and pus may exude between the papillæ of the wart, and the whole may be crusted. The lesion is generally single, and may attain several inches in diameter. Rarely numerous lesions are present.

Treatment.—Small lesions are best excised. Destruction by the actual cautery, or by diathermy, may be practised in some cases. In this variety a pastille dose of X-rays may flatten down the warty growth, and this may be followed by the use of salicylic acid or mercurial plasters, or by painting with acid nitrate of mercury.

Local Tuberculous Ulcers

These occur usually as complications of tuberculosis of other organs. They are frequently present on the mucous membranes, or around the orifices of the body. Little can be done except palliative treatment if they are numerous; but isolated ones can be destroyed by one of the methods already described.

Scrofulodermia

This term is applied to secondary infection of the skin from the bursting of deep-seated tuberculous abscesses. The lesions either take the form of a

thick crust overlying an area of unhealthy-looking granulation tissue, or are purplish-red shiny areas surrounding a sinus.

The term is also applied to single or multiple subcutaneous abscesses, not infrequently seen in children, which contain pus, in which numerous tubercle bacilli can be found. They are sometimes called *tuberculous gummata*.

Treatment.—The treatment of the underlying condition is essentially surgical and where possible the affected skin should be excised, otherwise scraping, followed by painting with acid nitrate of mercury, is the best treatment

THE TUBERCULIDES

These lesions, which are due to the lodgment of tubercle bacilli in the peripheral capillaries, with the production of a local inflammatory reaction, differ from the foregoing tuberculous diseases of the skin in that there is no tendency for the individual lesions to spread. They are thus comparable to the secondary syphilides, and like them are of several different types.

THE LICHENOID TUBERCULIDE.—**Symptoms.**—This condition, also known as *lichen scrofulosorum*, is chiefly seen in young children with glandular tuberculosis. The lesions come out in crops, chiefly on the trunk, and are arranged in circular or oval groups, made up of pinhead-sized acuminate follicular papules. These lesions may be of the same colour as the normal skin, or of bright red colour. There is usually a small crust on the summit of each papule, or sometimes a small pustule. The disease lasts from a week or two to many months.

Diagnosis.—In lichen spinulosus there is less obvious inflammation, and a horny spine projects from the centre of the papule, which can be removed by forceps.

The small follicular syphilide occurs in adults, and is associated with other syphilitic phenomena.

Treatment.—No special treatment of the skin has any effect. The treatment is that for glandular tuberculosis.

THE ACNEIFORM TUBERCULIDE.—**Symptoms.**—This condition, also known as *acne scrofulosorum*, occurs in children and adolescents who are suffering from some form of tuberculosis, and chiefly affects the buttocks and thighs, but may be more extensive. The lesions are lentil-sized, acuminate, follicular papules and pustules, and are generally distributed discretely. They are of bright red colour and pustular or crusted.

Diagnosis.—The affection is sometimes difficult to diagnose from staphylococcal folliculitis; but the individual lesions run a much slower course, and are usually more numerous and not painful.

Treatment.—This is the same as for the lichenoid tuberculide.

THE PAPULO-NECROTIC TUBERCULIDE.—**Symptoms.**—In this variety of tuberculide the lesions are small lentil- to pea-sized nodules starting deep in the dermis or in the hypoderm, eventually softening and bursting through the skin with the production of a small, rather indolent ulcer. After healing, pitted scars are left. The lesions are usually numerous and come out in crops, which may continue to appear over a period of some years. The parts affected are chiefly the distal extremities of the limbs, *e.g.* the backs of the hands and feet, the sides of the fingers, and the extensor aspects of

the forearms and legs. Lesions in these regions have been named *folliculis*. Somewhat similar lesions have been described on the face and termed *acnitis*, but it is still not quite clear that they belong to the same group; it is more probable that they are the same as the benign miliary sarcoid of Boeck (see p. 1339). The eruption nearly always occurs in patients who have some other manifestations of tuberculosis, and occurs chiefly in young adults.

Diagnosis.—These cases can be distinguished from erythema multiforme by their deeper site of origin, and by their tendency to ulcerate and produce scars.

Treatment.—As for other tuberculides. No local treatment has any effect on the lesions.

THE GUMMATOUS TUBERCULIDE.—**Symptoms.**—This condition, which also goes by the name of *erythema induratum* or *Bazin's disease*, is not uncommon, and is almost entirely confined to the legs, especially the calves, and is usually bilateral. It occurs chiefly in girls and young women between the ages of 15 and 25. The initial lesion is a deep-seated nodule, from a pea to a hazel-nut in size, starting in the subcutaneous fat. The nodule slowly increases in size, involves the skin, which becomes purplish in colour, and eventually softens and bursts. The ulcer thus produced has a ragged edge and an unhealthy purplish-red base, often covered by a dirty greenish slough. These ulcers are very sluggish, and take weeks or months to heal. Fresh lesions are constantly forming, and a dozen or more lesions may be found simultaneously on the two limbs. There is often considerable pain in the lesions.

Diagnosis.—**From syphilitic gummata.**—In this condition the lesions are less numerous—indeed often single—and are rarely so symmetrical. The lesions are usually painless. The edge of the ulcer is sharper and more cleanly cut, and the base is cleaner, or has a characteristic wash-leather slough. Other stigmata of syphilis may be present, and the Wassermann reaction is positive.

From the hypodermic sarcoids of Darier-Roussy.—In this condition somewhat similar nodules appear, but are usually fewer in number. They never break down or ulcerate, and occur at a later period of life, namely, in middle-aged women. The tuberculin reaction is usually negative.

Treatment.—The ulcers heal readily if the patient is kept in bed, but are liable to recur when she gets up again. General tonic treatment should be given, and in many cases salvarsan has proved to be a potent remedy. Locally antiseptic baths and dressings are required.

LUPUS PERNIO

This is a rare condition in which the nose, cheeks, ears and fingers become swollen and purplish in colour. At one time thought to be related either to lupus vulgaris or lupus erythematosus, it is now recognised as a distinct disease. It has been shown by Schaumann that the skin lesions are frequently associated with areas of rarefaction in the small bones of the hands and feet, and even of the larger bones. Granulomatous deposits also occur in the lymphatic glands and other lymphoid structures. It is closely related to the cutaneous sarcoids of Boeck described below.

THE SARCOIDS

Under this heading have been classified a heterogeneous group of lomata, which have a histological picture similar with that of the culous granulomata, but have two features which differentiate them from tuberculosis, *i.e.*—(1) the lesions never break down and ulcerate, and (2) the results to tuberculin tests and inoculation experiments are negative for tuberculosis. Recently, however, Schaumann has claimed that he has cultured the bovine tubercle bacillus from lesions of cutaneous sarcoid and lupus pernio.

Two main types are recognised: the cutaneous of Boeck and the hypodermic sarcoid of Darier.

The Cutaneous Sarcoid of Boeck

The *cutaneous sarcoid of Boeck* generally attacks the face and upper part of the body, and may appear in small nodules or in plaques. The small nodular variety is usually symmetrical, and the nodules are numerous; they are usually lentil- to pea-sized, firm to the touch, of deep reddish-brown colour, and tend to be arranged in groups, especially about the lower lids and chin. There is no tendency for them to break down, and they often persist for many months.

The other variety is usually asymmetrical, and the lesions often single or few in number. They occur chiefly about the ears, nose and cheeks. They form either large nodules or irregular infiltrated plaques of a purplish-red colour, and up to 1 to 2 inches in diameter. Both these varieties generally occur in middle-aged adults.

Diagnosis.—The condition has to be distinguished from lupus vulgaris, as brownish nodules are sometimes present. These, however, are much firmer than those of lupus vulgaris, and the pointed match does not sink into them.

Treatment.—Some cases clear up slowly under arsenic, especially salvarsan, and tuberculin is said to be beneficial in some cases; cod-liver oil is also beneficial. The writer has had good results from the intravenous injection of 3 per cent. sodium morrhuate solution, in doses of 1 to 2 c.c. once or twice weekly. General arc-light baths are also of considerable value.

The Hypodermic Sarcoid

The *hypodermic sarcoid* chiefly occurs about the lower limbs, but may also be seen on the trunk. It commences as deep, rather painful nodules in the subcutaneous fat, which may eventually involve the skin, producing a localised redness. The lesions do not break down; but some fibrous contraction may be present when the lesions subside. They are not usually very numerous.

Diagnosis.—This is from the nodular syphilides and from the tuberlides. From the former they are separated by the absence of a positive Wassermann reaction, and by their chronicity; from the latter by their failure to ulcerate, and by the absence of positive inoculation experiments.

Treatment.—Darier recommends combined treatment with tuberculin and neosalvarsan.

GONORRHŒAL KERATOSIS

The lesions in this condition are probably produced by gonococci circulating in the blood stream, although they have not been demonstrated.

They occur in patients suffering from gonorrhœal arthritis and other manifestations of general gonococcal infection, and usually appear on the palms and soles, though other parts of the hands and limbs may be affected.

The lesions are red patches covered with cone-shaped horny thickenings, and are generally numerous. In addition, a general hyperkeratosis of the palms and soles may occur.

Treatment.—General treatment for gonorrhœa is required, together with ung. ac. salicylic. locally.

SPOROTRICHOSIS

In addition to those bacterial conditions which attack the skin by way of the blood stream, a certain number do so by way of the lymphatics. Lymphangitis with abscess formation from pyogenic organisms is well known, and the same condition in tuberculosis has already been described under the title of "scrofulodermia." Actinomycosis is another such condition, and has already been dealt with (p. 177). Somewhat similar conditions to the two last mentioned may be produced by certain fungi, of which the only one which requires special notice is sporotrichosis.

Symptoms.—Infection may take place through a crack in the skin, usually on the hand or foot. From this a lymphangitis starts, which spreads up the affected limb, and subcutaneous cold abscesses soon appear at points along the affected lymphatics. These eventually burst and leave indolent fungating ulcers, which show little or no tendency to heal spontaneously. A good deal of pus or yellowish fluid exudes.

Diagnosis.—Cases are usually diagnosed as *tuberculosis*, and a certain diagnosis can only be made by obtaining the fungus in culture. This should be done on Sabouraud's proof medium and incubated at room temperature.

Treatment.—The lesions usually disappear under large doses of potassium iodide administered internally.

XANTHOMA

Xanthoma forms an interesting link between the inflammations due to chemical toxins circulating in the blood and those due to bacteria, for in this condition lesions of a granulomatous nature are produced around a deposit of a chemical substance in the tissues. Apart from this condition, all the granulomata whose nature is known are produced directly by bacteria; tubercle, syphilis and lepra are the best known examples.

Three clinical varieties of xanthoma are recognised: (1) xanthoma tuberosum, (2) xanthoma diabeticorum, and (3) xanthoma planum. This last variety has no connection with the first two, but is considered here for convenience.

Ætiology.—Xanthoma tuberosum and diabeticorum occur in patients who for some reason or other have an excess of cholesterin in the blood

serum. This is why one form is seen in diabetics. The cholesterin becomes deposited in the tissues and causes a reaction, chiefly among the fixed connective-tissue cells of the dermis, particularly the endothelial cells, and a granuloma not unlike that seen in tuberculosis is produced. Histologically the tumours of xanthoma consist of large cells, arranged around the vessels, containing droplets of a cholesterin-fatty-acid-ester and some fat. Around these cells a varying degree of connective-tissue hypertrophy may occur.

Symptoms.—*Xanthoma tuberosum.* — In this condition numerous discrete yellowish nodules appear in the skin. These increase in size and may form tumours as big as an orange. They are most commonly seen on the extensor aspects of the limbs, especially on the elbows and knees, where they may form large firm tumours, but they may be seen on any part of the skin. The bones, tendons, viscera and mucous membranes may also be involved. The colour varies from a bright yellow to an orange or red. The disease is usually seen in young adults. It does not generally affect the general health, but is occasionally associated with jaundice. The lesions are very persistent.

Xanthoma diabeticorum.—The lesions are usually smaller and more numerous; they are lentil-sized lesions and come out in crops, usually on the buttocks and extensor surfaces of the limbs. They disappear rapidly under appropriate treatment for diabetes.

Treatment.—In the diabetic cases, the underlying disease must be treated. For xanthoma tuberosum no definite treatment can be laid down, but a diet which contains as little cholesterin as possible should be prescribed.

Xanthoma planum.—**Ætiology.**—This has been considered to be a fatty degeneration of the fibres of the orbicularis palpebrarum muscle, but in some cases an excess of cholesterin in the blood has been demonstrated.

Symptoms.—The lesions consist of flat, yellow, slightly raised patches, which are often symmetrically placed, on the eyelids near the inner canthus. They may be as small as a pin's head or may involve almost the whole eyelid. They produce no symptoms. They mostly occur in old people.

Treatment.—They can be destroyed by electrolysis or by caustics, or removed by excision.

C. INFLAMMATORY DERMATOSES OF NERVOUS ORIGIN

Apart from trophic conditions of the skin due to disturbances of the nervous system, and to which reference has already been made, there is only one condition which is known definitely to be associated with lesions of the nervous system, and that is herpes zoster.

HERPES ZOSTER

Ætiology and Pathology.—This condition is associated with inflammatory lesions of the posterior root ganglia. Some cases are the results of known poisons acting on these structures, as, for example, arsenic and the syphilitic virus. In the bulk of cases, however, no definite toxin can be found, and it is assumed that some unknown organism is the causative

agent. Recently much attention has been attracted to the supposed relationship of herpes zoster to varicella, but no common ætiological factor has yet been demonstrated.

Symptoms.—The attack is usually preceded by pain along one or more nerve trunks, generally one of the intercostal nerves, but the fifth cranial and any spinal nerve may be affected. In the course of a day or two crops of vesicles appear on an inflamed base. These vesicles are shotty and have little tendency to rupture. These crops are distributed along the course of the affected nerve. In the course of a week or so they dry up, often leaving a black gangrenous spot, which leads to pitted scarring.

Herpes zoster of the ophthalmic division of the fifth cranial nerve may cause damage to and even loss of the eye, and in any case usually causes much scarring. The glands in the neighbourhood are often enlarged. Recurrences are very rare, and it is thought that one attack immunises against another.

The neuralgic pain associated with zoster is often severe, especially in old people, though children are usually free from it. In an ordinary case it may precede the appearance of the eruption by several days, but it usually disappears when the eruption begins to subside. Occasionally, however, it persists for a considerable time after the eruption has subsided and may be of very severe character, entirely destroying sleep. It is often accompanied by acute hyperæsthesia of the skin.

Diagnosis.—This is easy, on account of the distribution along certain nerves and of the nerve pain.

Treatment.—As far as the local lesions are concerned, it is best to avoid moist applications; and, with the object of diminishing suppuration and subsequent scarring, they may be dressed with a bland talc and zinc oxide powder, or painted with collodion.

If, as is usual, there is pain, in the milder cases, this may be relieved by such drugs as antipyrine or phenacetin, in 10 grain doses, together with the local application of hot, dry cotton wool pads, or medical diathermy may be used. The application of the galvanic current is also effective in some cases, as is ionisation with quinine. In the more severe cases, bromides and chloral, or other more powerful hypnotics, are called for. Morphine should be avoided as far as possible, but should not be withheld in the extreme forms of the affection.

When the eruption has subsided, glycerine of atropine painted on and covered by hot, moist compresses is useful, and counter-irritation over the spine in the region of the affected nerve, either by a mustard plaster or blister, will allay the symptoms. Small doses of X-rays to the affected area sometimes produce considerable relief.

HERPES FEBRILIS

This is a condition to which some people, and especially children, are prone whenever they develop a slight febrile attack or even a slight cold.

Ætiology.—The disease is produced by a filter-passing virus, which, when injected into rabbits, produces a fatal form of encephalitis, and is closely related to the virus of encephalitis lethargica.

Symptoms.—The lesions consist of small groups of vesicles, on an

inflamed base, which come out chiefly in the neighbourhood of the mouth. They are irregularly distributed, have no relations to any nerve trunks, and are generally bilateral. They disappear in the course of a week or so, after crusting over, and leave no scars. In one type, seen especially in children, recurrent attacks occur on the cheek, often at regular intervals and without any special cause. These attacks also clear up and leave no scars. A recurrent type is also found affecting the buttocks in adults.

Treatment.—A bland protective ointment, such as zinc cream or Lassar's paste, is all that is required.

HERPES PREPUTIALIS

This is the name given to small crops of two or three to half a dozen or more small vesicles which sometimes appear on the under surface of the prepuce. The vesicles quickly rupture and leave behind pinhead-sized ulcers which are painful. There is no tendency for these ulcers to increase in size. This latter feature helps to differentiate them from both syphilitic ulcers and soft sores.

Treatment.—This is the same as for Herpes Febrilis.

D.—INFLAMMATORY DERMATOSES OF UNKNOWN ORIGIN

In this group are included certain dermatoses with well-defined characters which entitle them to be considered clinical entities, but whose ætiology is entirely obscure. The following diseases are included under this heading: psoriasis, parapsoriasis, pityriasis rubra pilaris, lichen planus, lupus erythematosus, sclerodermia and sclerema neonatorum. It must not be assumed that because these conditions are grouped together that they have any relationship to one another.

PSORIASIS

A very common condition characterised by the presence of red, scaly papules and patches of characteristic appearance on various parts of the body and unassociated with any disturbance of the general health.

Ætiology.—The disease frequently begins towards the end of the second decade, and is not infrequently seen in children from about 7 years of age and upwards, but is very rare in small children. Both sexes are equally affected. On the other hand, the first attack may occur in advanced age. It has been attributed to parasitic agencies, toxins of bacterial and metabolic origin, and to neuropathic causes, but there is very little evidence to support any of these views. There is no doubt that in some cases a strong family history can be made out.

Pathology.—Histological examination shows a great overgrowth of the epithelium, with downward growth of the interpapillary processes, and corresponding elongation of the papillæ. The horny layer is badly formed (parakeratosis), and collections of leucocytes can be found between the horny cells. There is a cellular infiltration around the papillary vessels and those of the subpapillary layer.

Symptoms.—The malady is a chronic one and may come and go throughout life. Usually attacks occur at quite irregular intervals, but

in some cases they may appear at definite seasons—some appearing in the summer, others in the winter. The extent also varies greatly in different cases, some only having a few patches, others being covered with lesions.

The sites of predilection are the extensor aspects of the limbs—especially of the elbows and knees—the trunk—both back and front, but especially the waist region, the scalp and, more rarely, the face, nails and palms and soles.

The lesions begin as pinhead-sized papules, and are from their very beginning surmounted by a small silvery scale. The individual lesions usually spread centrifugally and may eventually attain great size. Usually, however, they join with other patches and so form plaques, which may, for instance, cover the whole back in one continuous sheet. The same type of scaling persists even in the largest patches, though in chronic treated cases the surface of these patches may appear to be highly polished; on scratching, however, with a sharp instrument the silvery scales are immediately apparent. The whole mass of scales can, with care, be removed in one continuous sheet, and underneath is found a shiny, dry red surface which, on examination with a lens, shows the dilated papillary vessels as tiny red points.

The arrangement of the lesions varies. In some cases the body and limbs are studded with lesions the size of a small pea or a threepenny-piece (psoriasis guttata); in others the lesions are larger (psoriasis nummulata); in some the centre of the lesions clears up, leaving rings (psoriasis circinata), and the rings may run together, forming gyrate figures (ps. gyrata). Occasionally the crusts are very thick (ps. rupioides), and this is especially the case on the scalp, where the hairs prevent the scales from falling off.

In some cases the lesions remain small and confined to the follicles (follicular psoriasis), and these may occasionally group into patches. They may also come out along scratches on the skin. When the nails are affected, either small pinhead-sized pits may be produced, or the whole nail may be forced up by lesions occurring in the nail bed, the nail eventually breaking up and thick masses of scales being found beneath it. The palms and soles are less frequently involved, but when they are affected circumscribed red patches form, associated with scaling and fissuring in the deep folds. The mucous membranes are not affected.

The lesions vary from a pale to a dark red in colour, and on clearing up usually leave little or no pigmentation, though in very chronic patches, especially on the legs, some pigmentation may remain for a time.

There are usually no subjective sensations, but occasionally itching is present. The general health is not affected.

Diagnosis.—This disease may resemble the secondary *papulo-squamous syphilide*. It differs, however, from this condition in the fact that the lesions are scaly from the start; that when the scales are removed no infiltration can be felt, and that the surface left is smooth, dry and studded with numerous small red points; that pigmentation is generally absent or little marked; that the lesions are mainly distributed on the extensor aspects of the limbs, and that the scalp may be extensively involved without loss of hair; and that other signs of syphilis, such as general adenitis and involvement of the mucous membranes, are not present. The Wassermann reaction and the effect of treatment will generally confirm a clinical diagnosis.

In *seborrhœic dermatitis* the scales are greasy, the patches spread by aggregation of follicular papules, and the scalp, face and centre of the chest and back are chiefly affected. The lesions respond quickly to sulphur, which is not the case with psoriasis.

In *eczema* itching is marked, when the scales are removed a moist surface is left, and the lesions are made up of aggregation of papules and papulo-vesicles.

In *pityriasis rosea* the scaling is usually in the form of a collarette, the lesions are of a pale pink colour, and the limbs are little affected, especially below the elbows and knees.

In *lichen planus* some typical papules can almost always be seen, the lesions have a characteristic lilac or purple colour, the flexor aspects of the limbs are most involved, and itching is generally intense.

Treatment.—Internal treatment is considerably employed, but it is difficult to estimate its value. Arsenic is the most valuable drug, and should be given in increasing doses up to the limit of tolerance, but should be entirely discarded if no effect is produced. Fowler's solution, ℥ iii, t.d.s. and upwards, and pil. asiatica are chiefly employed. Recently mercury-salicyl-arsenate (enesol) has been used by intramuscular injection with success. Arsenic should not be given when lesions are coming out rapidly. In these cases salicin, gr. xv, t.d.s., and thyroid extract, gr. i, t.d.s., have been recommended by Crocker and others. Lately emulsions of sulphur and colloidal sulphur have been given with good results.

Local treatment is the most efficacious, and chrysarobin gives the best results, but is messy, stains linen permanently, and is liable to set up a severe dermatitis if used carelessly. It is best applied in 5 per cent. to 10 per cent. ointment rubbed into the patches daily, after the scales have been removed in a hot bath with the aid of soft soap.

If this treatment is carried out thoroughly for 3 or 4 weeks the patches will disappear. This treatment is best carried out in hospital or in a nursing home, and is not suitable for out-patient treatment. Pyrogallic acid ointment 10 per cent., oil of cade ointment 20 per cent., or an ointment consisting of ac. carb. 2 per cent., ac. salicyl. 3 per cent., soft soap 4 per cent., and sulphur 5 per cent. may be used. If the patches become inflamed they are best treated temporarily with linimentum calaminæ. Isolated resistant patches may be treated by a pastille dose of X-rays, but this cannot be often repeated. For the scalp, the crusts should be removed with soft soap, and the pyrogallic or sulphur and carbolic acid ointment recommended above applied. This latter ointment is useful in psoriasis of the nails, after the nail has been cut away and the scales removed.

PARAPSORIASIS

This is a term applied to certain rare forms of resistant erythemato-squamous lesions which occur on the body. Three types are recognised—(1) parapsoriasis en gouttes, (2) parapsoriasis en plaques, and (3) parapsoriasis lichenoides.

Ætiology.—Nothing is known of the ætiology of these conditions.

Symptoms.—*Parapsoriasis en gouttes* occurs as pea-sized or slightly larger red spots, covered by fine branny scales, chiefly on the upper part of the trunk.

Parapsoriasis en plaques occurs as symmetrical patches, oval or linear, of pale yellow or red colour, with a shiny surface or covered by fine scales, and occurring chiefly on the legs, thighs and lower trunk.

Parapsoriasis lichenoides forms a reticular pattern, chiefly on the extensor aspects of the upper limbs. The lesions are red or purplish in colour and the surface is either shiny or covered with fine scales.

Treatment.—These cases are very resistant to treatment, but should be dealt with on much the same lines as psoriasis.

PITYRIASIS RUBRA PILARIS

This is a rare disease characterised by the appearance of follicular papules, with horny spines, which tend to involve the whole cutaneous surface and eventually produce a generalised dermatitis resembling pityriasis rubra of Hebra.

Ætiology.—This is very obscure. It is thought by some observers to be a follicular form of psoriasis, but at present there is no conclusive evidence. The disease occurs in both sexes and at varying periods of life, but sometimes in the very young.

Symptoms.—The lesions are of two types: red follicular papules with horny spines, which are chiefly seen on the extensor aspects of the limbs, and especially on the dorsum of the hands and fingers; and red scaly plaques or sheets, which involve the scalp, face and trunk. Either of these types may predominate. Where the former type occurs the skin presents the appearance of a nutmeg grater. Hyperkeratosis of the palms and soles develops, with fissuring of the deeper folds, and the nails become pitted and brittle. Ectropion followed by conjunctivitis may occur. The mucous membranes usually escape. The malady does not seriously affect the general health, and subjective symptoms are usually absent.

Treatment.—No specific treatment is known. Thyroid extract has been recommended, but the results are very uncertain. Bran and alkaline baths, followed by inunctions of ac. salicyl., grs. x, glycer. amyl., adip. lanæ hydros., āā ℥ss., seem to give the best results.

PITYRIASIS ROSEA

A widespread eruption of pinkish macules and papules of round or oval outline, with branny scaling, which does not usually extend to the periphery of the lesion.

Ætiology.—This is still obscure. It was originally thought to be of parasitic origin, probably owing to the resemblance of the lesions to ringworm, but no definite parasite has been discovered. It is possible that it may be of the nature of an acute exanthem, as it occasionally has a sudden onset with slight fever and malaise. One attack is said to confer immunity, though this is not absolute, and it seems to occur at times almost in epidemic form. It has been thought by others to be a toxic eruption. The disease occurs chiefly in children and young persons, but no age is exempt.

Symptoms.—The eruption usually comes out suddenly, and the onset may, though this is not usual, be accompanied by slight fever, malaise and sore throat. In some cases the general outbreak is preceded by the appear-

ance of a single patch, the "herald" patch, which may appear a week or 10 days before the general eruption. The lesions are usually most profuse on the trunk and central portions of the limbs, the distal parts of the latter escaping. The face, neck and scalp may be affected, but this is not common.

The lesions are pinkish macules or papules, mainly macules, which vary in size from a lentil to patches a couple of inches across. They tend to be arranged in lines parallel to the ribs, and the larger patches are oval. When the lesions reach the size of a pea, central scaling commences, and as the lesions grow the scales tend to form a collarette, with the free edge directed towards the centre. The colour of the portion within the scales changes to fawn and eventually returns to the normal skin tint. Sometimes pinhead-sized follicular papules of skin colour are seen among the lesions in considerable numbers. In rare cases vesicles and bullæ form.

Subjective symptoms are usually absent, but sometimes itching is a prominent feature. The rash usually lasts about 4 weeks and then disappears, but it may persist for several months.

Diagnosis.—Seborrhœic dermatitis is distinguished by its greasy scales and by its distribution; secondary syphilis, by the presence of other syphilitic lesions; and ringworm, by the small number of lesions, their asymmetry, and the presence of fungus in the scales.

Treatment.—No internal treatment is known to affect the disease. In the early stages a simple coal tar and lead lotion can be used, as this allays itching if present. Once the rash is fully developed a daily warm bath, followed by the application of 3 per cent. salicylic acid in linimentum calcis, will usually cause the lesion to disappear. If there is fever the patient should be put to bed.

LICHEN PLANUS

An intensely itchy eruption characterised by the presence of angular papules of pinkish or lilac colour tending to be localised in special areas.

Ætiology.—The disease occurs chiefly in adult life and is very rare in young children. Two views are held as to its ætiology. By some it is thought to be of nervous origin, following shock, mental anxiety, worry, etc. It is true such a history is often obtainable, but Graham Little has pointed out that it has not appreciably increased as a result of the late war, which might have been expected if such was the main factor in its production. The other view is that it is of toxic origin, but there is no direct evidence on this score.

Pathology.—The microscopic anatomy of the papules is very characteristic. There is a circumscribed, dense, round-cell infiltration in the upper part of the dermis beneath the papule, and the epidermis is much thickened. The papillæ are flattened out. The granular layer is irregularly thickened and there is a hyperkeratosis, most marked at the orifices of the hair follicles and sweat ducts.

Symptoms.—The most common variety is the *localised type*. The lesions are chiefly found on the flexor aspects of the forearms and wrists, the inner aspects of the thighs near the knees, and on the front of the shins. The trunk, especially the lower part, the palms and soles, and the penis are also

occasionally involved. The mucous membrane of the mouth is frequently attacked. The lesions on the skin are discrete, lentil-sized papules, raised sharply from the skin, with polished shiny surface and usually of lilac colour. They have a curious and typical angular outline, due to the fact that they are bounded by the fine lines of the skin, and sometimes they are definitely umbilicated. Frequently the papules are arranged in lines along scratch marks. Occasionally patches are formed by the aggregation of papules and resemble rather closely patches of psoriasis. On the palms the lesions are generally circular, vary in size from a pea to a threepenny-bit, and the horny layer over them is much thickened.

In the mouth irregular dead white patches are found, usually on the tongue or inner aspect of the cheeks.

Several other types of lichen planus are seen. In one variety the lesions form rings and gyrate figures (*lichen planus annularis*), while in another atrophy occurs (*lichen planus atrophicus*). In a large number of cases the horny layer is much thickened (*lichen planus hypertrophicus*), and this is especially seen on the legs, where warty patches occur (*lichen planus verrucosus*). Occasionally the lesions are arranged in a single line, sometimes following the course of a nerve (*lichen planus linearis*), and very occasionally bullæ and vesicles may occur. Rarely cases are met with in which the papules are few in number, and very much hypertrophied, forming dome-shaped tumours, which itch intensely (*lichen obtusus*).

Another variety is an *acute generalised type* in which a large number of lesions are scattered diffusely over the trunk and limbs. In this type the papules are pale pink in colour and not so raised as in the chronic forms. Even in these cases the face and scalp almost invariably escape.

In association with the above-mentioned lesions small groups of follicular papules with horny spines may be found. The same condition is sometimes found independently of lichen planus and has been called *lichen pilaris* or *spinulosus*. Whether these latter cases have the same origin is still unsettled.

Lichen planus lesions are almost invariably accompanied by intense itching and often by marked neurotic manifestation, but otherwise the health remains good, though slight fever may accompany the acute cases.

The disease runs a very chronic course and is sometimes very resistant to treatment.

Diagnosis.—This is usually easy, as the lesions are very characteristic. The diagnosis from psoriasis has already been dealt with. From **lichenification (lichen simplex chronicus of Vidal)**, which is produced by friction on the skin, the diagnosis is made by the fact that the latter only occurs in circumscribed patches, and that the typical discrete papules of lichen planus are absent.

Treatment.—In the acute generalised cases rest in bed is essential, and it is of the greatest service in chronic cases, materially shortening their course. Arsenic is looked upon as a specific, but may require to be pushed; salvarsan has been recommended by some authors. As in psoriasis, arsenic is not advised in cases in which the eruption is coming out, these cases doing best on mercury; liq. hydrarg. perchlor., ℥i, t.d.s. If the irritation is very bad, bromides or some hypnotic at night may be required, and for this symptom lumbar puncture has been recommended.

For local treatment anti-pruritic lotions and ointments are required; of these ichthyol, oil of cade, coal tar, carbolic acid and menthol are most useful.

For the hypertrophic patches, ac. salicylic plaster, followed by X-rays or CO_2 snow, is the most satisfactory method of treatment.

LUPUS ERYTHEMATOSUS

An inflammatory condition of the dermis, usually chronic but occasionally running an acute course, characterised by the presence of circumscribed red patches, with or without adherent scales and which on recovery leaves scars.

Ætiology.—This is still unknown. It has for many years been thought to be due to toxins of the tubercle bacillus and is sometimes associated with tuberculosis, but cases occur in which this disease cannot be traced. Lately a good deal of attention has been called to focal sepsis as a cause, but the evidence is no more conclusive than for tuberculosis. It is thought that it may be produced by more than one variety of toxin, or that it may be due to a specific organism as yet undiscovered. The disease is chiefly found in middle age, but may begin before the age of 20. It is more frequent in women.

Pathology.—The chief change in the skin is an infiltration in the neighbourhood of the vessels of the dermis with round cells, which may destroy the hair follicles and sweat ducts. In the epidermis there is a hyperkeratosis, which is especially marked at the follicular openings, so that horny plugs are formed.

Symptoms.—Two main types are seen—(1) The non-scaly or erythematous, and (2) the scaly.

1. *The erythematous type.*—This is less frequent and has a greater tendency to be generalised. It may run an acute course or may develop into the scaly type. The lesions are chiefly seen on the cheeks and form circumscribed disk-like lesions, raised and slightly infiltrated and of a pale-red to a purplish-red colour. These often show patulous follicular openings on the surface. They may also occur as diffuse flat non-infiltrated sheets of redness. This type is very apt to be associated with lesions in other parts of the body, particularly the backs of the hands and fingers, the arms and forearms, the chest, neck and ears. Occasionally an almost universal eruption appears. The patches may sometimes become bullous and hæmorrhage may occur into the bullæ. These disseminated cases may be associated with acute visceral diseases, such as pneumonia, pleurisy and nephritis, and even in the absence of these high fever may be present. Usually in this type of case, if the patient survives, the eruption clears up without much scarring.

2. *The scaly type.*—This is by far the commonest variety, and is generally very chronic and localised, but may occasionally be acute and generalised. The lesions are chiefly seen on the nose, cheeks, ears and scalp, but are not uncommon on the backs of the hands. They are very apt to be distributed symmetrically in the shape of a bat's wing on the nose and two cheeks. The lesions are usually irregularly shaped red patches, often sunk below the surface of the skin, and covered with greyish scales, which are extremely adherent. When removed horny plugs are seen to penetrate into the epidermis, and when the patches clear up a depressed scar is left, often with numerous pits on its surface. When the scalp is attacked the hair is lost permanently. The

mucous membranes may be attacked, the most frequent sites being the vermilion border of the lips and the palate.

Pain sometimes occurs in the patches and sometimes they itch, but generally no local sensations are present. The patient's health is usually below par, and there is often considerable neurosis, but severe constitutional symptoms are usually absent.

The course is exceedingly chronic, the patches often persisting for years in spite of treatment.

Diagnosis.—The condition is differentiated from **lupus vulgaris** by the absence of nodules, the symmetry of the lesions, the absence of ulceration and the age of the patient; from **erysipelas**, by the slowness of the spread and the absence of high fever; and from **erythema multiforme**, by the chronicity of the lesions and the presence of destructive effect on the skin shown by scarring.

Treatment.—The acute erythematous cases should be kept in bed and complications treated. All possible sources of focal infection should be removed. The drug which appears most to influence cases is quinine, which should be given in full doses. Local treatment is not usually required in the acute erythematous cases.

In the chronic scaly cases, quinine and general tonic treatment are indicated. Recently good results have been obtained by the intravenous injection of gold compounds, such as krysolgan, triphal or sanocrysin. Rest in bed is always beneficial, and the patient should not be allowed to go out in a strong wind or in the hot sun, as these aggravate the condition.

Local treatment is chiefly directed to removal of the scales and the production of a mild inflammatory reaction in the patches. For the former ac. salicyl. ointment, 3 to 5 per cent., or plaster, 5 to 10 per cent., may be employed. For the latter 5 to 10 per cent. pyrogallic acid, painting with pure carbolic acid, or applications for a few seconds of CO_2 snow. Ultra-violet light has proved useful in some cases.

SCLERODERMIA

This is a condition of hardness and rigidity of the skin, caused by the overgrowth of fibrous tissue, which is probably of inflammatory origin. It is met with in two forms—(1) Generalised sclerodermia, and (2) localised sclerodermia or morphœa.

Ætiology.—Nothing is known of the cause. It is chiefly a disease of young adult life and is more common in women than in men. It has been variously attributed to a tropho-neurosis, to alterations in endocrine secretion, to an endarteritis, and to a primary hyperplasia of the fibrous tissue of the skin.

Pathology.—There is an overgrowth of the fibrous tissue bundle in the dermis and subcutaneous tissue, with replacement of fat by fibrous tissue in the latter. There is also an exudation of cells around the vessels of the dermis, with some endothelial proliferation. The epithelium may be flattened by pressure and excess of pigment may be present.

Symptoms.—1. *Generalised sclerodermia.*—This condition may appear rapidly or slowly. In both cases a disturbance of the general health, such as fever, joint pains, neuralgia or itching, may precede or accompany the attack. Stiffness of the parts involved is often the first symptom, and this may spread

rapidly or slowly till it produces fixity of the joints, followed by progressive wasting of the muscles. Breathing may become difficult, owing to fixation of the skin of the chest, and taking of solid food may be prevented by the involvement of the cheeks and mouth. The skin appears swollen and glossy and is very hard ; the deeper structures are fixed and the furrows of the skin disappear. The colour of the skin may be normal or waxy in appearance. The lesions are usually symmetrical and the mucous membranes may be affected. These cases may occasionally clear up spontaneously, but often end fatally.

Occasionally the disease begins in the hands. The skin is drawn tightly over the fingers, fixation of the joints occurs and atrophy supervenes, so that the fingers become pointed. This type is called *sclerodactylia*.

2. *Localised scleroderma or morphœa.*—In this type the lesions vary from the size of a pea to large patches involving almost all the back or front of the trunk. Patches may be pinkish in colour and raised, with a smooth polished surface and with a sensation of rigidity ; or slightly depressed below the surface, very rigid and fixed, and often surrounded by a lilac border, and occasionally occurring in bands ; or again they may be of dead white colour, with more or less irregular edges, and of normal consistence. This latter type is one of the forms of so-called *white-spot disease*.

These cases run a very chronic course, often of many years, and are resistant to treatment.

Diagnosis.—From sclerema neonatorum, by the age of the patient and the fact that this condition is confined to the subcutaneous fatty layer.

Treatment.—In generalised cases, the patient should be kept warm, and massage and hot air baths given. Cod-liver oil internally is of value. Thyroid extract is largely given in all varieties, but its action is very uncertain. In morphœa, fibrolysin injections have been given with success. X-rays are claimed to be beneficial. Treatment, however, is unsatisfactory.

SCLEREMA NEONATORUM

This condition has no relationship to the foregoing. It occurs in newly-born infants, and is characterised by hardening of the subcutaneous fatty layer in certain parts of the body.

Ætiology.—It has been attributed to hardening of the fat, owing to lowering of body temperature and to a low percentage of olein of the fat. There is evidence of a deposit of crystals in the tissues, and of a well-marked proliferation of the reticulo-endothelial cells in the neighbourhood of these deposits, but the chemical nature of the changes is still undetermined.

Symptoms.—The affection usually begins within a day or two of birth. It occurs symmetrically and chiefly affects the calves, thighs, buttocks and back. The subcutaneous fat becomes very hard, and does not pit on pressure. The edges are well-defined. A certain number of cases die, but in the less severe cases the patches disappear in a month or two. A generalised hardening of the fat occurs all over the body in infants suffering from severe diarrhœa, but this condition appears to have no relation to that just described.

Treatment.—The child should be kept warm and given plenty of nourishment. Cod-liver oil is said to be very beneficial.

E.—THE LYMPHO-GRANULOMATA

These cases form a bridge between the inflammatory dermatoses on the one hand and the new-growths on the other. The lesions in many ways resemble the granulomata produced by bacteria, and in other ways resemble sarcomata. The following conditions are included—(1) Leukæmia cutis, (2) lymphadenoma cutis, and (3) mycosis fungoides. Possibly the sarcoids, including lupus pernio, should be included, but these have been previously considered.

LEUKÆMIA AND LYMPHADENOMA CUTIS

Symptoms.—In both these conditions itching may be a marked symptom; sometimes it occurs without any cutaneous lesions, while at other times very persistent urticarial or prurigo-like lesions are present. Hæmorrhages may occur into the skin, and in some cases exfoliative dermatitis is present.

The more characteristic lesions are, however, granulomatous infiltrations of the skin, which form tumours, either in certain localities or more or less all over the skin. In the former case the face is most affected, the tumours forming chiefly on the forehead, about the nose and on the cheeks, producing a leonine appearance. The lesions vary from a pea to an orange in size, and are usually of a dull purplish-red colour. Most of the cases recorded occur in lymphatic leukæmia, but a few have been reported in the myeloid cases. They also occur in lymphadenoma, but there is great difficulty in distinguishing aleukæmic leukæmia from lymphadenoma, unless the glands have been examined microscopically.

Treatment.—This has been dealt with in the articles on Leukæmia and Lymphadenoma (pp. 716 and 699).

MYCOSIS FUNGOIDES

A chronic inflammatory dermatosis with a tendency to form granulomatous tumours, which usually ends fatally.

Ætiology.—It is a disease of late middle life, and more common in men Its cause is quite unknown, but it is probably an infective process and closely related to leukæmia, though no characteristic blood changes have been observed.

Symptoms.—In the early or premycosic stage the most frequent lesions are patches of redness and scaling, associated with intense itching. After a time these lesions become infiltrated and raised above the surface of the skin. Later, tumours appear in these patches, usually about the size of an orange, but not infrequently much larger. The epidermis over them gives way and a fungating mass is produced. These tumours are usually multiple.

Sometimes the initial lesion takes the form of an eczema, an urticaria or a dermatitis exfoliativa, but in all these cases itching is a prominent symptom. In other cases the tumours appear without any pre-existing dermatosis.

The course is slow, and the general health is affected first by loss of sleep and then by septic absorption. Practically all cases eventually terminate in death.

Diagnosis.—This may be very difficult in the premycosic stage. The itching and the persistence of the symptoms in spite of treatment, together with the age of the patient, will help in coming to a diagnosis.

Treatment.—The only treatment known to benefit these cases is X-rays or radium. Either of these will keep the lesions quiescent for a considerable time, but recurrence generally takes place sooner or later. Arsenic and antimony may also be given.

A. M. H. GRAY.

IV. TUMOURS OF THE SKIN

Tumours can be divided into epithelial and connective-tissue tumours, and each of these varieties into benign and malignant.

BENIGN EPITHELIAL TUMOURS

WARTS

These are benign epithelial tumours, characterised by an overgrowth of the prickle-cell layer, with or without hyperkeratosis, and produced by an infective agent, the nature of which has not been discovered. The following types are recognised :

1. *Verruca vulgaris.*—This is the common wart which is so frequently met with on the back of the hands, but may occur on the face and other parts of the body. The lesions are raised tumours, varying in size from a pinhead to a large pea, and are usually discrete, but may group to form larger swellings. They have a rough surface, rise sharply from the surrounding skin, and are skin-coloured. Histologically they show great hypertrophy of all the epithelial layers, with downward growth of the interpapillary areas, and a corresponding papillary elongation They occur chiefly in children. They are inoculable from one spot to another, and from one individual to another.

Treatment.—Isolated lesions are best removed by the application of CO_2 snow for from 15 to 40 seconds, according to their size. They may be burnt away with glacial acetic, trichloracetic, or nitric acid, silver nitrate or even the actual cautery. When very numerous, magnesium ionisation or X-rays are most satisfactory.

2. *Verruca plana juvenilis* are pinhead-sized warts, seen chiefly on the face and hands of children, though they are met with in adults. They have smooth, flat tops, and are usually very numerous.

Treatment.—They are best treated by touching with the galvano-cautery, or by magnesium ionisation.

3. *Verruca plantaris.*—This is a wart which occurs in the centre of the ball of the foot, and has the appearance of a corn, because it is surrounded by a hyperkeratotic ring, and on account of the pressure on the foot does not stand up above the level of this ring. It is, therefore, often mistaken for a corn. It is usually extremely painful.

Treatment.—The most satisfactory treatment is by X-rays ; a full pastille dose is usually sufficient ; but occasionally larger doses are necessary, the surrounding zone being carefully screened. These warts may also be removed by salicylic acid plaster, followed by touching with acetic acid or by CO_2 snow.

4. *Verruca filiformis.*—These minute warts are usually about 1 mm. in

diameter at their base, with long filamentous processes. They are sometimes found on the face; but chiefly occur on the genitals, and around the anus. They frequently occur in very large numbers forming cauliflower-like growths. They are often seen in cases of gonorrhœa, and are sometimes known as *gonorrhœal warts*; but they may be present apart from this disease, and are probably due to some other infecting agent. In these warts there is very little overgrowth of the horny layer.

Treatment.—Locally antiseptic applications, such as 1 in 1000 perchloride of mercury in spirit painted on frequently, or silver nitrate 3 per cent. in sp. æth. nitros., will cause them to dry up, or they may be removed with the galvano-cautery.

5. *Keratoma senile.*—These so-called senile or seborrhœic warts are commonly seen on the face, back and chest of old people; but may occur in younger persons. They vary in size from a pea to a filbert, and are only slightly raised from the skin. They are soft to the touch, and have a slightly warty surface. Their colour varies from yellow to a deep black, and they may itch a good deal. The distribution is much the same as for seborrhœic dermatitis.

Treatment.—Washing with soap and water, followed by the application of 10 per cent. ac. salicyl. ointment will often remove them. Failing this, painting with trichloracetic acid, freezing with CO_2 snow, or a pastille dose of X-rays should be employed.

ACANTHOSIS NIGRICANS

This is a rare condition in which warty pigmented growths appear on the neck, axillæ, groins, umbilicus, and flexures of the limbs and on the face. These growths often fungate and suppurate, especially in moist areas. In addition areas of pigmentation and scattered warty growths may occur. The mucous membrane of the lips, cheeks and tongue may be affected. In a large proportion of cases abdominal malignant growths have been found; but in other cases no such complication exists. The nature of the condition is not understood.

Treatment.—No treatment is known to affect the condition.

THE DYSKERATOSES

MOLLUSCUM CONTAGIOSUM

In this condition small tumours appear on the skin which, like the warts, are of infective origin, though no organism has yet been isolated. They differ from warts, not only in clinical characters, but in the peculiar degenerative changes which occur in the process of horny cell formation.

Pathology.—The most striking feature in a section is the presence between the Malpighian and horny layer of large cells containing large transparent oval bodies. These are known as "psorosperms," and at one time were thought to be coccidial bodies, but are now considered to be degenerations of the cell protoplasm.

Symptoms.—The lesions consist of small lentil- to pea-sized bodies of a white or pinkish colour, with a smooth glistening surface. They may

appear anywhere on the skin. They are dome-shaped, and have a central pit, in the floor of which the thickened horny layer can be seen. Not infrequently they become inflamed.

Treatment.—By taking a sharpened match, and introducing it into the central depression, the whole horny mass can be forced out, and if the cavity be painted over with pure carbolic acid a cure will result.

DARIER'S DISEASE

This is a very rare condition of the skin usually seen in young adults in which an eruption of follicular papules develops on the face, scalp, abdomen, back, and the flexor aspects of limbs. The lesions run together and form warty-looking masses. The disease is slowly progressive, and the lesions are resistant to treatment, but the general health is not affected.

Microscopic examination shows similar changes to those seen in molluscum contagiosum, namely, an irregular hyperkeratosis with formation of " psorosperms " in the region of the granular and Malpighian layers of the epidermis.

Treatment.—This consists of baths and the application of keratolytic agents, such as salicylic acid.

PAGET'S DISEASE OF THE NIPPLE

This is a chronic affection which usually develops around the nipple in middle-aged women, but has been described in other parts of the body and in men. It is seen as a sharply defined, red, oozing area involving the nipple, the areola, and the skin around for a short distance, and is almost always unilateral. The whole area has a distinct parchment-like induration. The nipple becomes retracted, and eventually disappears. The condition is associated with carcinoma of the breast, and whether it is primary or secondary is still a matter of dispute.

In this condition, as in the two diseases just referred to, " psorosperms " are seen under the microscope. The surface horny layer is mostly lost, and the deeper layers of the epidermis are much hypertrophied and œdematous, but show no obvious epitheliomatous proliferation.

Treatment.—Amputation of the breast is the only treatment that can be advised.

MALIGNANT EPITHELIAL TUMOURS

RODENT ULCER

A slowly growing epithelioma usually single, but sometimes multiple, which may cause considerable local destruction of tissue but does not form metastases.

Pathology.—This variety of epithelioma is usually described as a basal-cell epithelioma. In section epithelial processes are seen penetrating into the underlying dermis and subcutaneous tissue; but the processes are bounded by a regular basal layer of cubical cells, and although degeneration cysts may form in these processes no cell-nests are formed.

Symptoms.—The lesions chiefly occur in old people; but this is not

always so. They also rarely begin anywhere but on the face, and then chiefly in the neighbourhood of the eye, or on the nose or cheek. At first a small raised white nodule appears, with small vessels coursing over it. Then, as it spreads, an ulcer forms in the centre, but the raised intensely hard white border persists. If not treated a great deal of tissue destruction occurs; the nose may be destroyed, or the antrum perforated, and the whole of the nasal cavities opened up. In advanced cases practically the whole face is destroyed. Some cases, however, remain superficial, spreading slowly, the older parts healing as the lesion spreads. Multiple lesions are not very rare.

Benign forms are also recognised. In one the lesions are pea-sized or slightly larger nodules, scattered over the face, and of the same type as the early lesions referred to above. Sometimes they undergo cystic change. They were described by Brooke under the name of *epithelioma adenoides cysticum*. Another benign type is seen in which multiple walnut-sized tumours form on the scalp. A third type occurs in the form of multiple psoriasiform patches on the trunk and has been named by Graham Little *erythematoid benign epithelioma*.

Diagnosis.—This can always be made in cases of doubt by microscopic examination.

Treatment.—Excision is the best treatment when possible; but excellent results are obtained by radium. CO_2 snow has been advocated for early cases, and the results obtained are excellent. In advanced cases, which are unsuitable for surgical treatment, scraping followed by the application of arsenic paste has given good results, and diathermy is also useful.

SQUAMOUS EPITHELIOMA

In this condition rapidly growing tumours form, which ulcerate and cause local destruction of tissue, and also cause secondary glandular involvement. It is chiefly a disease of old age.

Pathology.—Sections show an irregular proliferation of the Malpighian layer, with the formation of cell-nests, and the limiting basal layer is absent.

Symptoms.—The lesions begin as nodules, much like those of rodent ulcer, but they spread much more rapidly and either form irregular deep cut ulcers, without the characteristic edge seen in rodent ulcer, or else they become raised and form mushroom or cauliflower-like growths. The glands are soon involved, and general dissemination may occur. The condition may sometimes supervene on pre-existing non-malignant conditions. It may commence in a keratoma senile, in the warty conditions which occur in cases of atrophy of the skin due to exposure to tropical sun, on an old lupus scar, on X-ray dermatitis, in xerodermia pigmentosa, in arsenical keratoses and in tar molluscum.

Treatment.—This is purely surgical, and consists of erasion of the local growth and of the glands draining the area concerned. In the case of epithelioma complicating lupus vulgaris, however, secondary glandular involvement does not appear to occur, and local destruction with arsenic paste, or by diathermy, gives even better results than excision.

TUMOURS OF THE APPENDAGES OF THE SKIN

MILIUM

In this disease pinhead-sized yellowish-white bodies are seen in the skin of the face, chiefly on the cheeks, eyelids and forehead. They are often very numerous. They can be shelled out, and are found to consist of a whorl of epithelial cells. Their origin is unknown, but they are probably derived from the lanugo hair follicles.

Treatment.—These tumours can be destroyed by electrolysis.

SEBACEOUS CYSTS

These are painless cystic swellings chiefly found on the scalp, face, ears, back and scrotum. They vary in size from a pea to an orange. When incised they are found to be filled with cheesy matter. They are either due to blocking of the sebaceous duct, or according to some authorities they are of embryonic origin. True *dermoid cysts* of the skin are also found.

Treatment.—Excision is the most satisfactory method of treatment.

ADENOMA SEBACEUM

A symmetrical eruption of pinhead-sized, bright red papules, of congenital origin, on the face. It commences very early in life, and is often associated with mental defect—in fact cases are most often seen in asylums. The lesions are distributed chiefly over the nose and cheeks, and consist of hypertrophied sebaceous glands and numerous capillary vessels.

Treatment. The lesions can be destroyed with the galvano-cautery, by electrolysis or by diathermy.

Tumours of the sweat glands and ducts are so rare as to need no description here.

CONNECTIVE-TISSUE TUMOURS

KELOID

This is a fibrous tumour developing in a scar. The mere overgrowth of a scar is sometimes referred to as a *hypertrophic scar*, while the term keloid is limited to those cases in which the tumour extends beyond the original limits of the scar. In this latter condition processes often grow out in all directions like tentacles, and also in some cases the condition appears to start spontaneously from the normal skin; but there can be little doubt that some small abrasion was present. Small keloids often appear after acne vulgaris, varicella and other dermatoses which lead to scarring. There can be little doubt that this fibrous overgrowth is due to some chronic bacterial infection of the wound—probably a staphylococcal infection.

Treatment.—The best results are obtained by radium and X-rays. With the latter, pastille doses given at about two months' interval on two or three occasions give satisfactory results.

FIBROMA—MOLLUSCUM FIBROSUM

Hard fibromata of the skin are rare, and usually occur in pear-sized nodules scattered about the skin. Soft fibromata are common, and are met with as small pedunculated tumours, chiefly on the trunk. They may occur in large numbers, and are then described as molluscum fibrosum. In this condition the tumours vary in size from a small pea up to several inches in diameter. Not only the skin but the mucous membranes may be the seat of these tumours. At times they form huge dependent unshapely masses, which completely disfigure the part from which they arise; this condition is called *dermatolysis*. Not all the tumours are pedunculated—as some are sessile—but all have the same softness. Some definitely surround nerve trunks, and it has been thought that they all develop in connection with the nerve fibres; hence they are often called *neuro-fibromata* or *plexiform neuromata*.

In some cases true neuro-fibromata and molluscum fibrosum lesions occur in combination with pigmented spots about the body. This syndrome is called *Recklinghausen's disease*, and is sometimes associated with mental disturbance.

Treatment.—Nothing can be done except surgical removal of the tumours, and this is only occasionally necessary.

LIPOMATA

These are soft freely movable lobulated tumours in the subcutaneous tissue, and may be single or multiple. One variety is very painful and associated with general adiposis, and is referred to as *Dercum's disease* (p. 177).

Treatment.—Excision is the only treatment.

MYOMATA

Small multiple tumours of the size of a pea are sometimes found which have the structure of leiomyomata, and arise from the arrectores pili muscles. The lesions are often numerous, grouped and painful.

Treatment.—The cautery, or excision, is the only treatment.

MULTIPLE IDIOPATHIC SARCOMA OF KAPOSI

This is a curious condition chiefly seen in old people, and generally in the natives of Eastern European countries; but cases have arisen *de novo* in this country. The lesions occur chiefly in the region of the ankles, but have also been found on the hands and on the trunk. They are irregularly shaped red plaques raised from the skin, and of firm consistence. Histologically they consist of an overgrowth of fibrous tissue with dilated blood spaces. Whether this condition is of inflammatory origin, or is a species of nævus is as yet undecided. The condition does not affect the general health.

Treatment.—No treatment is known to affect the condition.

SARCOMATA

Both round- and spindle-celled sarcomata have been found arising in the skin, but are rare. They may be single or multiple, of any size, sessile or pedunculated, and are usually of a purplish-red colour. They tend to break

down and produce fungating ulcers, and run a rapid course ending in death unless removed in the early stages.

Treatment.—This is purely surgical.

NÆVI

This term should be applied only to certain new formations of congenital origin; but in practice certain other conditions have been included. They fall into four classes—(1) Vascular nævi; (2) lymphatic nævi; (3) pigmented nævi; and (4) hyperkeratotic nævi.

VASCULAR NÆVI.—There are two chief varieties, the capillary and the cavernous nævi.

Capillary nævi.—These nævi are essentially dilatations of the capillary vessels of the papillary and subpapillary layers of the dermis. They form flat red patches of varying size. They may be small pea-sized lesions, or they may practically cover the whole body, including the mucous membranes. When they occur in large patches they are called *port-wine stains.*

The lesions are usually not raised and not infiltrated, the only change being in the colour of the skin, which is red or purple in the affected areas. Sometimes, however, thickenings occur irregularly throughout the patches. On examination with a lens the capillaries can often be seen. These nævi are either present at birth or appear shortly afterwards. They tend to get paler as age advances, but rarely disappear.

Treatment.—These cases are very difficult to treat, especially the more extensive ones. CO_2 is useless, unless the application is sufficiently long to destroy the skin. Radium, though sometimes successful in removing the nævus, is inclined to produce atrophy and telangiectases in its place. The best hope in disfiguring cases rests with excision and plastic surgery, though some fair results have been obtained with diathermy.

Cavernous nævi.—These are soft or hard tumours, which appear as bright red sharply defined swellings raised above the level of the skin or as purplish indurations in the skin and subcutaneous tissue. The blood can usually be squeezed out of them by pressure. They consist of a fibrous stroma surrounding irregular blood spaces, the whole being more or less encapsuled. The tumours vary much in size and extent, some being as large as a cricket-ball or larger. Any part of the body may be affected, but they are frequent on the face and scalp, the lips and eyelids often being attacked.

Treatment.—Small tumours are best treated with CO_2 snow, one exposure of 15 to 30 seconds being sufficient to remove them. Larger tumours may be dealt with by repeated applications of snow, but they do better with multiple punctures with a fine galvano-cautery at dull red heat. In some situations excision is the best treatment, while radium can often be used with success. Electrolysis was formerly much employed, but is slow and has been superseded by the methods mentioned above. It is often advisable to abstain for a time from active treatment, as there is a tendency for the tumours to disappear spontaneously.

Stellate nævi.—These are not strictly nævi at all—that is, they are not congenital growths. The cause is not clear, but they may be degenerations or possibly traumatic dilatation of venules. The lesions consist of a central pinhead-sized dilatation of a venule, with a stellate arrangement of dilated

vessels running into it. They are seen chiefly in children on the face, but also occur in adults. It has been thought that insect bites may be a determining cause.

Treatment.—If the central vessel is destroyed by a fine galvano-cautery or by electrolysis the lesion will disappear.

LYMPHATIC NÆVI.—**Synonym.**—Lymphangioma Circumscriptum.

This occurs as a raised circumscribed patch of skin colour, which on close examination is seen to consist of closely grouped vesicles, varying in size from a pin's head to a lentil. There may be a few discrete vesicles surrounding the main patch. In some cases, too, the surface is warty. The patches appear at or soon after birth, but may come out later. Microscopic examination shows dilatation of the lymphatic vessels of the dermis, with or without epidermal hypertrophy.

Treatment.—Excision, cauterisation or treatment by radium are the three methods applicable.

PIGMENTARY NÆVI OR MOLES.—Nævi of this class are very numerous and vary considerably in type. They may consist of pigmented patches of varying size and various depth of colour from a pale yellow to a deep black. These may be associated with hairy growth. In other cases smooth lobulated pigmented tumours may occur on any part of the skin. Some cases have a rough, warty surface, while others are hairy. They may be quite small, no larger than a pea, or may cover large areas of the body, and have a distinct tendency to occupy segmental areas. They may appear at or soon after birth, or may occasionally develop later in life. The histological picture is characterised in all types by the presence of masses or columns of round embryonic cells in the dermis and also in the deeper layers of the epidermis. There is excess of pigment in the cells of the basal layer, in the adjoining Malpighian layer, and also pigmented wandering cells in the upper part of the dermis. The epidermal changes vary with the type of nævus.

There is a slight tendency for these pigmented moles to undergo malignant transformation into *nævo-carcinoma*, which has a high degree of malignancy, giving rise to rapidly generalised metastases.

Treatment.—It is best to leave pigment moles alone unless some definite indication for treatment is present. Free excision with grafting or plastic procedures is indicated in some disfiguring lesions, or in those liable to irritation from friction. CO_2 snow or electrolysis may be used in the case of the smaller tumours.

HYPERKERATOTIC NÆVI.—**Synonyms.**—**Linear Nævi; Ichthyosis Hystrix.**

In this type of nævus the lesions are arranged in lines or bands, usually on the limbs, and often appear to follow the course of certain nerves. They are frequently unilateral, though in the ichthyosis hystrix type they are frequently symmetrical. The lesions consist of thick horny plugs, which can be pulled out from depressions in the skin, and are closely packed together; sometimes great horns protrude from the skin. On microscopical examination an irregular hyperkeratosis is found, with alternating depressions and elevations.

Treatment.—This is very unsatisfactory. Salicylic acid plasters may be used to soften and remove the horny masses, and small areas can be excised or cauterised.

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V. OTHER MORBID CONDITIONS OF THE SKIN

ANOMALIES OF PIGMENTATION

Pigmentation may be produced by the deposit of blood pigment in the skin, by the excessive production of melanin—the normal pigment of the skin, or by the deposition of such substances as silver, seen in poisoning by that substance.

Blood pigment is found after hæmorrhages have subsided and in congestive conditions.

Increase in melanin occurs in the pigmentary nævi already referred to; in certain internal diseases, such as Addison's disease, diabetes and exophthalmic goitre; and in pregnancy; after the ingestion of arsenic; and locally, after certain inflammatory conditions of the skin, such as sunburn, erythema ab igne, lichen planus and syphilis. It also occurs in a curious condition named vitiligo, the ætiology of which is obscure.

LENTIGO

This is the name given to *freckles*, which occur on parts of the body exposed to the sun in certain individuals. The lesions are so well known as to require no description.

Treatment.—This is purely preventive. The application of a greasy preparation, such as lanolin, to the skin before exposure to the sun will protect the face from an erythema; sunshades and veils, especially red or brown, are also useful.

CHLOASMA UTERINUM

This is a peculiar yellowish-brown pigmentation which occurs chiefly about the face in women who are pregnant, or suffering from some uterine disturbance. It occurs in ill-defined patches, chiefly on the forehead and on the abdomen. It disappears after the termination of pregnancy, or when the pelvic condition is rectified.

VITILIGO

This condition, also known as *leucodermia* and *melanodermia*, may occur at any age or in either sex. The ætiology is quite unknown, both toxic and tropho-neurotic theories having been invoked to explain the phenomenon, but very little evidence is at present forthcoming in favour of either view. It consists of patches of a dead white colour appearing in various parts of the body; they may be quite small, or may in rare cases completely cover the body. The edge of the patches is sharp, and the surrounding skin is hyperpigmented; the texture remains normal. In the white areas pigment is entirely absent, but no other histological changes can be observed. The patient's health is in no way affected, nor can any derangement of any of the organs of the body be made out in the majority of cases.

Treatment.—The only treatment which appears to have any effect is the repeated application of ultra-violet rays, either by the Kromayer lamp or by arc-light baths.

ALBINISM

This is a congenital condition in which there is complete absence of pigment in the skin and other epidermal structures. The hair is white, the eyes pink from absence of pigment in the iris, and the skin fails to pigment, even when exposed to the strongest sun.

ATROPHIES OF THE SKIN

Various conditions may cause atrophy of skin, particularly local inflammations, but under this heading certain atrophic conditions are dealt with that have not been considered elsewhere.

SENILE ATROPHY

Generalised atrophy of the skin occurs in old age. The skin becomes thin and loses its elasticity; irregular pigmented spots, small telangiectases and vascular cysts (de Morgan's spots) appear, especially on the face and trunk; wrinkles are very numerous; and the skin develops a yellowish colour. A generalised pruritus may occur. Senile warts are frequently found, and these may be the seat of a localised pruritus. They occasionally become transformed into squamous epitheliomata.

Treatment.—This is purely symptomatic.

STRIÆ ATROPHICÆ

These are bands of atrophic skin which develop in areas where the skin has been much stretched. They are seen best on the abdomen, breast and hips of women who have borne children. The lines when first formed are red in colour and about ½ inch in diameter, but as they get older they become greyish-white. It is thought that they are produced by damage to the elastic fibres of the skin by stretching.

No treatment is required.

XERODERMIA PIGMENTOSA

This is a rare condition of the skin which is hereditary. The ætiology is quite unknown, but there is no doubt that light-rays play a part in the production of the lesions. The affection begins in infancy, and is characterised by the appearance on the face and backs of the hands of macules of yellow and brown pigmentation. The disease is slowly progressive, and in addition to pigmentation other signs of skin degeneration appear, namely, atrophic patches, telangiectases and warty growths. Later ulceration occurs and epitheliomatous tumours appear on the warty growths.

Treatment.—The patient should be protected from the sun's rays as much as possible. The warty growths can be removed and the ulcer treated antiseptically. Epitheliomatous growths can be checked by radium, but the cases always end fatally.

CONGENITAL CONDITIONS OF THE SKIN

Most of these, such as ichthyosis, the nævi and xerodermia pigmentosa, have been already considered. There still remains one condition which has not been alluded to, namely, epidermolysis bullosa.

EPIDERMOLYSIS BULLOSA

This is a congenital defect of the skin which renders it extremely sensitive to the slightest injury. In those affected, the slightest knock is sufficient to produce a blister. The disease is hereditary, and can often be traced to a considerable number of members of a family. The lesions usually appear first in early infancy, but occasionally they have occurred for the first time later in life. They vary much in degree. In some cases the lesions are slight and cause very little inconvenience, and no disturbance to the general health. In other cases the lesions are numerous, almost all parts of the body being affected at one time or another; teeth and nails develop badly, septic complications are often severe, and these cases usually do not live to adult age.

Treatment.—Nothing can be done except by prevention of sepsis and the antiseptic treatment of the lesions when once formed.

DISEASES OF THE HAIR

ALOPECIA

Loss of hair occurs in many diseases. It may fall out after acute illnesses, such as influenza and typhoid fever, in inflammatory conditions of the scalp, in secondary syphilis, and in dermatitis exfoliativa. It is also lost locally in scarring conditions, traumatic or inflammatory, as seen in lupus erythematosus or tertiary syphilis. A progressive loss also occurs in senile atrophy of the skin; this, however, may occur prematurely.

Alopecia Prematura.—Ætiology.—The disease is essentially one of the male sex, and usually begins at about the age of 20. The ætiology of the disease is not clear. Two factors appear to be present, heredity and seborrhœa of the scalp. It is quite clear that the latter condition by itself does not always produce baldness, but it appears to accelerate the loss of hair, as might be expected. Heredity seems to be important, especially in those cases where complete baldness occurs at an early age, and there is no doubt that fine hair is more liable to fall out early than is stouter hair.

Symptoms.—This gives rise to a very characteristic type of hair loss which is familiar to every one. The hair gradually gets thin on both temples and on the vertex, and by slow progression these thinned areas eventually meet, leaving the top of the head entirely bald or only covered by a fine down, while the sides and back of the scalp are covered normally. The progress varies very considerably in different individuals, some becoming completely bald in a year or two, while others still have a good crop of hair at 50.

Treatment.—This has mainly to be directed to curing the seborrhœa,

and the methods for doing this have been dealt with under that heading. Apart from this, avoidance of tightly fitting hats, and gentle massage with the fingers are the most appropriate remedies. Certain drugs such as pilocarpine, have been thought to have a stimulating effect on hair growth, and rubefacients, such as cantharides, are also much employed. The general health should receive attention.

ALOPECIA AREATA.—In this condition the hair falls out in patches, leaving smooth, shiny, bald areas. There is a general tendency for the hair to grow again.

Ætiology.—The malady affects both sexes and generally occurs in early adult life. It is probable that the disease is an inflammatory condition, but the nature of the irritant is unknown. A somewhat similar loss of hair can be produced by the administration of thallium salts, which lends support to the toxic theory. It was at one time thought to be due to an external parasite, but there is no evidence to support this view. It has also been thought to be of nervous origin, as damage to nerves has produced bald patches over the areas supplied.

Symptoms.—The disease may start suddenly or slowly. In some cases a large circular patch of baldness may occur in a single night, and in these cases the skin may be tender and reddened. Generally, however, a small bald patch appears, which spreads slowly, and other patches may subsequently arise, causing considerable loss of hair and a curious patchy condition of the scalp. Not only the scalp hairs but those of the beard, the eyebrows, axillæ and pubes may be affected, and in severe cases all the hairs of the body, including the eyelashes may fall out. In one type a band of hair may be lost extending from ear to ear around the margin of the scalp, either in front or behind the head or even in a complete circle.

In the patchy form, the individual patches are characteristic. The centre is usually completely bald and shiny, though new downy hairs may be seen. Around this a row of stumps may be observed. These are club-shaped, like a note of exclamation, being very thin as they enter the scalp and thicker above. When pulled out, a shrunken hair bulb comes out and the hair does not break as in ringworm. The zone outside the zone of stumps looks normal, but if the hairs are pulled upon many loose hairs may be detached.

Course.—This varies in different cases. Usually new hair grows fairly rapidly, and the patches cease to spread. The new hair is usually white when it first appears, but pigments later. In some cases, however, the patches progress as new hairs grow and this may continue for many months. In the band-form hair growth is usually much slower. In the generalised cases the prognosis is not so good, a large proportion losing the hair permanently.

Diagnosis.—This has to be made from ringworm and is generally easy. In ringworm the patch is scaly and covered by stumps, which break easily and have an irregular fractured end. Under the microscope the fungus can be seen.

Impetigo contagiosa of the scalp sometimes gives rise to bald patches. They are numerous, small and usually red in colour, and no stumps are seen.

Treatment.—The general health must be looked to and all possible sources of irritation removed. The teeth must be attended to, tonsillar sepsis treated, and errors of vision corrected. General tonic treatment

should be prescribed, and rest from overwork and worry ordered. Thyroid extract has been recommended, but in the writer's experience has sometimes made the condition worse.

Local applications which cause hyperæmia are of most value. Painting the patches with pure carbolic acid, iodine or blistering fluid, or rubbing in oil of turpentine are useful. Various antiseptic lotions, such as perchloride of mercury and resorcin, have been used with success. High frequency current and ultra-violet rays have given good results when other means have failed. If seborrhœic dermatitis is present it should be treated.

CICATRICIAL ALOPECIA.—In this condition, also known as *pseudo-pelade* or *folliculitis decalvans*, progressive loss of hair takes place, and the scalp shows signs of atrophy or scarring. There is a progressive patchy loss of hair occurring over considerable areas of the scalp, and on examination inflammatory lesions are often present round the hair follicles. The denuded areas show obvious scarring, and hair does not regrow on the patches. The disease occurs chiefly in young adults, and though it does not usually lead to complete baldness, very disfiguring patches remain.

Treatment.—This consists in the application of antiseptic ointments and lotions, perchloride of mercury, resorcin and sulphur being the most useful, but no treatment is very efficacious.

HYPERTRICHOSIS

This is the term applied to an excessive growth of hair. It is usually confined to those cases in which a growth of stout hairs occurs in sites usually covered with lanugo hairs, such as the face in women. This may sometimes be very excessive, and the "bearded woman" and the "dog-faced man" are extreme examples, though the latter are often cases of hairy moles. The only conditions that the medical practitioner is likely to have to deal with are those in which stout and dark hairs occur on the chin and upper lip in women. The treatment consists in removal of the hairs by electrolysis, but considerable judgment is often required to decide whether a case is suitable for treatment. Electrolysis consists in passing a current of about 1 milliampere for a quarter to half a minute into the hair bulb by means of a fine needle attached to the negative pole of a galvanic battery. The hair then loosens and can be removed. It is important not to remove hairs too close to one another at the same sitting, or troublesome scarring will supervene.

A. M. H. GRAY.

VI. TROPICAL SKIN DISEASES

CRAW-CRAW

Definition.—A West African native name (kra-kra) applied indiscriminately to any itching, papular or pustular eruption of the skin.

Ætiology.—O'Neil claimed he found filarial embryos in an eruption which clinically resembled scabies. It is quite possible the subjects already had filarial embryos in their blood, and when he pared the tops of the

papules with a sharp knife some of the blood infected the smears. This would account for their presence in the papules. Recently, however, Scott Macfie has shown that filarial embryos (*Agamofilaria streptocerca*) are very common in the skin of West African negroes, and may be demonstrated in sections. There is no doubt that these are what O'Neil saw. Possibly they have nothing to do with the eruption.

Treatment.—Many of the so-called craw-craw cases are really a form of scabies, and respond quickly to sulphur baths. Castellani believes some of these cases are the same as coolie itch. This consists of an eruption of intensely itchy papules, converted by scratching into pustules and often into open sores. No acari are obtainable, however, and no burrows are seen. He advises a salicylic acid spirit lotion, followed by a β-naphthol ointment. Carbolic lotion improves some of the cases.

PRICKLY HEAT

Definition.—A form of miliaria, due to excessive sweating in hot climates.

Ætiology.—No organism has been isolated, and as the condition quickly disappears in a cold climate it is possibly purely a mechanical process—blocking of the orifices of the sweat glands by sodden cells of the stratum corneum.

Symptoms.—Most people are attacked shortly after arriving in the tropics. The eruption is very irritating, and causes a pricking sensation with great itching. The lesions chiefly occur on the trunk, but may also attack the arms and legs. The itching may become intolerable and render sleep difficult, if not impossible. The eruption consists of small watery vesicles and inflamed papules generally merged together, which feel like grains of sand. If the weather becomes cooler it tends to disappear, only, however, to return quickly in the hot weather.

Treatment.—The underclothes should be changed daily, as failure to do so seems to add to the irritation. Some recommend washing with fairly strong carbolic soap, or painting the patches with corrosive sublimate solution 1 in 1000. Rubbing with lime juice is recommended in the West Indies. After the bath some dusting powder, such as zinc oxide with boracic acid and starch in equal parts, should be employed. Sea bathing often seems to improve it, if not actually to cure it.

FURUNCULOSIS

Boils and similar pyogenic conditions are very commonly met with in the tropics. People are so often bitten by all sorts of insects that there is a constant source of infection, more or less, always present. The best *treatment* for boils is the same as at home, namely, an autogenous vaccine. If that does not succeed the patient should be sent home to a cold climate for a change.

Veldt sore (Barcoo rot) is another coccal infection, due to streptococci. A definite ulcer forms, very difficult to heal, and often lasting 3 to 6 months. Several sores may exist at the same time. Some of the sores may reach the size of half a crown.

Diagnosis.—This has to be made from Leishmanial sores and from tropical ulcer (see p. 1368).

Treatment.—Local applications of ammoniated mercury, or the nitrate of mercury ointment, often do great good. Other antiseptics may also be tried, and vaccine therapy should not be omitted. Inquiry should be made of the general condition of the health, and a tonic of iron and arsenic may be given.

PEMPHIGUS CONTAGIOSUS

Definition.—A contagious skin affection characterised by inflammatory vesicles or bullæ with ulcer formation and scabbing.

Ætiology.—This condition has lately been termed a pyosis, non-follicular in nature, and has been given the name of *Pyosis mansoni* by Castellani and Chalmers. They add a further series of pyoses, namely, *Pyosis tropica*, *P. palmaris*, *P. corletti* and *P. discoides*.

The causative agent is a staphylococcus, the *aureus* or *albus* being usually grown from the lesions. The condition more resembles an impetigo than a real pemphigus. It is common in hot, damp, steamy parts of the tropics.

Symptoms.—The lesion begins as a minute red speck, which rapidly grows larger, becoming a vesicle, then a bulla, then a bleb-like pemphigus. At first the fluid in the bleb is clear, then later becomes turbid, and generally bursts; but the process may still continue to spread. Finally, a pinkish, slightly glazed spot is left to indicate the original site of the bleb. The lesions are mostly confined to the axilla and crutch; but may be spread over other parts of the body by the fingers.

Treatment.—Cleanliness comes first. The patient should be warned against scratching himself for fear of spreading the trouble. Perchloride lotion may be used to wash the parts, followed by a dusting powder of zinc oxide, boracic acid and starch.

TROPICAL ULCER

Synonym.—Tropical Sloughing Phagedæna.

Definition.—A gangrenous condition of the skin and subcutaneous tissues, resulting in loss of tissue and the formation of sloughing ulcers.

Ætiology.—The condition is common in many parts of the tropics, especially in damp, steamy, low-lying areas. The causative agent is supposed to be a spirochæte, *Treponema schaudinni*, either alone or in conjunction with fusiform bacilli. It is specially common in the debilitated; but also may attack healthy individuals. Both sexes and all ages are liable.

Symptoms.—The sore begins as a bleb, which bursts, exposing a grey-coloured slough. The gangrene quickly spreads and involves the deeper tissues, and also extends at the point of origin. An area of some inches may be involved. Subsequently, in many instances, the sore ceases to spread and becomes limited, the sloughing tissue being thrown off. Great destruction may be caused to the deeper tissues, though in other cases the ulceration remains superficial.

Diagnosis.—This has to be made from tropical sore due to Leishmania tropica, and from ordinary pyogenic sores. Examination of smears will show spirochætes and fusiform bacilli.

Treatment.—Novarsenobillon injections intravenously should be tried, in view of the possible spirochætal nature of the condition. Locally powerful antiseptics (pure carbolic) or caustics must be applied, preferably under an anæsthetic. The general condition of the patient must also receive attention.

TINEA

Ringworms abound in the tropics, some being specific to those parts, while others are much the same as in temperate regions. Two may be mentioned here.

Tinea cruris (Dhobie itch).—This troublesome complaint is very common in the tropics. According to Castellani three species of Epidermophytons and one Trichophyton may give rise to the condition. The condition often excites an inflammatory eruption, which is painful and itchy, rendering the parts raw and tender.

Treatment.—If not too extensive, and not too inflamed, linimentum iodi will often cure the condition. Chrysophanic acid ointment is also used, or glacial acetic acid, or resorcin and salicylic acid. The crutch should be dusted daily with some dusting powder.

Tinea imbricata (Tokelau).—**Definition.**—A form of ringworm indigenous in certain tropical regions (chiefly the Eastern Archipelago and South Pacific), due to an Endodermophyton, and characterised by flaky tissue paper-like scales arranged in concentric rings.

Symptoms.—The peculiar tissue paper-like scales are very characteristic, as also the absence of inflammation. The scales are firmly attached by their bases.

Treatment.—The condition is difficult to cure. Linimentum iodi clears it away for the time being; but it is apt to return. Resorcin dissolved in tincture of benzoin (resorcin, ℈ij, tinct. benzoini co., ℥i) or chrysarobin ointment 5 per cent., sometimes gives better results.

Pityriasis versicolor is also common abroad; ordinary white and black varieties are described.

PINTA

Definition.—A fungus disease associated with peculiar pigmented patches of the skin.

Ætiology.—The disease is found in parts of tropical America, is said to be contagious, and attacks both sexes and any age. A variety of fungi seem to be implicated—*Penicillium*, *Aspergillus* and *Monilia*.

Symptoms.—The patches are very striking owing to their peculiar colouring, some being blue, others red, white or black. From the parent spot others develop, till large areas of the skin are involved. The white spots do not itch or desquamate, so the possibility of leucodermia should be considered. When the scalp is affected the hair becomes white. The skin has an offensive odour.

Diagnosis.—The patches are distinguished from leprosy by the absence of anæsthesia.

Treatment.—As for ordinary ringworms.

LEUCODERMIA

There is nothing peculiar about this condition in the tropics. It is however, much more striking on a black-skinned negro than on a white skin. Occasionally an albino negro is seen.

PIEDRA

Definition.—Gritty nodosities on the hair of the scalp.

Ætiology.—The disease is seen in Colombia and South America, and is supposed to be due to a fungus. The hair appears surrounded by a sheath. The condition must not be confused with the ordinary *Trichomycosis nodosa*.

ULCERATING GRANULOMA

Synonyms.—Ulcerating Granuloma of the Pudenda; Serpiginous Ulceration of the Genitals.

Definition.—A chronic ulcerating condition of the genitals and groins, venereal in origin, and due to a short rod-shaped bacillus.

Ætiology.—The disease is very common in the Guianas in South America; it is also found in Madras, amongst the aboriginals in Northern Australia and also on the West Coast of Africa. Males and females are both subject to the disease. Children before the age of puberty do not suffer. All races suffer equally, if exposed to infection. Donovan in India first saw the parasites, but for some time there was some uncertainty as to their nature, some believing them to belong to the protozoa. Recent South American work has demonstrated they are non-motile capsulated bacteria of the rhinoscleroma group, and the name *Calymmatobacterium granulomatis* has been given to them. They occur in little round clusters in the endothelial cells of the lesions, and also in zooglœa masses in the tissues between.

Pathology.—The type of the lesion microscopically is an infective granuloma. The new-growths at the margins of the sore consist of nodules, made up of round cells in which the nuclei are difficult to see. The older parts of the lesions consist of fibrous tissue with smaller clusters of the same sort of cells. The parasites are found lying in the cells as described above. There is no suppuration or caseation in the lesions.

Symptoms.—The disease begins on the genitals as a small, slightly raised sore, which soon breaks down and leaves a small ulcerated area. The latter spreads serpiginously, the ulceration not extending deeply but gradually involving more and more of the healthy skin. It is auto-inoculable, so that apposition of adjacent parts, such as the scrotum and thighs, or the opposed surfaces of the labia, readily become affected. The whole of the groins,

the penis and scrotum in the male, and the vulva, labia and vagina in women, finally become involved, and if unchecked the ulceration eats its way into the rectum and urethra. The general health remains wonderfully good, the lymphatics not being affected, and the disease remaining strictly local. The condition, however, lasts indefinitely, partial healing occurring at some parts, while extension is taking place at others.

Diagnosis.—This has to be made from lupus, rodent ulcer, malignant disease—epithelioma—syphilis, etc. The Wassermann test is negative.

Prognosis.—This has improved with the new methods of treatment now in vogue. Formerly the condition was hopeless, lasting for the rest of the patient's life.

Treatment.—Sexual connection with infected women should be avoided. Excision of the early lesions is curative. The ulceration does not extend deeply, so the part can be cut out successfully in many instances. In past days scraping and caustics of various sorts were used. The modern treatment consists of intravenous injections of tartar emetic, which is a specific. This is given in the way described under Leishmaniasis and bilharziasis. The total dosage may have to be as high as 50 or 60 grains *in toto*. Complete cures can be effected by such treatment.

Protein shock produced by the intravenous injection of T.A.B. vaccine may also be employed in addition to the antimony. It stimulates healing in a marked manner.

G. Carmichael Low.

SECTION XIX

DISEASES OF THE NERVOUS SYSTEM

AFFECTIONS OF THE CRANIAL NERVES

INTRODUCTORY

Affections of the cranial nerves are often very important indications, not only of local disease which may involve them at any part of their course from their nuclei of origin to their extreme peripheral distribution, but also of certain general diseases in which either the neurones are poisoned generally by toxic agents circulating in the blood or gaining access to the nervous system from local points of infection, by ascending to the nervous system along the perineural lymphatics which accompany the peripheral nerve fibres, and so delivering a local dose of poison within the nervous system, as, for example, in polyneuritis, tetanus, rabies, etc.; or the general disease may produce multiple local lesions, some of which may affect the cranial nerves, as in syphilis of the nervous system, disseminate sclerosis, tuberculosis, etc. The nuclei of the cranial nerves may be affected by local gross lesions, by toxic processes or by primary neuronic degeneration producing nuclear paralysis, which in the case of the oculo-motor and sixth nerves differs conspicuously in type from the paralysis due to lesion of the peripheral nerve trunks. Between the nuclei of origin and the point of emergence of the nerve from the surface of the brain, the nerves may be involved by inflammation, vascular lesions, tumours, syphilitic lesions and patches of disseminate sclerosis, and the resulting clinical picture will include the results of the lesion upon the other nervous structures implicated. In their subarachnoid course between the superficial origin from the surface of the brain and their exit through the dura mater, these nerves are apt to be involved by inflammatory conditions, such as meningitis, syphilis, tumours and pressure. During their passage through the cranial foramina, they are especially often affected by inflammatory processes involving the periosteum, as in the common Bell's paralysis of the facial nerve, and they may be injured in fracture of the skull. In their peripheral course they are prone to the same local affections as are the peripheral nerves generally. Throughout their whole course, local syphilis is by far the most frequently occurring individual lesion.

THE OLFACTORY NERVE AND TRACT

The olfactory tract gathers from two roots: an outer, which sinks into the anterior perforated region to end in the uncinate gyrus of the same side,

and an inner, which crosses in the anterior commissure to end in the uncinate gyrus of the opposite side. There is thus a semi-decussation of the olfactory path similar to the semi-decussation of the visual and of the auditory paths. From the olfactory bulb the olfactory nerves pass as many fine non-medullated nerves to be distributed to the upper meatus of the nose. The sense of smell includes the appreciation of all flavours, and in its absence taste is reduced to the appreciation of bitter, sweet, salt and sour. Only those substances are appreciated by the sense of smell, which are readily oxidisable, and for this reason this sense should be tested by means of essential oils. Most conditions of anosmia are due to affections of the nasal mucous membrane, or they follow general diseases such as influenza or syphilis, and are to be disregarded in the diagnosis of nervous disease. Unilateral anosmia is more important, and is indicative of the involvement of one olfactory tract by tumour, or pressure, and is suggestive of tumour involving the orbital lobule.

OPTIC NERVE

The optic nerve, from its origin at the back of the eyeball to its termination in the optic chiasma, is liable to injury from the pressure of tumours within the skull, or at the back of the orbit, and from inflammatory conditions of the bone and periosteum as it passes through the optic foramen. It may be affected by a primary thrombosis of vessels, or from thrombosis of the ophthalmic artery in the condition known as carotid hemiplegia. These conditions result in blindness of one eye, which may be partial or complete, and with a varying visual field, according to the degree of the lesion and the manner in which the pressure falls upon the optic nerve. On account of the cutting off of the light-reflex path, the pupil will be moderately dilated and insensitive to light. Notwithstanding the fact that the nerve cells which control the nutrition of the optic nerve fibres are situated in the retina, lesions of the optic nerve of any long duration produce atrophy of the optic disk.

Retrobulbar Neuritis

Inflammatory and other local lesions in the substance of the optic nerve between the globe and the chiasma are of very common occurrence. According to their severity they give rise to partial or complete blindness, which often recovers wholly or in part. The central part of the optic nerve is the seat of election for these lesions and, therefore, the visual defect appears commonly in the form of a central scotoma. According to the degree of the visual defect, the pupil tends to be dilated, and to react poorly to light, and dilate badly to shade. These conditions of retrobulbar neuritis are very often followed by optic atrophy of varying degree. When the inflammatory lesion occurs far forwards and impinges upon the optic papilla, papilloedema occurs, and, as this region is sensitive, whereas the optic nerve is not, there is usually pain in the eyeball. The prognosis in this condition varies with the causes, which are as follows:

1. *Syphilis.*—The lesion is a diffuse gumma of the nerve, and sometimes there is thrombosis. It is commonly unilateral, and often recovers, if treated early and energetically, but in severe untreated cases, and when thrombosis occurs, it not uncommonly ends in complete blindness. It is the common

cause of complete blindness confined to one eye in tabes, and in other syphilitic conditions.

2. *Disseminate sclerosis.*—Plaques in the optic nerve are very common in this disease. When they first form they are swollen œdematous pink patches and cause pressure upon the nerve fibres, and on their subsequent shrinking, this pressure is removed, and the nerve fibres recover to a great extent, and never become completely destroyed. This condition is the cause of the very common transient amblyopia or transient blindness which is met with in cases of disseminate sclerosis, and which may come on very suddenly. It may be unilateral or bilateral, and may recur many times. It always causes some degree of optic atrophy, but is never followed by complete blindness.

3. *Local septic conditions.*—Suppuration and chronic disease in the vicinity of the orbit, and particularly that of the ethmoidal cells, sphenoidal sinus, nasal cavities, frontal sinuses, antrum or even, it is said, of the teeth, are frequent causes of retrobulbar neuritis. The process presumably is an extension of organisms by the lymphatics into the optic nerve, and the setting up of a non-suppurative inflammatory process. It is more often unilateral than bilateral, but may occur first in one eye and then in the other. It usually recovers to a very considerable extent. Not infrequently the inflammation extends through the sclerotic to the papilla, and is seen on ophthalmoscopic examination as a papillœdema. This is by far the commonest cause of papillœdema confined to one eye. The diagnosis rests upon the discovery of a septic focus likely to cause the condition. The treatment is that of the cause, and, in addition, the liberal administration of mercury and salicylates. It is unwise to operate upon the septic condition of the nose, etc., until the retrobulbar neuritis is quieted down and the vision improved by medicinal treatment, for such operation is sometimes associated with an acute and serious exacerbation of the retrobulbar inflammation.

4. *Diabetes.*—In this malady a progressive and absolutely incurable form of retrobulbar neuritis occurs. It commences with a central scotoma for colour, and the failure of vision progresses to blindness, with optic atrophy.

5. *Other toxic causes.*—Tobacco, if over indulged in, may cause a curable form of retrobulbar neuritis, commonly called "tobacco amblyopia," of which the chief sign is central scotoma, and the symptom misfiness of central vision. It recovers rapidly on the removal of the cause.

6. Alcoholic indulgence, and especially taking of wood spirit and some other poisons, may cause retrobulbar neuritis.

The expansion of the optic nerve within the globe of the eye is visible on ophthalmoscopic examination, and the pathological changes therein occurring afford important indications which cover the whole realm of medicine. Among these changes the most important in connection with diseases of the nervous system are: syphilitic choroiditis, as an indication of the presence of syphilis, papillœdema, which is fully described in the section on intracranial tumours, and optic atrophy.

Optic Atrophy

Optic atrophy is recognised, on ophthalmoscopic examination, by a peculiar opaque whiteness and flatness of the disk, with a very high

contrast at the edge of the disk between disk and surrounding retina, both as regards colour and limitation. The lamina cribrosa—the sieve-like cross-latticing of the strands of the sclerotic through which the bundles of optic nerve fibres pass—becomes visible as a stippling of the temporal region of the disk. The vessels of the retina become atrophied, and are seen to be unduly small. In many atrophies the edge of the disk is sharply cut; but when atrophy follows papillœdema the edge is apt to be fluffy, like that of torn cotton-wool. Optic atrophy may be of three kinds—(1) Primary optic atrophy results from an original devitalisation and death of the nerve cells of the retina with their processes, which constitute the fibres of the optic nerve. This is a primary neuronic degeneration, analogous to that of the anterior horn cells in progressive muscular atrophy. (2) Secondary or retrograde optic atrophy results from lesions of the optic chiasma and optic nerve, and is the constant result of long-continued pressure upon these structures. (3) Consecutive optic atrophy follows the more severe grades of papillœdema and papillitis, in proportion as these are of long standing, and proportional to the amount of exudate, and is due to strangling of the optic nerve fibres by the œdema in the first place, and by the cicatrisation subsequently. Severe degrees of papillœdema may, if pressure be relieved, recover perfectly without atrophy or impairment of sight. It may be that there is another factor in the atrophy following papillœdema, and that is the long-continued pressure of a distended infundibulum upon the optic chiasma.

Ætiology.—1. It is of frequent occurrence in familial, hereditary or congenitally installed diseases in which primary degeneration of neurones occurs, as in cerebral diplegia, amaurotic family idiocy, and hereditary cerebellar atrophy where it is characteristic of Marie's type, and sometimes occurs in Friedreich's type. It is the chief feature of the familial optic atrophies, of which Leber's type, appearing about the twentieth year, is one. It occurred in several members of a family with peroneal atrophy under our observation.

2. It is one of the common manifestations of syphilis of the nervous system, and may occur alone, but much more usually as part of the syndrome of tabes and general paralysis. It is not rarely met with in congenital syphilis. It is commonly associated with local lesions of the chiasmal region, pituitary neoplasms being the most often met with. The optic atrophy of disseminate sclerosis is not a primary optic atrophy, but is secondary to retrobulbar neuritis.

3. It may follow the exhibition of certain drugs, and noticeably the injection of the earlier used arsenic preparations, such as atoxyl, soamin and orsudan. In rare cases it has followed the use of quinine.

4. Optic atrophy has also occurred in connection with diabetes, malaria, and arterial disease, and has been probably of the nature of secondary atrophy. Its occurrence in glaucoma from increase of the ocular pressure requires no explanation.

Prognosis.—This is uniformly bad in primary atrophy. When once the degenerative process is installed, the atrophy proceeds to complete blindness, sometimes slowly, sometimes quickly, and seems entirely uninfluenced by any form of treatment, even in the syphilitic cases. We believe we have seen one permanently arrested case in a congenital syphilitic subject.

Secondary optic atrophy is frequently arrested, with the recovery or removal of the cause; but some defect of vision usually remains. Consecutive atrophy from neuritis may be of any degree of severity, from the slightest, which allows of $\frac{5}{6}$ths vision, to the most complete with utter blindness and loss of light reflex.

OCULO-MOTOR NERVES

The third nerve has its nucleus of origin immediately below and lateral to the aqueduct of Sylvius in the mid-brain. The fibres sweep in a semicircle through the substantia nigra and inner part of the crus cerebri to emerge on the inner side of the crus between the two diverging crura. After a short arachnoid course, it perforates the dura, and runs in the outer wall of the cavernous sinus where the relation of the several nerves from above downwards and from within outwards is the third, the fourth, the ophthalmic division of the fifth nerve and the sixth nerve, to pass through the sphenoidal fissure and supply the two internal muscles of the eye, and all the external muscles of the eyeball, except the superior oblique, which is supplied by the fourth nerve, and the external rectus, which is supplied by the sixth nerve. The branches which supply the intra-ocular muscles pass through the lenticular ganglion, which lies in the orbit close to the optic nerve. Complete paralysis of this nerve produces a dilated and inactive pupil with complete ptosis, a downward and outward strabismus and complete loss of upward, downward and inward movements. There is often no diplopia complained of by the patient, because of dropping of the lid. When diplopia is present it is a crossed diplopia, because the strabismus is divergent. There is secondary deviation of the sound eye, and false projection in the visual field.

The fourth nerve takes origin in the middle part of the general oculo-motor nucleus, and decussates with its fellow of the opposite side in the valve of Vieussens, from the lateral part of which it emerges to take a winding course round the crus, and enter the wall of the cavernous sinus. It passes into the orbit through the sphenoidal fissure, and supplies the superior oblique muscle. Paralysis produces no obvious strabismus, but in looking outwards or downwards there is a wheel movement of the globe which can be detected by observing the conjunctival vessels when the eye moves. The diplopia is most discomforting, and occurs in every position of the eyes, except on looking up. The diplopia is uncrossed, and the false image is lower than, and with its top tilted toward, the true image.

The sixth nerve has its nucleus of origin beneath the fasciculus teres in the floor of the fourth ventricle, and leaves the medulla on its ventral aspect at the junction of the medulla with the pons. It has a very long arachnoid course, and perforates the dura mater lateral to the posterior clinoid process, to gain the outer wall of the cavernous sinus, whence it runs, via the sphenoidal fissure, into the orbit to supply the external rectus muscle. Paralysis of the sixth nerve produces an internal strabismus with an uncrossed diplopia.

Within the orbit lesions of any of these nerves or of their branches may occur from perforating wounds, blows upon the eyeball or from local syphilitic lesions of a gummatous nature. Injury to the lenticular ganglion, with resulting complete internal ophthalmoplegia, not uncommonly results from

a blow on the eyeball. A lesion, confined to the nerve to the inferior oblique, occurs in rare cases from syphilis, and produces a peculiar attitude of the head, for, since the resulting diplopia occurs only above the horizontal level of the eyes, the patient constantly throws back his head, and looks down his nose to avoid the diplopia.

Lesions at the back of the orbit may involve one or more of the oculo-motor nerves, and since the first division of the fifth nerve passes through the sphenoidal fissure with these nerves, and the second division of the fifth nerve is entering the infra-orbital canal at the apex of the orbit, both these nerves are commonly involved in the same lesion. New-growths, including those of the bone, periosteal inflammation and subperiosteal hæmorrhages arising from fracture of the skull are the common lesions. There is one not infrequently occurring class of these cases, which needs special description:

Oculo-motor Paralysis from Orbital Periostitis.—This condition is very closely allied to the common facial paralysis from exposure to cold. It may occur at any age from puberty onwards. The serum reactions for syphilis have always shown that this infection is absent. The condition may arise from exposure to cold or from septic conditions of the nose and its accessory sinuses, and sometimes without obvious cause. The malady commences with pain in the orbit, which is often severe and long lasting. Soon after some proptosis is evident, and there is tenderness on pressing the globe backwards. This is soon followed by signs of involvement of the nerves which pass through the sphenoidal fissure. The sixth nerve is the first and sometimes the only nerve involved, but usually the paralysis of this nerve is followed by that of the fourth, the first division of the fifth, the third, and the second division of the fifth nerve in that order. The final result usually is that of a total ophthalmoplegia with anæsthesia of the upper two divisions of the fifth nerve, unilateral proptosis and tenderness of the eyeball, and often excruciating and lasting pain. When the sixth nerve is involved alone, and there is no spread to the divisions of the fifth nerve, there may be little pain, and the proptosis and tenderness may be little marked. Under treatment with mercury by inunction, salicylates in full doses, warm applications to the eye and counter irritation, the condition recovers in a few weeks in the milder cases, to a few months in the more stubborn ones. Forty cases of this nature have been under our observation, and in almost all of them complete recovery has occurred. In one case, three attacks were observed, all severe: the first recovered in 6 weeks and recurred 8 years later, and recovered in 5 weeks, the third attack occurring after an interval of 17 months. In only one of these cases have we seen extension to the region of the optic foramen, and involvement of the optic nerve. Both in their mode of origin, in their commencement with local pain and tenderness, in the absence of syphilis as a cause, in the nature of the treatment which is successful in their cure, and in constancy of the recovery these cases show a marked resemblance to cases of Bell's palsy which are due to a similar periosteal lesion in the region of the stylomastoid foramen. Other of the cranial nerves may be similarly affected at their foramina of exit from the skull, notably the twelfth nerve. In one case under our care a coincident lesion of the twelfth nerve occurred, and recovered under the treatment described above.

In their course between the sphenoidal fissure and their superficial origin

from the brain stem the oculo-motor nerves may be affected singly or collectively by lesions of the outer wall of the cavernous sinus, which are usually neoplasms, or by thrombosis of the sinus. Further back they may be affected by tumours, meningitis, syphilis and by general intracranial pressure. This last factor is commonly productive of paralysis of the sixth nerves, often on both sides, from the shifting backwards of the brain stem and consequent stretching of the sixth nerves, which are at the same time exposed, during their long intrameningeal course, to the general increased intracranial pressure. It thus arises that unilateral or bilateral paralysis of the sixth nerves is of no localising significance in the diagnosis of intracranial tumours. The third nerve is sometimes similarly affected by general intracranial pressure, and this usually occurs on one side only, from lateral displacement of the brain stem as it passes through the tentorial foramen, the third nerve being pressed against the edge of the tentorium. The fourth nerve from its sinuous course seems never to be similarly affected.

Any lesion of the crus cerebri may affect the third nerve, the result being the syndrome of Weber—a hemiplegia of the opposite side with third nerve paralysis on the same side as the lesion.

Ætiology.—By far the commonest cause of paralysis of the oculo-motor nerve trunks, in any part of their course to their terminal branches, is syphilis, the lesion being a gummatous infiltration of the nerve. Such paralyses if diagnosed and treated early almost invariably recover. If left for long without treatment vascular changes and cicatrisation in the region of the lesion may render recovery impossible. The next most common cause is intracranial tumour.

Among other causes of oculo-motor nerve trunk paralysis which have not as yet been referred to are—(1) Encephalitis, which usually produces a nuclear ophthalmoplegia, but which may cause a peripheral trunk lesion, the pathological condition productive of the latter being an inflammatory focus round the point of superficial origin of the nerve. This is most commonly met with in lethargic encephalitis; (2) disseminate sclerosis, rarely—though this malady frequently produces diplopia, it rarely produces a definite peripheral trunk palsy; (3) diphtheria; (4) ophthalmoplegic migraine, which may produce a severe and sometimes recurrent paralysis of one or all of the ocular nerves, and may be bilateral—this condition usually recovers if the migraine be treated; (5) it may occur in aged subjects without any obvious cause. Possibly arterial thrombosis of the nerve trunk may be responsible for this condition; (6) it may occur as a transient and as a permanent event in diabetes; (7) paralysis of the sixth nerve has been frequently noticed as a slowly transient event after the use of spinal anæsthesia.

Nuclear Ophthalmoplegia.—The paralyses just described are in terms of the anatomical distribution of the nerve trunks to the various individual ocular muscles, and must be strongly contrasted with those paralyses due to lesions just above the oculo-motor nuclei and with those involving these nuclei. The pure supranuclear lesion separates the oculo-motor nuclei from their cerebral connections, and the resulting paralysis is in terms of conscious vision: namely, paralysis of upward movement, paralysis of downward movement, paralysis of lateral movement to right and to left respectively, and paralysis of convergence. There is no diplopia and no strabismus. Such

lesions are found just above the level of the posterior commissure. The path for lateral conjugate movements is situated lateral to the paths for upward and downward movement, and both the latter appear to cross the middle line in the posterior commissure. Unless it be a simple atrophy of the cells, the nuclear lesion must of necessity involve some of the supranuclear path fibres, some of the nerve cells, and some of the thence-emerging lower motor neurones. It involves, therefore, the movement of both eyes, but irregularly and often unequally upon the two sides. There is always diplopia, and the axes do not remain parallel. A lesion in the region of the third nucleus always causes disturbance of the functions of the pupil and of accommodation. A lesion in the region of one sixth nucleus causes complete loss of lateral conjugate movements to the same side if it involve the upper part of the nucleus, and therefore interrupts the whole of the supranuclear path for lateral conjugate movement. In the case of a lesion a little lower down, there is a major paralysis of the external rectus of the same side, combined with weakness of the opposite internal rectus ; and with a lesion at the lower pole of the nucleus, the resulting paralysis exactly resembles a pure paralysis of the sixth nerve.

Nuclear ophthalmoplegia is a conspicuous feature in the following diseases: (1) All local gross lesions in the region of the oculo-motor nucleus, of which mesencephalic, pontine and pineal tumours and vascular lesions are the usual varieties. (2) Myasthenia gravis. (3) Lethargic encephalitis. (4) Polyneuritis, including diphtherial polyneuritis. (5) Veronal poisoning (the pupils are here exempt). (6) Nervous syphilis, especially in connection with tabes. (7) It occurs in rare cases as a progressive condition akin to progressive muscular atrophy.

Pathological Conditions of the Pupil and of Accommodation.—Myosis or unusual smallness of the pupil is a common sign of syphilis of the nervous system. It is an important sign of paralysis of the cervical sympathetic. It occurs in lesions of the pons below the third nerve nucleus, is often met with in advanced age without pathological associations, and is also a symptom of the morphine habit.

Eccentricity of the pupil and varying unroundness of the pupil are important signs of nervous syphilis, and these signs occur also in lesions of the foremost part of the third nucleus.

Inequality of the pupils occurs in connection with all nuclear and peripheral ocular paralyses, and with cervical sympathetic paralysis. It accompanies all defects of vision from lesions of the visual path between the eye and the external geniculate bodies, provided the appreciation of light be unequal in the two eyes. It may be congenital or associated with inequalities of the refraction of the two eyes, and then has no pathological significance. It is commonly a sign of nervous syphilis.

The Argyll Robertson pupil or reflex iridoplegia may result from any lesion in the region of the posterior commissure, interfering with the anterior end of the third nucleus. It has been produced experimentally in animals, by severing the connection of the optic tract with the quadrigeminal region in front of the external geniculate bodies on both sides. It is an important sign of nervous syphilis, and is rarely met with except in this condition. It consists of loss of reaction to light with preservation of reaction upon convergence, and often progresses to complete iridoplegia in tabes and other conditions of nervous syphilis. A very similar condition is the inverse

combination of preservation of reaction to light with loss of reaction on convergence. The Argyll Robertson pupil occurring as a sign of gross local disease is a certain sign of a lesion in the region of the posterior commissure. Rarely it is met with in disseminate sclerosis from a lesion in this position, and it is then generally one-sided. It is not infrequent in lethargic encephalitis.

Total internal ophthalmoplegia is met with in lesions of the anterior part of the third nucleus, and in lesions of the lenticular ganglion in the orbit.

Wernicke's hemianopic pupil phenomenon is a test for the position of a lesion causing hemianopia. If the lesion is situated upon the visual path where that path contains the light reflex path, the pupil does not react when light is thrown on the blind side of the retina. In other words, this sign is present if the lesion is involving the visual path between the eye and the external geniculate body. When the lesion is between the geniculate body and the visual cortex in the occipital lobe, the pupil reacts equally well from the blind and from the seeing field.

PARALYSIS OF THE CERVICAL SYMPATHETIC

The cervical sympathetic fibres for the eye emerge from the eighth cervical and first dorsal segments of the spinal cord by white rami communicantes, which ascend via the cervical sympathetic trunk, carotid plexus, ophthalmic plexus and lenticular ganglion to the eyeball and orbit. The centre for sympathetic control is in the region of the oculo-motor nucleus, and the tecto-spinal tract connects this nucleus with the cervical region of the spinal cord. Lesions close to, but above, the level of the posterior commissure produce bilateral retraction, or "tucking" of both eyelids, while lesions of the oculo-motor nucleus at or below this level produce bilateral partial ptosis. Thus, in ophthalmoplegia from a lesion of the upper part of the third nucleus one may find either retraction or drooping of both lids, or perhaps retraction on one side, with drooping of the lid on the other side. So far as the eye and orbit are concerned, the sympathetic is the tonic retractor of the lid, the tonic protruder of the eyeball, and the tonic dilator of the pupil, and stimulation of this mechanism results in retraction of the lid or widening of the palpebral fissure, exophthalmos and wide pupil, while paralysis of the cervical sympathetic produces narrowing of the palpebral fissure (cervical sympathetic ptosis), enophthalmos and a small pupil. The excitation condition is seen in Graves' disease; the paralytic condition is of common occurrence in nervous diseases. The cervical sympathetic is also the tonic vaso-constrictor and secreto-motor nerve of the head generally, but disturbance of the mechanism does not often give rise to characteristic or important clinical phenomena. A curious lack of expression is, however, sometimes observable in the face on the side of the lesion. Cervical sympathetic paralysis occurs in the following clinical associations: (1) In all lesions of the cervical cord, especially when the last cervical and first dorsal segments or roots are damaged. It is common in syringomyelia and hæmatomyelia. (2) In lesions of the cervical sympathetic trunk by cervical ribs, trauma, pressure, growths, etc. (3) It is very common in tabes and nervous syphilis generally, where it appears as partial bilateral ptosis with enophthalmos and small pupils. It appears to be a primary neuronic degeneration in this condition and never improves.

THE FIFTH OR TRIGEMINAL NERVE

The sensory portion of the nerve impinges upon the central nervous system by sending its terminals to a column of cells which extend from as low as the third cervical segment of the spinal cord to the upper limit of the medulla, the intramedullary portion of the nerve lying outside the cell column and deep to the restiform body, and being known as the "ascending root" of the fifth nerve. In the lower part of the pons, it turns outwards and leaves the surface of the brain stem to enter Meckel's space just below the free edge of the tentorium, where it lies between two layers of the dura mater in a depression upon the superior surface of the temporal bone. Here it expands into the trilobed Gasserian ganglion, each lobe of which is continued forwards by one of the three great divisions of the nerve, which are distributed as follows:

Ophthalmic division.—The first division supplies the eyeball and lachrymal glands, the conjunctiva except that of the lower lid, the skin of the forehead and scalp up to the centre of the vertex, with the cranial bones and meninges, the mesial part of the skin of the nose, and the mucous membrane of the upper part of the nasal cavity.

Superior maxillary division.—This division supplies the skin of the upper lip and side of the nose and adjacent portion of the cheek, lower eyelid and conjunctiva and part of the temple, the upper jaw and its teeth, the nasopharynx, uvula and tonsil, and the lower part of the nasal cavity.

Inferior maxillary division.—The third division supplies the skin of the posterior aspect of the temple and adjacent parts of the pinna, the anterior and upper wall of the external auditory meatus and drum, a part of the cheek, lower lip and chin, the lower jaw, teeth and gums, the floor of the mouth, inner surface of cheek and salivary glands, and the anterior two-thirds of the tongue as far back as the circumvallate papillæ.

The greater part of the hard meninges of the brain are supplied by the fifth nerve.

The motor part of the fifth nerve takes origin from a nucleus in the grey matter of the pons, where it emerges close to the sensory root and passes through Meckel's space beneath the Gasserian ganglion to join with the third sensory division of the fifth nerve. It supplies the temporal and pterygoid muscles, the masseter, the mylohyoid, the anterior belly of the digastric, and the tensor tympani.

The chorda tympani is conveyed to the tongue by the lingual branch, which it joins on leaving the Gasserian fissure.

Symptoms of Lesions of the Fifth Nerve.—Pain over the sensory distribution of this nerve occurs from irritating lesions and reflexly, if its periphery be irritated. With organic lesions in any part of its course, the pain is followed by sensory loss, corresponding with the part involved. The peculiar disease, neuralgia, of which the pathological basis has not been as yet discovered, is practically confined to the distribution of this nerve, which cannot be too carefully learned, since pain really due to the implication of this nerve may be considered as belonging to other territories, as, for example, the pain deep in the side of the throat (tonsillar branch) and in the occipital region (meningeal branches), which are common in neuralgia. Herpes zoster over

the distribution of this nerve is common, and results from a lesion, usually a hæmorrhage or small focus of inflammation, in the Gasserian ganglion, and is in every respect comparable with that occurring in the distribution of the spinal nerves from similar lesions in the posterior root ganglia. It produces bad scarring, and when affecting the cornea is apt to produce ulceration, very destructive to the eye. It is accompanied by severe pain, which may be persistent for months. It should be borne in mind that the sensory supply to the cornea is entirely from the naso-ciliary branch, via the long ciliary nerves, and that herpes zoster of the cornea is usually accompanied by a small group of vesicles only at the tip of the nose on the same side.

Taste.—It has frequently been argued that loss of taste over the anterior two-thirds of the tongue follows destruction of the Gasserian ganglion and proximal portions of the fifth nerve. Cushing has, however, recently investigated this subject upon a series of cases of complete Gasserectomy, and has found that in every case the sense of taste was preserved. The path of taste thus seems proved. It is from the glossopharyngeal nucleus via the fasciculus solitarius, portio intermedia, facial nerve, chorda tympani and lingual nerve to the tongue.

Trophic changes.—Lesions of the first division of the fifth nerve are often productive of serious corneal deterioration and ulceration, which may be followed by septic panophthalmitis. These changes, however, have been proved to be the result of mechanical damage upon the insentient surface. If, for example, after destruction of the fifth nerve for neuralgia, the eye be carefully protected either by covering or sewing it up, these changes do not occur. After a little while, the anæsthetic cornea becomes much less vulnerable, and will stand the wear and tear of ordinary life without disturbance.

Paralysis of the motor function of the fifth nerve occurs in lesions of the nucleus in the pons, or of any part of the peripheral course of the motor division. The signs of such paralysis are not apparent to the patient, who experiences no difficulty in mastication, provided the lesion be unilateral. To the observer, the jaw deviates to the side of the paralysis on opening the mouth, on account of the action of the unopposed external pterygoid of the sound side. The masseter, as felt by the finger on its anterior edge, does not harden on biting, nor do the temporal muscles harden. The floor of the mouth does not stiffen on the paralysed side on forcibly opening the mouth.

Bilateral involvement of all the muscles supplied by the fifth nerve is the rule in all cases of progressive muscular atrophy where the bulbar nuclei are affected.

THE SEVENTH OR FACIAL NERVE

This nerve takes its origin from a nucleus in the ventral part of the reticular formation of the pons. The nerve fibres course dorsally, forming a loop round the sixth nucleus and, descending, make their exit from the brain stem at the uppermost end of the groove between the olivary and restiform bodies close to the auditory nerve, but separated from it by the pars intermedia. It passes forwards and outwards with the auditory nerve to the bottom of the internal auditory meatus where it is joined by the pars intermedia, and enters the aqueduct of Fallopius. Thence it passes outwards, and then makes a sharp turn backwards, at which angle it is enlarged to form the geniculate

ganglion. Subsequently, it runs downwards behind the tympanum, and emerges at the stylomastoid foramen to pass in the substance of the parotid gland, over the ramus of the jaw, to supply all the facial muscles of expression. Its landmark in crossing the jaw is one half-inch below the external auditory meatus, and just below Stenson's duct. In the petrous bone, it gives off a branch to supply the stapedius muscle. One quarter of an inch above the stylomastoid foramen, it gives off the chorda tympani, which enters a small foramen, the iter chordæ posterius, which leads it to the tympanum, where it crosses the long process of the malleus and enters the temporal fossa by a canal, the iter chordæ anterius, and subsequently joins the lingual, by which it is conveyed to the anterior two-thirds of the tongue and to the submaxillary and sublingual glands.

The facial is the most commonly paralysed nerve of any in the body. It may be involved in focal and general lesions of pons and medulla, as, for example, by tumours and vascular lesions, encephalitis, especially the lethargic variety, and by diphtheria, rabies, tetanus and polyneuritis. Between the medulla and the petrous bone it is prone to be the seat of origin of tumours of an especial nature, and to be pressed upon by tumours in the vicinity, and here the auditory nerve is likely to be co-involved. During its course within the petrous bone, it is often affected by caries, and sometimes by growth in the bone. At its point of exit from the stylomastoid foramen, it is very commonly affected by fibrositis, and periostitis, which give rise to Bell's palsy. In its course over the face it may be injured by the pressure of forceps at birth or by trauma in later life, and may be involved by parotid tumours.

Bell's Paralysis (Common Facial Palsy)

Definition.—A very common type of peripheral paralysis of the facial nerve, of which the only known ætiological factor is exposure of the face to cold, and accompanied in a great majority of the cases by signs of local fibrositic inflammation in the region of the stylomastoid foramen. The paralysis almost invariably recovers, but if the recovery is slow, a very peculiar spasm or facial contracture accompanies or follows the recovery. This contracture in its turn disappears slowly.

Ætiology.—Facial paralysis is very rare at the extremes of age and it is most common in early adult life. The sexes are equally affected. The only definite known cause is local exposure of one side of the face to cold, such as driving in a wind or sitting in a draught. Many different views have been held as to the pathogenesis of Bell's palsy, but it seems certain that it is the result of a local inflammation of the fibrous tissue forming the deep part of the sheath of the parotid gland, from which a process in the form of a sheath accompanies the facial nerve into the Fallopian aqueduct and along which the inflammation extends and compresses the facial nerve in that canal. The proofs of this view are, that facial paralysis is so often accompanied at its onset by pain in the stylomastoid region and behind the mastoid process and by tenderness on pressure, and that in some cases there is very considerable swelling of the deep part of the parotid gland. In several cases this swelling has been so great as to cause me to admit the patients into hospital with a diagnosis of growth of the stylomastoid region, where the subsequent course of the cases proved them to be cases of Bell's paralysis of a simple

type. Moreover, it is obvious that the pathological process begins outside, and subsequently spreads up the facial canal, since the loss of taste in the anterior two-thirds of the tongue, from involvement of the chorda tympani, is so often not present when the palsy first appears, and develops in the course of a few days, as the inflammatory process spreads up the facial canal, and reaches the region where the chorda tympani leaves the facial trunk.

Symptoms.—The onset is usually rapid and sometimes even sudden. It may follow definite exposure of the face to cold, but often there is no such history. Pain of a neuralgic character below the ear, behind the mastoid process, or referred to the occipital region, is common, but it does not last more than a few days, and sometimes pain is entirely absent. On deep pressure upon the styloid region behind the ramus of the jaw on both sides, one can almost always elicit the fact that there is tenderness on the paralysed side, and sometimes obvious swelling of this region may be felt. The first sign of the facial paralysis is that the patient feels the face to be stiff when he attempts to move it. Subsequently, the paralysis appears rapidly, and the face is drawn over to the opposite side. The paralysed side is motionless, according to the degree and distribution of the paralysis, if incomplete, and, if complete, is expressionless. The eye cannot be closed, and there is epiphora from paralysis of the tensor tarsi. The paralysis at the corner of the mouth causes difficulty in articulation and escape of fluids on drinking, but the patient soon learns to dodge these disabilities. When the paralysis is partial it is nearly always the lower part of the face which is the most affected. The facial muscles soon become hyperexcitable to mechanical stimuli, and in complete cases present a reaction of degeneration in a few days. In nearly all the severe cases, there is loss of taste over the anterior part of the tongue. It should be remembered that the sense of taste is confined to a very small area on the lateral edge of the tongue, some half an inch behind the tip.

There is never any pain in the distribution of the facial nerve. After a time, which may vary from a few days to two years, the paralysis begins to recover, and almost invariably this recovery appears in the upper facial region first, and in almost every case becomes complete. We have seen perfect recovery follow complete paralysis lasting 21 months.

Diagnosis.—Great care in diagnosis is necessary lest peripheral facial palsy of very unfavourable prognosis should be mistaken for it. The facial palsies which result from lesions of the nerve in the temporal bone, from caries and from tumour, those due to lesion of the nerve within the skull and from pontine lesions, rarely make any recovery. To this rule the following exceptions must be made: In the peripheral facial paralysis of poliomyelitis, lethargic encephalitis, tetanus and diphtheria recovery always occurs, if the patient survives.

Facial contracture.—In cases of long duration when recovery commences, the face goes into a condition of persistent spasm which causes often a very unsightly distortion of the face, which is very disappointing to the patient, who after waiting many months for improvement, now finds the face distorted in the opposite direction and to a more severe degree than at the onset. No adequate explanation of facial after-contracture has ever been put forward, and no similar condition occurs after the lesion of any other peripheral motor nerve, so far as we are aware. It recovers slowly in the

majority of cases. Patients should be warned from the first about the occurrence of after-contracture so that disappointment may be obviated, and at the same time encouraged as to the probability of complete recovery.

The diagnosis is not difficult, and mistaken diagnosis means faulty examination. In disease of the temporal bone, the facial palsy is accompanied by signs of such disease, which should be carefully sought, namely, deafness, perforation of the drum, discharge from the ear, and signs of long-standing otitis.

Lesions within the skull are apt to co-involve the auditory nerve, the fifth nerve or the cerebellum, and the characteristic signs of tumour of the lateral recess are common. In the pons, hemiplegia, hemiataxy and hemianæsthesia are likely to coexist.

Course and Prognosis.—Recovery is so usual that it should be promised in every case. The date of recovery is often difficult to forecast. If at the end of a week after the onset there is the slightest trace of any voluntary power in the orbicularis palpebrarum, which is the "ultimum moriens" of the facial muscles, or if any trace of faradic excitability to bearable stimuli remains, then it may be confidently said that recovery will be complete and rapid within 3 months, and that there will be no contracture. Cases in which no complete paralysis occurs in any region of the face usually recover in a fortnight. In complete cases, with complete reaction of degeneration in the muscles, it is difficult to say when recovery will occur or when the effect of contracture will be at an end. Cases which show no loss of taste and, therefore, in which there is no great extension of the inflammatory process up the facial canal, usually recover rapidly. Traumatic facial paralysis from blows upon the side of the face, and obstetrical facial paralysis from the pressure of forceps during delivery, always recover and leave no sequelæ.

Treatment.—The immediate treatment at the onset should be that suitable for the amelioration of a fibrositic inflammation. Mercury by inunction and salicylates and iodides internally are most valuable. While there is pain, the application of warmth or the use of counter-irritants, of which the best is strong tincture of iodine, is indicated. Massage to the face should be used from the onset. It is really doubtful whether electricity in any form or at any time materially helps in recovery, but in the present day any failure will be assuredly attributed to its non-employment, and therefore galvanism may be used. Electricity should never be used where there is after-contracture, for it increases this condition.

Facial paralysis from caries of the temporal bone rarely makes any recovery, and it is almost always complete and permanent. To remedy the unsightly and permanent distortion of the face, union of the peripheral trunk of the facial to the central end of the divided spinal accessory or preferably the hypoglossal nerve, has been performed, and with considerable success. Section of the hypoglossal with consequent hemiatrophy and hemiparalysis of the tongue produces no disability with speech, mastication or swallowing. It is not so much that re-union of this nerve restores volitional power to the face, but associated movement does return and also some after-contracture, which restores to some degree the symmetry of the face.

Peripheral Facial Spasm

Definition.—A unilateral malady of the facial nerve, in which intermitting spasm of the facial muscles occurs, exactly like that caused by faradism of the facial trunk. It is occasionally associated with a slowly oncoming facial paralysis, and may follow a facial paralysis due to injury.

Ætiology.—This malady occurs in adults, and the onset is usually insidious and without known cause. We have seen many cases, however, during the Great War in which injuries in the region of the facial nerve in its course through the temporal bone, such as gunshot wounds, shell fragment wounds with much scarring, and contusions with much bruising of this region, have been followed by peripheral facial spasm. It is certainly due to a lesion of the peripheral facial nerve trunk, and this lesion seems to be of such a nature as to irritate, and not in most cases to destroy; but in some cases partial destruction, with the appearance of partial facial paralysis, does occur.

Symptoms.—It commences with twitching of some part of the facial musculature, which occurs at first at rare intervals, and subsequently becomes more and more frequent, so as in some cases to be almost continuous. Commencing locally, it tends to spread so as to involve the whole face in a sudden and hideous contortion. We have seen cases in which the attacks of peripheral facial spasm at first glance almost exactly resembled a Jacksonian fit of the face, the obvious distinction being that no Jacksonian fit can be confined to the supply of the facial nerve, but eyes, tongue, etc., are also involved. The spasms may be so severe and continuous as to keep the eye closed for long periods together, and to interfere greatly with the work and enjoyment of life. The malady is associated with no other symptoms. Cases exist in all degrees of severity, from the mildest, in which an occasional flicker of the face occurs, to the most severe and incapacitating and unsightly malady.

Course and Prognosis.—Some of the cases recover spontaneously, and others under treatment; but when the malady becomes severe and the spasm hardly remitting, it is practically intractable, except by operative interference.

Treatment.—In the milder cases, measures calculated to subdue chronic inflammation, such as mercury, iodides and salicylates, are sometimes of remarkable benefit. In severe cases, the only remedy which affords relief is the injection of alcohol into the facial nerve either at the stylomastoid foramen, or as it crosses the ramus of the jaw half an inch below the external auditory meatus, or when one division of the nerve only is affected, in any part of the pes anserinus. Brilliant results have followed this method, which was first used by Patrick. A facial paralysis has been produced which quickly passes off with complete relief of the spasm, sometimes permanently, sometimes temporarily, but always for such a time as to make this slight operation a brilliant success. Weak alcohol should be used so as to damp down rather than destroy the facial fibres, 40 per cent. to 60 per cent. The needle must be introduced with great accuracy and the injection made very slowly, not more than a minim at a time, the face being watched all the time, while the patient is repeatedly instructed to move it. With the first sign of oncoming weakness the injection is stopped, for this weakness will deepen considerably from diffusion effect after the injection.

Herpes from lesion of the geniculate ganglion.—Under this title an affection

has been described by Ramsay Hunt in which herpes zoster in and about the external auditory meatus has occurred, and in some of the cases this has been complicated with facial palsy, and occasionally with symptoms indicating irritation of the auditory nerve. Such cases are by no means rare. The inconspicuous herpetic vesicles situated in the concavity of the concha should be looked for in every case of Bell's palsy.

THE AUDITORY AND VESTIBULAR NERVES

The auditory or cochlear nerve takes origin from the spiral ganglion of the cochlea, situated near the inner edge of the osseous spiral lamina. The cells of this ganglion are bipolar, and their peripheral processes are distributed to the organ of Corti while the central processes pass down the modiolus of the cochlea and through the internal auditory meatus, where they join those of the vestibular nerve, to the upper part of the groove between the restiform and olivary bodies, where they end among the cells of the tuberculum acusticum and cells of the ventral nucleus. This nerve is concerned entirely with the sense of hearing.

The vestibular nerve takes its origin in the cells of the ganglion of Scarpa, which is situated at the outer end of the internal auditory meatus. The peripheral processes supply the labyrinth and semicircular canals; the central processes join with those of the cochlear nerve and course to the upper end of the groove between the olivary and restiform body. Here the vestibular fibres diverge from the cochlear fibres, and passing between the restiform body and the ascending root of the fifth nerve, end in a mass of nerve cells called the vestibular nucleus, beneath the lateral part of the floor of the fourth ventricle.

The central path for the impressions conveyed by both the cochlear and the vestibular nerves is believed to undergo a semi-decussation similar to that of the olfactory tracts and optic nerves.

Lesions of the cochlear nerve produce deafness, and in addition pathological changes in its peripheral termination are productive of tinnitus. Except from direct involvement of this nerve or of its terminations in the cochlea, deafness is practically unknown as a symptom of disease of the nervous system. In other words, lesions of the central auditory paths are not as yet recognisable by any known symptoms.

Nerve deafness may be produced by any lesions of the cochlea and cochlear nerve, and is confined to diseases of the temporal bone and labyrinth, lesions of the intermeningeal part of the eighth nerve by tumours, meningitis or pressure, and lesions of the lateral side of the medulla. The deafness is the same wherever the lesion may be, and the position of the lesion is to be deduced from the associated involvement of contiguous structures. Nerve deafness, which characterises lesions of the cochlea and its nerve, is distinguished from deafness due to middle-ear disease by the facts that hearing both by air conduction and by bone conduction is diminished or lost, while in middle-ear deafness the hearing by bone conduction is increased. If a tuning-fork in vibration be applied to the forehead until it is no longer audible, and then presented to the ear, it will not be heard aerially in middle-ear disease, since the aerial conduction is impaired in that condition. But in nerve deafness it is either not heard through the bone when the tuning-fork

is applied, or if heard, when it has ceased to be audible to bone conduction, will still be audible when presented to the ear. This is known as Rinne's test, and it is a reliable one. Weber's test for nerve deafness consists in the application of a tuning-fork to the forehead in the middle line, the patient being asked which ear the sound comes to most. In middle-ear deafness the sound is heard best on the deaf side, and in nerve deafness it is best heard on the sound side. As a symptom of nervous disease, nerve deafness is met with in disease of the lateral region of the medulla, in tumours of the cerebello-pontal angle growing from the eighth nerve, following epidemic meningitis, and in syphilis of the nervous system, especially congenital syphilis.

Tinnitus

Ætiology.—Tinnitus or the occurrence of persistent recurring noise referred to the ears may be produced by wax in the ear, by otitis media, or by any other condition of vascular congestion, or by inflammation in the region of the auditory mechanism. It occurs in those who work exposed to deafening noise, as in boiler-makers and riveters, and may be produced by the administration of quinine and salicylates. It is much more frequently indicative of a mysterious and intractable disease of the cochlea, which often ends in complete deafness. Persistent tinnitus is a malady of adult life, the earliest cases occurring after puberty. It is rare for the malady to commence in old age. It begins insidiously, and as a rule without cause, but debilitating influences may precede its onset.

Diagnosis.—The diagnosis of tinnitus presents no difficulty. A careful examination of the ears will discover and cause to be removed any local trouble in the external auditory meatus and tympanum. Moreover, these conditions do not give rise to persistent tinnitus with nerve deafness.

Symptoms and Course.—The sounds commence faintly and often intermittently, and at first may be only perceived in stillness and silence at night, and later become louder and more persistent, and are often absolutely continuous. The slight sounds may be low pitched, a low rumble like a distant wagon, or a faint murmur such as may be heard when a shell is held to the ear. The loud sounds are never low in tone. They may be humming, hissing, rushing or bell-like noises. The common simile used by the patient is that of a hissing kettle, of a gas jet, of a threshing machine, of a steam-engine, or of a room full of machinery. The same patient may have several sounds, sometimes successive and sometimes heard all at once. When the sounds are rhythmical they are usually synchronous with the pulse. In some of the cases labyrinthine vertigo occurs, and the attack may be heralded by an increasing intensity of the sound. The condition of hearing in patients suffering with tinnitus may vary in each case, and from time to time in any one case. In many cases hearing is perfectly normal, and may remain so for years, in spite of increasing tinnitus. One of my patients retained perfect hearing for over twenty years, with increasing tinnitus; but the hearing rapidly declined afterwards. In many cases, however, there is some degree of nerve deafness on one or both sides. In the course of time the deafness increases even to absolute deafness, and in a few of them the noises persist in spite of absolute deafness. As a rule, the noises decrease as deafness becomes severe.

Prognosis.—The prognosis is very uncertain, and for the most unfavourable. In many cases the noises persist in spite of all treatment, sometimes treatment secures considerable relief, and not infrequently the symptom is removed by treatment.

Treatment.—In the early stages the disease may be much benefited by the exhibition of salicylates and iodides. As a symptom, tinnitus is more affected by bromides than by any other drug, and these should be given in doses of from 10 to 20 grains twice or three times daily. The effect of the bromide is sometimes increased by the addition of from 5 to 10 minims of tincture of belladonna. Frazier has reported a successful intracranial division of the auditory nerve in a case of tinnitus. Such a procedure could be only admissible where the trouble was confined to one side. This operation has proved immediately fatal in one case.

Vertigo

Definition.—The word "vertigo," which by derivation means a "turning," is used to designate any movement or sense of movement or unsteadiness either in the individual himself (subjective vertigo) or in external objects (objective vertigo) that involves a defect, real or seeming, in the equilibrium of the body. It is a sensation of involuntary movement, either of subject or of external objects. It always involves a slight interference with consciousness, and in severe vertigo consciousness is often momentarily lost.

Ætiology.—Vertigo is always the result, direct or indirect, of disturbance of the labyrinth, vestibular nerves or cerebellum. It is commonly associated with vomiting and with vasomotor and secretory phenomena, such as "cold perspiration." The disturbance of the vestibular mechanism which results in vertigo may be set up by multitudinous causes, among which may be mentioned toxic states as in specific fevers, and from the administration of alcohol, anæsthetics and morphine, irregularities of blood supply as in fainting, loss of blood, cardiac feebleness, Stokes-Adams' disease, and sudden alterations of position and in arterial disease; from visual or bodily disorientation as in diplopia, dancing, swinging, sea-sickness and train-sickness; in anæmic states; in migraine, and as an aura in epilepsy; in diseases of the tympanum, labyrinth and semicircular canals; in diseases of the vestibular nerve and cerebellum, and in conditions of raised general intracranial pressure.

Diagnosis.—The vestibular mechanism is closely connected functionally with the cerebellum, and the symptoms which result from its disturbance are almost identical with those resulting from lesions of the lateral lobe of the cerebellum, and comprise nystagmus to the side of the lesion, vertigo, forced movements, hemiataxy and hypotonus on the side of the lesion. There are two points which serve to separate the two conditions. In the first place, vestibular lesions are usually associated with nerve deafness, which is absent in cerebellar lesions, and secondly, the cerebellar symptoms are only marked in vestibular lesions when the condition is acute, or during acute exacerbations.

Tests for vestibular lesions.—1. Barany's caloric test is made by irrigating the external auditory meatus with either hot or cold water or air. With an intact vestibular mechanism this causes irritation of the vestibular appara-

tus with the appearance of nystagmus or lateral deviation of the eyes to the side of the irrigation. When the vestibular mechanism is impaired this test fails relatively or completely.

2. If the patient be rotated either by placing him in a special rotating chair, or by turning him round several times in the standing position, lateral conjugate deviation of the eyes immediately after the rotation will show nystagmus in the opposite direction to the rotation, if the labyrinth on that side is intact. It will not appear if the functional activity of the vestibular mechanism is deficient.

Ménière's Disease (Labyrinthine Vertigo)

Definition.—A malady in which paroxysmal attacks of severe labyrinthine vertigo occur at irregular intervals, associated with tinnitus and progressive deafness, and due to disease of the labyrinth of a chronic nature.

Ætiology.—Little is known of the causal factors in this disease. It is a disease of adult life, and usually appears without definite antecedents. Ménière, who described the clinical picture of the malady, considered that hæmorrhage into the labyrinth was responsible for the condition; but in view of the frequency with which the attacks may occur, and the very slow loss of vestibular function which accompanies the course of the disease, it seems highly improbable that so destructive a lesion as hæmorrhage can be responsible for the majority of the cases.

Symptoms.—The attacks set in suddenly with a buzzing noise in the ears, followed immediately with intense vertigo, both subjective and objective. The vertigo may be so intense that the patient feels he is hurled to the ground. He often falls as if shot; sometimes he has time to assume the sitting or lying position, before the vertigo reaches its height. Consciousness is often lost, or seriously impaired, for a few moments only. Spontaneous nystagmus occurs to the side of the lesion, and unilateral cerebellar signs on the side of the lesion. The patient becomes nauseated, and often vomits repeatedly. The skin is pale and covered with a clammy sweat. The patient lies perfectly still, and in terror lest the least movement should bring on more vertigo. The duration of the attack and the time taken in the recovery from an attack vary from a few minutes to 24 hours. Sometimes the attacks are excited by some sudden movement, such as coughing or sneezing, but they are usually without any such antecedent. They may occur during sleep, and wake the patient. The recovery from the attack is usually perfect, the vertigo disappearing: but in some cases slight persistent vertigo remains between the attacks. When Ménière's disease is persistent a slow onset of nerve deafness and signs of slow vestibular destruction follow, and as these signs deepen the attacks become less and less severe, and finally cease when the functions of the labyrinth become destroyed.

The **diagnosis** of Ménière's disease presents no peculiar difficulty, for the symptoms are highly characteristic, and although the attacks vary in the degree of their severity, from a slight momentary giddiness to a sudden falling, with the most acute cerebellar symptoms, yet the first attack is usually severe. The rapid disappearance of the symptoms is striking. Vertiginous attacks from all other causes must be excluded. In epilepsy consciousness

is usually lost. In Ménière's disease it is momentarily impaired, and there is no convulsion. In acute cerebellar lesions the symptoms are very like those of labyrinthine vertigo, but they are not transitory in a few hours. A careful search of the nervous system for signs of organic nervous disease should in every case avoid any mistake.

Prognosis.—The outlook in Ménière's disease is uncertain. Some cases go from bad to worse in spite of treatment, and progressive deafness ensues with disappearance of the attacks. Many cases however recover perfectly with little or no impairment of hearing.

Treatment.—The salicylates seem to have a definite specific effect upon the morbid process, and should be given in doses of 20 grains thrice daily. In the form of aspirin they may be even more beneficial from the sedative effect of the latter drug. The bromides have a wonderful effect in relieving the symptoms, and in averting the attacks, to the extent that it may be said that labyrinthine vertigo may be almost diagnosed by the beneficial effect of bromides upon it. They should be given in doses of from 10 to 20 grains three times a day. Syphilis must be excluded, and if present, treated. Counter-irritation of the mastoid region has been recommended, and can certainly do no harm.

Acute Vestibulitis

In this rare disease slight general febrile symptoms are followed rapidly by severe bilateral cerebellar symptoms, intense vertigo, incessant vomiting and bilateral ataxy, which entirely prostrate the patient. The symptoms begin to remit in the course of 2 or 3 days, leaving complete bilateral and permanent deafness. The cerebellar or vestibular symptoms clear up in the course of a few weeks. This condition seems to be dependent upon an acute inflammatory condition of the labyrinth and cochlea. Four cases have been under my personal observation. The malady at first resembles an acute bilateral lesion of the cerebellum; but the rapidly increasing deafness, which soon becomes absolute, should serve to distinguish the conditions. Jenkins has suggested an early tapping of the semicircular canals to avoid the deafness, which he considers due to the increase of perilymph pressure.

Endemic Paroxysmal Paralysing Vertigo (Gerlier's Disease)

Gerlier in 1887 described a curious endemic disease, occurring only in a certain district of the canton of Geneva, with which cowherds and workers in the fields alone were affected, and only in the summer months. Miura has reported a similar endemic condition in the northern regions of Japan. A typical attack may be described as follows: the patient, usually a vigorous young man, is suddenly seized with pain in the neck and back and with vertigo, and the sight becomes clouded to the point of temporary blindness. Bilateral ptosis occurs, and all the bodily muscles become weak; the patient reels, and has all the appearance of drunkenness, and often falls. After a period, not exceeding 10 minutes, rapid recovery takes place. This malady has never been known to be fatal.

THE NINTH OR GLOSSOPHARYNGEAL NERVE

This is a mixed nerve, which takes its origin by 5 or 6 filaments, from the upper end of the groove between the olivary and restiform bodies, continuing the line of the vagus roots, of which it is in reality a part. The motor fibres take origin from cells immediately below those of the facial, and above those of the ventral motor nucleus of the vagus, and are conveyed in the trunk of the nerve for the supply of the stylo-pharyngeus and middle constrictor of the pharynx.

The sensory fibres arise in the two ganglia, jugular and petrous, which lie in the jugular foramen on the trunk of the nerve, which here is placed in a special compartment of its own outside that containing the vagus and spinal accessory nerves, and between the inferior petrosal sinus in front and the lateral sinus behind.

The sensory branches enter the fasciculus solitarius, and end in the neighbouring grey matter.

The mixed nerve trunk appears in the neck between the jugular vein and the internal carotid artery. Coursing downward beneath the styloid process and over the carotid artery, it turns forwards over the stylo-pharyngeus and beneath the hyoglossus, to end in the posterior third of the tongue. Lesions of this nerve involve loss of taste over the posterior one-third of the tongue, with some unilateral paresis of the pharynx. It is rarely involved alone; but, with the other nerves taking origin in the neighbourhood, by tumours of the lateral region of the medulla.

THE TENTH OR VAGUS NERVE

This nerve is a mixed nerve. The motor fibres arise from two long columns of cells in the medulla, a dorsal column of small cells and a ventral column of large cells, called the nucleus ambiguus. They supply the voluntary muscles of the soft palate (except the tensor palati), pharynx and larynx in conjunction with the accessory fibres, and the non-striped muscles of the respiratory and alimentary tracts.

The sensory fibres take their origin from the ganglion of the root which is situated in the jugular foramen, and from the ganglion of the trunk which is situated just below the skull. Their central connections are with the fasciculus solitarius and surrounding nerve cells.

The vagus nerve takes its superficial origin from the medulla in the groove between the olivary and restiform bodies in the line of the glossopharyngeal and accessory roots. It leaves the skull along with the accessory nerve by the inner division of the jugular foramen, and appears in the neck between the jugular vein and internal carotid artery, and enters the carotid sheath. On the right side the nerve enters the thorax by crossing the first part of the subclavian artery, behind which its recurrent laryngeal branch passes upwards, and behind the innominate vein. It reaches the side of the trachea, forms the posterior pulmonary plexus on the back of the root of the lung, and subsequently the plexus gulæ on the œsophagus, and enters the abdomen through the œsophageal opening, and is distributed to the posterior surface of the stomach and cœliac plexus. On the left side the nerve enters the thorax between the left carotid and subclavian arteries and behind the

innominate vein, and crosses the arch of the aorta, behind which its recurrent branch ascends, and subsequently follows a course similar to that on the right side. Just below the ganglion of the trunk the vagus is joined by the bulbar fibres of the accessory nerve.

The sensory fibres of the vagus supply the respiratory tract, the pharynx and œsophagus. Its visceral fibres supply the lungs, heart and abdominal viscera. No sensibility seems to be supplied to the abdominal viscera by this nerve, since with division of the spinal cord above the offshoot of the splanchnic nerves all sensibility in the abdomen is lost.

LESIONS OF THE VAGUS.—The important signs of lesion of this nerve and its nuclei are pharyngeal and laryngeal paralysis and loss of sensibility. Symptoms indicative of lesions of its complicated and mysterious visceral supply are neither well marked nor well understood, and in unilateral lesions seem to be entirely absent; they are therefore not considered.

Lesions of the vagus in the medulla are common. Syringomyelia, when affecting that region, usually involves the nucleus ambiguus, causing unilateral palsy of palate, pharynx and larynx. Thrombosis of the posterior inferior cerebellar artery which supplies that region of the medulla containing the nucleus ambiguus is likely to produce vagus paralysis of the same side. Progressive muscular atrophy, in the form of progressive bulbar paralysis, may affect its cells, as does often polyneuritis and lethargic encephalitis and rabies. Lesions of the nerve roots often occur from tumours of the lateral region of the medulla, and growths outside the medulla from nerve roots and meninges, and here the lesion of the vagus roots is associated usually with those of the glossopharyngeal, spinal accessory and hypoglossal. In the neck perforating wounds and growths may implicate the nerve, and in the thorax tumours, particularly aneurysms and new-growths, are apt to cause paralysis of the muscles supplied by its recurrent branches.

Unilateral pharyngeal paralysis.—This is characteristic of all unilateral lesions of the vagus high up. It is recognised by the low-lying motionless palate and the loss of sensibility of one side of the pharynx, with loss of the pharyngeal reflex on that side. There is no impairment whatever of deglutition.

Bilateral pharyngeal paralysis.—This results from nuclear lesions of the nucleus ambiguus on either side, and is common in diphtheria, polyneuritis, myasthenia gravis and progressive muscular atrophy. The whole palate is low and paretic or paralysed, the voice is nasal, there is nasal regurgitation of liquids, the cheeks cannot be forcibly blown out, and there is difficulty in pronouncing final "b" and "g," the words "rub" and "egg" becoming "rum" and "enck."

Total unilateral laryngeal paralysis.—Since the superior laryngeal nerve which supplies the cricothyroid muscle, which is the chief tensor and adductor of the vocal cords, is given off high in the neck from the ganglion of the trunk of the vagus, it follows that total paralysis of the larynx on one side can only result from a lesion of the vagus, between the ganglion of the trunk and the nucleus ambiguus in the medulla. The vocal cord on the paralysed side is motionless in the cadaveric position—that is, midway between abduction and adduction. The larynx is insensitive on the same side. There is some loss of tone of voice but no stridor.

Unilateral abductor paralysis or recurrent laryngeal paralysis.—This occurs

from all lesions of the trunk of the vagus below the ganglion of the trunk, and from lesions of the recurrent laryngeal branch. The vocal cord on the side of paralysis lies close to the mid-line. It fails to abduct on taking a deep breath. There is no change of voice; but there may be slight stridor on inspiration—the sensibility of the larynx is not affected.

Bilateral abductor paralysis.—This condition is most commonly seen in the earlier stages of nuclear laryngoplegia, and is most often met with in tabes, sometimes in bulbar paralysis, and we have seen it in disseminate sclerosis. It occurs also in bilateral lesions of the recurrent laryngeal nerves in the thorax, which may occur from aneurysm and new-growths. It is the most dangerous form of laryngeal palsy, as the vocal cords cannot be abducted from close to the middle line, and they tend to open during expiration, but to suck together during inspiration, and for this reason may cause death from asphyxia, or necessiate laryngotomy.

THE ELEVENTH OR SPINAL ACCESSORY NERVE

This is a purely motor nerve consisting of two parts, a spinal portion and a bulbar portion. They arise from the ventro-lateral cells of the anterior horn from the level of the fifth cervical segment to that of the lower third of the olive. The lower spinal fibres leave the cord in the middle of the lateral column, while above they are blended with the posterior roots, and go to supply the sternomastoid and trapezius muscles. The bulbar fibres join the vagus nerve below the ganglion of the trunk. On emerging from the spinal cord the spinal fibres ascend between the ligamenta denticulata and the posterior roots, and turning outwards at the level of the olive pass through the jugular foramen in the same compartment as the vagus nerve, and appear in the neck between the jugular vein and internal carotid artery. The nerve crosses the jugular vein, and enters the anterior border of the sternomastoid muscle an inch below the mastoid process, and leaves this muscle at the middle of its posterior border to cross the posterior triangle of the neck and end in the trapezius muscle. This nerve may be caught with the vagus by lateral lesions outside the medulla, or by lesions in the region of the jugular foramen; but it is more often damaged by injuries to the neck, and by operations for the removal of cervical glands. The spinal accessory nerve, as it crosses the posterior triangle of the neck, is very liable to injury, either from blows or from sudden strains, and most of the isolated trapezius palsies are due to local neuritis of the nerve trunk, so arising. Paralysis and wasting of the sternomastoids is conspicuous in most cases of myotonia atrophica. That of the trapezius is often conspicuous in the facio-scapulo-humeral type of myopathy. Both muscles are commonly affected in progressive muscular atrophy.

When the sternomastoid is paralysed there is neither weakness complained of, nor deformity, nor peculiar attitude of the neck, other muscles compensating for its paralysis. The muscle does not harden when turning the head to the side opposite the paralysis, and its reaction to faradism is diminished or lost.

Paralysis of the trapezius, on the other hand, causes great disability in raising the arm above the horizontal level of the shoulder and also difficulty in shrugging the shoulder or approximating the scapula to the middle line

behind and therefore also in carrying the extended arm backwards. It produces a very ugly deformity, for the scapula unsupported by the trapezius rotates so that the superior internal angle appears as a hump in the slope of the neck above the clavicle, and there is also winging of the angle of the scapula with the axillary border of that bone horizontal. This paralysis of the trapezius may be confused with that of the serratus magnus, for in both winging of the angle of the scapula is marked. In trapezius palsy, however, the deformity is much more marked, the scapula is farther away from the spine, and is much more rotated. Tests for the movements of these two muscles and the faradic excitability should prevent any confusion.

THE TWELFTH OR HYPOGLOSSAL NERVE

This is a purely motor nerve, which takes origin in a column of large nerve cells in the lower part of the medulla. The filaments leave the medulla in the groove between the pyramid and olivary body and pass through the anterior condylar foramen, whence the trunk of the nerve inclines forward, between the jugular vein and the internal carotid artery to the lower border of the digastric muscle and is thence directed forwards above the hyoid bone and resting upon the hyoglossus muscle, to the under part of the tongue. Below the skull the hypoglossal nerve has an important connection with the first and second cervical nerves, from which the nerve supply to the descending muscles from the hyoid bone is derived. The hypoglossal nerve supplies all the muscles of the tongue, both intrinsic and extrinsic.

Unilateral lesions of the hypoglossal nerve are usually the result of tumours in the lateral region of the medulla, or local lesions just lateral to the medulla, and catching the nerve roots. At the anterior condylar foramen the hypoglossal nerve is sometimes the seat of an acute fibrositis, which gives rise to a hypoglossal palsy associated with pain, and recovering in every way comparable to Bell's palsy of the facial nerve. Syphilis is a not uncommon cause of hemiatrophy of the tongue, the lesion being a gumma on the hypoglossal nerve. Hemiatrophy of the tongue is perhaps more commonly seen in tabes than in any other condition. A hemiatrophy also occurs in cases of facial hemiatrophy, where the lower distribution of the fifth nerve is the region affected; but this variety does not involve paralysis of the tongue. Spastic paralysis of the tongue, with well-marked dysarthria and dysphagia, occurs in double hemiplegia and amyotrophic lateral sclerosis. Atrophic paralysis of the whole tongue, with exactly similar defects of articulation and swallowing, occurs when the hypoglossal nuclei are affected, and is commonly seen in progressive bulbar paralysis and sometimes in polyneuritis and myasthenia gravis. The sole physical sign of a lesion of one hypoglossal nerve is atrophic paralysis of one side of the tongue with loss of faradic excitability. The affected side of the tongue shrinks and comes in the end to consist solely of mucous membrane, fibrous tissue and glands. The tongue becomes sickle-shaped, with the concavity on the paralysed side. There is little impairment of movement, and no defect of articulation from a unilateral lesion.

The treatment is that of the condition causing the paralysis.

TRIGEMINAL NEURALGIA

Synonym.—Tic Douloureux.

Definition.—A disease of the fifth cranial nerve, in which no definite morbid changes in the nerve have been discovered and in which no loss of function, either motor or sensory, occurs in the distribution of the nerve. The chief feature of the malady is the occurrence of pain of varied intensity which tends to be paroxysmal, and is often excruciating. Tenderness over the branches of the fifth nerve is always present during the bouts of pain, and when the third division of the trigeminal nerve is affected there is conspicuous unilateral furring of the tongue when pain is present.

Ætiology.—The malady is first met with at the age of puberty; it is not seen in childhood. In the earlier years of adult life it is often a mild and curable condition, though notable exception to this rule may occur; but as age advances, and especially after the age of 50 years, it tends to be increasingly severe and intractable by any measures save those for the destruction of the affected branch of the nerve, or of the Gasserian ganglion. Often no causal factors can be adduced. The sexes are equally affected. Hereditary influences are not uncommon. It is much more common in cold and damp climates, than in southern and dry countries. Any debilitating influences, such as overwork, general ill-health and specific fevers, especially influenza, may precede the onset of the malady. Peripheral irritation of the branches of the nerve from dental caries, or periostitis, or from injury, or any other long-lasting painful affections in the distribution of this nerve, may be the starting-point of true neuralgia.

Symptoms.—The chief feature of the malady is pain, which may be general throughout the area of distribution of the nerve, but which is more commonly confined to one of the three divisions of the nerve and often to one branch of a division. It is characteristic for the pain of neuralgia to commence locally, and subsequently to spread in each attack and gradually, in the course of the disease, permanently to invade a larger area. Two different kinds of pain occur, the sharp and paroxysmal, and the dull and continuous pain. The paroxysmal pains are sudden in onset and in cessation. They have a lightning-like character, and are described as piercing, knife-like, or as if the affected region were penetrated by red-hot wires. Often quite spontaneous, these pains may be brought on by touching the surface, by a cold draught, by movement of the face and jaw, or by the act of swallowing, and in this last condition mastication and deglutition may become so difficult as to render feeding the patient a matter of great anxiety. When the paroxysms are occurring in a severe case the patient remains for a period, which may be from a few minutes to several hours, paralysed under the fear of the pain, unable to move a muscle lest a spasm more dreadful than the last should occur. The paroxysmal pains are usually followed, if severe, by a more lasting dull continuous pain, often of a boring character, and sometimes such pain becomes absolutely continuous for months and years. The skin over the affected region is sore and tender after the paroxysm, and the patient may be unable to bear brushing the hair or shaving the face. The pain may be of every degree of severity, from mild momentary starts, such as occur in many young people when run down, to continuous incapacitating

pain, interrupted only by excruciating attacks of agony which render life a piteous burden. The distribution of the pain may be anywhere or everywhere in the distribution of the trigeminal nerve. It must be especially remembered that this nerve supplies the middle ear, the Eustachian tube and the region of the tonsil. Pain in the ear and low down in the pharynx is not uncommon. The lightning-like onset of the agony often causes convulsive spasm of the face and of the body and limbs, and from this feature the names "tic douloureux," "spasmodic neuralgia," and "epileptiform neuralgia" arose. The tender points of Valleix are constantly present during the attack, and for some little time after. When the first division is affected the tender points are found above the supra-orbital notch, over the external angular process, on the upper outer aspect of the nose, and on the globe of the eye. When the superior maxillary division is affected the chief tender point is over the infra-orbital foramen, while other points may be found over the points of exit of the temporo-malar nerves and in the roof of the mouth. When the third division of the nerve is involved, the chief tender points are over the mental foramen, the side of the tongue, and just in front of the external auditory meatus. When the third division is affected unilateral furring of the tongue, which always occurs when the pain is present and which does not seem to occur with organic lesions of the fifth nerve, nor constantly in any other malady except neuralgia, is seen. Vasomotor and secretory disturbances are common. During the paroxysms, tears and saliva may flow in abundance. The trophic changes which have been described in the skin are usually the result of rubbing during attacks of pain, or of the application of heat or liniments. Local greying of the hair however, does undoubtedly occur. The clinical picture of trigeminal neuralgia is completed with varying degrees of general physical ill-health, mental apathy and depression, which occur in proportion to the frequency and severity of the attacks, the presence of continuous pain, the ability to take food and to sleep, and the possibility of taking any interest in life. It is surprising in England how few of the sufferers from severe neuralgia become habitual drug-takers.

Course.—In patients under the age of 40 years the malady is often transient and is completely and permanently recovered from, though even at this age cases occur which are only amenable to surgical interference. But when the malady commences after the age of 40 years, it is the rule for it to become progressively worse. The paroxysms become more severe, and occur at shorter and shorter intervals, continuous pain sets in, sleep and the taking of nourishment become difficult, and useful life becomes more and more restricted.

Diagnosis.—There should be no difficulty in making a correct diagnosis if proper care be taken. In the first place, all local cause for pain in the peripheral distribution of the trigeminal nerve should be excluded. The teeth should be most carefully examined and the jaws skiagraphed for any concealed disease, which should be put right if present. Organic disease of the fifth nerve can be excluded by the facts that such disease cannot long exist without signs of loss of function, which never occur in neuralgia. Diminution of sensibility, which is first marked perhaps by increased tolerance of the conjunctiva and cornea to touch, and weakness of the musculature with deviation of the chin on opening the jaw, and diminution of taste

are certain signs of a local organic lesion. Moreover the pain of neuralgia, with its lightning onset and cessation, is hardly imitated by any pain of organic origin. Ocular conditions, such as glaucoma, which may give rise to agonising pain can hardly be mistaken for neuralgia.

Treatment.—Having in the first place seen that all possible causes of local irritation in the region of distribution of the fifth nerve are absent, or, if present, adequately dealt with, it is essential to improve the nutrition and general physical health with tonic, dietetic and hygienic treatment, and such remedies alone will often cure slight cases. Tr. gelsemii in doses of from 10 to 20 minims thrice daily is an admirable remedy, and arsenic is a useful adjuvant. All the analgesic antipyretics of the coal tar series are of great value, not only as immediate relievers of pain, but also as curative agents, and among these aspirin is most important. In cases where malaria has been recently present, quinine should never be omitted. In very severe cases, and when operation is to follow, morphine is an invariable temporary relief to the pain. But if persisted in, the beneficial effects of moderate doses soon disappear. In every case except in old subjects, a thorough trial of the above treatment should be made over a sufficient period to make a competent judgment of its efficiency or inefficacy, as the case may be. When failure is met with, and in old subjects, who will be found to respond little if at all to such treatment, operative relief should be sought. In the first place, the injection of alcohol should be performed, and if this fail, as it sometimes does, on account of anatomical peculiarities of the individual, recourse should be had to the operation for dividing the fifth nerve proximal to the Gasserian ganglion. The method of alcohol injection consists of introducing a few minims to a drachm of 80 per cent. pure alcohol by means of a long, hollow needle and syringe into the region of the Gasserian ganglion, via the foramen ovale. The foramen ovale is reached by a lateral route, by introducing the needle about an inch in front of the external auditory meatus and between the zygoma above and the sigmoid notch of the mandible below. The direction taken is almost at right angles to the surface, but if anything a little upwards and backwards. The right direction, however, varies with individual skulls. In edentulous subjects, there may be little or no room for the passage of the needle between the sigmoid notch and the zygoma, and this difficulty is avoided by keeping the mouth open. The alternative route is an antero-posterior one, from the front of the face to the foramen ovale, directed somewhat inwards and skirting the lateral aspect of the superior maxilla. The needle is introduced just below the point of the malar bone. This operation should be performed under morphine and scopolamine, and not under general anæsthesia, for unless the patient is sufficiently conscious to describe his sensations during the procedure, and to respond to tests for the trigeminal anæsthesia which it is essential to produce, it is impossible for the operator to be sure either of what he is doing or whether he has succeeded in his endeavour to destroy the ganglion. The sign of success is the appearance of complete anæsthesia over the whole distribution of the fifth nerve, and complete motor paralysis. Even when such success is not accomplished, great relief of the pain may occur. In bilateral cases complete paralysis of the jaw on both sides must be avoided by attempting first a partial injection on the less severe side, which may relieve the pain without producing lasting paralysis of the jaw on that side,

and then, when the paralysis of the jaw has recovered, to attempt a complete injection upon the more severe side. We have in several cases effected complete relief in this way, without causing any difficulty in mastication. The permanence of the effect of alcohol injection varies, sometimes lasting relief is obtained; more often, after a period which varies from months to years, some return of the pain occurs from partial recovery of nerve elements which have escaped destruction. The alcohol injection can, however, be repeated, and in this way permanent relief obtained. This operation is a minor one from the patient's point of view—it causes a minimum of suffering, and is soon over. It is, however, a most difficult procedure for the operator, and requires great skill and experience. While absolutely devoid of risk in skilled hands, alcohol injection should never be undertaken by one who has not special training in its performance. The radical operation produces brilliant and final cure. It is, however, a severe procedure, not unaccompanied by risks, and it produces unsightly sinking in of the temporal fossa. The ganglion is reached by removing the calvarium over the temporal fossa as low as the zygoma, lifting the dura mater from the middle fossa of the skull, defining the inferior division of the fifth nerve and following it back to Meckel's space, which is opened up and the nerve divided behind the Gasserian ganglion.

FACIAL HEMIATROPHY (PARRY-ROMBERG SYNDROME)

Definition.—A peculiar malady confined to some part of the distribution of the trigeminal nerve, or rarely extending from thence on to the area of sensory distribution of the upper four cervical nerves. It is characterised by a progressive atrophy of all the tissues, skin, subcutaneous tissue, muscle and bone, without sensory loss or paralysis. It comes to an arrest after a few years. No pathological condition has been discovered to account for the atrophy.

The disease may commence in childhood even as early as the second year, but it is most commonly started in early adult life. Females are much more often affected than males. Sometimes it appears without any exciting cause, but more often some injury of not very severe nature, such as a blow on the face, fracture of the alveolar processes during dental extraction, or other surgical procedure, seems directly to have initiated the atrophy. It has been known to follow both scarlet and typhoid fever.

Symptoms.—The atrophy may be distributed over the whole area of the supply of the trigeminal nerve, or, as is more usual, may be confined to one or more of its branches. In general atrophy, a gradual diminution in the bulk of the whole side of the face is the first indication of the disease. When the disease is confined to one of the three great divisions of the nerve, the atrophy usually commences in one spot, commonly on the cheek just below the malar bone, where the skin becomes thin and pale from loss of pigment, and the down falls out. The submalar fat disappears, leaving an unsightly hollow. The atrophy spreads to the side of the nose, where the cartilages and bones become gradually smaller. The jaws gradually decrease in size upon the affected side, until they are too small to hold the teeth, which are actually pushed out by the decreasing size of the tooth sockets. The half

of the tongue upon the affected side decreases in size, and thereby is rendered sickle-shaped. Even the eye may be remarkably lessened in size. The upper part of the first division of the fifth does not seem so liable to involvement, for it is rare to see any diminution of the size of the forehead, or dropping out of the hair of the scalp. S. A. K. Wilson has, however, recently shown a case in which the first division alone was affected. The ear, however, may be remarkably reduced in size. The skin in the end becomes very thin and parchment-like. The ultimate condition in well-marked cases is very striking and unsightly. The facial appearance is as if the face were made up of two unequal halves from different individuals, and this inequality may reach a most grotesque degree in cases where the disease has commenced in infancy and where the effect of growth upon the normal side of the face has added to the disparity. The normal side has the fullness of youth and the other the wrinkles and atrophy of age. The atrophy not uncommonly affects the ear and may spread on to the side of the neck over the areas of the first three cervical nerves. J. P. Martin has recently shown a case in which all three divisions of the fifth nerve were severely affected and in which the atrophy extended as low as the fourth dorsal distribution, the folds of the axilla and the mamma being conspicuously affected. The upper limb, however, escaped. There is no impairment of sensibility except some blunting in a few of the cases where the skin has wasted to less than a tenth of its normal thickness and become like parchment. Notwithstanding that the muscles diminish in size with all the other soft tissues and bones of the face, they do not in any way lose power or cease function. No pain or subjective sensation of any kind accompanies the atrophy, which commences insidiously and progresses steadily for some years, and then becomes finally arrested. The most marvellous feature of this malady is that it is not an arrest of growth but the reverse; there is an ever-progressive diminution of hard bones and soft tissues alike, their conformity and function being preserved meanwhile. The malady is associated with no ill effect other than the very ugly and unsightly facial appearance.

Diagnosis.—This is simple, as there is no other cause of smallness of one side of the face, involving bones and soft tissues alike, except congenital facial asymmetry, which is at once distinguished from this disease by the history of atrophy in a previously normal face and by the remarkable thinning of the skin, wasting of the fat and wrinkled appearance.

Treatment.—The only treatment is cosmetic, to improve somewhat the appearance of the face, by the injection of semisolid paraffin, to replace the fat and fill the unsightly submalar hollow.

THE SIGNS OF LOCAL LESIONS OF THE BRAIN

The localisation of the position of lesions within the nervous system depends upon the presence and recognition of local signs, indicative of the impairment of function of nervous elements of which the function is definitely known. Sometimes localisation may be deduced with relative accuracy by the absence of local signs, which then indicate that no elements with definitely known function are involved. Inasmuch as the focus of disease involves nuclei or tracts with well-defined function, definite symptoms appear and

localisation will present no great difficulty. For example, in the cerebellum of which the functions are known, in the brain stem where many conducting tracts and nuclei of known function are crowded together, and in the basal ganglia whose functions are becoming definitely known, a lesion can hardly exist of any size without causing easily recognisable localising signs. On the other hand, in the cerebral hemispheres, where localisation of function is mysterious and where so many "silent areas" exist, regional diagnosis is much more difficult and is sometimes impossible. It may be said that it is only when conducting tracts of known function are involved on their way to the cortex, or at their impingement upon the cortex, that the more definite signs of hemispheric localisation appear. If then in a case where general signs of a local intracranial lesion are present, all localising signs are absent, it may be deduced with certainty that the lesion is in the cerebral hemispheres, and that it does not involve the regions upon which the visual and sensory tracts impinge, nor the region from which the pyramidal tract emanates, nor those deeper structures through which these tracts pass. The importance of localising signs varies greatly with the stage of the illness at which they appear. Those which appear early are all important, those which appear late, when increased intracranial pressure and evascularisation have disturbed both the anatomical relations and physiological activity of many regions of the brain, are of little localising value.

HEMISPHERES GENERALLY. — Diminution or disappearance of the abdominal reflexes upon one side is an indication that a cerebral lesion is in the opposite hemisphere. This sign may be the earliest organic sign to appear and the first localising sign of a lesion in the cerebral hemisphere. It is of great importance. An extensor response in the plantar reflex is of similar significance. Both these signs actually depend upon slight disturbance of the pyramidal system, but they occur with lesions far distant from that structure.

Prefrontal lobes.—Localisation is often difficult and uncertain. Mental changes such as alterations of character, temperament and tastes, loss of reserve, inattention, loss of concentration, loss of memory for recent events and, in a few cases, grandiose ideas and loss of all perspective occur. With large lesions, delusions, stupor and dementia may supervene. If the lesion involve the left third and second gyri, definite localising signs—verbal aphasia and agraphia may appear, and Jacksonian fits commencing with aphasia may be met with. Adie and Critchley have described a "grasping" reflex, which they deem highly characteristic of pre-frontal lesions. When the palm of the hand on the opposite side is stroked with an object, the fingers involuntarily close upon the object.

When the lesion affects the orbital lobule, there may be anosmia. This is of greater localising value if it is unilateral. There may also be pressure upon the optic nerve on one side, with corresponding visual defect. Lesions of this region, and especially tumour, are apt to cause slight impairment in the functions of the ascending frontal or motor convolution, which lies immediately posterior, and slight signs of hemiplegia, especially weakness of the face, are most important. Tremor of the homolateral limbs has been observed. Incontinence of sphincters of the mental variety may occur as in temporal lesions.

Ascending frontal convolution (*motor area*). — Hemiplegia is the char-

acteristic sign of local lesion of this region. On account of the wide extent of the ascending frontal gyrus it is rarely involved to its entire extent in one lesion. Partial involvement produces monoplegia of face or of arm or of leg, according to the position of the lesion. Conjugate deviation of the head and eyes may be met with, away from the side of the lesion, if this be irritative, as at the commencement of an apoplexy, or of a local fit, or towards the side of the lesion if the lesion be paralysing. The two forms of conjugate deviation often follow the one after the other, from the same lesion which is at first exciting and afterwards paralysing. Conjugate deviation of the head and eyes is seen with acute lesions rather than with those of slow development. Jacksonian attacks are frequent and take the form of local convulsion, followed by a varying degree of temporary weakness (Todd's paralysis). The more deeply the lesion extends into the sublying white matter, the more does it tend to produce an extensive hemiplegia, since the pyramidal fibres converge from the cortex towards the capsule. Loss of localisation to sensory stimuli is not infrequent from simultaneous involvement of the neighbouring post-central convolutions.

Parietal lobe.—Astereognosis is the all-important localising sign of lesion in this locality. It consists in the inability to recognise the nature of an object placed in the hand by its shape, size and consistency. The summation of all the sensations produced by the presence of the object in the hand, by which we instantly recognise a well-known object, is lacking. Cutaneous sensibility, and particularly tactile sensibility, may be impaired. Localisation may be inexact. The appreciation of active movement and passive position is apt to be faulty, and some ataxy may result therefrom. Trophic changes may be observed in the periphery of the limbs, and lesions in this situation seem to be responsible for the arrest of growth which is seen in cases of infantile hemiplegia. Jacksonian attacks, consisting of a peripheral sensory aura, sometimes followed by convulsions, occur. These localising signs are confined to the opposite side of the body.

Occipital lobes.—Lesions of the cuneus and region of the calcarine fissure on the mesial aspect of the occipital lobe result in hemianopia of the opposite field, but central vision escapes. If the lesion is limited above the calcarine fissure a quadrantic hemianopia of the lower field results, and if the lesion is below the calcarine fissure the quadrantic hemianopia resulting is of the upper field. Since central vision is represented at the posterior pole of the hemisphere, a lesion of the posterior pole causes central hemianopic scotoma, vision in the periphery of the field remaining intact. Consequently a bilateral lesion of both posterior poles will result in bilateral central scotoma, and a bilateral lesion of the calcarine region will produce blindness of both peripheral fields, central vision remaining intact. If the lesion extends deeply into the occipital lobe so as completely to sever the optic radiation to the occipital cortex, complete hemianopia, affecting both the central and peripheral part of the visual field, will occur. The hemianopias resulting from lesion of the occipital lobe are distinguished from those due to lesion of the optic tract by the fact that in the former the pupil reacts to light thrown on to the blind part of the field (Wernicke's hemianopic pupil phenomenon). On the outer surface of this lobe, a lesion extending deeply on the left side may sever the connection of the visual centres with the speech centres, and so produce word-blindness. Such a lesion is usually situated at the

junction of the left occipital and temporal lobes. Jacksonian attacks are often of great value in occipital localisation, and take the form of visual hallucinations, often accompanied by transient hemianopia.

Temporal lobe.—The uncinate and hippocampal regions of this lobe are the cortical seats for taste and smell, and the localising symptoms which are rarely absent when lesions in this region exist are Jacksonian attacks in the form of hallucinations of taste and smell, nearly always of an unpleasant nature. The hallucination is often immediately followed by a "dreamy state," during which smacking movements of the lips, or champing movements of the jaw, or spitting may occur. Experience seems to prove that all highly organised hallucinations, whether auditory, visual or psychic, when occurring from organic lesion of the brain, point to a lesion in the uncinate region. The senses of taste and smell are not lost from a unilateral lesion of this region, since they are bilaterally represented in the cerebral hemispheres. The outer surface of the temporal lobe is concerned with hearing, but from the complete semi-decussation of the auditory path, unilateral lesions never produce detectable deafness. On the left side, however, the temporal lobe is concerned with speech, and destruction results in serious disorder of speech functions. Inasmuch as lesions of this region are situated far forward toward the insula, they result in "verbal aphasia," or towards the centre of the convexity of the temporal lobe, in amnesia, or lack of recall of words and "word-deafness," while if towards the posterior limits of the lobe they produce "word-blindness" from severance of the visual path to the speech region. Deeply seated lesions isolating the speech region from the incoming auditory path produce jargon aphasia. Jacksonian attacks, consisting of auditory hallucinations, which may or may not be followed by aphasia or by convulsions, may occur. Extensive lesions of the left temporal lobe cause much mental impairment. On account of the wide excursion which the optic radiation makes into the deep part of the temporal lobe in its course from the thalamus to the cuneus, homonymous hemianopia, especially of the upper quadrants, is very common in deep-seated lesions of the temporal lobes. The occurrence of incontinence of sphincters of a mental type is highly characteristic in some cases. When lesions extend deeply there may be a paresis of the opposite face for emotional movements, out of all proportion to the loss of volitional movements.

Corpus callosum.—Lesions of this region present the greatest difficulty in diagnosis, but if the anterior part of this structure is affected, there may be apraxia of the limbs, and when the splenium is involved we have observed several cases in which loss of memory and amentia, in the absence of other local signs, were so conspicuous and came on so early as to enable us to make with certainty a correct local diagnosis.

Internal capsule.—In this region, the chief motor tract is condensed into a small space, and is situated immediately in front of a narrowly localised sensory tract, while not much farther posteriorly, the visual path enters the thalamus. Lesions of this region therefore produce severe and widely-spread hemiplegia of the opposite side, often associated with hemianæsthesia and not infrequently with hemianopia of the opposite side. From the proximity of the thalamus and corpus striatum, there is often involvement of these structures in a capsular lesion, with appearance of the characteristic, spontaneous involuntary movements and sensory loss.

BASAL GANGLIA.—*Optic thalamus.*—A very characteristic clinical picture results from destruction of this structure which is termed the "thalamic syndrome" of Dejerine and Roussy; there is hemiparesis with spontaneous involuntary movements of the opposite side, which may be of the nature of tremor, intention-tremor, choreic, athetotic, dancing or irregular movements. Most of the post-hemiplegic involuntary movements are due to a lesion of the thalamus. In addition, there is hemianæsthesia, often with a characteristic hyper-sensitivity to aggressive stimuli, such as tickling, cold water, etc., which may produce agonising distress. Sometimes spontaneous, constant and unrelievable pain occurs on the opposite side. Emotional movement of the opposite face may be impaired much more than is volitional movement.

Corpus striatum.—Paresis of the opposite side with spontaneous involuntary movements also occur with lesions in this situation. These may be of a rhythmic tremulous order, as in paralysis agitans, or athetotic (Klumpke syndrome), and, when the lesion is situated in the posterior part of the lenticular nucleus, both athetotic and choreic.

Region of the optic chiasma and pituitary body.—The most common lesion in this region is pituitary tumour, which involves the optic chiasma, at first in the middle line posteriorly, and subsequently advancing forwards. Three sets of symptoms are likely to arise—(1) Those due to dyspituitarism, such as acromegaly or gigantism if there is hyper-pituitarism, or Fröhlich's dystrophia adiposo-genitalis, or Lorrain infantilism if there is hypopituitarism. Adenomata of the pituitary body produce hyperpituitarism if they contain eosinophile cells, and hypopituitarism if such cells are absent. (2) Those due to the pressure upon the optic chiasma, which commence as bitemporal paracentral scotomata, which enlarge as the compression extends until a complete bitemporal hemianopia results. It cannot be too strongly impressed upon the reader that the pattern of the visual field defect is determined by the position of local pressure upon the visual paths, and that any variety of defective field may occur. While bitemporal loss is the most usual, yet when the pressure is far forward, uniocular hemianopia, blindness of one eye, and central scotoma are all of common occurrence, and when the pressure is farther back than usual homonymous hemianopia is frequently seen. And (3) those due to the general effect of the tumour, namely, headache and vomiting. Optic atrophy is the rule, as the result of the direct pressure, and not papillœdema. It is to be remembered, that all pituitary cases are prone to headaches and subject to fits.

Region of the falx cerebri.—Lesions of this structure are likely to affect both hemispheres equally. Tumours opposite the paracentral lobules cause bilateral crural monoplegia, and those in the posterior region of the falx, bilateral hemianopia. Thrombosis of the superior longitudinal sinus produces widely spread bilateral softening of the hemispheres, with double hemiplegia.

Corpora quadrigemina.—The oculo-motor nuclei lie on either side of the aqueduct of Sylvius, and lower down on either side of the middle line, in the floor of the upper part of the fourth ventricle, and lesions of this region cause nuclear ophthalmoplegia—that is, paralysis of both eyes in terms of the conjugate movements upwards, downwards or laterally. From before backwards, lesions of this column of oculo-motor nuclei will produce Argyll Robertson pupils paralysis of accommodation, paralysis of upward, downward

and lateral movements respectively. Immediately ventral to the oculo-motor nucleus and decussating beneath it, lie the superior peduncles of the cerebellum, involvement of which causes bilateral ataxy of limbs and trunk. Lesion of the dorsal part of the quadrigeminal layer produces a characteristic syndrome of nuclear ophthalmoplegia with bilateral ataxy, which is termed Nothnagel's syndrome. The pyramidal fibres for the face leave the pyramidal tract in this region of the tegmentum and may here be involved alone, causing bilateral spastic paralysis of the face. In the ventral portion of this region of the brain stem are the crura cerebri with the third nerve, perforating each crus to emerge upon its inner side, and the optic tract running round the crus from the geniculate bodies to the optic chiasma. A lesion of one crus will cause hemiplegia of the opposite side and paralysis of the third nerve on the same side. This pathognomonic localising combination is known as Weber's syndrome. Situated a little more dorsally, a lesion of the crus will produce ophthalmoplegia of one eye with tremors and inco-ordination of the opposite limbs. This is known as Benedikt's syndrome. Extension of a lesion outwards from the crus will cause tract hemianopia, in which the half-fields are completely involved, with no light reaction from the blind fields. Interference with the fillet may cause hemianæsthesia.

PONS AND MEDULLA.—In these regions the motor and sensory tracts, the cerebellar peduncles, the cranial nerve nuclei, and the outgoing cranial nerves are closely packed together, and the signs resulting from destruction of these will be varying combinations of spastic paralysis, ataxy and sensory loss—from interference with the long conducting tracts—in the body and limbs, with nuclear and peripheral nerve palsies and anæsthesia in the region of the face. If the lesion is unilateral the body and the face will be affected on opposite sides, causing the "crossed paralyses" or "alternate paralyses" of lesions of the brain stem, of which facial palsy with contralateral hemiplegia, trigeminal palsy and sensory loss, and vagal palsy with contralateral hemiplegia are usual varieties. From the smallness of the brain stem lesions most often involve both lateral halves of this structure, and bilateral symptoms result. Lesions of the brain stem below the oculo-motor nuclei, cause small pupils (pontine myosis) from cutting off of those nuclei from the spinal cord, whence the tonic dilator of the pupil—the cervical sympathetic system—emerges. Glycosuria may occur from interference with the vasomotor centre, and involvement of the respiratory centre is frequent.

CEREBELLUM.—Lesions of the lateral lobe of the cerebellum produce a series of physical signs which are so characteristic that they can hardly be overlooked in any patient who is well enough to respond to the necessary tests. These signs are not always all of them present in any given case, nor in one patient at any given time. Cerebellar signs often vary in degree from time to time. They are as follows:

1. Nystagmus, with a long-range slow movement on conjugate deviation to the side of the lesion, and a short-range much quicker movement on looking in the opposite direction. Lesions of the middle lobe give a nystagmus equal in both directions, and sometimes nystagmus may be absent.

2. Hemiataxy on the side of the lesion. It is dynamic ataxy; that is to say, it becomes obvious only when the patient moves, and is due to the loss of postural tone, of which the cerebellum is the central organ, and which is essential to the accurate co-operation of the synergic muscles. There is no

loss of the muscular sense or sense of position, and, therefore, no change on closing the eyes, and Romberg's sign is absent.

3. Loss of unconscious balancing movements. No attempt is made unconsciously to recover balance when this is upset. It is done consciously, and is therefore late and slow, and the patient can be pushed over easily. This sign is often conspicuously seen when the patient is walking, when the arm of the normal side makes the usual to and fro movements with each step, but the other arm, though hypotonic, hangs motionless. This sign is of the utmost importance when present, as a true indication of the side of the lesion.

4. Hypotonia or unusual flaccidity of muscles on the side of the lesion.

5. Dysdiadokokinesia or inability to perform any rapid alternate movements upon the side of the lesion. The test is easily performed by asking the patient to extend the arms with the fists closed, and rotate them rapidly. The inability upon the affected side becomes at once apparent.

6. Attitude. When standing or sitting, the patient naturally assumes a position in which the occiput approximates to the shoulder on the side of the lesion, and the face is turned slightly to the opposite side. The homolateral leg is slightly abducted so as to broaden the supporting base, the spinal column tends to be concave to the affected side, and the shoulder on that side is held higher and a little in advance of the opposite shoulder.

7. Gait. This is often described as reeling, staggering or drunken, but it is often slow and careful, though clumsy. The affected leg makes less excursion than the sound leg, as if it were not trusted. When attempting to walk in a straight line, the patient tends to walk in a curve towards the side of the lesion, and he tends to fall to that side.

8. Unwillingness to look to the side of the lesion, although the ocular movements are perfect, may be a conspicuous and important sign.

9. In a few cases a peculiar strabismus known as the "skew deviation" is seen—one eye looks up and in, and the other down and out.

In acute and irritative lesions of the cerebellum, such as vascular lesions, severe vertigo, forced movements of rotation which always turn the patient so that his face on the side of the lesion is in contact with the pillow, and severe vomiting occur. When the lesion is in the middle line, and especially when it extends into both lateral lobes, the signs are bilateral, and there may be ataxy of articulation, resembling that of disseminate sclerosis. The deep reflexes are variable: at one time diminished, at another exaggerated. The superficial reflexes are not affected; the plantar reflexes are of the flexor type.

10. Lateral recess. The angle formed by the posterior surface of the petrous bone and the tentorium is a common situation for neurofibromata which grow usually from the eighth nerve, but occasionally from the seventh and from the fifth nerve, and press into the lateral lobe of the cerebellum. A highly characteristic clinical picture results, of slowly oncoming nerve deafness, unilateral signs of cerebellar involvement and some peripheral facial spasm, to which are sometimes added facial weakness and tinnitus. Such tumours are not of great size, and therefore headache and papilloedema are often absent or occur late.

INTRACRANIAL TUMOURS

Under this heading are grouped all new formations which encroach upon the intracranial space, and which produce the familiar pressure symptoms and local symptoms of tumour, though some of these are not, strictly speaking, neoplasms.

Ætiology.—The brain is actually the most common seat of new-growth among all the individual organs of the body. At the National Hospital, London, 500 cases were admitted in 9 years, and Cushing reports a similar number in his clinic in the same period.

Age.—Cerebral tumour may occur at any age, but it is relatively uncommon in the very young and in the very old. It seems to be considerably more common in the female sex. The relation between cephalic trauma, and the first appearance of symptoms of cerebral tumour, is one which occurs much too often to be ignored, though it is likely, in many of the cases in which this relation exists, that the blow on the head has simply served to bring a pre-existing tumour into symptomatic prominence, either by causing œdema or hæmorrhage in its substance, or vicinity. It must be remembered in this connection that a cerebral tumour may exist for long periods without definite symptoms. For example, a patient of ours had suffered with rare attacks of epilepsy, commencing with a complicated visual aura, for 17 years. After natives in the West Indies had attempted his assassination by bombarding his head with cocoanuts, many of which struck him, and rendered him unconscious, he developed urgent symptoms of intracranial tumour without localising signs. On the history of visual fits of 17 years' duration, Sargent explored the corresponding occipital region and came immediately upon a large growth of the right occipital convexity.

Pathology.—A short account of the nature of intracranial tumours in order of the frequency of their occurrence here follows :

Gliomata.—These are by far the most common of brain tumours. They are essentially ectodermal tumours, taking their origin from any part of the primitive ectodermal tube, its developments and vestiges, which ultimately make up the central nervous system. They may occur, for example, in the remote coccygeal region, from rests there remaining of the primitive neural tube. The gliomata must therefore be strictly separated from sarcomata, for the latter arise from mesodermal, and not from ectodermal structures. The glioma grows from the brain substance, and is usually a soft, rapidly-growing very vascular tumour, and in its vessels degenerative processes are liable to occur, causing thrombosis and hæmorrhage, while in its vicinity and substance acute œdema is very prone to occur. The importance of these three associates of cerebral tumours, acute œdema, hæmorrhage and thrombosis, and especially of acute œdema, can hardly be overestimated in the causation of increased intracranial pressure, sudden appearance or exacerbation, or sudden remission of symptoms, in cases of cerebral tumour. Acute œdema, occurring in the vicinity of a previously symptomless and structurally obsolete tumour, no larger than a marble, has caused death within a week of the first symptom twice in my experience. Gliomata are often diffuse with no sharp limit separating them from normal brain tissue. They may grow between and displace the nerve elements, causing

little interference with their function, until degeneration or vascular lesions occur in the tissues of the tumour. On the other hand, it is important to remember they may be strictly encapsulated. In the absence of degenerative changes and of vascular lesions within its substance, the glioma resembles the greyish red of cortical tissue in colour, and in consistence it is not unlike the normal brain, so that when not encapsulated it may be very difficult to distinguish from the surrounding brain tissue, when exposed at operation or at autopsy. The glioma, like other brain tumours, does not metastasise, but when it is exposed to the cerebro-spinal fluid by rupture of its surface, grafts may be washed off, which may cause fresh growths in the course of the cerebro-spinal fluid, and especially in the pockets of the nerve roots in the spinal theca. The same event may occur when other primary brain tumours become similarly exposed to the cerebro-spinal fluid.

Endotheliomata.—These are the next most frequent of all the true intracranial tumours. They grow commonly from the endothelial lining of the meninges, much more rarely from the endothelium of blood and lymph vessels; but they frequently become deeply embedded in the brain substance, though they are always strictly limited from and detachable from it. They may involve and cause great thickening and deformity of the skull case. These tumours are intrinsically benign. They grow slowly, and in Cushing's opinion are the most favourable of all for operative removal.

Sarcomata.—These tumours are firmer in structure than the glioma, and are always strictly limited and encapsulated. Not infrequently they are of cranial origin, and arise in the diploë, and may enlarge the skull externally, and give evidence of their presence and situation by being palpable and visible upon the surface of the skull. Sarcomata found within the brain substance are usually of metastatic origin, and show the characters of the original tumour.

Carcinomata.—These occur as metastases most commonly from mammary cancer: they are often multiple and frequently show cystic degeneration. Primary carcinomata of the lung and of the kidney are particularly prone to give rise to metastases in the brain.

Cholesteatomata.—Sometimes called "mother of pearl" tumours, on account of their glistening appearance, are found in connection with the basal meninges. Their origin is uncertain. They are either of slow growth, or run a symptomless course. They consist of a greasy, greyish, friable and more or less laminated mass, made up of layers of a closely packed mosaic of flat polygonal cells. The tissue is necrotic, and contains no blood vessels.

Among the rarer tumours of the brain may be mentioned dermoid tumours, teratomata, chordomata, which arise from rests of the anterior end of the primitive notochord and are found below the base of the brain, lipomata, fibromata, neuromata, neuroblastomata, consisting actually of undifferentiated nerve cells, enchondromata, angiomata and psammomata.

Cysts.—Cysts of the following nature may occur—(1) Congenital interpeduncular or pituitary cysts, which arise from a pharyngeal rest in connection with the development of the pituitary gland; the resulting signs are those of pituitary insufficiency, together with those of pressure upon the optic chiasma. (2) Simple serous cysts which are presumably the remains of soft tumours, which have become completely degenerated. (3) Tumours

containing cysts, presumably on the way to the formation of the above. (4) Blood cysts, the rare results of hæmorrhage which has become arrested. (5) Cysts which result from softening after embolism and thrombosis. When occurring in the young, these cysts may lose every trace of their original origin, and form thin-walled cavities, containing colourless fluid, often extending from the ependyma to the pia mater, and involving the whole thickness of the pallium. They are termed "porencephaly." (6) Cystic distension of the ventricles from obstruction, which forms local or general hydrocephaly. These are met with in connection with tumours in any situation and result from adhesive meningitis, particularly syphilitic meningitis. (7) Dermoid cysts. (8) Parasitic cysts, of which the more common is the bladder worm of the tapeworm, *Tænia solium*, which is called, on account of the thickness of its wall, cysticercus cellulosæ. They are usually multiple, and choose the region of the fourth ventricle as their site of predilection. They may be multiple in the basal meninges, and constitute a "cysticercus meningitis." It is usual for these cysts to shrink and to become calcified and obsolete in from 3 to 6 years. Less commonly, the hydatid of *Tænia echinococcus* is found. It is usually single, may reach a large size and present the signs of a slowly growing tumour with eosinophilia.

Infectious granulomata.—Tuberculomata are more common in the young; but they may occur at any age. They vary in size from that of a millet seed to that of a hen's egg, and are more often found in the posterior fossa of the skull than above the tentorium. When large, coagulation necrosis and caseation occur in the centre, and on section the tumour presents a dry yellowish crumbling or even diffluent centre, with a greyish-red peripheral growing zone, where are located living tubercle bacilli and actively growing tubercles. The tuberculoma has an important aspect in connection with operation for extirpation. They are often situated favourably for extirpation, yet in every case where this operation has been performed the patient has succumbed to tuberculous meningitis, often after recovery from an apparently completely successful operation. Such a tumour recognised on decompression should be left severely alone.

Syphiloma.—This is not a common intracranial tumour. It grows most commonly from the meninges, and is therefore a surface lesion, though it may burrow deeply in the brain tissue. It is most commonly found above the tentorium. It is occasionally very hard in consistency, and tends in many cases to scar and become obsolete. It is sometimes impossible to distinguish this tumour from a tuberculoma without the aid of the microscope and the serum reaction.

Actinomycomata and tumours from streptothrix infection occur in very rare cases.

Symptoms.—An intracranial tumour may produce symptoms, either by raising the intracranial pressure (general symptoms), or by involving elements of the nervous system, of which the loss of function can be exteriorised (focal symptoms). Such symptoms may be in large measure produced by certain secondary processes occurring in the vicinity of the tumour, such as œdema and vascular lesions, and the subsidence of acute œdema so produced may give rise to dramatic amelioration of symptoms under treatment. On the other hand, œdema of the brain may give rise to the clinical picture of cerebral

tumour, when no tumour exists, as was frequently seen from contusions, concussions and bullet wounds during the Great War. Further, a cerebral tumour may exist, even of large size, without raising the intracranial pressure, and without causing focal symptoms. Consequently no symptoms whatever arise, and the existence of a tumour is a post-mortem discovery. Or a tumour, after remaining latent perhaps for years, may give rise to the rapid development of symptoms, usually from the occurrence of œdema in its vicinity. It is owing to the occurrence of this œdema that tumours of small size may give rise to severe and rapidly fatal symptoms. Thus patients may present themselves with (1) Tumours which give absolutely no recognisable evidence of their existence, and are found post mortem—this event seems to be more common in advanced age, and in subjects with hard arteries; (2) tumours which give focal symptoms alone without evidence of increased pressure—this again is met with more often in advanced age, and when arterial disease is present; (3) tumours which give general manifestations of increased pressure, but no focal symptoms—these are always supratentorial in situation, and do not occupy those regions of the hemispheres with known and exteriorised function; (4) tumours which give typical signs both of increased pressure and of focal destruction—these are the most commonly occurring; and (5) the symptom-complex, both general and local, of tumour may be brought about by the occurrence of cerebral œdema from any cause when no tumour is present. It is important to realise that all tumours for a varying time after their commencement must fall into the first group of symptomless tumours.

General Manifestations.—These symptoms are the result of raising of the intracranial pressure, and accordingly fail when there is no considerable raising. Therefore they tend to be conspicuously absent in the slowly growing tumours of the cerebello-pontal angle, in all tumours of the brain stem, in infiltrating tumours of the centrum ovale, and also for some unknown reason in advanced age and in the subjects of marked arterial disease. They consist in the following signs: Papilloedema, headache, vomiting, loss of vivacity and mental drowsiness, nasal irritation, giddiness, alteration of pulse-rate, of blood-pressure, respiration, and general convulsion.

Papillœdema.—This is by far the most constantly present of all the general manifestations. It is frequently present for a long time without headache or vomiting; but, on the other hand, it is rare to meet with either conspicuous headache or vomiting in the absence of papillœdema, and therefore this may be judged the earliest sign of increasing intracranial pressure. It fails to appear sometimes even with greatly increased intracranial pressure, as in hydrocephalus; but this is explained perhaps by the deterring effect upon its occurrence, of direct pressure upon the optic chiasma by a distended infundibulum. This is only seen in the hydrocephalus of children; in adults papillœdema is invariably present with active hydrocephalus. Papillœdema appears to be a stasis œdema of the nerve-head owing to the increased intracranial pressure forcing the cerebro-spinal fluid into the meningeal sheath which invests the optic nerve, and into the perivascular spaces which accompany the central vessels of the nerve. The nerve sheath becomes distended, and venous stasis occurs. On ophthalmoscopic examination the earliest changes are increased redness of the disk, distension of the veins, loss of distinctness of the nasal margin of the disk, with disappearance of the physio-

logical pit. As the process increases the whole margin of the disk becomes lost. It enlarges in area, and becomes visibly swollen and presents the appearance of a mole-hill as seen from above. The point of emergence of the vessels, at the centre of the disk, becomes buried by white exudation, which occurs also all over the disk, and taking a form determined by the radiating nerve fibrils, gives the disk the appearance of being striated in a radial fashion, like a chrysanthemum. A similar exudate may rupture the membrana limitans interna in little droplets at the macula, and coagulating as it comes in contact with the vitreous humour, produce the characteristic radially arranged macular figure of "macular fan," exactly similar to that seen in renal disease. The venous congestion of the retina leads to multiple hæmorrhages, which infiltrate along the radially arranged nerve fibres, and for this reason are flame-shaped. With the outpouring of much exudation, the disk becomes white. In the course of time the hæmorrhages become white flame-shaped scars, the whole disk contracts, the swelling disappears, and the disk becomes white, flat and atrophic, and distinguished only from that of primary optic atrophy by the scarred remains of the exudate at its edge, producing a fluffy outline like that of torn cotton-wool, along the vessels and at the centre. In the early stages of papillœdema, even though there be considerable swelling of the disk, vision may be little impaired. As the process increases however, in proportion to the degree of the swelling, to the amount of the exudate, and to the length of time the papillœdema has lasted in a severe condition, vision becomes impaired, and blindness results. Peripheral constriction of the visual fields, large pupil and dimness of vision, are the signs that, if the papillœdema be not speedily relieved, blindness will certainly result. Perfect vision may be retained for a time, even with a high degree of papillœdema. So important is papillœdema in the diagnosis of tumour of the brain, that it is necessary to bear constantly in mind all other causes which may give rise to it.

Papillœdema may occur in certain general intracranial conditions other than tumour. In meningitis it occurs as a late sign, and rarely before the tenth day, and as so many cases of meningitis do not survive so long, it is chiefly met with in the more chronic forms, such as tuberculous meningitis, and untreated cases of meningococcal meningitis. Abscess may also cause papillœdema; but it is by no means common in this condition. It may occur, too, in every variety of encephalitis, traumatic, poliomyelitic and lethargic, but only in exceptional cases.

Apart from intracranial disease papillœdema occurs in the following conditions: (1) Local conditions of the retina and optic nerves. In connection with tuberculoma of the retina in the neighbourhood of the disk, the most intense papillœdema may be found. Retrobulbar neuritis occurring close behind the disk may cause a similar condition, especially if it be of a syphilitic nature. Septic conditions of the ethmoidal cells, sphenoidal sinus, etc., may also cause papillœdema. In these three conditions the papillœdema is often unilateral, but in any of them it may be bilateral. (2) Renal disease may give a retinal picture of intense papillœdema, macular figure and hæmorrhages, sometimes quite indistinguishable from that due to tumour. This is often seen in the small white kidney of young subjects, and sometimes in small red kidney, but there is no form of renal disease, even including tuberculous, amyloid and lardaceous kidney, in which papillœdema has not been

observed. (3) Anæmic states of every kind sometimes give rise to papilloedema, even of severe intensity. This occurs most commonly in chlorosis. We have seen the sight lost in one eye, and seriously impaired in the other, as the result of atrophy after papilloedema in a severe case of chlorosis. As regards groups (2) and (3), it is essential to emphasise the facts that papilloedema, headache and vomiting may occur as a symptom-complex, both in renal disease and in anæmic states. More than one case of simple chlorosis has been decompressed for tumour. (4) Septicæmic conditions, and especially those producing arthritis. Of these infective endocarditis is the most common; but it has occurred with every form of septicæmic arthritis, and even in cases of acute rheumatism. (5) Further, papilloedema has been noted in connection with tumours, and with compressions and fracture-dislocations of the cervical cord, and also with acute myelitis.

The retinal changes in diabetes are always, and those in renal disease often, distinguishable from papilloedema resulting from increased intracranial pressure. In diabetes the change is essentially a hæmorrhagic retinitis from degeneration of vessels, sometimes with waxy-looking exudation in circinate patches; and in renal disease it is often a general œdema of papilla and retina, with hæmorrhages and white patches far away from the disc. The papilloedema resulting from increased intracranial pressure is always bilateral, though it may appear in one eye before the other, unless there be local pressure upon one optic nerve, which always delays or prevents papilloedema appearing in that eye. Otherwise, an earlier commencement upon one side is of no localising value whatever.

Headache.—It has been proved beyond dispute that the brain itself and the pia-arachnoid are insensitive to pain. It is probable that the headache of cerebral tumour is due to irritation of the terminations of the trigeminal nerve in the dura mater and bones of the skull from stretching and pressure, when the intracranial pressure is high. On the other hand, headaches due to abnormally low intracranial pressure, such as may follow upon the removal of cerebro-spinal fluid by lumbar puncture, etc., are probably due to venous congestion of the same tissues, or to stretching of dura mater by displacement. After destruction of the fifth nerve by Gasserectomy, headache never again occurs upon that side. The complete relief of headache after a successful decompression, is proof that pressure is the all-important factor in its causation. Small and slowly growing tumours therefore give rise to little or no headache, and this is especially true of the slowly growing tumours of the cerebello-pontal angle and of tumours of the brain stem. The latter, however, may cause obstruction of the aqueduct of Sylvius or of the fourth ventricle, with secondary hydrocephalus, and may then be productive of severe headache. The sensation may vary from a mere feeling of fullness of the head to the most agonising pain. It is more often remittent than continuous, and may be absent for long periods together. It is rarely localised to any definite region, except when the growth actually involves the bone, or when pressure has caused local thinning of the bone, when local pain and tenderness on pressure may occur. Usually it is referred indefinitely to the frontal or to the occipital or to the vertical region. When occipital it may be associated with pain and stiffness of the neck, and head retraction. This is due to a general pressure effect, and does not indicate any localisation. Headache may be entirely absent, even in the presence of severe papilloedema.

It may precede the development of papillœdema, but more often it is later in its appearance.

Vomiting.—Only two-thirds of all cases of intracranial tumour present vomiting as a symptom. It rarely occurs in the absence of the two chief signs of increased intracranial pressure, papillœdema and headache. When the headaches are severe, it may be associated with much nausea, and the attacks are often referred to by the patient as "bilious attacks." Usually a result of increased pressure, it may be directly produced by lesions of the cerebellum, irritation of the vestibular nerve, and by the visual disorientation resulting from diplopia. As a symptom of intracranial tumour it hardly deserves the cardinal importance which has been assigned to it in most descriptions of this disease.

Loss of vivacity and mental drowsiness.—Even when intellectual capacity shows not the slightest impairment, there is from the first onset of symptoms a loss of vivacity, a slight heaviness and an absence of restlessness and irritability, which is of value in diagnosis. It is almost unheard of for a tumour patient to suffer from insomnia. As the symptoms increase, so do heaviness and drowsiness, though a perfect but slow cerebration may persist until the latest stages of the disease.

Nasal irritation.—The patients suffering from intracranial tumour at the National Hospital, London, during the past twenty-five years, have been noticed to rub their noses with such frequency as to render this circumstance a sign of real diagnostic value. The patients do not complain of nasal irrita tion, but will be seen frequently to rub the tip of the nose with the hand as if to relieve irritation. The sign seems to depend upon increased intracranial pressure for it occurs in a few conditions other than tumour, in which the pressure is markedly raised.

Giddiness.—Though this is an inconstant sign, it is often met with, and it may be due to vestibular irritation, when it amounts to an actual vertigo, or it may be a sense of general unsteadiness. It is met with most often in subtentorial tumours, but may be quite a general symptom when very high pressure exists. Vertiginous attacks comparable to those occurring in Ménière's disease, are only met with when acute lesions of the cerebellum are present. It is important that tinnitus occurs rarely as a sign of intracranial tumour.

Convulsions may occur as the result of the general disturbance of blood supply from high intracranial pressure, and are perhaps akin to asphyxial convulsions; they may occur irrespective of the situation of the growth. Such convulsions from general pressure occur late in the course of the case; early convulsions always have a localising value. They are of uncommon occurrence when the tumour is situated beneath the tentorium.

Blood-pressure, pulse-rate and respiration.—There is a compensatory increase of the blood-pressure for every raising of the intracranial pressure, so that the cerebral circulation may be kept going. The failure of such compensation is often the cause of the sudden death which occurs in tumour cases. The pulse-rate is in the inverse ratio of the blood-pressure, and, therefore, of the intracranial pressure, and the pulse is slower than normal, where pressure is above normal. Respiration tends to be slow, and when the physiological condition of the intracranial contents is much disturbed, it tends to become irregular, grouped, and may show the wax and wane of movements which bears the name of Cheyne-Stokes respiration.

Focal signs.—These have been fully described in the section upon the localisation of lesions of the brain. In connection with localisation, however, it is important to recognise certain possible sources of fallacy in making a diagnosis. Blindness from papillœdema prevents any localisation by means of the visual functions. Papillœdema usually causes at one stage great peripheral constriction of the visual fields which might be attributed to a bilateral lesion of the cuneus, and it may cause altitudinal hemianopia, *i.e.* blindness of the upper half of both fields, by sagging of the exudation into the lower part of the retina. Jacksonian epilepsy may occur in long-standing cases without any relation to the position of the tumour.

Paralyses of cranial nerves are serious pitfalls. They are of value in localisation when occurring early, and in association with alternate hemiplegias, and paralyses of the eighth, ninth, tenth, eleventh and twelfth are always of sure localising value. Paralysis of the sixth cranial nerve, perhaps, should always be disregarded as a localising sign for the following reasons: When the intracranial pressure increases from the presence of a growth, the first effect is that any superfluous cerebro-spinal fluid, of which there is normally very little, is expelled from the skull. Later, with further increasing pressure, since the only escape from the rigid skull is by its only opening, the foramen magnum, the medulla and cerebellum are pushed backwards towards the foramen magnum and come to fill up this aperture as with a cork. In all long-standing cases of increased pressure, the cerebellum will be found on autopsy, and especially when hardened *in situ*, to be deeply marked by the edge of the foramen, part of the cerebellum and medulla actually occupying the spinal cord. We have found part of the cerebellum pushed down in the form of a jelly bag, lying as low as the third cervical vertebra. Corking up of the foramen magnum in this way offers a marked impediment to the flow of cerebro-spinal fluid, and is a most important factor in the production of hydrocephalus, secondary to tumour. A vicious circle is set up, for the greater the blocking of the foramen magnum by the pushing back of the cerebellum and medulla, the greater is the retention and therefore the pressure above the obstruction. Bearing this in mind the immediately fatal effects which have followed lumbar puncture in long standing cases of high intracranial pressure will be at once understood and for ever avoided. This shifting backwards of the medulla and cerebellum will cause stretching of those cranial nerves attached to the medulla, in proportion as they are directed antero-posteriorly, and take a straight course between their attachments to the dura mater and their origin from the medulla, and of these the sixth nerves will be most affected, and afterwards the third, seventh and fifth in that order. These nerves will not only be stretched, but are subject to the increased pressure also, and they may accordingly cease function simply as the result of the increased pressure. Nor is this all, for the cerebellum, squashed down into the spinal canal, may too show signs of abrogation of function. The following case well exemplifies the occurrence of false localising signs, with long-standing pressure. A man aged 24 years came under observation totally blind from complete optic atrophy following papillœdema. He had had general symptoms of intracranial tumour for 18 months. He presented bilateral cerebellar signs, more marked on the right side, and right paralysis of the seventh nerve. He had had two Jacksonian attacks, commencing in the right arm. No history of any cerebellar symptoms could be gathered from the history of

the first year of his illness. Notwithstanding a warning, an operation for decompression of the subtentorial space was performed, with an immediately fatal result. An extradural tumour was found in front of the tip of the right temporal lobe. In this case, all the late developing signs were of false localising value.

Diagnosis.—The differential diagnosis of intracranial tumour has to be made—(1) from other conditions causing papillœdema, (2) from other conditions causing headache, and (3) from other local lesions causing local signs within the brain. Renal disease, conditions of severe anæmia, encephalitis and meningitis may on occasion gave rise to a combination of all three of these, very easily confused with the papillœdema, headache and vomiting of cerebral tumour.

Hydrocephalus is only distinguishable from intracranial tumour by the enlargement of the head which takes place in young subjects, but when the skull is rigidly closed, the symptoms are identical with those of a non-localisable tumour.

Intracranial abscess is not often confused with tumour, when it has an obvious cause in the vicinity of the brain, from bone disease, or an embolic cause at a distance, such as ulceration of the lung. It is an acute disease and rarely develops an increasing papillœdema. Accuracy in the early diagnosis of tumour cases depends upon the pertinacity with which every case of headache, every case of "fits" and indeed every case which shows any nervous symptom whatsoever, is systematically examined for signs of organic disease, and importantly upon that skill and practice with the ophthalmoscope which is so easily acquired with patience and a little determination. The presence of a tumour having been determined, the necessity is to localise it. This can be done with an accuracy which approaches certainty in recent cases of tumour situated anywhere below the tentorium, provided that the condition of the patient admits of adequate examination, and even in half-comatose patients accurate judgment may lead to brilliant success. For example, in a case recently in the National Hospital with intense papillœdema, the patient was seen for the first time more than semi-comatose and half-moribund, and not in a physiological condition for examination. Yet the extreme hypotonicity of his limbs on one side, as compared with the other, led to the immediate and successful removal of a tumour of the lateral lobe of the cerebellum.

Above the tentorium tumours may be difficult or impossible to localise. So far as decompression is concerned the least indication, however slight, should determine the position of decompression. The external surface of the head should be carefully examined, and especially after it has been shaved, for now and then important indications of the position of a tumour may be afforded, for tumours may grow from the bone, or when internal may cause local absorption of the bone, and bulging of the skull. X-ray examination should not be omitted, though it does not often afford important information.

The determination of the nature of a growth is one of great difficulty, except in metastatic growths, when the primary growth has been discovered. Even where the serum reactions for syphilis or definite tuberculosis are present, the nature of a growth must remain one of probability and not of certainty.

Especial care must be taken not to assign a growth to a syphilitic origin because the administration of mercury and iodides relieves or even removes

the symptoms. We have on five occasions performed autopsy upon such apparently cured cases, after an interval of from 1 to 2 years, and we found sarcoma twice, glioma twice and tuberculoma once.

Course and Prognosis.—An intracranial tumour usually causes increasing symptoms, which progress with exacerbations and remissions, until papilloedema ends in blindness, and until the pathological intracranial condition becomes incompatible with even vegetative existence. At any time death may occur from vascular lesions, acute œdema or sudden raising of pressure. Tumours occasionally become obsolete—thus a tuberculoma may become scarred and calcified, and a glioma may become calcified or cystic; but this result is too rare for consideration within the grounds of practical perspective. The average duration rarely exceeds a year after the diagnosis has become possible.

Treatment.—In every case, whatever be the nature of the tumour, the regular administration of mercury, preferably by inunction, and of iodide of potassium is likely to lessen the severity and to slow down the course of the symptoms, and it should be used as an initial palliative measure in every case after the blood and cerebro-spinal fluids have been examined for syphilitic reactions. In syphilitic cases a cure may be effected, but such a cure occurs as a rule only in cases of syphilitic hydrocephalus from adhesive meningitis, which have simulated tumour. Massive cerebral gummata are not easily removed by treatment, and some of them are so hard as to be practically uninfluenced by anti-syphilitic treatment. Pain and vomiting may be relieved admirably with the various analgesics of the coal-tar series. When intracranial pressure becomes so high as to cause agonising pain, pulselessness and impending death, morphine in full doses will always relieve, and it is not dangerous. Convulsions should be combated with administration of bromides. The painful, dangerous and incapacitating symptoms of cerebral tumour—pain, sudden death, blindness and increasing torpor—result from increased pressure upon the brain; and if that pressure can be safely relieved, pain disappears for good and all, the sight is saved, and mental torpor is much lessened. This relief can be obtained by the operation of decompression, which by removal of the bone of the skull widely over the site of the growth, and the severance of the hard membranes, allows the tumour to bulge and grow outwards beneath the scalp, and frees the brain permanently from pressure. This operation should be undertaken in every case where localisation is certain, and where the tumour is in such a position that decompression will give relief, as a palliative measure to relieve headache and to prevent blindness, and it should be performed before the papilloedema has put the patient within any risk of blindness. If, by good fortune, a removable tumour is found at the operation for decompression, and can be removed without too much damage to brain and vessels, the operation becomes a radical curative one. Decompression is inadmissible in tumours of the brain stem, for it does no good, and when secondary hydrocephalus is associated, it is highly dangerous. When no localisation can be made, and the general symptoms are very urgent, decompression should be made far back and upon the right side over the hemisphere. It is made on the right side to avoid injury of the left convexity producing aphasia, and far back to avoid hemiplegia. It is by no means a light matter to decompress far away from the situation of the tumour, since the tumour will tend to shift

and grow towards the opening in the skull and produce disastrous effects in the way of tissue dislocation, vascular lesions and œdema; but where no localisation can be made, these results must be risked in the attempt to relieve the symptoms. Decompression is fraught with considerable danger to life, which becomes much greater the longer it is delayed. In decompression below the tentorium, the bone is removed both above and below the line of the lateral sinus, so that if hydrocephalus be present, as is so often the case, the supratentorial pressure can be relieved at any moment by tapping the lateral ventricle through the occipital lobe. The margin of the foramen magnum is cut away, so as to obviate the blocking effects of the pressure cone.

No attempt must be made to remove a tuberculoma which is found on decompression, however favourably it may be situated for removal, since any disturbance of its seat results invariably in tuberculous meningitis and death. On the other hand, tuberculous tumours not unfrequently become obsolete after decompression.

HYDROCEPHALUS

Definition.—The term "hydrocephalus" denotes a regular distension of the ventricular system of the brain by the accumulation of cerebro-spinal fluid within it; and this distension is associated, sooner or later, with an expansion of the cranial bones and enlargement of the skull.

Hydrocephalus was formerly divided into acute and chronic, acute being applied to the condition of tuberculous meningitis. But since any marked degree of ventricular distension is unusual in that affection, and enlargement of the head very rarely occurs, this term has fallen out of use. In the majority of cases in which general atrophy of the cerebral tissues occurs, fluid accumulates both in the ventricles and in the sub-arachnoid space; but such compensatory enlargement is not to be regarded as, in any sense, of the same nature as true hydrocephalus. Such accumulation of fluid is found in cases of cerebral diplegia and general paralysis of the insane in children, and it also occurs in the brains of old people. It is merely the result of wasting and shrinkage of the brain-tissue, and the accumulation of fluid takes place in order to fill up the space which is vacated within the rigid skull.

The enlargement of the head, which is not uncommonly found in rickets, has no connection with hydrocephalus. It is probably the result of malnutrition of cranial bones, which grow irregularly, and, being unduly soft, yield somewhat to the intracranial pressure. In rare cases of moderate degree, ventricular distension has been met with, but the enlargement of the head is never progressive, and the symptoms of hydrocephalus are absent.

According to their clinical aspect, cases of hydrocephalus may be placed in one of three groups—(1) congenital hydrocephalus, in which the enlargement of the head is present at the time of birth; (2) acquired primary hydrocephalus, which may appear at any period of life; and (3) secondary hydrocephalus. Under the name of secondary hydrocephalus may be grouped together all cases in which there is obstruction in the usual path by which the cerebro-spinal fluid leaves the ventricular cavities, or to the

venous outflow from the choroid plexuses. But it is by no means clear that such obstruction is the sole or even the important agent in producing the ventricular distension.

Ætiology.—Hereditary influences are of importance in the causation of congenital hydrocephalus. This disease frequently affects several children of the same parents, and it may even appear as a striking family disease, affecting members of several generations of the same stock. The writers have on two occasions seen hydrocephalic twins. Spina bifida, meningocele and hydromyelia are of frequent occurrence in association with this disease, and arrested and irregular development of the brain stem and cerebellum are the rule. Among other bodily deformities not infrequently associated with congenital hydrocephalus, may be mentioned harelip, cleft palate, talipes, rectal and testicular ectopia and imperforate anus. Consanguinity of parents and parental alcoholism have been recorded, and syphilis seems to have a definite connection with certain cases of congenital hydrocephalus. In the majority of syphilitic cases, the morbid anatomy of the hydrocephalus presents no special feature. In a few cases definitely syphilitic lesions of the ependyma in the region of the brain stem have been found. The causation of primary hydrocephalus occurring after the time of birth is often obscure. The majority of the cases occur in childhood, yet no period of life seems to be exempt. History relates that Dean Swift died of this malady at the age of 70, after having suffered from symptoms for 3 years. In children, acute infective diseases, and especially gastro-intestinal infections, may occur as antecedents of hydrocephalus. In adults, syphilis stands in important relation in certain cases, some of which have been examined pathologically. In 3 of such cases there was evidence of old syphilitic disease of the brain, but no obstructive lesion by which ventricular distension could have arisen mechanically. A history of traumatism, such as a severe blow or fall upon the head, a short time prior to the onset of the symptoms, is obtained so frequently as to have led to the description by certain authors of traumatic hydrocephalus as a special variety. There seems to be little doubt that injury may be the immediate cause of the appearance of symptoms, and that it is not always merely coincidental.

The causes of secondary hydrocephalus are, first, the sclerosing forms of meningitis, especially posterior basic and epidemic meningitis, very rarely tubercular; secondly, intracranial neoplasms encroaching upon the ventricular system, especially tumours of the brain-stem and subtentorial region; thirdly, adhesive phlebitis of the cerebral blood-sinuses.

Pathology.—Hydrocephalus is immediately due to an excess of cerebro-spinal fluid present in the cavity of the central nervous system. Such accumulation may result from the over-production of cerebro-spinal fluid by the epithelial lining of the nervous canal, or from an obstruction of those paths by which the fluid leaves the ventricles to enter the arachnoid space, or of the channels by which the fluid returns to the blood stream. Our knowledge concerning the origin and fate of the cerebro-spinal fluid, and of the manner in which it circulates, is at the present time far from complete. It appears to be secreted by the ependymal lining of the nervous canal, especially by that portion overlying the choroid plexuses of the ventricles. In some cases of cerebral tumour, a part of the lateral ventricles may be completely cut off by the growth from the general ventricular cavities, gener-

ally the tip of either the anterior or posterior cornu; and in such circumstances the isolated portion of the ventricle does not necessarily become distended. This fact would suggest that the cerebro-spinal fluid is chiefly secreted in the region of the choroid plexus. There are three pairs of choroid plexuses, situated respectively in the floor of the lateral ventricles, hanging from the roof of the third ventricle, and in the roof of the fourth ventricle. Cerebro-spinal fluid secreted in these regions is supposed to leave the nervous canal and enter the arachnoid space by certain apertures where these spaces communicate. Such communications exist in the region of the anterior perforated spots, in the region of the posterior perforated spot, and, lastly, in the thin roof of the fourth ventricle. The latter are comparatively large apertures, and are three in number, one being situated dorsal to the opening of the central canal of the spinal cord (foramen of Majendie), and the other two are placed one over each lateral recess of the fourth ventricle (foramina of Luschka).

Entering the subdural space, the fluid is absorbed by the vessels of the Pacchionian bodies and by the vessels of the meninges generally.

There are certain strong arguments that much of the cerebro-spinal fluid is absorbed in the lower part of the theca spinalis. Further, it is the rule in human subjects, where blood has escaped into the subdural space of the cranium as the result of injury or operation, to find blood clots around the nerves of the cauda equina, when opportunity is afforded for examining such cases at an early period after the extravasation has occurred. A further argument in support of the stream of cerebro-spinal fluid from brain-case to theca is that in certain cases of cerebral tumour, as a result of general pressure, the cerebellum and medulla become pushed down and plug the foramen magnum. Distension of the ventricle and urgent symptoms immediately follow, while no cause for such distension, other than filling up the foramen magnum, is discernible.

The quantity of cerebro-spinal fluid present in the normal human subject is quite small, probably less than 6 ounces. It comes and goes as the volume of the central nervous organs expands and contracts under the influence of the blood-pressure and of the relative calibre of the cerebral vessels. In so doing, the intracranial pressure is kept almost constant. When the subdural space is opened, the amount of cerebro-spinal fluid which may escape in the course of 24 hours is great, amounting in some cases to several gallons. It is improbable that secretion takes place as rapidly in the intact subject, and it may be that the copious draining of the fluid, when the dura mater is opened, is simply the expression of the natural mechanism for raising the lowered intracranial pressure to the normal.

According to the results of the investigation of the central nervous organs, cases of hydrocephalus fall into two groups. In one, the ventricular distension is the result of a known antecedent morbid condition, either meningitis or some form of intracranial growth, and the mechanism of its production, in part at least, is the obliteration of the usual paths of flow of the cerebro-spinal fluid. In addition, strangling of the veins collecting blood from the choroid plexuses may cause congestion and consequent transudation. The second group comprises those cases in which the hydrocephalus is apparently idiopathic, the veins and the outlets of the cerebro-spinal fluid being free. There is always some departure from the normal to be found in the structure

of the ependymal lining of the ventricle, and sometimes the change is very marked. Meningitis is apt to be followed by hydrocephalus in proportion as recovery from the initial disease occurs, in proportion as cicatrisation follows the inflammatory process, and in proportion as the affection of the covering of the fourth ventricle tends to cause obliteration of the foramina of Magendie and Luschka; and, further, in proportion to the amount of ependymal cicatrisation that may result. When blocking of the posterior foramina occurs, the only path of exit for the cerebro-spinal fluid is by the fine canals in the perforated spots. These, when patent, appear to be inadequate to prevent a relative increase of intraventricular pressure, for they are frequently found so enlarged in cases of hydrocephalus as to admit a fine probe. More frequently, however, they too are easily sealed by the inflammatory process, and a gradually increasing general ventricular distension thus results.

Not infrequently the vascular supply of the large choroid plexuses of the lateral and third ventricles is interfered with by cicatrisation following inflammatory processes which, spreading between the cerebrum and cerebellum, have extended to that double fold of pia arachnoid which extends into the great transverse fissure of the brain and separates the lateral and third ventricles, the *velum interpositum*. This membrane carries the great choroid plexuses, those of the lateral ventricle upon its upper surface, and those for the third ventricle upon its under surface, and lying between its folds are the veins of Galen which convey the blood from these plexuses to the straight sinus. Cicatrisation of the velum interpositum of necessity hinders the blood flow in the veins of Galen, and there being no anastomosis with the superficial cerebral veins, the result is an increased production of fluid by the congested choroid plexuses. In the hydrocephalus following meningitis the phenomena above described often coexist. It will follow from the above statements, that hydrocephalus is not a sequel of the more acute and rapidly fatal forms of meningitis, but of the more chronic and indurated forms, when these affect the posterior fossa of the skull, namely, epidemic meningitis, posterior basic meningitis and syphilitic meningitis.

Tumours of the brain cause hydrocephalus in the majority of cases by simple mechanical obstruction of the channel of exit of the cerebro-spinal fluid. The growth is usually situated in the mid-brain or pons, and, either by pressure or actual involvement, occludes the Sylvian aqueduct. Less commonly, pressure upon the brain stem from a growth in the immediate neighbourhood may cause the same result—for example, a tumour of the fifth nerve pressing upon the pons. Tumours which are firm and those which grow rapidly are more liable to obstruct the aqueduct than those which are soft or which grow slowly. It may be remarked in this place that in the majority of cases of cerebral tumour of long standing some dilatation of the ventricles is found post mortem, yet the growth neither involves nor presses upon the aqueduct, but may be situated in the frontal or temporal lobe, or may even be extra-medullary and growing from the skull in the anterior fossa. The degree of distension is usually not great, and it involves all the ventricles. Sometimes, however, the distension is extreme and the outward manifestations of hydrocephalus are present.

The quantity of fluid which is found in the ventricles after death varies greatly, a usual quantity being from 15 to 20 ounces. In long-standing

cases with great cranial enlargement, very large quantities have been met with, and in one instance recorded by Esquirol as much as 720 ounces were found. The characters of the fluid do not differ greatly from those of normal cerebro-spinal fluid. Its density varies from 1008 to 1010. It is clear, colourless or slightly yellowish, and the reaction is alkaline. It contains a very small quantity of albumin and a comparatively large quantity of alkaline chlorides.

The dilatation of the lateral ventricles is always more extensive than that of the third ventricle, and is usually symmetrical upon the two sides, and it affects the body of the ventricle more than the cornua, so that the central cortex is the most thinned. Sometimes one lateral ventricle is much more dilated than the other, and one of the horns may present extensive enlargement while the others are less affected, no cause being apparent for this irregularity, such as occlusion of any of the interventricular passages. The foramina of Monro are greatly enlarged and the anterior pillars wasted. The anatomical limitations and markings which are normally seen upon the walls of the ventricles become less obvious and often unrecognisable.

The ependyma is sometimes thickened, generally shining, and the network of subependymal vessels stands out obviously. The choroid plexuses are hypertrophied and thickened in less acute cases, but they may be found small, flattened and bloodless in acute cases. The dilatation of the ventricles occurs chiefly at the expense of the white substance of the hemisphere, the cortex and central ganglia being less affected. The convolutions are flattened, and the sulci indistinct or unrecognisable, according to the degree of distension. The thickness of the cerebral substance is much reduced, and especially in the region of the central convolutions, where in severe cases it may measure a few centimetres only. The corpus callosum is greatly wasted. In advanced cases, the cerebral hemispheres have the appearance of a thin-walled sac, which collapses entirely when the contained fluid is allowed to escape. The aqueduct of Sylvius may be much dilated, and when this is the case, the fourth ventricle shares in the general ventricular distension, the cavum cerebelli being especially enlarged. In many cases, however, the aqueduct and the fourth ventricle are not markedly distended. In a few cases, the aqueduct has been found closed, as if by antecedent adhesive ependymitis. The posterior part of the cerebellum and the medulla are passed down as a plug into the foramen magnum, and there is constantly a well-marked constriction in the posterior inferior part of the cerebellum, caused by the pressure of the bony ring of the foramen magnum. The theca spinalis and its processes into the intervertebral foramina may be much distended.

The condition of the pial roof of the fourth ventricle is of great importance, considering the widely-held opinion that hydrocephalus is of obstructive origin. In congenital and in primary hydrocephalus there may be some thickening of the ependyma, both of the roof and of the floor of the fourth ventricle, but there is no blocking of the posterior foramina. Where hydrocephalus is secondary to the presence of intracranial tumour, the growth may be situated in any position, either above or below the tentorium, and is not necessarily in such a position as to cause direct obstruction to the flow of the cerebro-spinal fluid. Sometimes, the lateral ventricle may be completely divided by a growth, and then the isolated portion of the ventricles

is sometimes found distended, and sometimes empty. Tumours, which directly or indirectly block the foramen of Monro and the aqueduct of Sylvius, are almost invariably associated with hydrocephalus, and of these glioma of the pons is the most frequent.

When hydrocephalus is secondary to meningitis, there is usually much meningeal cicatrisation about the roof of the fourth ventricle at the anterior and posterior perforated spots, and about the edge of the tentorium, where the veins of Galen enter the straight sinus, and extend forwards along these veins in the velum interpositum. The ependyma is usually thickened and shows evidence of past ependymitis.

Symptoms.—The clinical manifestations of hydrocephalus fall into two groups, which result, respectively, from the effects of the abnormal intracranial pressure, first upon the brain-case, and secondly upon the nervous structures. In the congenital form, the enlargement of the head is the first noticeable feature; and this is true also of some cases of acquired hydrocephalus in young children. In most cases of acquired hydrocephalus, on the other hand, the nervous symptoms are first in evidence—namely, persistent headache, vomiting, mental impairment, convulsions and sometimes papilloedema. The evidence of cranial enlargement may succeed these symptoms, and the older the subject, and consequently the more resistant the cranial walls, the more severe are the nervous symptoms, and the later is the cranial enlargement in appearing. In some cases of congenital hydrocephalus, enlargement of the head takes place during intra-uterine life, and it may be so great as to make delivery impossible without destruction of the head. More frequently, the cranial enlargement, not noted at the time of birth, becomes evident during the first few weeks of life.

Enlargement of the head is the most striking feature of hydrocephalus in children. The increase usually affects all the diameters of the cranial cavity, and is most marked on the vertex and least at the base. Trousseau compared the opening out of the cranial bones, which occurs as the head enlarges, to falling back of the petals of an opening flower. The forehead is large, rounded, and projects forwards; the temporal fossæ are obliterated, and the parietal eminences carried backwards. The vertex is often somewhat flattened, as also may be the occipital region. The direction of the external auditory meatus alters with the increasing size of the head; normally directed obliquely forwards, it comes to look directly inwards, or even obliquely backwards in severe cases. The head is frequently asymmetrical. In young children the sutures may be widely open, and then there is marked bulging along those lines and at the fontanelles. The skull may attain enormous dimensions, and many examples are recorded in which the circumference has been from 60 to 90 cm. The face is characteristically triangular, contrasting markedly with the forehead. Wasting of the facial subcutaneous tissues and retarded development of the maxilla and mandible often render this contrast still more striking. Bulging of the orbital plates of the frontal bone presses down the eyeballs, so that the pupils become more or less covered by the lower lids, and a band of the sclerotic may be visible between the iris and the upper lid. The hydrocephalic child often uses his hands to depress the cheeks, and so draw down the lower lids out of the position in which they impair the line of vision. The hair of the head becomes scanty, the subcutaneous veins of the scalp are often greatly developed and distended,

and sometimes a vortex of distended veins radiates from the region of the anterior fontanelle. The general nutrition is poor, and bodily development retarded, in proportion to the severity of the effect of the intracranial pressure upon the nervous system. Auscultation may reveal a cephalic bruit, but this is neither a characteristic nor a constant sign in hydrocephalus, for it is frequently met with in rickety children, and may be present in a normal subject.

The nervous disorders which appear during the course of hydrocephalus are both variable and inconstant, and acute symptoms are of rare occurrence, if the disease appears at an age at which the skull is still yielding. On the other hand, if the ventricular distension commences when the growth and ossification of the skull are complete, the nervous symptoms which arise are very severe, and resemble closely the general effects of intracranial growths. In secondary hydrocephalus, the symptoms due to this condition emerge from those of the preceding meningitis or sinus thrombosis, or are blended with those of the coexisting intracranial growth.

In children, the nervous symptoms of hydrocephalus, whether it be congenital or acquired, may be summed up in the following list, the symptoms being frequent in the order in which they are enumerated: convulsion, mental failure, spastic paralysis of the limbs, headache, optic atrophy, nystagmus, vomiting, papilloedema. There is no constancy in the occurrence of these symptoms. Convulsion may not occur at all, and mental acuity may be unimpaired. Spastic weakness occurs in less than one-half of the cases, whilst optic atrophy is met with still more rarely, and papilloedema is distinctly unusual.

Convulsion.—While it is to be borne in mind that the whole course of hydrocephalus in children may run without the occurrence of convulsion, yet in the majority of cases this symptom is conspicuous. In some of the post-natal cases the symptoms of cerebral disorder are ushered in by convulsion, and it is probable that such convulsions are the immediate expressions of the morbid process, of which the primary hydrocephalus is the final result. The convulsions which recur at intervals throughout the course of the majority of cases of hydrocephalus result from a condition of functional instability of the cerebral cortex, which long-continued increased intracranial pressure brings about. The convulsions are usually general, with loss of consciousness. A preceding aura is rare. Local commencement of the spasm, which becomes general, associated with loss of consciousness, is not infrequently observed. Local convulsion without loss of consciousness (Jacksonian epilepsy) may occur repeatedly in some cases, and may lead to the erroneous diagnosis of a gross local lesion in the cerebral cortex, and especially is this error likely to occur when hydrocephalus is secondary to intracranial tumour.

The explanation of the occurrence of such local convulsion is that the effect of the pressure is not equally distributed upon the cortex,—the central region tends to suffer earlier and in greater degree than do other regions,—and that some *locus minoris resistentiæ* loses its functional stability earlier and in greater degree than does the rest of the cortex. All degrees of mental reduction occur, from the least noticeable to complete idiocy. The more severe forms of mental impairment are met with in congenital cases, and especially when cerebral agenesia, porencephaly and teratological defects are associated. The psychical reduction is less prominent the greater the age

at which the symptoms commence, and, as a rule, the intelligence is far greater than the severity of symptoms (cranial enlargement, paresis, etc.) might lead one to expect. Cerebration is usually slow and the disposition placid, and periods of somnolence are of common occurrence.

The effect of long-continued ventricular distension in many cases is to cause degeneration of the pyramidal system, and, according to its degree, the latter entails bilateral spastic paralysis with contracture. The first signs of the onset of this event are exaggeration of the deep reflexes, and the change in type of the plantar reflexes from the flexor to the extensor response. The lower extremities are affected earlier and to a greater extent than are the upper, and at one period of the disease a case may present the picture of cerebral paraplegic rigidity comparable with that of Little's disease. The upper extremities are affected later. The paresis of the limbs is almost always symmetrical and equal upon the two sides. Sensibility is generally normal.

Vision is interfered with in a considerable proportion of the cases. The enlargement of the infundibular portion of the third ventricle, by pressure upon the inner borders of the converging optic tracts, may cause bitemporal hemianopia with atrophy of the nasal portions of both optic disks, this condition subsequently progressing to complete blindness and complete optic atrophy. More often the increased intracranial pressure causes atrophy of the optic tracts and secondary atrophy of the optic disks.

In other cases, optic atrophy is the result of papilloedema. In late childhood and in adult life papilloedema is the rule, and optic atrophy seems always to be consecutive to this. Strabismus is commonly present in congenital cases, and it is most frequently convergent. Nystagmus is met with in the subjects of hydrocephalus who are blind from optic atrophy, and it is of frequent occurrence in long-standing cases in which spastic paresis is well-marked. In the latter case, it is probably a spastic ocular manifestation indicative of the degeneration of the cortical motor neurons subserving eye movements, and it is a feature of the same order as is spastic paresis in the limbs and trunk.

Headache is often complained of, and especially during the early days of illness in acquired cases, but this symptom never dominates the clinical picture in children, and is never so severe and persistent as that arising from the presence of an intracranial growth. Cerebral vomiting is of comparatively rare occurrence.

When one considers the profound anatomical alterations which take place in the advanced stages of the disease, the occurrence in some cases of unusual symptoms indicative of interference with the functions of the cerebellum, brain stem and cranial nerves is easily explicable. Unilateral or bilateral ataxy, vertigo, deafness, anosmia and paralysis of cranial nerves, are the most important of such unusual symptoms.

The signs of failure of the nervous system as a whole usher in the fatal result in severe cases. For some days or perhaps weeks before death, hebetude may become profound; spastic paresis gives place to flaccid paralysis with muscular wasting, the deep reflexes disappear, and the sphincter mechanism loses its control and subsequently its tone.

Hydrocephalus which commences in late childhood or in adult life presents an aspect widely different from that just described. At these periods of life,

the bones of the skull are firm and resistant, and the sutures resist for a long time before yielding to the increased intracranial pressure. The general symptoms are acute, and the course of the disease is often rapid to a fatal termination. There is usually no enlargement of the head to aid the diagnosis, and the symptoms—headache, vomiting and papilloedema—resemble those of a non-localisable intracranial growth.

The headache is severe and usually paroxysmal, and it may be so intense as to cause sudden death, while, not infrequently, the sufferer loses all control during the paroxysms. Speaking generally, the headache is of much greater severity in adult hydrocephalus than in intracranial growth. Similarly, vomiting is apt to be more severe and persistent than that associated with cerebral growth. In many of the cases, a fatal result occurs before enlargement of the head, and before cerebral degeneration has produced further signs of spastic paresis than an increase of the deep reflexes, foot clonus and the change of the plantar reflexes to the extensor type. General convulsions and attacks of coma are not rare.

Diagnosis.—Where enlargement of the head is manifest the diagnosis of the disease presents no difficulties. The large head of rickets is easily distinguishable from hydrocephalus by its different conformation, by the association of the other signs of rickets, by the absence of nervous symptoms, by its non-progressive nature, and by the results of anti-rachitic treatment. The distinction between the primary and the secondary forms of hydrocephalus in children should present no difficulty, if a correct history of the early symptoms can be obtained. The initial manifestations in the primary form are slight, and cannot be confused with those of meningitis or of sinus thrombosis. Intracranial growths which cause early and marked hydrocephalus are situated in some part of the brain-stem from the third ventricle to the medulla, and growth in such a position must of necessity produce such early pathognomonic localising signs as to leave no excuse for erroneous diagnosis, save imperfect observation.

The advent of ventricular distension in the course of intracranial growth is generally to be detected by the occurrence of widely spread bilateral signs such as bilateral spasticity, bilateral ataxy, general convulsion, and enlargement of the head. In the primary hydrocephalus of childhood, the disease is not distinguishable until the head begins to enlarge.

In adults the absence of cranial enlargement in most of the cases makes it impossible to separate the malady with certainty from intracranial growth. It must be borne in mind, however, that headache, vomiting and papilloedema of rapid progress are not necessarily signs of intracranial growth, but may be the symptoms of primary hydrocephalus.

Prognosis.—This depends upon the cause of the hydrocephalus, upon the degree of severity of the symptoms, and upon whether it is progressive or not. In all severe and progressive cases the prognosis is hopeless, and the same is true of hydrocephalus secondary to inoperable neoplasm. In some of the slighter cases, both of the congenital and of the acquired form, the process becomes arrested, and the patient may attain to adult life with the possession of all his faculties. In cases in which the disease becomes stationary, the prognosis as regards mental capacity and the continuance of recurring convulsion has to be considered. If the mental capacity at the time of arrest is fair, it is not likely to deteriorate further, unless epilepsy is

established. When mental reduction is marked at the time of arrest, a great degree of improvement cannot be reasonably expected.

Treatment.—While some cases of hydrocephalus cease to progress, and the symptoms disappear permanently under medical treatment, a like result has occurred in cases in which no treatment has been applied.

The importance of syphilis in the ætiology of hydrocephalus suggests the employment of anti-syphilitic treatment, and it is certain that the application of mercurial ointment to the head seems to do more good than any other measure, while the administration of iodide of potassium in full doses seems to benefit a few cases. The beneficial effect of the administration of mercury occurs not only in the syphilitic cases, but in all.

The results of surgical interference for the relief of pressure and to attempt the re-establishment of a way out for the cerebro-spinal fluid have been, up to the present, so unfavourable, that many writers and authorities consider such measures unjustifiable. It must be borne in mind, however, that in severe and progressive cases one is dealing with a necessarily fatal malady, and a few encouraging results have been published, which appear to justify further investigation. Paracentesis of the ventricle is both useless and dangerous, for when relief follows the operation it is only temporary, and where cerebral tension is very high an immediately fatal result may supervene. Repeated lumbar puncture is advisable in the earlier days; but this is only possible in cases in which the theca is in free communication with the ventricular space.

Various operations have been performed for the purpose of re-establishing communication between the ventricular and the sub-arachnoid space. The fourth ventricle has been drained and occlusion in its roof rendered patent, the trephine opening being made through the occipital bone; this operation has not been attended with successful results. An aperture has been made in the corpus callosum via the anterior fontanelle, with the object of establishing permanent communication between the lateral ventricle and the sub-arachnoid space. None of the many operative procedures which have been attempted for the relief of this malady have given particularly brilliant or uniform results, although there may have been occasional recoveries, even in advanced cases.

ENCEPHALITIS

Acute Encephalitis

Acute inflammation of the brain occurs under widely different clinical associations. It may occur as a primary disease or as a complication of known infective processes, affecting the system locally, generally, or as an associated event in diseases of the meninges. As a primary condition it is met with in the form of the Heine-Medin disease or poliomyelitis, and as lethargic encephalitis. It is the constant result of trauma to the skull, if this be sufficiently severe. It is found as the result of infection of the brain with pyogenic organisms, either from local sources in the neighbourhood of the brain (septic bone disease), or from pyæmia, and may be then either suppurative (brain abscess) or non-suppurative. Infections by many of the specific fevers may cause it, and especially measles and scarlet fever.

Acute encephalitis may occur in rare cases as the sole manifestation of cerebral syphilis. In all forms of meningitis there is some degree of extension of the inflammation into the brain tissue, and this assumes an important degree in tuberculous meningitis, and sometimes in epidemic meningitis. The symptoms common to all forms of encephalitis are the general symptoms of severe intracranial disease—headache, somnolence, coma, irritability, convulsions, delirium and vomiting; and, in addition, local symptoms of irritation and paralysis, which are determined by the position and extent of the lesions.

Traumatic Encephalitis

As the result of a local blow upon the head or from the general concussion of sand-bagging or bursting of high explosives, the "commotio cerebralis" causes tissue disruption or bruising, which is immediately followed by hæmorrhage both on the surface and in the substances of the brain tissue, by œdema with much swelling, and by a general inflammatory reaction, which may go on to suppuration if a punctured wound or other event allows of the access of micro-organisms. The hæmorrhage and œdema, and particularly the œdema, are the causes, on the one hand, of the deepening local symptoms which are often observed after injuries to the head, and on the other hand, of the increasing general signs of cerebral loss of function, such as increasing coma and failure of respiration. The local raising of tissue tension in the region of the local injury tends to evascularise the region of the lesion, and increase the permanency of the damage. The general raising of the intracranial pressure results from the swelling and hæmorrhage. The important indications to which these considerations point, are that the chief danger of death and an important cause of persistence of local symptoms is a raised intracranial pressure, and that in every case where local or general symptoms are severe and increasing, craniectomy should be performed for its relief. This is the more important because, in such cases, the presence of hæmorrhage gradually accumulating between the dura and the bone from rupture of a meningeal vessel can never be excluded, and because intracerebral and meningeal hæmorrhages can be drained, or the resulting clot removed. The lumbar puncture in these cases shows a bloodstained fluid. It is remarkable how little "commotio cerebralis" may result from the passage of a high velocity bullet through the brain and skull.

Suppurative Encephalitis (Intracranial Abscess)

Ætiology.—Suppuration within the brain substance is never primary, but the result of extension of infection from neighbouring tissues or by the blood stream from foci of infection in distant organs. In rare cases, the focus of original infection is undiscoverable.

The following are the important causal factors:

1. *Trauma.*—In the case of penetrating wounds the missile may be the source of the infection. Lacerated wound with fracture may allow of infection from the surface or from the middle ear, nose or pharynx. In these cases, meningitis often occurs in addition to abscess. Though not traumatic in a strict sense, any local lesion of the brain may become a locus resistentiæ minoris for the settling down of suppurative organisms derived

from the blood stream, and in this way abscess has followed upon vascular lesions and the lesions of primary encephalitis.

2. *Extension from infected regions* in the immediate vicinity. The important cause of infection is any form of infective disease in the bones or soft tissues of the skull, calvarium and surrounding regions. Caries of the petrous bone from middle ear disease is the most common cause, while septic conditions of the nasal cavities and their accessory sinuses, or of any of the bones of the skull, suppuration of the scalp, orbital cellulitis and carbuncle of the neck are other causes. The exact manner of advent of the infection into the brain substance may differ in different cases. It may be by a septic thrombosis of a vein communicating between the infected region and the brain, or by extension along lymphatics similarly communicating, or by direct extension, as when the temporal lobe becomes adherent to the tegmen tympani, or it may be trans-meningeal by the direct transference of organisms across the meningeal space, without general meningitis occurring. That this latter mode of infection is a common one is suggested by the facts, that when the primary disease affects the upper surface of the petrous bone, the abscess is in the temporal lobe, and when the posterior aspect of the temporal bone is affected the abscess is in the cerebellum; and, most importantly, in all these cases of abscess from extension, the cerebrospinal fluid shows the presence of polymorphonuclear leucocytes, thus showing that the meninges have been infected, although no symptoms of meningitis arise.

3. *Pyæmic states.*—Abscess of the brain does not often occur in symptomatic pyæmia. It may occur in infective endocarditis, and then multiple abscesses may be found. Sometimes in this condition multiple small spots of encephalitis, containing many polymorphonuclear cells but not definite abscesses, are met with. Much more commonly, abscess results from a single septic embolus from chronic pulmonary infection, such as bronchiectasis, empyema and lung abscess. In rare cases metastatic abscess may arise from bone disease, liver abscess and in the course of specific fevers. The microorganisms responsible for the infection are usually streptococcus, pneumococcus and staphylococcus, and often the infection is mixed. *B. coli* is sometimes found, and in rare cases streptothrix and oidium albicans.

Pathology.—The abscesses which result from local disease of the skull bones and surrounding tissues may be extradural, subdural or encephalic: in the first two cases they are invariably situated in the immediate vicinity of the antecedent seat of infection. The extradural abscess may reach a very considerable size and may burst externally, or into the meninges or into a blood sinus. The subdural abscess is confined in meningeal adhesions between the dura mater and pia mater. The contiguous surface of the brain is generally softened and has often disappeared, the abscess cavity extending deeply into the brain substance. This variety rarely has any capsule on the cerebral side. Encephalic abscess commences generally in the subsulcine white matter of the temporal lobe, and lateral lobe of the cerebellum. In one-half of all cases the abscess is in the temporal lobe, and in one-third in the lateral lobe of the cerebellum. The remainder are divided between the parietal lobe, the pons Varolii and the frontal lobe, in order of diminishing frequency. The size of the abscess varies up to that of a hen's egg. A recently formed abscess is irregular in shape with ill-defined limits, but in

about 7 days it shows a definite capsule which may rapidly become of considerable thickness. The interior of the abscess cavity is usually of a greyish-green colour, and the pus is greenish and often fœtid. The surrounding brain tissue is always œdematous and often softened. Rupture occurs in about one-sixth of all cases that are not afforded operative interference, and the rupture takes place most commonly into the ventricle and less frequently into the arachnoid space.

Symptoms.—An encephalic abscess has its origin in inflammation, and constitutes, when developed, a foreign body within the skull. Death may result from the effects of continually increasing intracranial pressure and wide interference with cerebral function, or from spread of the infection from the abscess. The symptoms may be grouped in four classes—(1) those of local suppuration; (2) those due to increased intracranial pressure; (3) localising signs dependent upon the position of the abscess; and (4) those of terminal extension of the infective process.

In extradural and subdural cases, the symptoms are generally acute and the course is rapid; the signs of pressure are severe, whilst localising signs are rare and a state of latency is not observed. In the majority of encephalic abscesses, on the contrary, the signs of initial suppuration are slight and are apt to be swamped by the symptoms of the preceding disease, otitis media, empyema, infective endocarditis, etc., and for this reason may be easily overlooked. A latent period in which symptoms are insignificant or completely absent may follow, and last for weeks or months. In the end, the latent period is broken, either by an acute outburst of symptoms, the result of extending infection, or the signs of progressive intracranial tumour arise.

The general symptoms which are likely to appear when a brain abscess is developing or emerging from a latent condition are pyrexia, which may be associated with rigor, headache, vomiting, irritability, vertigo, drowsiness deepening into coma, slowing of the pulse, respiratory and cardiac irregularity, convulsions rarely, and papillœdema as a late sign. In addition, there is a leucocytosis of the polymorphonuclear variety in the blood, and a small number of polymorphonuclear leucocytes in the cerebro-spinal fluid in those cases arising by extension from disease of the cranial bones, but not in metastatic abscesses. The general symptoms vary much in their intensity and in the individual incidence of each of them, and in metastatic abscesses they may be almost absent, the local signs alone giving the indication that a cerebral lesion is present. Headache is rarely absent, and may be intense with spreading abscess. Vomiting is also an almost constant sign. Drowsiness is one of the most valuable of all the indications when any cause for the occurrence of cerebral abscess is present. Slowing of the pulse is also an important indication of a rising intracranial pressure. Papillœdema occurs late, and is often not present in acute abscesses at the time when diagnosis is all-important from a surgical point of view. It rarely occurs until an abscess has been present for a week, and is generally of low grade. With half-latent chronic abscesses, and with metastatic abscesses which attain a large size, it may be intense.

Local signs.—Generally speaking, the more recent and acute the abscess is the less definite are the local signs. In more chronic abscess, and in metastatic abscess, the local signs are usually more distinct. When there is a

local cause for the abscess this constitutes an important localising sign, since abscess forms almost always in the immediate vicinity of site of infection. Thus rhinogenic abscesses are situated in the frontal region, and otitic abscesses are almost invariably situated either in the temporal lobe or in the lateral lobe of the cerebellum of the same side as the ear disease.

Metastatic brain abscesses may be situated anywhere, but they are more common in the region of distribution of the Sylvian artery, and in my experience have been more common in the posterior part of this supply—that is, in the parietal and occipital lobes. Metastatic abscess is sometimes preceded by definite indications of the embolism which gives rise to the abscess, such as local convulsion, local transient weakness or loss of consciousness, and such an event may precede the signs of abscess by many weeks. The local signs of lesion in the various regions of the brain are described in the section under that heading. Local diagnosis is often difficult owing to the condition of somnolence preventing the possibility of accurate examination. In these circumstances such slight signs as the absence of the abdominal reflex on one side, the presence of an extensor response in the plantar reflex of one side, or any aphasic signs, are important indications of temporal lesions, and unilateral hypotonia and nystagmus and attitudes of cerebellar lesions. The initial signs and symptoms of encephalic abscess may lessen and disappear, and the abscess is said to become latent. The latency may be complete, or it may be broken by occasional headaches and transitory symptoms indicative of intracranial mischief. Much more commonly the abscess grows, and death occurs invariably in the absence of surgical interference, either from increasing intracranial pressure or from the rupture of the abscess, either into the ventricle, or on to the surface, with the production of general meningitis.

Diagnosis.—In those cases where there is no local cause for the formation of an intracranial abscess by direct extension, and no distant cause known or discoverable for the formation of a metastatic abscess, diagnosis is difficult, and the distinction of an abscess from a tumour can hardly be made with certainty. The presence of pyrexia and of a polymorphonuclear leucocytosis in the blood may suggest the diagnosis in some cases. Where however the common antecedent causes of abscess exist in the form of ear disease, etc., or suppurative chronic lung disease, the diagnosis is relatively simple. For example, the advent of local or general intracranial signs in a case of chronic bronchiectasis from the first leaves no alternative diagnosis. When ear disease or local septic conditions of the region of the skull are present, local and general intracranial signs are due either to meningitis, abscess, sinus thrombosis, osteomyelitis of the base of the skull, or rarely to acute otitis.

Meningitis can be at once distinguished not only on account of the more irritative and rapidly oncoming symptoms, which differ somewhat from those of abscess, such as head retraction and rigidity of the neck, Kernig's sign, delirium and tremors, but by the lumbar puncture which gives the turbid cerebro-spinal fluid, containing polymorphonuclear cells and organisms in quantity. It must not be lost sight of that an abscess at any stage of its formation may be complicated by the development of general suppurative meningitis. Sinus thrombosis is usually accompanied by much oscillation of temperature, and by repeated rigors and œdema, and tenderness in the

region of the emissary veins of the blocked sinus may be present. The diagnosis of the latter condition is not of vital importance, and its consideration should cause no delay in summoning the aid of the surgeon. The presence of any symptoms of intracranial disturbance, where tympanic septic disease exists, calls for immediate surgical interference, and the surgeon, after cleaning out the diseased tympanum, completes the diagnosis by examining the lateral sinus, both the temporal lobes and the lateral cerebellar hemisphere, and proceeds to those measures which the results of his exploration indicate. Acute otitis media may give rise to severe intracranial symptoms like those of meningitis, convulsions even occurring which may subside dramatically after perforation of the tympanic membrane, but it must be remembered that the chronic and not the acute forms of otitis give rise to septic extension to the brain. Osteomyelitis of the base of the skull extends from chronic bone disease in the region of the ear or nose. There is much pain in the base of the skull, and sometimes many cranial nerves are implicated at their foramina of exit. Skiagraphy will indicate the loss of bony structure. The malady is a chronic one, and usually ends in a terminal meningitis.

Prognosis.—Cerebral abscesses with very thick walls and inspissated or even calcified contents have been found post mortem, many years after the presumed time of formation of the abscess. Spontaneous evacuation of an abscess through the diseased ear, or through a sinus in the area of the local disease causing the abscess, has been followed by recovery. It is probable that no abscess becomes permanently quiescent after it has given rise to severe symptoms. The prognosis in cases of cerebral abscess, therefore, is that a fatal result will occur, unless successful surgical interference is possible. If the abscess is reached and drained, recovery often occurs rapidly, but this is never certain, for extensive perifocal softening, meningitis and sinus thrombosis may occur. Moreover, a general suppurative encephalitis may extend, in spite of draining the abscess.

Treatment.—The most rigorous prophylaxis should be employed that all patients suffering from septic nasal and ear diseases, and infective disease of the scalp and cranial bones, shall not pass out of observation until such disease is beyond all doubt cured. The only treatment for developed abscess is exploration and drainage. The liability to the occurrence of septic meningitis may perhaps be lessened by the administration of hexamine. The usual measures for the relief of pain should be employed.

ACUTE POLIOMYELITIS (see p. 134)

LETHARGIC ENCEPHALITIS (see p. 145)

MENINGITIS

EXAMINATION OF CEREBRO-SPINAL FLUID

In the last years of the nineteenth century, Quincke brought into prominence the examination of the cerebro-spinal fluid withdrawn by lumbar puncture as a means of diagnosis of diseases of the nervous system, and so great has the value of this examination proved, that it is now a routine

method of investigation in almost every variety of nervous disease. The cerebro-spinal fluid is the secretion of the meninges, and in almost every condition of pathological changes in the meninges or of the sublying tissue, or of the meningeal vessels, important information is to be gained from the examination of this fluid. A fitting introduction therefore to a consideration of diseases of the meninges is a description of the normal secretion of those membranes, of the changes which occur in pathological states and their significance, and of the method of examination and of withdrawal of the fluid.

The normal cerebro-spinal fluid is a clear colourless fluid which shows not the least trace of clot or flocculence on standing. It contains a minute trace of albumin which becomes no longer recognisable to the nitric-acid test, at dilutions of from 1 to 6, to 1 to 20. It also contains a trace of globulin, which disappears to the ammonium-sulphate test at dilution of 1 to 2. The normal glucose content is rather less than 0·1 per cent. There are normally a few lymphocytes not exceeding 6 per cubic millimetre. The lumbar puncture is made in the first interspinous space above a line joining the highest points of the iliac crests, which is the space between the third and fourth lumbar spines, or it may be made with equal rectitude in the space between the second and third lumbar spines. The needle should be introduced exactly in the middle line and at right angles to the surface, close to the upper spinous process of the interval used. Normally the fluid escapes drop by drop. If it runs rapidly or spurts out, this is an index of the increase of the cerebro-spinal pressure. Such an increase is met with in all meningeal inflammation, congestion and hæmorrhage, and in increased intracranial pressure.

Increase in Protein Content.—This is of high importance, and occurs in all conditions of meningitis, and especially when the thecal space is obstructed by tumour, pressure from without, or meningeal adhesions. Normally the protein content is from 0·01 to 0·02 per cent. In pathological conditions it may reach 0·8 per cent. or more. A high protein content sometimes associated with xanthochromia, in the absence of cellular elements, is highly characteristic of thecal obstruction and is known as "Froin's syndrome." Lethargic encephalitis does not give any increase of protein.

All forms of polyneuritis (diphtherial excepted) are often accompanied by an increase of protein content.

Xanthochromia is a yellow colour of the cerebro-spinal fluid, and it is met with when the spinal canal is obstructed by tumours of the cord or meninges, or by external pressure. Occasionally the yellow colour may result from an old extravasation of blood either into the arachnoid or into the central nervous system bordering upon the arachnoid, and is then due to hæmatoidin.

Spontaneous coagulation of the fluid is met with in some cases of meningitis, when there is spinal obstruction, and in polyneuritis of any nature, except in diphtherial neuritis.

Blood may occur from the pricking of a small vessel in the lumbar puncture, and it renders the fluid useless for cytological examination. This bleeding usually ceases after a few cubic centimetres of the fluid have been withdrawn, and it is easily distinguishable by centrifugalisation from blood admixture due to pathological conditions, for in the latter case the supernatant fluid

after centrifugalisation is tinged yellow from hæmolysis. Blood may occur from every condition of hæmorrhage, injury and encephalitis, and sometimes in meningitis. Blood that has been long shed into the cerebro-spinal fluid tends to become brownish and later yellowish. The red blood corpuscles are soon disintegrated in the fluid, but the white corpuscles persist. The leucocytosis thus resulting in the fluid can be at once distinguished from leucocytosis due to meningitis, etc., since the differential count is the same as that in the blood. Leucocytosis is indicative of meningitis and often occurs in encephalitis. A lymphocytosis is characteristic of tuberculous and syphilitic meningitis, poliomyelitis, lethargic encephalitis, sinus thrombosis and mumps. A polymorphonuclear cytosis occurs in meningococcal meningitis and all the suppurative forms of meningitis. In tuberculous meningitis there is often a mixed cytosis at first, in which the polymorphonuclear cells may form 60 per cent. of the total. In poliomyelitis, the lymphocytosis disappears after the end of a week. In lethargic encephalitis there is frequently no lymphocytosis.

Pus may be present in quantities in all the septic forms of meningitis, and especially in pneumococcal and epidemic meningitis. A turbid fluid is often met with in tuberculous and septic meningitis.

Decrease in Glucose Content.—All conditions of meningitis cause decrease in the glucose, for this disappears from an autolysis controlled by the leucocytic ferments and is converted into lactic acid.

Lange's Colloidal Gold Reaction.—Increasing dilutions of the cerebro-spinal fluid when mixed with colloidal gold and allowed to stand for twenty-four hours, exhibit varying colours according to the nature of the protein exudate, and this forms a test which is valuable in the diagnosis of syphilis and of disseminate sclerosis.

The nature of the organismal content is determined (1) by the direct examination of films made from the centrifugalised fluid, (2) by cultures from the fluid, and (3) by the inoculation of animals from the fluid.

The Wassermann reaction in the fluid is positive in all conditions of recent syphilitic disease impinging upon the meninges, and always in general paralysis. Though often positive in tabes, it may be found negative. Lumbar puncture is dangerous in cases of long standing increased intracranial pressure, and if performed in such cases a minimum of fluid should be withdrawn. It may in some cases cause severe headache of long duration. It may be difficult or impossible to perform when there is bone disease of the lumbar vertebræ.

Definitions.—Inflammatory conditions affecting the membranes which cover the brain and spinal cord and which line the cerebral ventricles, may have their seat primarily in the dura mater (pachymeningitis), or in the pia arachnoid (leptomeningitis), or in the ependymal lining of the ventricles (ependymitis).

Ætiology.—Pachymeningitis is usually a local condition, and is often due to disease spreading into the dura from the contiguous bone. Leptomeningitis and ependymitis, from the facility with which microbic infection is spread in the cerebro-spinal space by the flow of the cerebro-spinal fluid, are not localised and the two conditions are often associated. The close relationship between the nervous tissue and its covering and lining membranes necessitate that leptomeningitis and ependymitis entail some degree

of encephalitis or myelitis by the extension of the inflammatory process into the sublying nervous tissue. With the exception of traumatic meningitis and possibly of serous meningitis, the various forms of meningitis are due to the infection of the cerebro-spinal space and its membranes by micro-organisms. This infection may arise secondarily to some well-marked infective lesion elsewhere within the body, or it may develop primarily.

CLASSIFICATION.—The most useful classification of the varieties of meningitis is according to the nature of the micro-organism producing the inflammation.

NAME.	ORGANISM.	CEREBRO-SPINAL FLUID.
Tuberculous meningitis	Tubercle bacillus.	Clear or turbid. Lymphocytes, either alone or in greater numbers than polymorphs. Tubercle bacilli.
Pneumococcal meningitis	Pneumococcus.	Turbid. Polymorpho-nuclear leucocytes. Pneumococci.
Meningococcal meningitis.		
Sporadic or posterior-basal.	Still's diplococcus.	Clear or turbid. Polymorpho-nuclear leucocytes.
Epidemic or "Spotted Fever."	Weichselbaum's diplococcus.	Intracellular diplococci.
Pyogenic meningitis	Staphylococcus. Streptococcus. *B. influenzæ*. Gonococcus. Streptothrix.	Turbid. Polymorpho-nuclear leucocytes. Organisms.
Syphilitic meningitis	*Spirochæta pallida*.	Clear. Lymphocytes only. Wassermann reaction. +.
Other forms	*B. typhosus*. *B. enteritidis*.	Turbid. Polymorphs.
Rheumatic meningitis	*Diplococcus rheumaticus*.	
Serous meningitis		Clear. Few cells. Sterile.
Traumatic meningitis.		

TUBERCULOUS MENINGITIS

This disease results from the general invasion of the cerebro-spinal lepto-meninges by the tubercle bacillus, and this organism invariably arrives in the meninges by the blood stream from some previously existing focus of tuberculous infection within the system, and most commonly from caseous glands and tuberculous bone disease. Occurring at all ages, it is the form by far the most frequently met with in the second and third years of life. The characteristic features of the cerebro-spinal fluid are, that it is usually under considerable pressure, it is clear or only slightly turbid, has no visible deposit before centrifugalisation, but it often forms a fine flocculent clot. It contains an excess of albumin. The normal sugar is generally absent. There is a pleocytosis with a high proportion of lymphocytes, 70 to 80 per cent. being of this nature, and the rest being polymorpho-nuclear. Careful examination will almost always reveal the presence of the tubercle bacillus.

Ætiology.—The inheritance of a lowered resistance to the invasion of the tubercle bacillus is an important factor, especially when such a tendency

exists in both parents. The sexes are equally affected. Tuberculous meningitis is rare during the first year of life, and especially during the first 6 months of life, when posterior basal meningitis is most common. Its greatest incidence is during the second and third years. It is common throughout childhood and early adult life, after which it becomes increasingly rare. The primary focus from which the organisms are spread to the meninges is most commonly a tuberculous mesenteric or bronchial gland.

Sometimes the source of infection is tuberculous disease of the lungs, of the abdomen, of the ear, of the joints, or of bone. Operations upon the sites of tuberculous disease may directly cause the dissemination of the tubercle bacilli, and especially surgical procedures upon tuberculous intracranial tumours, upon spinal caries, and upon tuberculous disease of bones and joints. The acute specific fevers, and especially measles, are sometimes the exciting causes of the disease. Injury to the head sometimes determines the attack.

Pathology.—In tuberculous meningitis three kinds of lesions of the meninges may be met with—(1) grey tubercles unassociated with inflammatory deposit; (2) tuberculous meningitis characterised by the presence of tuberculous granulations associated with a fibrinous and purulent exudation—the superficial tissue of the nervous system underlying the meninges is in this case always involved; (3) tuberculous tumours of any size up to that of a pigeon's egg. It is not uncommon to find such a tumour to be the focus of widely spread meningitis. The three kinds of lesions may coexist in the same case.

The flattening of the convolutions and the dry sticky feel of the surface of the brain are highly characteristic. The disease affects the pia-arachnoid and its processes, the small vessels entering the surface of the brain and the superficial tissues of the latter. Occasionally a few tubercles are found upon the inner surface of the dura mater. Generally the convexity of the brain escapes, or is little affected. In the intercrural space, around the optic chiasma, covering the tips of the temporal lobes, along the commencement of the Sylvian fissures and around the brain stem, there is an inflammatory exudation of tough consistency and of a pale yellowish-green colour. Spreading from the edge of this in decreasing numbers, grey tubercles are seen in the pia-arachnoid, particularly along the Sylvian fissures. If the fibrino-purulent exudation be examined by scraping where it is not too dense, or by opening up the Sylvian fissures which it firmly closes, it will be found to consist of grey and white tubercles which have become partly confluent, covered with a fibrino-purulent membrane. So firmly does this exudation cling to the brain tissue, that some of the latter comes away in the attempt to remove the affected pia-arachnoid. Miliary tubercles will almost invariably be found on the tentorial aspect of the cerebellum, and on the ependyma of the lateral ventricles. They may be found wherever the pia-arachnoid extends (the convexity, as a rule, excepted), but except at the base of the brain they are not, as a rule, accompanied by the characteristic tough exudation.

The brain as a whole is soft, and local softening of the walls of the ventricles, of the velum interpositum, and of the fornix is often present. This softening is caused by spreading of the tuberculous process from the pia-arachnoid to the small vessels of the surface of the brain, on the walls of which tubercles develop, sometimes in such numbers that a small entering vessel, when observed under low magnification, after the brain tissue has been removed

by careful washing, may resemble a bunch of grapes, each grape being a tuberculous nodule. Thrombosis is a common event in the vessels so involved, and softening follows. Some degree of thrombosis in the superior longitudinal sinus and in the veins of Galen is commonly present. It is probably owing to the softening of the nervous tissues that occlusion of the foramina by which the cerebro-spinal fluid leaves the ventricles does not often take place, and that, therefore, a condition of hydrocephalus does not occur in this form of meningitis. The cranial nerve palsies which are so frequently met with in this disease are the result of implication by adhesions and local interference with the blood supply of the nerves at the base of the brain, by the newly formed adhesive tissue. In the majority of cases the membranes of the spinal cord are affected, and the most common situation of the tubercles is upon the inner surface of the theca, and in the pia covering the lumbar enlargement.

Symptoms.—The onset is usually gradual, with signs of vague and slight illness. In children, general apathy and neglect of amusements and play, headache, loss of appetite, dullness, fretfulness, restlessness at night with grinding of the teeth during sleep, headache, vomiting and pyrexia are common symptoms. In older subjects, lassitude, depression, mental alteration, perversity and hysterical manifestations are common. Constipation is usually present, and the breath has a peculiar fœtor. The facial expression is one of illness and frowning discomfort, and there is disinclination to talk. Young children may be speechless for days together. As a rule, in this stage of the disease young children complain of nothing, and delirium is rare; but as age advances, delirium increases in frequency, and headache, usually frontal, is increasingly complained of. These slight and vague symptoms may last from a few days to several weeks, and constitute what has been called the prodromal stage of the malady. In those cases which are said to begin acutely, careful inquiry will generally reveal that some symptoms such as the above have preceded the acute onset. The further development of the disease is marked by the appearance of a lethargy, which soon deepens into a stupor, from which it is difficult or impossible to arouse the patient. Vomiting is of frequent occurrence, and headache may be severe. The child lies upon its side in the "cramped" position, resenting any disturbance. The expression becomes vacant, with wide-open eyes and dilated pupils, as if fixed upon some distant object. There is often some retraction of the angles of the mouth, and there is frequently a bright malar flush. In the later stages the limbs are generally extended and rigid. Stiffness of the neck is the rule, and head retraction may occur, but this is never so marked as in posterior basal meningitis. The abdomen is always markedly retracted and a tâche cérébrale is often conspicuous. A single sharp cry, apparently causeless, called the hydrocephalic cry, and which is common in all forms of meningitis and also in other infantile intracranial affections, is sometimes heard.

Ocular phenomena make their appearance towards the end of the first week of the developed disease. All varieties of varying and persistent strabismus and ptosis are met with, paralysis of the external rectus being the most common. Rolling movements and independent movements of the eyeballs may occur. The pupils may be contracted at first, and may show varying inequality, but in the later stages they are dilated. Papilloedema is almost

invariably present towards the end of the second week, if the patient survives so long. It is of moderate intensity, the height of the swelling rarely exceeding two dioptres. Choroidal tubercles sometimes occur.

Convulsions are common in every stage of the disease in children, but rare in adult cases. They may be the first symptom of the onset, but are more often met with in the later stages of the disease. They may be local or general. Repeated rhythmic movements are frequent, and are specially noticeable in connection with the mouth, where sucking and champing movements and grinding of the teeth are common. Rhythmic movements of the limbs may also occur. Coarse tremor upon movement of the limbs is the rule, and spasmodic twitching of the muscles is frequent. In rare cases, movements exactly like those of chorea occur. Kernig's sign is usually present.

As the disease advances, general paralysis of the limbs appears with rigidity in the extended position, with increased deep reflexes and extensor plantar reflexes. The deep reflexes generally disappear before death. The temperature is usually raised one or two degrees, but it presents no characteristic features, some cases being apyrexial throughout. Irregularity of the pulse is the rule, and is of considerable diagnostic importance. Rapid in the early stages, it tends to become unduly slow in the stage of coma, and again rapid as death nears. Cheyne-Stokes breathing and grouped breathing are common. Constipation is usually a marked and persistent feature.

Course.—The course of tuberculous meningitis is progressive to an invariably fatal termination in from a few days to 3 weeks after the appearance of definite symptoms, and no case of recovery is known to me in which the diagnosis has been unquestionably proved by the recovery of the tubercle bacillus from the cerebro-spinal fluid.

The end of the second week finds the patient emaciated, comatose and with papilloedema. Occasionally and more particularly in adults, marked remissions occur; for example, consciousness may be regained from a deeply comatose state, but such improvement is temporary. Death occurs quietly from asthenia, and may be hastened by the embarrassment which accumulation of mucus in the chest places upon the respiration and circulation.

The clinical course of tuberculous meningitis has been often described as consisting of four stages—(1) the prodromal stage; (2) the stage of irritation in which headache, convulsion, tremors and rigidity occur; (3) the stage of relaxation characterised by coma, flaccidity and loss of knee-jerk; and (4) the final stage of deep coma and paralysis. Such a division into stages, though useful as an aid to memory, is clinically inaccurate since it rarely, if ever, applies strictly to any particular case.

Diagnosis.—The early symptoms of the disease may give rise to difficulty in diagnosis, but the latter is relatively simple when the disease is advanced. The diseases liable to be confused with tuberculous meningitis at its commencement are gastro-intestinal catarrh, the exanthemata—especially enteric fever—and pneumonia. It must be borne in mind that in children convulsion, strabismus, head retraction and stiffness of the neck, with pyrexia, may be symptomatic of many maladies apart from meningitis, especially of apical pneumonia. In enteric fever the temperature is higher and the headache more severe, and irritability and resentment of interference are not present;

the decubitus is usually dorsal. Widal's test is of importance in this connection. When distinctive signs of intracranial disease have appeared the diagnosis has to be made from other forms of meningitis, sinus thrombosis, tumour, abscess and middle-ear disease. Careful examination of the retina and of the tympanic membranes is then necessary. In all cases the diagnosis must be made certain by the examination of the cerebro-spinal fluid, which will be found to contain lymphocytes in excess and tubercle bacilli. These organisms are sometimes difficult to isolate from the fluid, but their presence can be readily demonstrated by injecting the fluid into the subcutaneous tissue of guinea-pigs, when the characteristic lesion of tubercle results. It must be remembered that in some cases the polymorphonuclear leucocytes may be in excess, but these cases are at once distinguished from other forms of meningitis by the presence of numerous lymphocytes, by the absence of the meningococcus and of the other germs producing suppuration, and by the presence of the tubercle bacillus. Pirquet's skin reaction is often absent in tuberculous meningitis.

Treatment.—From the unvarying fatal issue of the malady, treatment can only be directed towards the relief of symptoms. Temporary improvement and relief of headache may be brought about by lumbar puncture, which may for this purpose be repeated several times. Bromides, chloral, aspirin and other analgesic drugs may be used to relieve the headache, check the convulsion and diminish the restlessness. Hexamine in large doses, inunction of mercury and administration of tuberculin have been largely used, but without any success. General treatment must be that which will secure such comfort as is possible for the patient. Where swallowing is difficult nasal feeding should be adopted.

Pneumococcal Meningitis

Pneumococcal infection of the meninges most commonly follows upon a similar infection elsewhere in the body, empyema and pneumococcal otitis being the commonest lesions, while pneumonia, abdominal infection, abscess and joint infection are less common. In one-third of the cases, however, the meningeal infection is primary. The characteristics of the cerebro-spinal fluid are that it is purulent and sometimes so thick that it will not flow through the needle. It is greenish-yellow in colour, contains a large amount of albumin, and multitudinous polymorphonuclear cells, among which the characteristic pneumococcus is found.

Ætiology.—The disease may occur at any age. It is sometimes a terminal event of a pneumococcal infection elsewhere, and passes almost unnoticed, or is discovered only at the autopsy. Meningitis which follows operations upon the nose and disease of the nasal bones is usually of the pneumococcal variety.

Pathology.—The surface of the brain and spinal cord is highly characteristic. Usually the whole surface of the vertex and of the base is covered with a thick, tenacious, greenish-yellow pus, which is contained in the meshes of the arachnoid, and between this and the dura. The ventricles often contain pus. A similar exudation is found upon the spinal cord, more especially upon the dorsal aspect, and in the cervical and lumbo-sacral regions. The major affection of the vertex of the brain is the peculiarity

of this disease, and only in the rarest cases is the base alone affected. The exudation is characterised by the greater amount of fibrin than in other forms of meningitis.

Symptoms.—The symptoms are those which are common to all forms of meningitis. Some of the cases are indistinguishable symptomatically from cases of tuberculous meningitis. Others run a very rapid course and present few features other than headache, vomiting and pyrexia, with rapidly oncoming and quickly fatal coma. In others again, the meningeal symptoms are concealed in the terminal asthenia of a previously existing pneumococcal infection elsewhere, such as empyema, purulent pericarditis or peritonitis.

Diagnosis.—This rests upon the presence of signs of meningitis or the existence of coma alone, together with a cerebro-spinal fluid which is purulent from the presence of polymorphonuclear leucocytes, containing the pneumococcus.

No case of recovery from this form of meningitis has hitherto been recorded. Lumbar puncture and intrathecal injections of anti-pneumococcal serum may be performed, but on account of the thick nature of the exudate, little relief must be expected from the former, while the latter cannot possibly avail except in primary cases.

Meningococcal Meningitis

See under Cerebro-spinal Fever, p. 152.

Pyogenic Meningitis

Apart from meningococcal and pneumococcal infections, suppurative meningitis may result from the invasion of the meninges by staphylococci, streptococci, gonococci, *B. influenzæ*, *B. anthracis* and streptothrix.

Staphylococcal and streptococcal infections are by far the most common. They may result in young children from septic conditions of the umbilicus and from infections of the skin. Usually they are due to extension of an infection of adjacent structures to the meninges, and follow disease of cranial and spinal bones, especially caries of the middle ear, erysipelas and other infections of the scalp, wounds of the meninges, especially bullet wounds, rupture of intracranial abscess, and they may occur in the course of a general septicæmia.

Pathology.—The pathology of these conditions does not materially differ from that of pneumococcal meningitis. In all cases the exudation is purulent, and in the meningitis due to *B. anthracis* it is of a red colour, due to concomitant blood effusion. The cerebro-spinal fluid contains large numbers of polymorphonuclear leucocytes, together with the micro-organism responsible for each variety. Suppurative meningitis resulting from bone disease and from wounds of the meninges may be localised by the formation of meningeal adhesions, and an intrameningeal abscess may result. Such an abscess situated upon the upper surface of the temporal bone is not an uncommon result of caries of the middle ear.

The clinical aspect is that common to all forms of acute meningitis, high pyrexia, rigors and delirium being conspicuous. The course is rapid to an almost invariably fatal termination. In the localised form where drainage can be ensured and extension of the infection prevented, recovery should

take place. Several cases of recovery from gonococcal meningitis have been reported. Influenzal meningitis is invariably fatal.

Diagnosis.—This depends upon the presence of the clinical signs of meningitis and of a cerebro-spinal fluid containing polymorphonuclear leucocytes in large quantities, and upon the recognition in this fluid of the several micro-organisms responsible, by microscopic and cultivation methods. The recognition of *B. influenzæ* requires that cultures should be made upon some blood medium, for otherwise the organism may be easily overlooked and the fluid reported as sterile. Further, the presence of some well-known cause for suppurative meningitis, such as ear disease, staphylococcal infection, etc., suggests the diagnosis.

Acute otitis media may give rise to symptoms closely resembling those of meningitis, such as headache, pyrexia, vomiting, head retraction and delirium. In such cases examination of the ear, which should be made a routine in all cases where meningitis is suspected, will reveal tympanic distension, the relief of which is followed by a speedy disappearance of the symptoms. In this connection it must be borne in mind that meningitis and intracranial abscess never follow directly upon acute otitis, but they are the sequelæ of chronic otitis, which has resulted in caries of the temporal bone. When evidences of caries of the middle ear are present in a case presenting cerebral symptoms, distinction has to be made between meningitis and abscess of the brain or cerebellum. Here the presence of localising symptoms, either temporal or cerebellar, and the presence of papilloedema and any tendency to a temporary abatement of the symptoms point to the existence of an abscess, and further lumbar puncture will in all but the rarest cases settle the point. In cases of abscess in which cells and organisms are found in the cerebro-spinal fluid, these exist in small numbers only, as compared with the copious cells and organisms present in the fluid of suppurative meningitis.

Treatment.—In cases of meningitis secondary to temporal caries, the source of infection should be at once cleared out by surgical procedure. Repeated lumbar puncture may relieve symptoms, and injection of an anti-serum to the organism present may be tried. Vaccines may also be used. Hexamine in large doses may be given, since this drug appears in the cerebro-spinal fluid and exercises a decided inhibitory effect upon the growth of organisms.

Syphilitic Meningitis

Meningitis due to infection by the *Spirochæta pallida* is one of the characteristic lesions met with in practically all cases of syphilitic disease of the central nervous system, and plays its part in the production of the symptom complexes of these maladies, from acute cerebral syphilis and acute myelitis to general paralysis and locomotor ataxy. It may occur at any period after infection, but one-half of the cases occur during the first four years. In a few cases the symptoms have been noticed coincidently with the syphilitic roseola.

Pathology.—The morbid process consists essentially in an infiltration of the meninges with lymphocytes and plasma cells, spreading from the perivascular lymphatics where the spirochætes multiply freely, and it may lead to scarring and opacity of the membranes, with consequent strangling of the nerves and vessels and occlusion of the arachnoid space, or to massive

gummatous formation in the meninges. It is essentially a chronic form of meningitis though it may result in the production of acute symptoms. A marked feature is that the meningeal changes may be found actively progressive in one spot, and equally regressive in another. The disease may be local or diffuse, and it may attack the dura (pachymeningitis) and involve the overlying bone, or it may spread from the pia-arachnoid into the sublying nervous tissue (meningo-encephalitis).

The cerebro-spinal fluid is characteristic. It is usually under increased pressure, is clear and colourless, and contains lymphocytes and no other cell forms. The number of the lymphocytes present is in direct proportion to the activity of the meningeal syphilis. The spirochæte has rarely been found in the fluid, yet inoculation of apes with the fluid has proved successful.

Symptoms.—Apart from those conditions of nervous syphilis in which meningitis is associated with arterial disease, the formation of massive gummata and neuronic degeneration, syphilitic meningitis may be described as giving rise clinically to the following conditions :

1. *Headache.*

2. *Hydrocephalus.*—In those acute cases of cerebral syphilis characterised by rapidly oncoming headache, vomiting and papillœdema, mental reduction and somnolence without localising symptoms, and which respond readily to treatment, it seems certain that ventricular distension, consequent upon adhesive meningitis and ependymitis, is responsible. A more slowly oncoming ventricular occlusion may give rise to symptoms which cannot be distinguished from those caused by a non-localisable intracranial tumour. Syphilitic meningeal occlusion may give rise to typical hydrocephalus, and a considerable proportion of the cases of infantile hydrocephalus are of this nature and are due to congenital syphilis. A few cases are recorded in which chronic hydrocephalus of this nature has occurred in adult life.

3. *Infantile syphilitic meningitis.*—This is a chronic malady which commences insidiously during the first few months of life, with signs of general nervous deterioration. The appearance of the brain is very characteristic. The membrane over the vertex is opaque and thickened and adherent to the cortex. The gyri are shrunken, the sulci wide and the surface of the brain has in parts the appearance of wash-leather. The child does not get on, and takes an ever decreasing notice of its surroundings. Power of movement lessens, the limbs become rigid and the clinical aspect comes to resemble exactly that of a severe cerebral diplegia. Convulsions are of frequent occurrence. The diagnosis is not difficult, for the signs of meningitis are obvious and those of congenital syphilis may be present. There is an excess of lymphocytes in the cerebro-spinal fluid, both in which and in the blood there is a positive Wassermann reaction. The prognosis in any case where the symptoms have become marked is most unfavourable.

4. *Adult syphilitic meningitis* with a symptom-complex closely resembling that of tuberculous meningitis, has been reported on many occasions. In some of the cases the onset coincided with the appearance of the syphilitic roseola. The diagnosis depends upon the presence of signs of active syphilis, upon the cerebro-spinal lymphocytosis and upon the existence of a positive Wassermann reaction. The prognosis under appropriate treatment is good.

5. *Paralysis of cranial nerves.*—This common and often isolated symptom of nervous syphilis may result from sclerosing basal meningitis or from the presence of a gumma in the course of the nerve. Several of the nerves may be involved together in one patch of meningitis. Any of the cranial nerves may be affected from the olfactory to the hypoglossal, but the third or oculo-motor nerve is by far the most frequently attacked.

Treatment.—The treatment of the above conditions is that appropriate for nervous syphilis in general (pp. 1489, 1490). The combined administration of mercury by inunction and of arsenic compounds by intravenous injection gives the best results. The intrathecal injection of salvarsanised serum has been largely advocated of recent years, but it is of doubtful value. Iodide of potassium is not nearly so useful as when massive gummata are present, and, moreover, it seems to increase the scarring process. Its use should be avoided until the patient has been under the influence of mercury for some time.

Other Forms of Meningitis

Meningitis due to the typhoid bacillus is a rare malady. It may occur as a primary disease, but is usually a complication in the course of enteric fever. It is to be remembered that while many cases of enteric fever present cerebral symptoms, in very few can meningitis be proved to exist. The meningeal exudation, generally serous, is sometimes purulent. The cerebro-spinal fluid contains lymphocytes, and Eberth's bacillus is present. The symptoms resemble those of acute meningitis in general. The diagnosis depends upon the presence of enteric fever, of Widal's reaction and the discovery of Eberth's bacillus in the cerebro-spinal fluid. The malady is generally fatal, but a considerable number of recoveries have occurred, especially in children. In rare cases symptoms of meningitis occur in the course of rheumatic infection, and Poynton and Paine have brought forward evidence that such symptoms are the result of infection of the meninges with the *Diplococcus rheumaticus*. The term "serous meningitis" is applied to those cases of meningitis in which the cerebro-spinal fluid is clear and sterile. In such cases recovery is the rule, and the symptoms are not rarely rapidly relieved by lumbar puncture. The term "meningism" is used for a group of cases which present symptoms of meningitis and in which no pathological change can be found either in the cerebro-spinal fluid, or, if death occur, in the meninges or cerebral tissue. It is met with in children in association with acute febrile diseases, and is presumably due to the toxin present. Recovery is usually rapid and complete.

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CEREBRAL VASCULAR LESIONS

The central nervous system, situated within the cranial cavity, is supplied by four arteries, two upon each side. The large internal carotid arteries enter the cranial space external to the posterior clinoid process, give off the ophthalmic artery for the supply of the eye and orbit of the same side, and divide into the anterior and middle cerebral arteries, which roughly supply

the anterior two-thirds of the hemisphere. Obstruction of the internal carotid, either by embolism, thrombosis or pressure, produces a very characteristic symptom-complex in which there is blindness of one eye with retinal anæmia, and infarct from obstruction of the ophthalmic artery, together with hemiplegia of the opposite side from obstruction of the anterior and middle cerebral arteries. The distinctive term carotid hemiplegia is applied to this condition.

The smaller vertebral arteries derived from the subclavians ascend through the vertebral canals in the cervical transverse processes and enter the skull through the foramen magnum. Within the skull the vertebral arteries give off the important posterior inferior cerebellar arteries, which supply much of the cerebellum and also the medulla with its vital centres and its closely crowded conducting tracts. Obstruction of one of the posterior inferior cerebellar arteries is the common cause of the remarkable "cerebellar apoplexy" in which acute hemiataxy, medullary paralysis and hemianæsthesia appear suddenly.

The two vertebral arteries then join to form the basilar artery which occupies the middle line upon the ventral surface of the pons, and which gives branches supplying the whole of the pons and upper part of the brain stem. The basilar artery ends at the level of the crura cerebri by dividing into the posterior cerebral arteries, after having given off a superior cerebellar branch on either side for the supply of the upper cerebellum.

The vertebral and basilar arteries and their branches, previous to the division of the latter into the posterior cerebral arteries, are much less prone to disease causing symptoms than are the anterior, middle and posterior cerebral arteries, and consequently vascular lesions of the brain stem and cerebellum are infinitely more rare than are similar lesions of the cerebral hemispheres.

The anterior, middle and posterior cerebral arteries, soon after their commencements, are connected by the communicating arteries to form the "circle of Willis" in the sub-arachnoid space at the base of the brain. When the circle of Willis is perfectly developed, there is free communication between the three great cerebral arteries on each side, and it follows clinically that obstruction of any one of these vessels on the heart side of the circle of Willis will either occasion no symptoms of local cerebral lesion, or such symptoms will be transient because of the compensatory blood supply through the circle of Willis. It must, however, be most carefully borne in mind that the circle of Willis is often developmentally very imperfect—one or more of the communicating arteries being absent. For example, ligation of the internal carotid artery in man has quite often been followed by the appalling disaster of complete and irrecoverable hemiplegia.

The anterior cerebral artery supplies the prefrontal lobes, the orbital lobules, the anterior part of the caudate nucleus, and the whole of the mesial aspect of the hemisphere and corpus callosum as far back as the parieto-occipital fissure, with such convolutions as border on the middle line.

The posterior cerebral artery supplies the rest of the mesial aspect of the hemisphere, the inferior surface of the temporal and occipital lobes, the uncinate region and the posterior part of the corpus callosum, together with the corresponding edge of the convexity.

The middle cerebral artery supplies almost the whole of the convexity of the hemisphere, with the exception of the marginal supply of the anterior and posterior cerebral arteries. Its supply extends to the posterior pole of the hemisphere where there is an important communication with the supply of the posterior cerebral artery. The supply of the middle cerebral to the occipital pole of the hemisphere is of great clinical importance, for at the occipital pole central vision is represented, and the escape of central vision in destruction of the cortex of the cuneus, from lesions of the posterior cerebral artery and its calcarine branch is thus explained by the middle cerebral arterial supply to the posterior pole of the hemisphere.

The corpus striatum, optic thalamus and region of the internal capsule are supplied by the deep perforating branches of the middle cerebral artery, which arise as that vessel crosses the anterior perforated spot, and which are named lenticulo-frontal, lenticulo-striate and lenticulo-optic arteries respectively. The supply of these three arteries is terminal without conspicuous anastomosis.

The supply of the choroid plexuses of the lateral and third ventricles is from the middle cerebral, and that of the fourth ventricle from the vertebral.

The cerebral veins are for the most superficial, those of the convexity draining into the superior longitudinal sinus, those of the base into the cavernous sinus, and those of the posterior fossa into the lateral sinuses, while the large choroidal veins from the plexuses of the lateral and third ventricles run by the velum interpositum to the straight sinus. There is the freest intercommunication between the sinuses at the base of the brain, so that ligation of the lateral sinus upon one side does not disturb the vascular supply of the brain. On the other hand, there is no other way out for the blood of the convexity of the hemispheres than by the superior longitudinal sinus, and it is for this reason that blocking of this sinus always results in disastrous bilateral softening of the hemispheres.

The cerebral sinuses communicate freely with veins outside the skull by means of the orbital veins, the various emissary veins, of which the mastoid vein is the most important, and by the vertebral veins. Thrombosis of the cavernous sinus is accompanied by œdema of the orbit, and that of the lateral sinus, by œdema over the mastoid process.

The amount of blood within the skull case seems to vary but little under normal circumstances, though its rate of passage may vary greatly. When, however, the bulk of the intracranial content is increased either by new-growth, hæmorrhage or œdema, this can only occur in the closed skull at the expense of the cerebro-spinal fluid, of which there is normally very little, and which is expressed thereby, or at the expense of the amount of blood within the skull case, which is lessened thereby. The important fact follows, that whenever from such a cause the intracranial pressure is increased, there is relative ischæmia of the brain, and, further, that an increase of intracranial pressure is accompanied always by a rise of systemic blood-pressure to compensate for such ischæmia, provided that the vasomotor mechanism be intact, and that if owing to the failure of the vasomotor mechanism such a rise of blood-pressure does not accompany a rising intracranial pressure, death soon results. It is obvious that the intracranial pressure can never exceed the maximum venous blood-pressure in the cerebral veins, for under such circumstances the cerebral circulation would cease. An adequate

supply of blood to the brain is necessary for the retention of consciousness. When the blood supply fails from lowering of blood-pressure, as in fainting, consciousness is lost. Similarly, when a rapid increase in intracranial pressure occurs, consciousness is lost from the resulting cerebral anæmia, and this is the common cause of loss of consciousness in intracranial hæmorrhage, in cerebral thrombosis, for severe local œdema is the immediate result of thrombosis, and in abscess and tumour.

Aneurysm

Pathology.—Miliary aneurysms, which are small seed-like dilatations of the finer arteries in the substance of the brain, are not uncommonly present in cerebral arterial degeneration. They are usually multiple. Much importance was formerly attached to miliary aneurysms as a common cause of cerebral hæmorrhage. The extensive researches of A. G. Ellis in 1909 and of Pick in 1910 have proved conclusively that miliary aneurysms are not a cause of hæmorrhage, and are of no practical importance apart from the associated arterial degeneration.

Larger irregular dilatations of the cerebral arteries are of frequent occurrence in connection with syphilitic and atheromatous vascular disease. They are of the nature of false aneurysms, are often of the dissecting type, and not unfrequently give rise to cerebral hæmorrhage. True aneurysms of the larger cerebral arteries are not uncommon, but they rarely reach a size larger than a small nut, and are most frequently unassociated with any symptoms during life. These may be grouped into the following order: (1) Congenital aneurysms which are attributed to local developmental imperfection in the vessel walls. These have been met with at all ages of life from early infancy upwards. Their size varies from that of a pea to that of a cherry. They are sometimes multiple. They are usually found upon the arteries in the vicinity of the circle of Willis, and especially at the junction of middle cerebral and posterior communicating arteries. They may also occur along the main cerebral trunks at some distance from the base. Most often such aneurysms occasion no symptoms during life, and are discovered only at autopsy; but they may rupture at any age, and are an important cause of cerebral hæmorrhage. Most important, they may leak and give rise to a clinical picture very different from that of rapid cerebral hæmorrhage. (2) Syphilitic aneurysms, which attain the largest size of all cerebral aneurysms, and which occur upon the *larger* vessels, especially upon the basilar artery. These may give rise to pressure signs, and may rupture. (3) Septic aneurysms from embolic infection of the arterial wall, of which the common cause is infective endocarditis. These are apt to be multiple. They are usually symptomless, but they may rupture. (4) Aneurysms which are usually of small size, not exceeding that of a small pea, due to arterial degeneration, are often multiple and always associated with extensive general atheroma of the cerebral arteries.

Symptoms.—Clinically, cerebral aneurysms fall into very definite groups—(1) Those which give rise to no symptoms whatever during life, but are discovered only upon necropsy. This group forms a large proportion of the cases. (2) Those in which the first indication of a cerebral lesion has been an apoplexy due to rupture of the sac, indistinguishable clinically

from other forms of cerebral hæmorrhage. (3) Those of which the peculiar symptoms of leaking aneurysm have been the only indications. (4) Those in which there have been signs of the presence of a cerebral tumour only. And lastly, (5) those in which symptoms of cerebral tumour have been followed by fatal apoplexy from rupture of a large sac. The last two groups are of rare occurrence.

It will thus be seen that a large proportion of the cases of cerebral aneurysm are symptomless. Among the remainder where symptoms occur, these are indistinguishable from those due to cerebral tumour, cerebral hæmorrhage, arterial degeneration, and infective endocarditis in general. There is, however, one clinical picture which may result from cerebral aneurysm which is definite and easily diagnosable, and that is when the aneurysm ruptures minutely and leaks slowly.

Leaking aneurysm (*Spontaneous sub-arachnoid hæmorrhage*).—It would seem to be the congenital aneurysm situated not far from the circle of Willis, which ruptures minutely and leaks slowly, and the escape of blood is usually into the sub-arachnoid space. Sometimes, however, the aneurysm becomes firmly adherent to the brain, and the escape occurs into the brain substance, and the symptoms are those of a slowly oncoming apoplexy.

In the first place, where the blood escapes into the meninges the clinical picture is very characteristic. The slowly escaping blood mingles with cerebro-spinal fluid, and in its course towards its exit in the spinal theca deposits fibrin and small clots around the nerve roots of the medulla and upper spinal cord, giving rise to pain and stiffness of the neck, which has been so considerable in several cases which I have seen as to cause the patients to have been treated for rheumatic stiff neck. Later, the continued slow outpouring of blood increases the intracranial pressure, and the medullary and spinal root irritation becomes greater, and headache, vomiting, head retraction and Kernig's sign appear. The symptom-complex at this stage exactly resembles a meningitis, but there is usually no elevation of temperature. Lumbar puncture reveals a cerebro-spinal fluid which is highly characteristic. It contains blood in quantity, and may be blood-coloured if the hæmorrhage is at all recent, or tends to a brownish colour if the bleeding is more remote. If the corpuscles are allowed to settle, or if the specimen be centrifugalised, the supernatant fluid is likely to be yellow or brownish in colour from altered blood pigment. A very large number of leucocytes may be present, since when blood is effused into the cerebro-spinal fluid the red cells are in time broken up, whereas the leucocytes persist. A differential count of the leucocytes will show that the proportion is exactly the same as in the patient's blood, thus excluding a meningitis.

As the hæmorrhage goes on, convulsions may occur, and the patient may become somnolent, apparently from the poisoning effect of the extravasated blood. At any time during the course of the case, which may last many days or even weeks, more rapid hæmorrhage may bring about the end with coma and general signs of high intracranial pressure, or the bleeding may cease and the symptoms abate or recover either permanently or temporarily, fresh hæmorrhages occurring weeks or even months later. The clinical pictures which may result from the escape of blood from an aneurysm into the meninges may be conveniently divided into three groups, which are determined by the rate and quantity of the blood escaping. (1) Severe

cases, in which the meningeal space is rapidly filled with blood and in which the aspect is that of cerebral hæmorrhage, except for the absence of local signs and for the immediate presence of profuse blood in the fluid withdrawn by lumbar puncture. In these cases it is usual to find on ophthalmoscopic examination large rounded subhyaloid hæmorrhages beneath the retina, which result from the pressure of the optic nerve sheath distended with blood. I have had one opportunity of observing the formation of these retinal hæmorrhages within three minutes of the rupture of the aneurysm. (2) Less severe cases, in which the above-described meningitic syndrome occurs. (3) Chronic cases, in which the escape is very slow or intermittent, which give an aspect of chronic headache and pain in the neck, perhaps with some stiffness of the neck, not suggesting meningitis. Obviously, all gradations between these varieties are met with.

In most of my cases, leaking of the aneurysm has occurred in the third or fourth decades of life. I have not met with a case in childhood, but I have seen one case at 17 years (recovered), one case at 18 years (fatal with necropsy), and also cases at 54 and 66 years (both fatal with necropsy).

Treatment.—This consists of absolute rest in the recumbent position. Repeated lumbar puncture should be employed and as much fluid as will run freely removed on each occasion. Any increase of the symptoms indicating increasing intracranial pressure should be an immediate indication for further drainage by lumbar puncture. Morphine, turpentine and calcium salts should be administered as possible aids to the arrest of the bleeding. Aspirin and the bromides are useful to combat restlessness and pain, while measures should be adopted to keep the blood-pressure low and without variations.

Embolism

The majority of embolisms of the cerebral arteries occur in valvular heart disease, 89 per cent. (Savcliew). Embolism may also occur from detached portions of clot from an aneurysm, from thrombi in connection with atheroma or syphilis of the aorta, and from detached clots which may form in the region of the pulmonary veins and left heart where there is no cardiac valvular disease. This latter condition is not an infrequent cause of puerperal apoplexy. Embolism is rather more frequent in women on account of the greater incidence of mitral stenosis in that sex, and from the puerperal cases.

The embolus comes from the left heart and may be a vegetation from a quite recent endocarditis, but is more commonly a detached vegetation from a chronic and especially from an infective endocarditis. Very frequently it is a detached portion of clot which has formed in the left auricle in mitral stenosis. The middle cerebral arteries are the usual sites of lodgment of the emboli, and the left middle cerebral is rather more frequently affected than is the right. Embolism of the other cerebral vessels may occur but is extremely rare.

The pathological events which may follow the plugging of a cerebral vessel with an embolus are varied and are highly important. In the first place, secondary thrombosis may proceed from the embolus throughout the whole distal distribution of the vessel, and lead to complete softening of its area of supply, and the clinical aspect will be that of severe and unchanging

damage to the brain. The softened area may shrink or may undergo cyst formation, or it may be completely absorbed, giving rise to a porencephalus. Secondly, the embolus in the absence of secondary thrombosis may become adherent to one spot of the vessel wall at the site of its lodgment, and retracting from the vessel wall elsewhere, the blood channel becomes reopened, and the clinical results of the embolus, at first very severe, may disappear with unexpected and dramatic rapidity, and complete recovery ensue. Thirdly, the embolus may contract at the site of its primary lodgment, and become detached and shifted on by the blood stream to find a second resting place in a much smaller artery. This event is manifest clinically by rapid clearing up of the physical signs in many regions, with persistence or even deepening of the involvement of one particular region. For example, a severe and complete hemiplegia clears up suddenly on the third or fourth day, leaving a brachial monoplegia only. Fourthly, an embolus may be impacted at the termination of the internal carotid artery, giving rise to severe hemiplegia with blindness of the opposite eye from blocking of the ophthalmic artery—carotid hemiplegia. Owing to the re-establishment of the circulation by the circle of Willis the hemiplegia is likely to recover rapidly, while the eye remains permanently blind owing to secondary thrombosis extending through the ophthalmic artery. When an embolus is finally lodged and completely occludes the artery, the condition, both pathologically, clinically and from the point of view of treatment, is one of thrombosis, the cause of the embolism being taken into consideration. As with thrombosis, the immediate result of permanent occlusion is a condition of infarct and acute œdema in the region from which the blood supply is cut off. The acute œdema causes local pressure and increased general intracranial pressure, and is a common cause of the transient coma which often supervenes a few hours after the stroke, in both embolic and thrombotic apoplexy.

Stroke from embolism is the most suddenly occurring of all apoplexies, and the ictus is not preceded by any prodromal cerebral symptoms. Consciousness is apt to be lost at once if the whole middle cerebral artery be occluded, especially if the lesion be upon the left side. Or it may be retained throughout if the embolus lodge in a small vessel only.

Diagnosis.—This rests upon the occurrence of sudden apoplexy without prodromal symptoms in the presence of an obvious cause for embolism such as cardiac valvular disease, aortitis, pulmonary thrombosis or the puerperal state. The diagnosis can be a matter of probability only in those conditions where either embolism or thrombosis is likely, such as enfeebled cardiac states and the puerperal state.

Prognosis.—The prognosis in cerebral embolism depends upon the size of the vessel which is plugged, as deduced from the severity of the initial symptoms and their extent, and upon the immediate pathological changes which occur in the obstructed vessel as above described; and according to the nature of these changes, it may be the most severe and least recoverable, or, on the other hand, the least severe and most recoverable of all forms of apoplexy. The prognosis of the condition causing the embolism is often the more important.

Treatment.—The treatment is that of cerebral thrombosis together with that of the condition giving rise to the embolus.

Arterial Thrombosis and Hæmorrhage

Cerebral thrombosis and cerebral hæmorrhage seem hitherto to have been described in text-books of medicine as quite separate conditions, almost antagonistic and mutually incompatible, between which it was highly essential and even possible to make a differential diagnosis for the purpose of applying a very dissimilar line of treatment in the respective conditions, each line of treatment being the worst possible for the other condition. It cannot, however, be too forcibly pointed out, that primary arterial thrombosis and primary arterial hæmorrhage depend in every case upon degeneration of the arterial wall, and that every condition of degeneration of the arterial wall may cause either thrombosis or hæmorrhage indifferently. It is a usual experience to find in patients who have had several strokes that thrombosis was the cause of the earlier, and hæmorrhage of the final apoplexy. Even in that condition which has always been held to be the most important antecedent of cerebral hæmorrhage—renal disease with high arterial tension—Janeway has recently found that thrombosis and not hæmorrhage was the cause of apoplexy in many of his cases.

On account, therefore, of the identity of the underlying pathological condition in every case, and the clinical association of thrombosis and hæmorrhage of the cerebral arteries, and the difficulty of distinguishing them clinically, the two conditions are here described together.

Ætiology and Pathology.—The arterial degeneration which may result in cerebral thrombosis and hæmorrhage is due to the following causes: (1) Syphilis, which is the commonest cause of thrombosis in the first half of adult life, and which is less commonly the cause of hæmorrhage. It may affect both the large and the small arteries, even to the smallest. All the coats of the artery are affected, and in the case of the finest vessels there is conspicuous lymphocyte accumulation or "cuffing" round the vessel. In the neighbourhood of the affected vessels there is always syphilitic cerebritis in the form of lymphocyte exudation and œdema, and meningitis, if the lesion come to the surface. This is the most recoverable of all thrombotic lesions of the brain. (2) Atheroma, which is the common cause both of thrombosis and of hæmorrhage in the second half of adult life, and which is by far the commonest cause of hæmorrhage. It must be especially borne in mind that cerebral atheroma may be local in the cerebral vessels, and unassociated with general atheroma of the systemic vessels. (3) Arterial hypertrophy, with secondary focal degeneration of the media, with or without its commonly associated renal disease, which is of the nature of "small white kidney" in children and younger adults, and of the various types of "granular kidney" in older subjects. (4) Abnormal conditions of the blood, especially when associated with feeble cardiac action and low blood-pressure, as in the puerperal state, and in septicæmic conditions, and at the time of the menopause. (5) In association with new-growths of the brain, both thrombosis and hæmorrhage are common events, especially when the neoplasm is soft and rapidly growing. The vascular lesion may occur quite early in the course of the new-growth, and apoplexy may be the first sign of its presence. (6) Inflammatory conditions of any nature may cause thrombosis and hæmorrhage. The most important of

these are lethargic encephalitis and poliomyelitis, and more rarely tuberculous meningitis. The vascular lesions are usually small, but they may be extensive, and may cause death. (7) Traumatic lesions, such as the passage of a bullet through the brain, or a blow upon the head, or concussion from high explosives, may cause extensive thrombosis or hæmorrhage.

While cerebral hæmorrhage results often enough from the direct rupture of a true aneurysm, or of one of those irregular local thinnings of the vessel wall which is called a "false aneurysm," and may take place from an artery the wall of which is softened by disease though there be neither thinning nor bulging of the vessel wall, yet cerebral hæmorrhage is very often the direct consequence of thrombosis, and especially of thrombosis which has occurred some time previously. The sequence of events is as follows: An area of thrombosis occurs within the brain, and the usual softening and necrosis follow. On the confines of this area, the necrosis spreads to come in contact with the wall of a living and unthrombosed artery, perhaps of considerable size. The arterial wall of this vessel was nourished by the capillaries of the necrosed area, and with its nutrient supply now cut off there is local degeneration of the wall of the living artery. Moreover, the shrinking of the necrosed area of brain causes loss of support to the degenerate wall of the vessel, which ruptures as the result, under the influence of any sudden increase of blood-pressure. It is for this reason that one commonly finds in patients who have had multiple attacks of apoplexy, that the final and fatal attack is one of hæmorrhage, and that the preceding attacks have been attacks of thrombosis. In the autopsy room I have repeatedly been able to demonstate antecedent thrombosis in cases of cerebral hæmorrhage. These spots of thrombosis, which cause hæmorrhage, need not be of large size, and they may be so small as hardly to cause symptoms on their occurrence. Marie first called attention to these small spots of thrombosis as *plaques jaunes*, small yellowish-brown spots, softened and sometimes cystic, and pointed out their importance as a cause of cerebral hæmorrhage. In a similar way the thrombosis of syphilitic arterial disease may cause subsequent hæmorrhage.

Syphilitic cerebral thrombosis is not usually a pure pathological process, for the vascular disease is often accompanied by acute syphilitic encephalitis, with much lymphocyte extravasation in the vicinity of the diseased vessels, and acute local œdema, which increase the evascularisation when thrombosis occurs. The symptoms of cerebral loss of function are not all due to the thrombosis, but are in part owing to the recoverable acute inflammatory condition, and it is for this reason that syphilitic apoplexy often shows much more recovery than do other forms of apoplexy.

Thrombosis is a more common cause of apoplexy than is hæmorrhage, but it is much more frequently survived, while hæmorrhage is nearly always fatal, within from a few hours to a few days of its onset. It follows therefore, that in the autopsy room of a general hospital, hæmorrhage is seen much more often than is thrombosis, while in infirmaries, where the survived cases of apoplexy collect, thrombosis is almost invariably the lesion found to be primarily responsible for the apoplexy.

Thrombosis tends to occur when the blood-pressure is low and the circulation less active, and is always strongly suggested when apoplexy occurs during sleep and conditions of quiet, and after exhaustion, exposure to cold,

severe purgation, and in debilitated states generally. It is preceded by slowing of the circulation in the area affected, and this may be productive of prodromal symptoms. Or there may be slight local thromboses preceding the main thrombosis, also giving rise to prodromal symptoms. Thrombosis may thus have an ingravescent onset, especially when clotting occurs in distal branches of an artery and extends towards the main vessel; but, on the other hand, it may have an absolutely sudden onset when the clotting occurs primarily in a large artery. The immediate effect of the thrombosis is a condition of infarct with œdema, extending widely in the vicinity, and it is this œdema which causes the loss of consciousness so commonly seen a few hours after the apoplexy has occurred. The œdema tends to pass off in a few days, and the area bereft of circulation by the thrombosis tends to become narrowed by collateral circulation from surrounding regions, and any recovery of function within the affected region must be by collateral circulation from elsewhere. The affected area at an early stage is bright red in colour, and soon becomes soft and shrunken (red softening). Later, the blood pigments degenerate with the production of bilirubin and are partly absorbed, producing a yellow-coloured lesion (yellow softening). Finally, much of the thrombosed tissue becomes necrotic and is absorbed, leaving one or several cystic cavities. These cavities are never so sharply defined as those resulting from embolism, because of the more complete necrosis occurring with the later lesion. Still, a severe arterial thrombosis occurring at an early age may result in a porencephaly. Cavities found in cases of apoplexy after years have elapsed, are too often attributed to hæmorrhage. In reality they are nearly all due to thrombosis or embolism. The cerebro-spinal fluid in thrombosis is never found to contain blood, but some little time after the apoplexy it is often coloured yellow or yellowish brown from escape of changed blood pigments, when the lesion has reached the surface of the convexity or the surface of the ventricle.

Hæmorrhage, which is usually described as an apoplexy of sudden onset, may be so when the escape is from a large vessel. When the bleeding commences from a smaller vessel, the symptoms are not sudden in their onset, but gather rapidly. Such a hæmorrhage is much like an avalanche. Commencing from a small vessel the hæmorrhage tears a small cavity, and in so doing opens up fresh bleeding points, and with increasing destruction more and more bleeding occurs from every piece of torn tissue, until the hæmorrhage reaches such a size as to burst commonly into the ventricle and much more rarely on to the surface. Indeed, it is difficult to conceive how a hæmorrhage into such a soft and vascular tissue as is the brain, should ever stop. As a matter of fact, it very rarely does so, but causes death in the first attack of hæmorrhagic apoplexy, within from a few hours to a few days after the onset, from widespread tearing up of the nervous system and bursting into the ventricle. One of the most important clinical distinctions between apoplexy due to thrombosis and apoplexy due to hæmorrhage is that the former is often survived, and that the latter is almost invariably fatal within a short time of the onset.

Hæmorrhage may occur anywhere within the nervous system, but its common seat of commencement is in the centrum semiovale, and the vessel which bursts is one of the perforating arteries, of which the lenticulo-striate which carries the name of the " artery of hæmorrhage " is the most common.

Such bleedings are often called "capsular hæmorrhages." It must be pointed out that this term capsular refers to the region outside the corpus striatum or external capsule, and not to the compact internal capsule as it converges to the crus cerebri. The cerebro-spinal fluid in cases of hæmorrhage contains blood within a very short time of the onset, and lumbar puncture often withdraws what is practically pure blood in large quantities. I have found blood present in large quantities very often within an hour of the onset.

Both thrombosis and hæmorrhage may occur in any part of the brain, while massive embolism is rare, except in the middle cerebral artery. The semioval centre, the calcarine region and the pons are the common sites of both hæmorrhage and thrombosis in that order of frequency. Hæmorrhage is rare except in these regions, while thrombosis is not uncommonly met with elsewhere.

Symptoms.—The nature of the symptoms in apoplexy will depend upon the site of the vascular lesion; and as the semioval centre or region of the middle cerebral artery is the commonest site for all the vascular lesions, hemiplegia is the common result; and this is associated with aphasia, if the lesion is in the left hemisphere, and involves or isolates the cortex. When the calcarine artery is the site of the lesion, hemianopia results; and this is apt to be accompanied by word-blindness, if the lesion be on the left side. Pontine apoplexy involves the appearance of double hemiplegia, bilateral ataxy and bilateral loss of sensibility, with signs of involvement of cranial nerve nuclei and cranial nerves. Cerebellar apoplexies and thrombosis of the posterior inferior cerebellar artery produce acute ataxy with forced movements and vomiting.

Prodromal symptoms in the form of transient weakness of one or both limbs of one side, transient aphasia and giddiness occur in thrombosis only. An ingravescent onset occurs in thrombosis only and when the clotting occurs in the periphery of arterial distribution first and spreads towards the main trunk. When commencing in the parietal region, tingling and numbness of an extremity first occur, followed by a spread of these symptoms over half of the body, and subsequent weakness deepening into hemiplegia. When commencing in the left temporal region gradually oncoming aphasia is first noticed, and when commencing in the ascending frontal convolution a peculiar sensation of heaviness in the limbs gradually increases until hemiplegia is obvious.

The onset in embolism is always instantaneous; it may be sudden in thrombosis, and in hæmorrhage from a large vessel. In hæmorrhage it is always rapid. Consciousness is lost or not, according to the severity of the initial lesion and the site it occupies, and to the magnitude of the processes which follow the initial lesion, namely, the œdema of embolism and thrombosis, and tearing of the brain tissue in hæmorrhage. In hæmorrhage, consciousness is lost soon, and the rapid development of severe symptoms which progressively deepen, is a most important early indication that this is the nature of the lesion.

In calcarine thrombosis the initial symptoms may be so slight as to pass unnoticed by the patient, whose first indication of defect may be, that he runs into objects on his blind side.

Convulsion sometimes occurs at the onset, and this nearly always indicates

thrombosis, rarely embolism, and never hæmorrhage. There may be some local spasm in the region of the cranial nerves in pontine hæmorrhage, but this is not convulsion.

Conjugate deviation of the eyes is a common feature of all apoplexy. Inasmuch as the lesion is irritative at its onset, and not too destructive, and always when convulsion occurs at the onset, there may be active conjugate deviation, the eyes being turned away from the side of the lesion and towards the paralysed or convulsed side in hemiplegic cases, or the blind side when hemianopia is present. But this active conjugate deviation lasts but a short while and is followed by a paralytic conjugate deviation in the opposite direction, both eyes being directed away from the paralysed side and towards the side of the lesion. This variety of conjugate deviation may last for a considerable time, but usually disappears with the onset of deep coma.

The pupils are often unequal; they may be contracted, or dilated widely, and may be insensitive to light. In severe apoplexy, when as the result of the cerebral shock or when hæmorrhage or œdema have so raised the pressure as to greatly reduce the physiological activity of all the intracranial elements with the production of deep coma, the pupils are widely dilated and insensitive. In pontine lesions, the pupils are often contracted to pin-point size, and this condition is of important localising significance.

In proportion to the severity of the general intracranial disturbance, respiration tends to be hurried, noisy and stertorous, and with increasing pressure to become irregular, grouped or of the Cheyne-Stokes type. The blood-pressure tends to be raised and the pulse full in all conditions of apoplexy, provided the heart will respond to the requirement of an increased blood-pressure in the face of an increased intracranial pressure.

Swallowing is often impossible, and the sphincters may be relaxed or retention may occur.

In the usual variety of apoplexy where the lesion is in the area of the middle cerebral artery and the local sign of the lesion is hemiplegia, it will be obvious that when the general intracranial pressure becomes severe and the coma becomes deep, the hemiplegia becomes less apparent, or masked by the universal condition of paralysis consequent upon the general intracranial condition. The physician often sees the patient for the first time when there is considerable coma, and he must determine upon which side the lesion is situated, and endeavour to have some perspective as to prognosis by determining the severity of the lesion.

The following points will serve to determine the side of the lesion when these signs are present: (1) The paralytic conjugate deviation is away from the side of the lesion. (2) The corneal reflex, when any is present, is diminished or lost on the hemiplegic side. (3) Painful stimulation will elicit less response or no response upon the hemiplegic side (hemianæsthesia). (4) The patient may respond by blinking to a feint made with the observer's hands towards the patient's eyes upon the sound side, and not on the hemiplegic side (hemianopia). (5) The limbs on the hemiplegic side when raised and allowed to fall passively, do so in a more lifeless, inert and flaccid fashion than upon the sound side. (6) And when there is any difference between the knee-jerks, abdominal reflexes and plantar reflexes, the former tend to be diminished and lost on the hemiplegic side while the plantar reflex will be of the extensor type on the hemiplegic side. It must be remembered in this connection, that a

severe lesion of one cerebral hemisphere abrogates for a time at least most of the functions of the whole hemisphere, and that the hemianæsthesia and hemianopia, here referred to, do not necessarily indicate that the destructive lesion involves the visual and sensory paths. And further, that the condition of coma due to increased intracranial pressure of itself causes such signs as bilateral loss of abdominal reflexes and knee-jerks, and bilateral extensor responses in the plantar reflex.

The severity of the lesion may be judged—(1) From the deepness of the coma; (2) from the degree to which the patient responds to any form of stimulation and from the general signs of nervous depression present—for example, a condition of complete bilateral flaccidity with complete loss of all reflex action and of all response to stimulation indicates a most severe lesion; and (3) from signs of failure of respiration as shown by irregular, grouped or Cheyne-Stokes breathing. It is further important to arrive at a determination if possible as to whether the condition present is stationary, deepening or showing signs of amelioration.

Vomiting is not an uncommon occurrence in the early hours of apoplexy and before coma becomes deep. Hyperpyrexia is often seen in fatal cases before the end. It is especially common and may reach a high degree in pontine apoplexy. It may be preceded by initial depression of temperature. It is of fatal prognostic import.

Cerebellar Apoplexy.—This is usually the result of thrombosis of the posterior inferior cerebellar artery, which is a branch of the vertebral artery, and the clinical picture is very unlike that of cerebral apoplexy. The patient is seized with a sudden intense vertigo which carries him to the ground, as in Ménière's disease. Incessant vomiting and forced movements follow, the forced movements rotating the patient, so that he comes to rest prone, with that side of the face corresponding with the side of the cerebellar lesion in contact with the pillow. There is intense ataxy, usually bilateral at first, and later becoming confined to the limbs and trunk on the side of the lesion. The patient is unable to lift his head, or to maintain the sitting or standing position. When placed in such a position he positively dives to the ground when released. Nystagmus with the long slow movement to the side of the lesion, and a short fast movement in the opposite direction is conspicuous, and the skew deviation of the eyes is commonly seen. There is much general hypotonia of limbs and trunk which soon becomes limited to the side of the lesion. Head retraction, pain and stiffness of the neck and opisthotonos may occur. When the patient's condition recovers sufficiently to allow of examination, all the signs of a unilateral cerebellar lesion will be found. Consciousness is not often lost. Since the posterior inferior cerebellar artery also supplies the lateral region of the medulla, signs indicative of disturbance of this region are usually present, and these may dominate the clinical picture rather than the cerebellar signs. Chief amongst them are analgesia and thermanæsthesia of the face and head, due to implication of that part of the spinothalamic tract which is as yet uncrossed at this level, and of the limbs and body upon the opposite side, due to involvement of that part of the spinothalamic tract which has crossed below this level. Between these two areas of sensory loss there is often a gap where sensibility is normal, corresponding with that part of the spinothalamic tract which is crossing obliquely at this level, and therefore is too near the middle line to be affected. Paralysis of

the motor vagus is often found from involvement of the nucleus ambiguus, and, from the extension of the lesion or of consecutive œdema towards and across the middle line, sometimes causes severe dysphagia and dysarthria, and one of the great dangers of this form of apoplexy is extension of the thrombosis to that part of the medulla which contains the respiratory and other vital centres. When, however, such extension does not take place, and if the destruction of the lateral lobe is not too extensive, the most remarkable recovery may take place. Compensation in other structures for moderate cerebellar destruction seems to occur readily and rapidly.

Diagnosis.—*The nature of the lesion.*—Embolism should be diagnosed in all cases where there is an obvious cardiac valvular lesion, particularly mitral stenosis, septic endocarditis, aortic disease and aneurysm. It is true that syphilitic cerebral thrombosis may occur with syphilitic aortitis, but the combination is rare, for syphilitis aortitis usually occurs at a much later age than does syphilitic cerebral thrombosis.

Further conditions of cardiac feebleness and corresponding feebleness of circulation must obviously predispose to thrombosis if arterial disease be present. Mistakes in diagnosis will, however, not often occur, and they are not of moment to the patient, for embolism when once the embolus is lodged is for all purposes of treatment and prognosis the same condition as is thrombosis. Thrombosis should be diagnosed in all primary apoplexies in young syphilitic subjects, for syphilitic hæmorrhage usually occurs at some time considerably subsequent to a syphilitic thrombosis. In this connection the serum reaction and the cytology and reactions of the cerebro-spinal fluid are all-important in the diagnosis.

Thrombosis should be diagnosed, notwithstanding the presence of high arterial tension or renal disease, in all cases of apoplexy without organic cardiac valvular disease, when the onset occurs during sleep or under circumstances of quiet, depletion or exhaustion, and in all cases where prodromal symptoms are marked, or where the onset of the apoplexy is gradual, and in apoplexies occurring in advanced age, for then hæmorrhage is almost unknown. All slight apoplexies and nearly all those that survive the first 10 days after the ictus, are due to thrombosis.

Puerperal apoplexy and that occurring at the time of the menopause in women are mostly due to thrombosis.

When the cerebro-spinal fluid obtained by lumbar puncture shows an absence of blood a few hours after the ictus, thrombosis is highly probable, and hæmorrhage is very unlikely. Hæmorrhage is a likely cause of apoplexy, occurring during exertion, especially if it occurs at a moment of severe physical strain, or at the height of passion. It is always a probable lesion in cases where a previous thrombotic apoplexy has occurred, the final event, where multiple strokes have succeeded one another, being almost invariably hæmorrhage. An apoplexy with rapid onset and with symptoms rapidly deepening, with a quick onset of deep coma, and the development of pyrexia and signs of respiratory failure, is usually due to hæmorrhage. The certain test that an apoplexy is due to hæmorrhage is the presence of blood in quantity in the cerebro-spinal space as proved by lumbar puncture. In cases of small white kidney in the young and of granular kidney before the age of 50 years, where the blood tension is very high, and where there is severe retinitis, hæmorrhage is the most likely cause of stroke.

The position and extent of the lesion.—The position of the lesion may be judged by the nature of the initial signs, whether visual, sensory, motor or aphasic, cerebellar or pontine, and later by the permanent symptoms resulting from the lesion. It must be carefully borne in mind in this connection, that a severe lesion of a cerebral hemisphere may entirely abrogate the functions of that hemisphere, initially by a process of shock and afterwards by the occurrence of œdema in the vicinity of the lesion, which may spread widely.

The extent of the lesion may be gathered by the severity or otherwise of the early symptoms and their rate of increase, and by early or immediate loss of consciousness, and by the completeness of the paralysis resulting. The more severe the extent of the lesion the sooner do grave signs of general cerebral failure appear.

Differential Diagnosis.—The diagnosis of coma due to a cerebral vascular lesion is usually made without difficulty from the history, and from the presence of unequivocal signs of local lesion of the brain. In a patient without history, and when the coma has become so deep as to remove the unilaterality of physical signs, from the severity of the general intracranial pressure, the diagnosis may be difficult from other causes of coma such as uræmia and diabetes, poisoning by opium, alcohol and its derivatives and illuminating gas, and in cases of difficulty search is to be made for the usually obvious signs of these conditions. Uræmia may present especial difficulties, for it is often associated with cerebral vascular lesion, and transient hemiplegic attacks may occur in this condition. Absolutely sudden death which is so often recorded in death certificates as due to apoplexy, is usually associated with a stoppage of the heart following the obliteration of one of its coronary arteries. Apoplexy never causes sudden death. There is one recorded case of death from cerebral hæmorrhage in five minutes, but it is rare in any apoplexy for death to occur in under 2 hours. Other conditions causing hemiplegia with coma must be taken into consideration. Epilepsy and especially hemi-epilepsy may be followed by marked unilateral paralysis (Todd's paralysis), which may last for a considerable time. Here the history of recurring attacks and the complete recovery will easily prevent confusion.

Hysterical attacks may show a superficial resemblance only to apoplexy, and are to be distinguished by the absence of any signs of organic disease. Cerebral malaria and sunstroke may closely resemble apoplexy, and should always come to mind when rapid coma follows the development of cerebral symptoms in circumstances where these causes are likely.

The congestive attacks of general paralysis of the insane are peculiarly difficult to diagnose from apoplexy. Perhaps they are due to suddenly occurring acute cerebral local œdema. They are liable to mistaken diagnosis, of course, only when occurring as the initial manifestation of the disease. These attacks take the form of rapidly occurring attacks of hemiplegia, aphasia, hemianopia, hemianæsthesia or of some combination of these conditions, usually associated with initial convulsions and followed by coma. The diagnosis of a syphilitic thrombosis is made with reason on the positive serum reactions, and cerebro-spinal fluid examination. If energetically treated it recovers with marvellous rapidity and completeness, to slowly develop the characteristic signs of general paralysis. It is the too rapid recovery in a case of apparent syphilitic thrombosis which should suggest the possibility of the stroke being a congestive attack in general paralysis

of the insane. In all cases of coma without history, especially when there are signs of local cerebral involvement, a very careful examination of the head should be made for traces of recent injury, and if signs of injury be found, the skull and meninges should be opened, and the nature of the lesion sought out and dealt with surgically.

Prognosis.—A majority of the cases of apoplexy from syphilitic thrombosis make a fair recovery, which obviously depends upon how much permanent thrombosis occurs in the lesion of acute syphilitic encephalitis which is responsible for this condition, and upon the early application of appropriate treatment for syphilis. In some of these cases even, no recovery occurs.

In embolism the course and prognosis depend upon the extent of the vascular supply cut off when the embolus comes finally to rest; and upon the amount of collateral circulation afforded, and upon the cardiac condition.

In thrombosis due to atheroma the apoplexy may be rapidly fatal from extension of the thrombosis and secondary œdema, which raise the intracranial pressure beyond the limits of survival. In cases which survive, considerable recovery may occur in proportion to the extent of the lesion, but in these subjects an apoplexy is usually the beginning of the end, since the underlying pathological causes, arterial disease and failing cardiac action, still exist and are not amenable to any radical treatment. It is astonishing, however, how many of the cases of apoplexy due to atheromatous thrombosis survive for years without any recurrence of the thrombosis or occurrence of hæmorrhage. In cases of hæmorrhage, the immediate prognosis is the gravest possible, the great majority of the cases surviving but a few hours.

Cerebellar thrombosis is a dangerous condition from the risk of extension of the thrombosis to the vital centres in the medulla, but if the acute stage passes without this untoward event, complete recovery may occur in those cases where the lesion is not very extensive, and recovery of working capacity is usual, even in more severe cases. A good many of the cases are, however, immediately fatal.

Treatment.—When arterial disease is known to be present, the only measure which can in any way tend to safeguard the patient from apoplexy is moderation in all things: in diet, alcohol, mental and physical exercises, and above all moderation in all measures tending to lower the blood-pressure, for hæmorrhage is due not so much to the immediate high blood-pressure as it is to an antecedent period of low blood-pressure in a high tension subject, which has allowed of thrombosis and which, when the tension is high, at some subsequent period causes rupture of a vessel in the thrombosed area. It is highly probable that no treatment influences the course and fatal issue of apoplexy due to hæmorrhage except surgical treatment. Cushing has urged that cerebral hæmorrhage should be treated surgically, and has performed this operation upon a number of cases with some degree of success. The difficulty is that hæmorrhage occurs so rapidly, and the cerebral destruction becomes so great during the first hour of the hæmorrhage. Even in cases of thrombosis and embolism which are severe, Cushing advocates exploration and decompression on the correct grounds that the immediate danger of death in these conditions is due to œdema raising the intracranial pressure beyond the survival limit. Thrombosis and embolism, however, allow some scope for medical treatment, which should be the same in the two

conditions; and as I have argued above that medical treatment in cases of hæmorrhage is useless and cannot avert the fatal result, I advise one line of treatment to be taken in all cases of apoplexy.

From the onset of symptoms in every case, a careful stimulant line of treatment must be adopted, and all depletive measures that may be calculated to lower the blood-pressure and diminish the force of the cardiac action should be scrupulously avoided. It has been pointed out in the preceding passages how much the local and general symptoms of apoplexy are the result of cerebral ischæmia produced by the raised intracranial pressure, either from hæmorrhage or from œdema, and how nature attempts to combat this ischæmia by a reflex raising of the blood-pressure, to keep the cerebral circulation going, and that how when the intracranial pressure exceeds that of the mean intracranial venous pressure, death must at once result from stoppage of the cerebral circulation. As Thomas truly emphasises, "How can the lowering of arterial blood-pressure possibly help such conditions?" Absolute rest is, in the first place, essential when prodromal symptoms appear, and at the onset of an attack diffusible stimulants in the form of alcohol and liquid food; the heart's action may be improved by strychnine, while restlessness may be combated with bromides. If the patient is conscious, he should make as little effort as possible. His head and shoulders should be raised, special care being taken that the neck is not bent, and that nothing shall interfere with the return of blood from the head. If there is unconsciousness with stertor, the head and shoulders should be turned upon one side, so that the tongue should not fall back and impede respiration. If there be much cyanosis from impeded respiration, as is often seen in plethoric subjects, it is advisable to withdraw blood by venesection, for such relief of embarrassment acts as a stimulant to the circulation. Purgation should be avoided, and the bowel relieved at intervals by enemata. Stimulating food in a liquid form should be administered with stimulants at regular intervals; and if there is any difficulty in swallowing, the food should be administered with the nasal tube. The bladder should be carefully watched from the first, lest retention should occur, and the catheter passed when necessary. Lumbar puncture should always be performed for diagnostic purposes, and it frequently gives relief from symptoms due to the high intracranial pressure. I have many times seen consciousness return within a few minutes of lumbar puncture, when much fluid can be withdrawn. It is advisable to withdraw all the fluid which will run out at a rate above the normal. When bloody cerebro-spinal fluid or pure blood is met with, the lumbar puncture should be frequently repeated for the relief of symptoms. Bed-sores and hypostatic bronchitis must be avoided by the usual measures. In the cases that survive the first few days, passive movements should be used daily to all the joints of the affected side in hemiplegic cases, for this will obviate the painful rest adhesions which form in the joints of the paralysed limbs, and especially in the shoulder joint, and subsequently cause so much pain and misery to the patient. With returning power, massage and passive movement should be used to the affected limbs, but electricity should not be used, since it tends to increase spasticity. A hemiplegic patient after apoplexy, should be got upon his legs and encouraged to make attempts to walk as early as ever the returning power allows any possibility of the attempt.

Sinus Thrombosis

Thrombosis of the cerebral sinuses may occur rarely as a primary condition, or it may be secondary to infective processes spreading to the sinuses from contiguous infected regions.

Ætiology.—Primary thrombosis is a rare condition. It is said to affect the superior longitudinal sinus most commonly. It is more common in the first year of life than at any other period, when it may follow diarrhœa, bronchitis or the conditions of exhaustion met with in tuberculous disease and in congenital syphilis, and it may follow acute diseases such as measles, diphtheria, etc. It occurs after puberty especially in connection with anæmic states, and particularly with chlorosis. In chlorosis, among 82 cases of cerebral thrombosis, 78 cases were of venous thrombosis and 32 were cases of sinus thrombosis. Such cases are said to be often fatal. It may also occur at any age, up to advanced old age, in the terminal stages of cancer, phthisis and other chronic diseases.

The essential cause of secondary thrombosis is the advent of micro-organisms to the sinuses. The infection is often a mixed one, but the common organisms present are streptococcus, pneumococcus and *Bacillus coli*. The sinus may become infected as a part of a general pyæmia, or infection may spread directly through its wall from a focus of local disease, most commonly from an extradural abscess. In most cases, however, the sinus becomes infected from a local spreading septic thrombosis of the veins which open into the sinus, from an infected spot at a distance. Thrombosis of sinuses may also occur from injury, as by bullet wounds and fractures of the skull, and may also result from surgical procedures in the region of the sinuses.

Pathology.—The affected sinus is bulged and distended, and feels to the touch as if it were injected with a solid mass. In the infective forms, the clot may very quickly break down into pus, and general pyæmia result. When the superior longitudinal sinus is thrombosed, there is marked congestion of the convolutions of the convexity of the brain, often with cord-like clot-distended veins. There is bloody serum in the sub-arachnoid space contaminating the cerebro-spinal fluid withdrawn by lumbar puncture. Later, there is extensive bilateral softening of the cerebral hemispheres, most marked in the paracentral and surrounding convolutions. The cavernous and lateral sinuses do not drain the brain directly, and blocking of one of them does not cause so much cerebral disturbance, on account of the presence of alternative paths for the blood. Thrombosis of the cavernous sinus, however, may extend to the ophthalmic veins and cause blindness with an anæmic and infarcted condition of the retina. The nerves which lie in its outer wall, namely, the third, the fourth, the ophthalmic division of the fifth and the sixth nerves, may be paralysed.

Symptoms.—The clinical aspect of this condition is made up of three groups of symptoms—(1) the general signs of some bodily condition likely to be associated with thrombosis, such as marasmus, chlorosis, pyæmia, local cranial injury or septic disease of cranial bones, and neighbouring tissues; (2) general signs of intracranial disturbance, which will depend upon how much the cerebral circulation is upset by the blocking, and which will be severe in cases where the superior longitudinal or the straight sinus

is affected, and perhaps altogether absent where the cavernous sinus or the lateral sinus is affected; and (3) local signs of blocking of an individual sinus.

The general signs depend upon congestion, œdema, meningeal exudation and increased intracranial pressure. Headache, drowsiness, deepening into coma, and vomiting are common, while delirium and convulsions may occur. Papilloedema is not infrequent, while head retraction and rigidity of the neck, trismus, strabismus, inequality of the pupils, nystagmus, and irregularity of pulse and respiration may occur. In infective thrombosis, high pyrexia and rigors are the rule.

Local Signs.—*Superior longitudinal sinus.*—The general signs are severe and convulsion is common, and bilateral hemiparesis or paralysis is likely to develop. There may be cyanosis and œdema of the forehead. The angular parietal and temporal veins may be distended, and in rare cases thrombosed.

Lateral sinus.—The clot may extend into the jugular vein and cause pain and stiffness on that side of the neck, and occasionally the thrombosed jugular vein may be felt beneath the anterior border of the sterno-mastoid as a tender solid cord. There may be tenderness and swelling over the region of the mastoid emissary vein.

Cavernous sinus.—There is œdema of the orbit, with proptosis and œdema of the conjunctiva, forehead and face. Amblyopia or blindness is the rule. Ophthalmoscopic examination reveals swelling of the disk with multiple hæmorrhages. Paralysis of the ocular muscles and anæsthesia of the eye on the same side may also occur.

Diagnosis.—If local signs, which give conclusive external evidence of sinus thrombosis, are absent, it may be very difficult to distinguish this condition from meningitis, abscess, encephalitis or other intracranial lesions. The septic forms of meningitis should be distinguished by the polymorphonuclear leucocytosis in the cerebro-spinal fluid. It must be remembered, that in the primary forms of sinus thrombosis in children, a copious lymphocytosis is met with, which may cause confusion with tuberculous meningitis. Abscess and sinus thrombosis often exist together.

Prognosis.—This disease is, as a rule, rapidly fatal from ever-increasing intracranial pressure; but some subjects, both in the non-infective and in the infective forms, survive. This is especially the case when the thrombosis is confined to one cavernous sinus. Cases of infective thrombosis of the lateral sinus following middle-ear disease have often been saved by timely surgical interference with ligature of the jugular vein and of the lateral sinus on either side of the thrombosed area, and with incision and turning out of the clot.

Treatment.—Beyond vigorous prophylactic measures against the causes of this condition and the palliative treatment of symptoms, surgical measures in cases of local infective origin alone are of avail. Further, in dealing with injuries of the skull in the region of the superior longitudinal sinus, trephining and exploration should be undertaken with a clear understanding of possible thrombosis of the sinus, and its appalling results.

APHASIA AND OTHER DEFECTS OF SPEECH

General Considerations.—The function of speech, which is the highest and most recently evolved human function which we have any means of directly analysing, has as its anatomical substratum a region of the cerebral convolutions situated in the left hemisphere and having its centre a little behind the middle of the first and second temporal convolutions. It is limited above by the posterior limb of the Sylvian fissure, occupies probably the tip and the whole external convexity of the left temporal lobe, and spreads backwards into the supramarginal and angular gyri, while it extends forwards over all the convolutions of the insula and possibly to the posterior ends of the second and third pre-frontal gyri of the left side.

This "speech region of the brain" comprises not only the cortex but also the subcortical white matter which carries the paths of communication between the speech region and other parts of the brain. Posteriorly it receives an important white tract which conveys incitations from the visual region of the cortex situated in the cuneus and posterior pole of both cerebral hemispheres. An interruption of this tract results in the condition known as "pure word blindness," or inability to appreciate written speech. Upon its deep aspect the speech region of the convolutions receives the temporal projection of fibres conveying the auditory impressions, and destruction of this system by a lesion undercutting the convolutions in the centre of the temporal lobe produces "word-deafness," or inability to appreciate spoken language. In this same region another set of afferents impinges upon the speech area which convey the muscular sense impressions and other sensory impressions which are produced in the movements of articulation and which are the only guidance which the "deaf mute" has in the knowledge of correct execution in his articulation.

A lesion deep in the temporal lobe which interrupts both the foregoing paths, isolates the speech region from any appreciation of correct execution, with the result that spoken language becomes unshapen and degenerates into a voluble jargon, "jargon aphasia."

In the anterior half of the speech area a tract of white fibres gathers by degrees, and passing forward constitutes the bulk of the "temporal isthmus," which joins the temporal lappet to the insula, and runs beneath the insula to the region beneath the first and second pre-frontal convolutions, from whence it is connected with the pyramidal path of the left side, and by way of the corpus callosum with the pyramidal path of the right side. This is the executive outgoing path for speech impressions and a complete lesion of this path, as by a limited subcortical lesion underlying the posterior end of the left third pre-frontal gyrus and anterior part of the insula, will result in complete inability to exteriorise either spoken or written speech—"pure aphasia" and "pure agraphia."

In the speech area of the brain thus limited, little or nothing is known of any localisation of function. It is generally held that there is a gradual passing over from receptive function (appreciation of spoken and written language) in the posterior regions, to executive function (exteriorisation of spoken and written language) in the anterior regions. And even this vague localisation is probably due to the fact that the incoming tracts from the

visual, auditory and sensory systems which join the speech area in its posterior half and the outgoing tract which leaves it anteriorly, neither end abruptly nor gather abruptly, but do so gradually, and therefore lesions of the posterior region will interfere more with the receptive paths and those of the anterior region with the outgoing path.

Inasmuch as the phenomena of " word-blindness " and " word-deafness," as well as executive " aphasia " and " agraphia " result from lesion of the speech area, these seem to result from lesion of the tracts concerned and not from interference with the function of the cortex. These phenomena are of common occurrence in connection with lesions of the speech region and, in the hands of Broca, Wernicke, Kussmaul, Lichtheim and others, lead to the formulation of localised areas of the cerebral cortex with specific functions in regard to speech. Thus, Broca's centre in the cortex of the posterior part of the left third pre-frontal convolution was the motor centre for spoken language, while Exner's centre in a similar position in the second left pre-frontal gyrus was the motor centre for written language. The " auditory word-centre " in which auditory memories of words were stored was in the cortex of the first and second temporal gyri, and the " visual word-centre " in which visual memories for words were impressed was in the cortex of the angular gyrus. These various centres were connected together by to-and-fro paths which could be separately affected by a lesion, and the attempt was made to explain the multitudinous and varied phenomena which occur in lesions of the speech region by damage to one or other of these hypothetical word-centres or to their connecting paths. The result was highly unsatisfactory, for the cases generally refused to correspond with the theories clinically, and practically never corresponded pathologically. Dejerine, by his discovery that a subcortical lesion in the right place could produce " pure aphasia and agraphia " at the front end of the speech area and " pure word-blindness " at the posterior end, the cortex being intact, went far to make untenable the theories of narrow localisation of function within the speech centre. Subsequently the work of Pierre Marie, Head and others has placed modern conceptions of speech function upon a less artificial basis.

The speech function seems to be concerned with the left hemisphere of the brain alone in right-handed persons, and this is explained by the major potential of the left hemisphere for receptivity and education associated with the major use of the right hand through the countless ages of humanity. Left-handedness is usually associated with a transfer of the speech function to the right hemisphere, but there are exceptions to this rule.

The possibility of the transference of the speech function from the left to the right hemisphere is great during childhood, to the extent that no lesion of the speech region of the left hemisphere, however extensive, causes lasting loss of speech in a child under the age of six years, provided sufficient intelligence remain. After this age the possibility of such compensation by the right hemisphere for lesions in the left hemisphere seems gradually to diminish and to occur but little after adult life is reached, but even in adult life remarkable exceptions to this rule are seen.

The descending paths from the brain by which speech is executed are the pyramidal paths. The pyramidal fibres for the movement of lips, tongue, larynx, etc., are situated exactly at the knee of the internal capsule, and bear the name " geniculate fascicle." The speech area of the cortex seems

to command both right and left pyramidal systems equally, so that no lesion of one pyramidal system is ever productive of speech defects, either aphasic or dysarthric.

From this it follows that aphasia, word-blindness, word-deafness, amnesia, etc., only result from lesions of the convolutions and of the white matter closely underlying the convolutions, and never from lesions of the deeper parts of the corona radiata and capsules.

When, however, both pyramidal systems are involved, as, for example, by bilateral lesions of the brain, or by lesions of the brain stem which involve both pyramidal systems where these are contiguous, or by neuronic degeneration of the pyramidal systems in general, then defects of speech execution arise comparable to the spastic paralysis of hemiplegia. These do not concern the pattern of speech, but solely the articulation, which becomes slow, clumsy, and slurring and indistinct, from weakness of movement, stiffness of the muscles concerned, and inability finely to adjust the stop positions at which the consonants are made. This condition, which is known as "spastic dysarthria," is commonly met with in double hemiplegia, in lesions of the brain stem involving both pyramidal tracts, and also in the tonic form of progressive muscular atrophy. In older writings it is often referred to under the most inappropriate name of "pseudo-bulbar paralysis."

When the lower motor neurons subserving the speech mechanism are bilaterally affected, a very similar dysarthria results, from the weakness and inaccuracy of the movements thus entailed, which is known as "flaccid or atrophic dysarthria," and which is met with in lesions of the medulla oblongata of all kinds, in progressive muscular atrophy, and in peripheral neuritis.

Lesions of the vermis of the cerebellum and of the cerebellar connections of the medulla oblongata are productive of a peculiar defect of articulation, "ataxic dysarthria," in which slurring, syllable-stumbling, syllable-elision and undue separation of syllables are conspicuous, and this sometimes deserves the name often used for it—staccato or syllabic utterance. Ataxic dysarthria is common in disseminate sclerosis, Friedreich's disease and in cerebellar disease. Aphonia, which is the loss of the vocal element in speech, the articulatory being preserved, is met with in bilateral complete paralysis of the larynx, as a reflex condition in affection of the vocal cords and as an hysterical manifestation. Mutism is invariably a symptom of hysteria.

Vascular Supply.—The speech area of the left cerebral hemisphere is supplied almost exclusively by the left Sylvian artery, the anterior branch of which supplies the posterior ends of the second and third pre-frontal gyri, the anterior part of the insula, and the sub-lying white matter. Lesions of this branch are apt to destroy the subcortical white matter containing the out-going path from the speech area—the so-called "motor aphasia," "Broca's aphasia," or "pure aphasia" resulting, according to the exact situation and extent of the lesion. The posterior branch of the Sylvian artery running in the Sylvian fissure supplies the rest of the speech area, and lesions of this vessel are productive of the so-called "sensory aphasia," "Wernicke's aphasia," or "total aphasia," according to the extent of the lesion. There is, however, a deep branch of the posterior cerebral artery,

via the calcarine artery, which supplies the white matter beneath the posterior limits of the angular gyrus, and a lesion of this branch, by severing the incoming path from the visual area in the cunei to the speech area, may cause "pure word blindness" as an isolated phenomenon or in conjunction with right hemianopia.

LESIONS RESPONSIBLE FOR APHASIA.—By far the most common cause of aphasia, in all its degrees and varieties, is vascular disease, usually thrombosis, less commonly embolism, and only in the rarest cases hæmorrhage—for the reason that the two former lesions often affect the vascular supply of the superficial parts of the hemisphere, whereas hæmorrhage is generally situated deeply; moreover, cases of cerebral hæmorrhage rarely survive the occurrence for more than a few hours. Cerebral tumour is the usual lesion causing aphasia of gradual onset, and is perhaps the only known cause of isolated "word deafness" and of "voluble jargon aphasia," for it is the only conceivable lesion which can undercut and, therefore, isolate the temporal convolutions without otherwise interfering with their function. Inflammatory conditions of the brain seem seldom to occur as factors of aphasia. One may meet with transient symptoms of this order in connection with the various forms of meningitis, and also in encephalitis, but I have never seen any permanent form of aphasia resulting either from polioencephalitis or from lethargic encephalitis. Traumatic lesions of the speech area which are common in times of war are often from their succinct nature productive of most valuable cases of aphasia from the point of view of the analysis of speech function. Aphasia may occur as a transient phenomenon in epilepsy and in migraine, of which disease it is a well-known sign. It may also be met with in uræmia, in the "nervous" attacks of high arterial pressure without albuminuria, and in the "congestive" attacks of general paralysis of the insane.

PHYSIOLOGICAL CONSIDERATIONS.—A useful conception of the physiological mechanism of speech is most easily arrived at by a consideration of the way in which speech is acquired by the infant in the process of its development. Within a short time after birth the child begins to recognise the nature and uses of some of the objects in the world around it, and to express its simple conscious process by gestures, and it early appreciates the "gesture language" of those around it. The "mimesis," or gesture language, thus early impressed and expressed, remains throughout life the most stable, the least vulnerable, and the longest lasting of the methods of receiving and communicating ideas. Even when the function of speech is reduced to annihilation by lesions of the speech area, mimetic language remains, and it only disappears when intelligence or consciousness is reduced to a low ebb. Long before it is able to utter any articulate sound, the infant learns to connect certain sounds which it hears with certain objects and with certain events, and the memories of these auditory patterns first implanted serve by far the most important function in the processes and expressions of thought throughout life. Whereas we rely upon our visual memories for our remembrance and intelligence in general matters almost exclusively, yet as regards speech we rely upon auditory memories to a very large extent, and of course those who have never learned to read do so exclusively. The process of recall, both in silent thought and in speaking, is the revival of auditory patterns. We are, therefore, strong "visuals" as regards general

memory, but strong "auditives" as regards speech memory, and the relative strength of the two functions varies somewhat in individuals, according to personal idiosyncrasy and to education, and this individual variation is sometimes apparent in the phenomena of aphasia. From the original connection with hearing, the memories of speech patterns come to be located in that part of the brain associated with the auditory function—in and around the temporal lobe. Later, guided by the auditory memories, the child begins to express himself in articulate speech and he does so by the revival of auditory memories.

It is essential to bear in mind that all motor processes have been evolved from reflex actions, and that all living motion is sensory-originated, sense guided and sense governed, and that a motor process of itself has no proved conscious concomitant, our consciousness of motor processes being the consciousness of the sensations which accompany the movement, or which result from the movement. In speaking, for example, we gain the knowledge that we have spoken what we wished correctly by the immediate backlash of our voices sounding in our ears, and also by the sensation of correct articulation which reaches the sensorium from the executive organs. The knowledge of correct execution so gained fortifies and increases the functional stability of the speech area, and is of immense importance in the speech function. If it be absent owing to a lesion isolating the speech area on the incoming side, speech degenerates into a jargon and soon becomes impossible; just as in tabes the walking becomes irregular from loss of the muscular sense conveyed in the posterior columns, and ultimately standing becomes impossible.

When at a considerably later and less impressionable age the child learns to read and to write, certain visual patterns (letters, words, sentences) become connected with certain objects and ideas, and become linked on to the already well-established auditory memories of speech. The meaning of the visual symbols is learned by the child from the meaning of the word or pattern spoken, which he already knows well, and the already developed auditory speech function serves as the instructor of the visual speech function, and throughout life remains the more potent, more dominant and less vulnerable function of the two.

Later still, in learning to write, the child relies upon his visual memories, and as his knowledge of correct execution in writing is largely visual and only in minor degree common sensory from the movements of the hand in writing, it follows that the function of exteriorising speech by writing becomes intimately connected with and a part of the visual speech function, and is usually depressed or lost with the visual speech function as the result of disease. It will thus be seen that there are not separate regions of the speech area in which the auditory memories of language and the execution of spoken speech on the one hand, and the visual memories of language and the execution of written language on the other hand, are represented, but that there are four functions intimately coupled in pairs, which have their seat in the same anatomical substratum. Supposing that in later years the child learns a language in addition to his mother tongue, there is no fresh organisation of speech centres, but he impresses a further function—another set of speech patterns—upon his already trained speech mechanism, but this added function will never be so deeply impressed as that of the mother tongue, and

when the speech region of the brain is damaged the less impressed function will tend to be lost first and most.

It is a general principle that when the speech area is damaged the speech function becomes depressed as a whole, with the result that function is lost in order of its depth of impression. For example, with any lesion of the speech area which does not conspicuously involve the incoming and outgoing paths the first signs likely to appear are depression or loss of the visual speech function, for this is much less deeply impressed than is the auditory speech function. This loss will be greatest upon the executive side and less upon the receptive side, for the receptive side is always more deeply impressed and functionally more stable. With an increasing lesion, as more and more of the speech area is involved, the auditory speech function will be involved first upon the executive side, and last and least upon the acceptive side. This principle first came into prominence many years ago with the general recognition of the clinical fact that the greater number of the cases of Broca's "motor aphasia," even though the lesion was subsequently shown to be confined to the base of the third pre-frontal gyrus and neighbouring part of the insula, showed for a time after the occurrence of the lesion, relative or complete inability to recognise written language—in other words, they were word-blind, although intelligence was good and there was no lesion in the region of the angular gyrus to account for the loss of visual speech. And it was emphasised by the many reported cases in which complete inability to speak was caused by a lesion confined to the temporal lobe.

Diaschisis.—Von Monakow, who still held that the visual and auditory, and the receptive and executive speech functions were separately represented in the cerebral cortex, gave this name to the dropping out of function in terms of the depth of impression of function. The term actually means "breaking of the synapses," and he applied the principle of diaschisis to the brain generally to explain the local loss of function in regions far distant from the lesion, but functionally connected with the damaged region. At the present day the term is used with a functional meaning only, for it is obvious that it can have no anatomical meaning.

The loss of the less deeply impressed elements of the speech function in regular order is sometimes well exemplified in aphasic persons who are facile in many languages. This principle is no more than a restatement of the well-known fact that as age advances, the nervous system is less impressionable and at a lower functional level, and, therefore, that memories of recent events are much less vivid, more easily forgotten and much more difficult of recall, than are memories of long ago.

Symptoms.—So far the varying degrees of word-blindness, word-deafness, aphasia and agraphia from lesions of the speech area, have been attributed in this account of the subject to sub-cortical lesions of the incoming and outgoing paths on the one hand, and functional depression of the speech mechanism as a whole on the other hand. It remains to make some attempt to elucidate the functions of the cortex of the speech area, or rather to suggest what defects may result when this cortex is damaged. It will be obvious that lesions confined to the cortex of this area alone are almost unknown.

Small lesions of the convolutions of the size of a sixpenny piece seem to produce no defects at all, and this is perhaps true of all the regions of the cortex of the brain. There can be, therefore, no narrow localisation of

function, and there must be capacity for compensation for such small lesions in the surrounding undamaged cortex. With larger lesions of the cortex, and in proportion to their extent, mutilation of the patterns of speech, slowness of utterance, inability to find the words (inability to recall), especially nominals, and above all isolated nominals, and finally confusion of speech intelligence occur, in that order.

In the mutilated speech of the aphasic may be sometimes noticed stammering, and I have seen two cases in which the end result after great improvement was indistinguishable from ordinary stammering even as to the words, thus constituting a jargon utterance. This condition is at once distinguishable from true jargon aphasia, since the former is slow and halting whereas the latter is facile and voluble. Misplacement of words and the use of wrong words is common and is called "paraphasia." A tendency to repeat a word once pronounced is sometimes present and bears the name "echolalia." The same faults occur also in writing, as faulty spelling, misplacement of letters and words, wrong words, "paragraphia" and "echographia." Dr. Head has classified those defects which may be due to the cortical lesion as (*a*) Verbal and Syntactical, which have to do with the faulty pattern of speech, (*b*) Nominal, which are the difficulties of recall, and (*c*) Semantic, which are the troubles of confused speech intelligence; and he suggests that the first of these groups is associated more particularly with damage to the anterior half of the speech cortex, and the second and third groups with damage to the posterior half. It is quite certain that these three groups make their appearance in this order with an increasingly extensive lesion of the speech area. Much defect of general intelligence always accompanies severe damage to the speech area, and this will be readily understood from the very large rôle which speech patterns play in the working of thought. Difficulty in the recall of words and speech patterns, which has been termed "verbal amnesia" or "nominal deficiency," is a characteristic feature of lesion of the speech area, and as a purely functional defect is a common experience in all of us when we are at a loss for a word or a name, or fail to express our meaning clearly, especially when the physiological level of the speech function is depressed by stage fright, or lack of confidence, or other embarrassment in consciousness. This difficulty is greatest with spontaneous revival than with recall, which is "kicked up" by direct sensory stimulation. For example, an aphasic person who is unable spontaneously to utter a word, may repeat the word at once when it is spoken to him, when he sees it in writing, or when the corresponding object is shown to him. It is greater with single words, especially with nominals, and less with sentences. For example, a patient was asked to say "No," and after vain endeavours he ended by saying, "I can't say 'No,' sir." Here the impossible word was brought up in the run of the pattern. It is important in this connection to bear in mind that we do not speak in the letters of the alphabet, nor in the words of our dictionary, but in a running pattern of sound. The pattern or context provides the meaning, while the individual words are negligible and have no meaning unless we put them into another pattern by parsing them. During the long ages in which man spoke before the invention of writing, he used the running pattern of sound, not yet arbitrarily made up of letters and divided into separate words. From this will be explained why an aphasic will often gather something from a sentence or speech pattern when he

accepts no meaning from a single word, and why he may be able to put forth a proposition in the form of a sentence when he cannot utter any one of the words composing it singly. The power of the pattern in aiding revival is very great both from sequence rhythm and musical quality. As examples, an aphasic who has no utterance spontaneously is told to count with his interlocutor. The interlocutor begins counting, the aphasic joins in. The interlocutor then stops, but the aphasic continues counting, carried by the sequence rhythm. Again, a patient under my care totally aphasic from a puerperal thrombosis, who had no speech acceptance and no speech utterance, was observed to join in with a hymn that was being sung in the ward and to sing lustily with only the slightest mutilation of the pattern. On the next occasion that this hymn was sung, orders were given for the singing to stop suddenly in the middle of a verse, when the aphasic patient went on singing alone, and the music continuing, she finished the hymn. This case clearly proves that the condition was not one of destruction of centres in which speech reception and speech exteriorisation were concerned, but it was one in which the speech function as a whole was depressed beyond power of physiological action from a lesion of the speech area, but yet could be roused into a condition of relatively high activity by the emotional element of rhythm and music. Dr. Hughlings Jackson reported a case of the inmate of an infirmary who had been bedridden and without utterance for years by reason of a Sylvian thrombosis, who waking in the night to find his ward in flames was so stirred by the prospect of being immediately roasted, that he shouted "Fire! fire!" with such vehemence as to summon the assistance by which he and his fellow inmates were saved.

The same phenomena are observed upon the acceptive side of speech as have been just exemplified upon the expressive side. Dr. Head has shown that patients who seemed entirely unacceptive of spoken and written speech could still match an object with its name, or a colour with its name, from among a set of objects, colours and names presented simultaneously. Here the sensory stimulus of both the object and its printed name served to rouse the speech function into some degree of recognition.

The confusional or semantic defects of speech function are met with in extensive damage to the speech area, and are usual as immediate and transient phenomena in all suddenly occurring lesions of the speech area. There is general mental dullness, with varying degrees, usually severe, of depression of speech function, and much confusion, both on the acceptive and expressive side, when any of these functions remain, and the results of the examination of the speech faculty are apt to vary very much from moment to moment, for attention is very difficult to hold and the patient is easily fatigued and bored. Severe degrees of this form of defect may be associated with inability to recognise objects—"object-blindness," and with loss of ability to convey ideas by gesture—"amimia."

Prognosis.—In attempting to estimate the degree of recovery which is likely to occur in cases of aphasia, it is necessary first to bear in mind that sudden cerebral injury is apt at first, by the process which has here been described as functional depression or "diaschisis," to cause very wide loss of function, though the lesion may not be very extensive. A total aphasia, for example, is often the immediate result of lesion of moderate size. Such phenomena last usually not longer than a week, and until they have passed off

it is impossible to make a definite statement, either as to the extent of the lesion or the likely degree of recovery. Speech may be regained by two entirely separate processes—either by recovery of function in partly damaged and functionally depressed areas, or by compensatory activity in the potential speech area of the undamaged hemisphere. The possible recovery of function will depend upon the nature of the lesion and upon its extent. It will be greater when a lesion may be judged to be one of pressure rather than of actual destruction, if such pressure be removable, as in sub-dural hæmorrhage, abscess and gumma, and least when widely spread arterial disease and a failing heart suggest that the lesion is a thrombosis, and when an irremovable tumour is present. The greater the extent of the lesion if it be presumably from vascular occlusion, as judged by the associated signs, paralysis, anæsthesia and hemianopia, the less is the chance for functional restitution, as there is then little hope of any useful restoration of the circulation through collateral vessels. When the lesion is deeply seated, as, for example, a lesion of the left internal capsule, producing dysarthria, the probability of recovery is great, as there is an alternate path for speech execution, by way of the corpus callosum and right pyramidal path. The capacity of transference of function from a damaged speech area to the corresponding region in the other hemisphere, varies so much in individual cases that few definite statements can be made with regard to prognosis, but as a rule the younger the patient is, the more certainly does this compensation occur. In children under the age of six years, unilateral lesions produce no permanent speech defects, provided sufficient intelligence remains, but even to this rule some important striking exceptions have been recorded. When adult life is reached, transference seems to occur but little, yet in a few recorded instances destruction of the posterior half of the speech area has been followed by an almost complete restoration of speech function.

Treatment of Speech Defects.—A careful and patient system of re-education in speech, such as is used in teaching mentally deficient children, is often of great value in all forms of speech defect. From the amount of labour that the teacher has to expend for very little progress made, this treatment is not often given a fair trial. A fair degree of intelligence must be present, and care must be taken that the lessons are not prolonged to the production of the boredom, with accompanying inattention and confusion, which occurs so readily in aphasic patients. The utterance of a simple vowel sound should first be taught, then that of the several vowel sounds, and afterwards that of consonants and their combinations, and the patient should be directed while learning to watch the movements of the lips, etc., of the teacher. The simultaneous presentation of an object with its spoken and written name is often helpful in stimulating the remains of speech function into activity. An intelligent patient soon comes to recognise under such tuition that he has no paralysis of the articulatory mechanism.

Testamentary Capacity.—No rule can be laid down as to the capacity of a person suffering from speech defects to exercise civil rights and to make a will, and each case must be judged upon its own merits. The first and all-important consideration is the degree of intelligence, and when this is good it is essential for such capacity that there should be some mode of cognition and of expression left. Pure word-blindness and the extremely rare condi-

tion of pure word-deafness do not interfere with the exercise of civil rights, for the patient can understand what he hears in the first case, and what he reads in the second, and in both conditions can express himself both in speech and writing. In cases of pure aphasia and pure agraphia there is complete civil capacity, but when, as usually happens, the two conditions co-exist, though intelligence and the receptive side of speech may be but little impaired, yet the expressive side of speech is reduced to gesture, and extreme difficulty may be met in ascertaining the patient's wishes. Auditory amnesia, and combined auditory and visual amnesia, and confusional defects, except in the slightest forms, interfere seriously with testamentary capacity and with capacity for exercising civil rights. In such cases there is great loss both on the acceptive and on the expressive sides of speech, with confusion of memory and impairment of intelligence. Most satisfactory results have, however, many times been brought about in apparently hopeless cases by careful, sympathetic and repeated procedures, in which the properties to be bequeathed and the likely legatees are assembled before the patient, thus allowing the testator to match the gift with the recipient. The proceedings should be conducted in the presence and under the direction of a physician thoroughly conversant with the subject of aphasia. All concerned should bear two points in mind, the one being that the wishes of the legator must be paramount, and the other that an obviously just will is most difficult to upset in a court of law.

THE METHOD OF EXAMINATION of patients suffering with speech defects should be in accordance with some definite scheme so drawn up as to test each function of the complex physiological process of speech.

The following scheme is convenient: (1) Is the patient right- or left-handed, and, if the latter, did he write with the right hand? (2) What was the state of education as regards reading, writing and foreign tongues? (3) Does he understand the nature and uses of objects, and can he understand pantomime and gesture, or express his wants thereby? (4) Is he deaf? If so, to what extent, and on one or both sides? (5) Can he recognise ordinary sounds and noises? (6) Can he comprehend language spoken? If so, does he at once attempt to answer a question? (7) Is spontaneous speech good? If not, to what extent and in what manner is it impaired? Does he make use of wrong words, recurring utterances, or jargon? (8) Can he repeat words uttered in his hearing? (9) Is the sight good or bad, is there hemianopia, or papilloedema? (10) Does he recognise written or printed speech and obey a written command? If not, does he recognise single words, letters, or numerals? (11) Can he write spontaneously? What mistakes occur in writing? Is there paragraphia? Can he read his own writing some time after he has written it? (12) Can he copy written words, or from print into writing? Can he write numerals or perform simple mathematical calculations? (13) Can he read aloud? (14) Can he name at sight words, letters, numerals and common objects? (15) Can he write from dictation? (16) Can he match an object with its name, spoken or written, when a series of objects and names are simultaneously presented? (17) Any other tests, emotional, rhythmical, or musical, which may raise the physiological level of the speech centres. (18) Any other means of proving in what way he can receive and express ideas.

Impediments of Speech

1. Stammering or Stuttering.—A spasmodic defect of articulation leading to a sudden check in the utterance or words, or to a rapid repetition of the consonantal sounds in connection with which the difficulty arises. To the trouble with articulation are often added spasmodic movements of the face and head, or indeed of any part of the anatomy.

Except in the rarest instances this condition is not associated with any structural changes in the nervous system nor in the organs of articulation, but it has been observed as the end result of a lesion of the speech area. The disorder seems to consist in a lowering of the functional stability of the executive speech mechanism by a physiological embarrassment in consciousness. It is begotten of shyness and self-consciousness. It is never congenital, nor met with in early infancy, but arises at the age when shyness and self-consciousness trouble youth most. It is infinitely commoner in boys than in girls, for the latter are much less liable to self-consciousness. The stammerer never stammers in the speech of thought, nor when talking aloud to himself alone, nor at any time when singing, for in the two former cases the embarrassment of self-consciousness is absent, and in the last case the element of rhythm and music greatly increases the stability and confidence of the function. It not uncommonly appears in conditions of debility, and especially after measles and diphtheria. It has a frequent origin in sudden fright, and during the Great War thousands of soldiers who had never stammered before were thus afflicted. It is the historical utterance of fright and of those who find themselves suddenly "flagrante delicto." In rebellious cases the element of self-consciousness seems to disappear, while the stammer persists as an ineradicable habit, and it is remarkable how many sufferers of this class have strong aspirations towards public speaking.

In articulate speech three muscular mechanisms are concerned—(1) the respiratory mechanism for supplying the blast of air, (2) the larynx for producing the voice, and (3) the muscles of the lips, tongue, jaw, and palate for articulation. For distinct speech there must be absolute co-ordination of these mechanisms one with another. Consonants are in nearly all cases the source of the difficulty in stammering, and while these are all buccal sounds, yet some begin with a laryngeal sound, while others are purely buccal. The former are termed "voiced consonants," and are B, W, V, Zh, Z, Th (as in "thus"), D, L, R, G, Y; and the latter "voiceless consonants," and are P, F, Th (as in "thin"), S, Sh, T, K; while N, M, and Ng terminal are "voiced nasal resonants." If one articulates these consonants it becomes at once clear that it is the presence of the initial laryngeal element or "voicing" which makes the difference between B, V, Z, D, G, and P, F, S, T, K, respectively.

A careful attention to the manner in which the letter sounds are produced is absolutely essential in the investigation and treatment of stammering. The difficulty occurs most commonly with the explosive consonants, P, B, T, D, G, K, and nearly always where these occur as initial letters—that is, in starting the articulatory mechanism; and to avoid this difficulty which arises after every pause, most stammerers speak in a rapid monotonous

fashion. The fault chiefly lies in the direction of energy to articulation rather than to phonation. The patient held up by his stammer usually remains silent, but occasionally, having produced the first sound, he continues to repeat it—the reduplication stammer which has been the origin for the names "stammer" or "stutter" by which the malady is known.

Often the patient uses a trick or contortion to prevent the stutter or to relieve the feeling of nervous tension and embarrassment in consciousness which the defect causes, and these tend to become engrafted on him, as (1) associated sounds—whooping, grunting, crowing, etc.; (2) habit spasms—contortions of the face, limbs, or body, which sometimes take a complicated form and exactly resemble the co-ordinated forms of tic.

Prognosis.—The majority of the cases tend to a spontaneous cure, and recovery is hastened in all cases by systematic treatment. In every class of case the results of treatment may come slowly at first, but perseverance will in almost every case bring success.

Treatment.—Attention should be paid to conditions of general health, and to the mental well-being and satisfaction of the child, with plenty of scope for pleasure and satisfying occupation. Subjects of a highly nervous and sensitive temperament are often much benefited by a course of strychnine, bromide and glycerophosphates, and also by aspirin—which should always be employed in a stammering child who is suspected of being rheumatic.

The patient should be removed as far as possible from causes tending to increase his self-consciousness and from the ridiculing of his defect, and he should have daily speaking exercises. It is well for him to speak, read, or recite in a large room alone, loudly, slowly and distinctly. The following system for such exercises is useful: (1) The chest must be kept well filled with air. This most important point is often most difficult to the patient. (2) He must speak slowly, with a full resonant voice. (3) When he comes to the word on which he tends to stutter, he should raise his voice and direct his energies to vocalisation, and not to articulation. If the difficulty be over a voiced consonant, he must be directed to voice it firmly. If the consonant over which he stumbles be a voiceless one, attention must be directed to the vocalisation of the subsequent vowel sound; for instance, in "pat" he must attempt to vocalise the "at," and he will find little difficulty in prefixing "p" as the syllable is uttered. (4) Gymnastic and singing exercises are valuable additions to treatment. Should associated movements be present, the speaking exercises may be carried on in front of a mirror, so that the patient may see these himself and endeavour to suppress them.

The development of confidence and self-reliance is everything in the treatment of stammering. The skilled teacher first gains the liking, respect, and submission of his patient. He then assures him that his defect will disappear, and that he can cure himself, and demonstrates to him by correcting the faults that he can speak normally. When stammering arises suddenly as the result of shock, as in the Great War cases, it should be treated as is aphonia and other hysterical paralyses, by demonstrating to the patient that his trouble is superable. I have seen a queue of such stammerers who were waiting for treatment cured by the emergence of the worst of their number from the "wizard's den" proclaiming his recovery.

2. LALLING.—A defect due to want of precision in the action of the oral articulatory mechanism. It characterises the speech of many children before the art of articulation is completely learnt. It is only a persistent condition in some cases of defective intelligence.

3. LISPING.—A defect due to the indistinct enunciation of certain consonants, or to the substitution of wrong consonants. It usually occurs in connection with the sounds of Th, R, and S, which change to V, L, and Th respectively. The condition, which is almost usual in infants learning to speak, is due to faulty articulation, and may become a habit, in which case the subject has probably a bad "ear" for sound. Defective conformity of the mouth may cause it; for example, a "tongue tied" person can never pronounce the English R correctly.

4. IDIOGLOSSIA.—A condition in which from the first moments of learning to speak, a child uses wrong consonants, or rather he tends to substitute three or four consonants for the whole series. Very slight degrees of idioglossia are common in little children, whose early speech is intelligible only to their nannies. In marked cases the child comes to speak a language entirely its own. The following admirable illustration is given by Dr. Colman from one of his patients, who thus repeated the Lord's Prayer:

"Ouë Tahde na ah in edde, anno de Di nay, I tidde tah, I du de di on eet a te e edde, te ut te da ouë dade ded, e didde ouë tetedde a ne ahdin to te tetedde adase ut, ne no te tetate, ninne utte enu, to I ah te ninne, pouë e dordy to edde e edde. Amé." This patient substituted "t," "d," or "n" for most of the other consonants.

The course of time and education removes the defects of lisping, lalling, and idioglossia, and the prognosis in all these conditions is invariably good.

Any deformity of the articulatory organs should be remedied if possible.

5. APHTHONGIA.—A condition in which the attempt to speak sets up severe spasms in the muscles of articulation, chiefly in the tongue. Nothing is known of the pathology of this rare disease, which from the descriptions (for I have never seen an example) may be akin to myotonia, tetany, or occupation cramp.

JAMES COLLIER.

APRAXIA

Definition.—A disorder of cerebral function, characterised by inability to perform certain familiar purposive movements, in the absence of motor and sensory paralysis and ataxia. This disorder does not depend upon defective perception (agnosia) nor upon general reduction of intelligence.

Ætiology.—Apraxia may result from both general and local diseases of the brain. It may be met with in general paralysis of the insane, in cerebral sclerosis and in several forms of dementia, and in paralytic chorea. It occurs in its purest form from local lesions of the brain, and may then be confined to one region of the body. It may result from lesions of the posterior part of the prefrontal area of the left side, the so-called "motor or verbal" aphasia and agraphia being good examples of apraxia of speech, and lesions in this region may also cause right-sided apraxia of the limbs. Lesions of the anterior half of the corpus callosum have been associated with conspicuous apraxia, as have also bilateral lesions in the posterior parts of

the hemispheres. In the latter cases, the apraxia is likely to be associated with some degree of lack of recognition of an object, and of its uses (agnosia), and this causes apraxia from a loss of correct comprehension of the act required. Von Monakow is of opinion that lesions of the supramarginal gyrus cause apraxia. Apraxia is sometimes met with in cases of hemiplegia in which, notwithstanding the complete recovery of motor and sensory paralysis, the performance of familiar acts—from the highest skilled movements, such as the fingering of the pianoforte or of the violin, or the use of his tools by a craftsman, to the simplest act—may be no longer possible. Apraxia may be summarised as an inability to convert a correct idea of an action into the required movement. The features of the condition may be well demonstrated by the consideration of left-sided hemiapraxia. There is neither loss of power nor loss of sensibility in the left upper extremity. When such a patient is asked to perform some familiar act with the right hand, he at once does so correctly, but when ordered to perform the same act with the left hand he is unable to do so. Either he makes aimless wandering movements with the left hand, or he may succeed in making movements somewhat resembling those required of him, with much slowness and clumsiness. Sometimes he may perform some act which is entirely different to that required of him, and this phenomenon is called parapraxia. When the apraxia is partial, the patient may be able to perform some acts and not others, his inability usually, but not always, increasing with the complexity of the act required. Or he may be able sometimes to perform an act in which he commonly fails. Not infrequently such a patient, wearied with the unsuccessful attempts of his left hand, will abruptly perform the act correctly with his right hand, to get rid of it. And he will define his defect by saying, "I know quite well what you want me to do, but I cannot do it." Spontaneous volitional movement is similarly affected, and this leads invariably to a marked loss of initiative in the use of the affected limb—the patient will not try to use it. The apraxic patient is often to an astonishing degree unaware of his disability, and frequently becomes conscious of it for the first time when it is pointed out to him by another person. For instance, a patient who had been skilled in boxing, was affected with apraxia of the left upper limb. When asked by his physician to stand up and spar with him, he at once arose with evidence of confidence and pleasure, and placing his feet, body and right arm in the correct position, commenced to box with his left upper extremity swinging helplessly from the shoulder. He then for the first time became aware of his disability.

Diagnosis.—Apraxia may be confused with astereognosis, with agnosia and with cortical ataxia. A correct conception of the nature of the two former conditions will exclude the possibility of error. In cortical ataxia the patient obeys the word of command at once and succeeds more or less with the act required, the defect being clumsiness of execution. The clinical examination of patients for apraxia must include—(1) the general psychical condition as regards attention, memory and reasoning; (2) an inspection of sensory appreciation for defects of simple perception in the regions of smell, sight, hearing, taste, cutaneous sensibility and muscular sense; defects of recognition of sensory impressions in these regions (agnosia); defects of memory; and (3) an examination of executive power for any defects in the movements determined by visual, auditory, tactile and kinæsthetic

stimuli. What response does the patient make to objects held in front of him or to gestures made to him ? Can he imitate movements ? Can he when requested make simple and purposive movements, with and without the objects in his hands ? When given an object, how does he hold it and use it ?

AGNOSIA

In certain conditions of cerebral disease, it is found that each and all of the sensory organs, when called into play, may fail to arouse an intelligent perception of the object exciting them. This inability to recognise the import of a sensory stimulus is called agnosia. Those patients who present apraxia and agnosia, often show other interesting phenomena which are of importance ; these are (1) inattention, (2) defective capacity for retaining recent impressions, (3) lack of initiative, and (4) perseveration. Perseveration consists in the repetition of an already executed movement when and only when the patient desires to make a fresh movement. A patient of Pick's, for example, blew out a candle and then blew upon all objects presented to him during the next few minutes. The relation of apraxia and agnosia among the disorders that impair voluntary movement is well shown by a scheme which, passing along the cerebral sensory-motor path from sensory to motor, sets down in order these clinical conditions. The following scheme is from Kinnier Wilson's monograph :

(1) Cortical blindness, cortical deafness, cortical sensory paralysis,—loss of visual, auditory and cutaneous, etc., ingoing impulses. (2) Cerebral ataxia : loss of afferent kinæsthetic impressions, resulting in erroneous estimation of range of movement, power, etc. (3) Mind palsy : incapacity of movement from loss of kinæsthetic memories for complex movements. (4) Agnosia : Conservation of sensation, but failure of recognition ; loss of sensory memories. (5) Ideational agnosia : loss of the spatial associations and interconnections which make up the idea of an object from its component ideas. (6) Ideational apraxia : defective synthesis of the ideational components in a movement-complex. (7) Motor apraxia : intactness of the cortico-muscular apparatus, but inability to translate a normally produced idea of movement into its corresponding movement-form. (8) Cortical motor paralysis.

CEREBRAL DIPLEGIA

Synonyms.—Congenital Spastic Paralysis ; Lobar Atrophic Sclerosis.

Definition.—A series of clinical conditions, dependent, not upon gross local lesions of the higher nervous system, but upon lack of, or imperfect development, or degeneration of the nerve cells of the cerebral cortex, basal ganglia or cerebellum. This agenesia of nerve cells may affect those cells of the pyramidal system which are the latest to develop before birth, namely those for the supply of the lower extremities and the resulting clinical condition is cerebral spastic paraplegia or Little's disease, or all the cells of the pyramidal system may be affected, producing generalised spastic rigidity.

Again, the higher regions of the cortex may be affected, and the result is congenital idiocy. Similar affection of the cells of the basal ganglia result in congenital bilateral athetosis, and congenital chorea. When the cerebellum is involved, congenital cerebellar ataxy results. Further, there may be any combination of the above conditions. Lastly the whole of the cells of the entire nervous system may be progressively affected, as in amaurotic family idiocy.

Ætiology.—The malady may be apparent at the time of birth, as the child may be born with contractures present. More often, the signs of deficient or perverse movement, or of mental deficiency, appear during the first year of life, as the signs of cerebral activity commence to be exteriorised. In other and rarer cases, the degeneration of the nerve-cells seems to be truly post-natal in onset, as in amaurotic family idiocy. In most cases no heredity can be traced, but sometimes several children of the same mother may be affected, and direct heredity has been known. Amaurotic family idiocy is always familial, and is almost, but not quite, limited to the Hebrew race.

Abnormalities of birth are remarkably frequent. Premature birth, precipitate birth, prolonged birth from uterine inertia rather than from dystocia, and asphyxia neonatorum are all common, and it is possible that prematurity and asphyxia neonatorum may be definite causal factors in some of the cases. Maternal ill-health during pregnancy has occurred in a few cases, but it is usually conspicuous by its absence.

If we regard the brain from the time of its earliest stages of development as a field sown with seeds (neuroblasts), which germinate at different periods of fœtal life, and the germination is not even complete at the time of birth, the germination of all the elements in due time and their complete development being necessary for the formation of the perfect brain, then we may liken the cause of diplegia to some baneful influence, such as a frost, which acting at a particular time, may spare those seedlings which are well developed and able to withstand it, and those seeds as yet not germinated, but which causes havoc among the tender germinating seedlings, either to their death or severe maiming. In some cases, as, for example, in Little's disease, the neuroblasts thus affected may, after a period of retarded development, ultimately become strong plants and complete their development. The nature of this baneful influence is mysterious. It may be of the nature of a toxin, or of an internal secretory deprivation. It is of interest, that in the highest degrees of cerebral agenesia, anencephaly, pituitary abnormalities seem to be constant.

Pathology.—The essential histology of the affected regions is that of non-development, paucity in numbers and degeneration of the nerve cells, with corresponding absence, poor development, degeneration or a combination of these states, of the tracts which spring therefrom. The pyramidal tract, for example, may be found absent throughout, or it may reach to the medulla, or to the cervical region only, and so show at what period development was arrested. The changes in the nerve cells are followed by secondary gliosis, and the affected regions are firmer and smaller than normal. The final result is termed atrophic sclerosis, which is greater in degree, the more severe the case, and the longer life has been preserved. The atrophic sclerosis may affect the whole surface of the hemispheres equally, but more often certain regions are profoundly affected, while others escape relatively or completely;

but the distribution is always symmetrical upon the two hemispheres. In generalised rigidity with idiocy, the whole of the hemispheres may be affected. Where motor symptoms are slight and mental reduction profound, the frontal and occipital regions are predominantly affected. In paraplegic rigidity, the atrophy is confined to the paracentral lobes and neighbouring convolutions upon the convexity of each hemisphere, a lozenge-shaped depression of remarkable appearance occupying the summit of the cerebral vertex. In the atrophied region, the convolutions are unduly hard to the touch. They stand away from one another and are smaller than are normal convolutions, and the sulci between them are widened. Their surfaces often present a worm-eaten and faceted appearance. Each convolution is ridge-like, and does not preserve its level, now sinking and now rising. This irregular form of the convolutions, with wide, separating sulci, gives the brain a characteristic appearance, like that of a walnut kernel. Affection of the cerebellum causes a similar shrinking and hardening. Sections of the brain stem and spinal cord may show a complete, or relative, absence of the pyramidal tracts.

Symptoms.—The clinical picture of the several forms of cerebral diplegia presents a combination in varying degrees of certain characteristic symptoms, always bilaterally distributed, though sometimes more severe on one side than on the other. These symptoms are: muscular rigidity, paresis, perverse movements, contractures and increased deep reflexes. Mental deficiency, optic atrophy, ocular palsy, ataxy, and bulbar paralysis are other important symptoms. The signs of the disease become obvious during the first year of life or soon after. In severe cases, soon after birth, the nurse, in washing the child, is the first to notice the stiffness of the limbs, or the regular assumption of a curious bodily attitude. Otherwise, the abnormalities may not be obtrusive, until the child should sit up or learn to get about, when weakness, rigidity, perverse movements and pes cavus may call attention, or backwardness in learning to walk and to talk, and mental deficiency may first suggest that there is something wrong with the child. The following are the common types of the disease, but it must be remembered that any combination of, or transition between, the types may be met with. Amaurotic family idiocy has certain peculiar features which necessitate a separate description for this malady:

1. *Generalised rigidity; general congenital spastic paralysis.*—There is extensive defect of the pyramidal system. The rigidity and weakness affect the whole of the musculature.

2. *Paraplegic rigidity; congenital spastic paraplegia; Little's disease.*—The pyramidal deficiency is confined to that supplying the lower part of the trunk and lower limbs.

3. *Congenital bilateral athetosis and congenital chorea.*—The agenesia affects the cells of the basal ganglia, with the appearance of irregularity of movement, and of spontaneous involuntary movements, which may be of an athetotic, choreic or irregular type. A certain variable degree of general rigidity is present in these cases.

4. *Congenital cerebellar ataxy.*—The agenesia affects the cerebellum with the appearance of cerebellar ataxy. In this type, the limbs are flaccid, and in mixed cerebral and cerebellar types there is a tendency to hypotonicity of the muscles, instead of rigidity.

5. *Congenital idiocy; restless idiocy.*—The agenesia affects those parts of the brain concerned with the higher functions. These children are emotionless, restless and unteachable. The skull often shows frontal or occipital microcephaly.

6. *Microcephalic idiocy*—where the agenesia is of the whole brain and the skull very small.

7. *Amaurotic family idiocy.*

PARESIS AND RIGIDITY.—Except in severe cases, in which the weakness amounts to complete paralysis, there is more rigidity than weakness, and it is often astonishing that there should be so much power in the presence of such a degree of rigidity. The lower extremities are generally the most affected, the upper to a less degree, and the facial region still less. Movement is slow and clumsy and resembles that of the tardigrade animals, and spontaneous involuntary movements are often present in the limbs. Contractures accompany the rigidity, and if walking is possible the gait is digitigrade from contraction of the calf muscles, the knees are flexed from contracture of the hamstrings, the thighs are rotated inwards, and the knees pressed together, rubbing against one another. More severe adductor spasm gives rise to the cross-legged progression. The rigidity and contractures, when severe, may give rise to peculiar attitudes and deformities. A mask-like expression of face, with wide palpebral apertures and large open mouth, is not infrequent. Slobbering is very common. The head may be rigidly retracted, but more commonly the chin is pressed down upon the chest. The spinal column generally shows some deformity in the way of kyphosis, lordosis or scoliosis, and pes cavus or equino-varus is the rule.

PERVERSE MOVEMENTS.—Under this heading must be grouped the very constant maladroitness of voluntary movement, the facial over-action and grimacing in speech and in mimetic expression, choreic movements, athetotic movements and intention tremor. Common sensation and the muscular sense are unimpaired. The sphincters are unaffected. The deep reflexes are increased, but are often difficult to obtain when rigidity is very marked. The trunk reflexes are often absent, the plantar reflexes usually are extensor in type. Since the growth of the skull follows and conforms with that of the brain, cranial abnormalities are common. There may be microcephaly, asymmetry and flattening in the region of the central convolutions, or a furrow corresponding with the interhemispheric fissure, or frontal, or occipital smallness and flattening. Every degree of mental reduction may be met with, from precocity and slight mental dullness to complete amentia. But this by no means corresponds with the severity of the bodily symptoms, for the mental defect is often most severe, when the bodily symptoms are slight, and conversely. In some cases, very high intelligence persists, when there is utter uselessness of the limbs, and when speech is hardly intelligible. Primary optic atrophy occurs in a small number of cases. Inequality of the pupils and slowness of light reaction are not uncommon. Nystagmus is often met with. Convergent strabismus occurs in about one-third of the cases. Convulsive attacks are of common occurrence, and in about one-eighth of the cases epilepsy becomes established.

Diagnosis.—When the symptoms are well marked, the diagnosis presents little difficulty, since the disease dates mostly from birth, or is discovered during the first year of life. Paraplegic rigidity may possibly be confused

with other forms of paraplegia, and, especially, with that resulting from spinal caries. Certain cases of pontine tumour may closely resemble generalised rigidity. The occurrence of such conditions during the first two years of life is, however, very rare.

Prognosis.—In many cases of generalised rigidity, and in all cases of paraplegic rigidity, there is a tendency to slow amelioration of the rigidity, an increase of voluntary power and control of the muscles in the course of time, especially under the influence of careful training, and in paraplegic rigidity, if the mental acuity be not seriously impaired, laborious treatment may result in an almost normal condition of the limbs by the age of puberty. On the other hand, some cases of generalised rigidity become progressively worse, and succumb, usually before the end of the fourth year. Bilateral athetosis and choreic diplegia, as a rule, follow a very slowly progressive course, without tendency to a fatal result. Paraplegic rigidity apart, a great many of the cases of all forms of diplegia succumb before the sixth year, and in those who survive this age, the tenure of life is short, few reaching far into the third decade of life.

Treatment.—In those cases with a marked degree of mental impairment, and in those which show a course of progressive degeneration, no treatment is of avail. In slighter cases of generalised rigidity, and in paraplegic rigidity, treatment is to be directed to the prevention of the rigidity, to regaining of voluntary control, and the improvement of mental acuity. There is, perhaps, no disease which demands greater patience and persistency in carrying out of suitable treatment, and there are few diseases in which more brilliant results may be produced from apparently hopeless cases by pertinacity in treatment. It is in the early years, when treatment is for the most neglected, that good results are more quickly and readily obtained. From the first, regular massage and passive movements should be employed. Voluntary movement should be encouraged, as far as possible, and as power and movement increase, gymnastic exercises of every kind should be employed. Rigid apparatus for prevention of deformity and to reduce contracture is harmful, for it increases the weight of the limb, and interferes with movement, which is the remedy with which paralysis is to be combated. Tenotomy is of great service in the relief of deformity and contracture, and should be soon followed by passive movements. It should never be performed, unless a fair degree of voluntary power is present. Many of the patients seem to improve more rapidly if thyroid extract be administered in moderate daily doses.

Amaurotic Family Idiocy

1. Waren Tay-Sachs' Disease: The Infantile Form

Definition.—A family disease of infancy occurring chiefly, but not entirely, in the Hebrew race, affecting children during the first year of life, who are apparently quite healthy when born, and characterised by—(1) progressive mental impairment, ending in absolute idiocy; (2) progressive paralysis of the whole body; (3) progressive diminution in sight, ending in absolute blindness. Pathognomonic retinal changes are constantly present, consisting of a large and conspicuous "cherry-red spot" in the region of the macula, and, in addition, optic atrophy occurs later and (4) a fatal termination in the marasmic state before the age of 2 years.

Ætiology.—Nothing is known of the ætiology of the disease apart from its familial and racial incidence. The tendency to the disease is unquestionably congenitally installed.

Pathology.—This is very striking. It consists of a progressive degeneration of the nerve cells from the highest to the lowest, and ultimately there may be no normal cells remaining anywhere in the nervous system. The degeneration takes the form of swelling of the cell protoplasm, and of the dendrites with chromatolysis, swelling of the hyaloplasm and destruction of the cell fibrils, followed by disappearance of the nucleus, and finally by absorption of the remains of the cell. Every cell of the central nervous system both of the brain, spinal cord and spinal ganglia, is in the end similarly affected.

Symptoms.—There are few diseases in which the *clinical manifestations* are so perfectly uniform as in this malady. The children have all been born at full term, and in perfect health. They thrive well during the first 3 to 6 months of life, when they gradually become listless and apathetic, cease to take interest in the surroundings, and begin to show signs of the visual failure which ends in blindness. Later, the child is unable to sit up, or to hold up its head. The limbs, which may be slightly spastic at first, become flaccid and motionless. There is a gradual increase of all these signs. The mental defect becomes more and more noticeable, the paralysis more extreme, complete blindness follows, and the patient sinks into a condition of marasmus, in which he dies. Convulsions, nystagmus and strabismus are sometimes present.

The retinal changes are pathognomonic and are due to a degeneration and disappearance of the nerve cells of the retina and their processes, which constitute the fibres of the optic nerve. This change is most intense in the region of the fovea centralis, where the retina thins and disappears over a circular area, exposing the vascular choroid. This gives rise to the characteristic appearance, on ophthalmoscopic examination, of a cherry-red spot in the region of the macula. This spot is actually a hole in the retina exposing the choroid. The optic disk shows progressive atrophy.

Diagnosis.—Distinction has to be made between this and other forms of progressive diplegia. The symptoms are so distinct, that a physician, who is acquainted with the disease, and able to recognise the retinal picture, can hardly fail to make the correct diagnosis.

Treatment.—No treatment is of any avail.

2. OTHER FORMS OF AMAUROTIC FAMILY IDIOCY

In addition to the classical *infantile form* described in the preceding article, cases have been observed in which, while the pathological changes are the same as in Waren Tay-Sachs' disease, the incidence is non-racial, the onset of the disease is later, the ophthalmoscopic signs are different, and the course is slower. According to the age of onset, these are classified as the *late infantile form* and the *adult form.* In these two forms, there is no cherry-red spot at the macula. The characteristic ocular change is a disturbance of the retinal pigment—a kind of retinitis pigmentosa—around the macula, with or without optic atrophy; in some cases optic atrophy alone is found; rarely, vision is normal and the fundi are healthy. Otherwise, the symptoms are the same as in the infantile form.

INFANTILE HEMIPLEGIA

While in childhood hemiplegia of slow onset is due to the same causes as in adults, cerebral tumour being the common cause and chorea not an infrequent one, yet the majority of the cases of infantile hemiplegia of rapid onset are examples of diseases peculiar to children, to which no comparable disease occurs in adults, and to such cases the term "infantile hemiplegia" is restricted. These conditions are due to gross organic lesions of the brain, and for this reason must be strictly separated from the cerebral diplegias which are the result of cell lesions and not of gross lesions.

Ætiology.—In two-thirds of all the cases, the onset occurs within the first three years of life. The malady becomes increasingly rare as childhood advances. A few of the cases are of prenatal origin, and some of these have been proved to have been due to injury to the fœtal brain from a blow upon the mother's abdomen, while others are due to syphilitic fœtal vascular disease. In a third class of mysterious origin, mothers have given birth to several hemiplegic children, examples of which we have recorded. Some of these children are born with definite hemiplegia and contractures. Again, a very few cases are due to obstetrical events during birth, by which the cerebrum is injured. Acute infective diseases play a very important rôle in the causation of the disease, for about one-third of all the cases develop the malady during the course of a known infection. By far the most important of such fevers are measles and scarlet fever, but hemiplegia may occur in the course of pertussis, small-pox, rötheln, diphtheria, dysentery, pneumonia, typhus, typhoid, mumps, malaria, chorea and endocarditis. While there can be no doubt that primary vascular lesions are responsible for a few of the cases in which this condition complicates the specific fevers, whooping-cough, for example, may cause cerebral hæmorrhage; marasmic conditions in any fever may cause thrombosis of cortical veins, and chorea and endocarditis may cause embolism, yet it is certain that in the majority of cases, an inflammatory focal lesion of the brain or encephalitis is the pathological lesion. In cases which arise with no definite ætiological connection, it seems clear that a primary encephalitis is responsible, and in a large number of instances the cerebral form of poliomyelitis is certainly the cause of the malady.

Pathology.—There is but rarely any opportunity for the examination of the brain until long after the occurrence of the primary lesion, and it is sometimes difficult to deduce with accuracy the exact nature of the primary lesion from the end results. The following lesions are met with, either alone or combined in order of frequency: (1) Atrophic sclerosis; (2) cyst formation; (3) shrunken patches resembling wet wash leather, with some degree of atrophic sclerosis in their vicinity, and (4) porencephaly. Of these, the atrophic conditions seem to be the results of encephalitis, which may also cause some cyst formation; the cystic conditions may result from the above, or from hæmorrhage or thrombosis, and porencephaly is certainly due to embolism.

Symptoms.—The onset is rapid, and in two-thirds of all the cases the disease is ushered in by convulsions, which may be unilateral, but are more frequently general, and are frequently repeated during a period of from a

few hours to 24 hours, after which the patient sinks into a subconscious state, from which he gradually emerges in the course of a few days, to show the signs of some cerebral defects, usually hemiplegia, sometimes hemianopia, or aphasia, or any other sign of local cerebral or cerebellar lesion. Pyrexia often accompanies the convulsion, and vomiting is common. In cases due to poliomyelitis, there may be general signs of that disease, in the form of malaise and pyrexia, for some time before the nervous symptoms are manifest. Both with the specific fevers and with poliomyelitis, the onset may be without convulsions or loss of consciousness. We have seen this chiefly in older children, when the cause has been poliomyelitis. The first sign of the cerebral trouble was the weakness of the limbs. The prognosis as regards rapid recovery is much better when convulsions are absent.

The relation of the onset of the paralysis to the convulsion varies. It may reach its height immediately after the initial convulsion, or slight hemiparesis may occur which deepens after each subsequent convulsion. Sometimes the early convulsions leave no paralysis, but this appears towards the end of the first week, either suddenly with fresh convulsion, or gradually, as the patient recovers from the comatose state. The paralysis at its onset is flaccid, and involves the whole of one side of the body to a greater or smaller extent. An initial monoplegia is of extreme rarity. The paralysis may not reach the greatest intensity until the end of the second week. Subsequently it lessens, in some cases disappearing completely in from a few weeks to 3 months; in others, it may show no signs of improvement. The limbs, at first flaccid, subsequently become spastic and develop contractures. In the course of years there may be great arrest of growth on the affected side, and this is not in relation with the degree of paralysis, but apparently depends upon the degree of destruction which has occurred in the parietal lobule. Post-hemiplegic spontaneous movements of an athetoid, choreic or irregular kind are common, and are attributable to lesions in the corpus striatum and subthalamic grey matter, for which regions encephalitis shows an especial predilection. In the early stages of the poliomyelitic cases, the blood shows a polymorphonuclear leucocytosis and the cerebro-spinal fluid shows a marked lymphocytosis, which disappear usually within 10 days. There is increase in the albumin and some decrease in the sugar content. Epileptic fits recur at varying intervals in about half of all cases of infantile hemiplegia. These always commence upon the affected side and are sometimes confined to it. Mental deficiency is met with in all degrees, in relation to the position and extent of the cerebral cortex which is involved in the lesion.

Diagnosis.—The nature of the malady at the onset, with convulsions, may be possibly suggested by prodromal pyrexia, by the severity and long duration of the convulsions, and by the prolonged subconscious state that often follows. At this stage, too, the presence of a marked lymphocytosis in the cerebro-spinal fluid with a polymorphonuclear leucocytosis in the blood strongly suggests poliomyelitis. Convulsions occurring several days after the onset of specific fevers should strongly suggest the diagnosis. When the signs of hemiplegia or of other local cerebral lesions appear, the diagnosis presents no difficulty.

Course and Prognosis.—In a very small proportion of the cases the patient does not survive the initial manifestations of the disease, and dies in

convulsions. Apart from this event, infantile hemiplegia has little tendency to destroy life. The initial flaccid hemiplegia tends to improve and gives place to a slowly improving spastic hemiplegia, which, with the return of some power, shows perversity of movement, stiffness and slowness, ataxy, athetosis and choreic movements or tremors according to the position of the lesion. The spontaneous movements appear within a year of the onset. Slow improvement may go on for years, but cases with much mental reduction or when recurring epilepsy is frequent, improve but little.

Treatment.—We know of no measures that avail to prevent the occurrence or lessen the severity of the cerebral destruction which occurs from encephalitis. Too often the damage to the brain has happened as soon as a diagnosis is possible. When the paralysis has developed, treatment is to be directed to the prevention of rigidity and contractures by regular passive movements, to regaining voluntary control by encouragement and patient exercises, and to the improvement of mental acuity. Where there is much contracture and deformity, tenotomies are of great service, provided there be some voluntary power in the muscles, the tendons of which are to be divided. Recurring convulsions should be treated as idiopathic epilepsy.

SYPHILIS OF THE NERVOUS SYSTEM

Of the known causes of organic disease of the nervous system, syphilis stands first in frequency and importance. Of the many problems presented by syphilis of the nervous system one may be chosen for special reference, namely, the alleged dual nature of nervous syphilis and of the causative organism. It has been maintained that there are two distinct pathological forms of nervous syphilis, namely, primary *parenchymatous* syphilis, as exemplified in tabes and general paralysis, where the initial lesion is held to be in the nerve elements themselves, and primary *meningo-vascular* syphilis, in which the initial lesion is in the blood vessels and meninges. But the dual nature of syphilis implied by these distinctions is subversive of pathological principles, for the initial and fundamental lesion of syphilis, wherever found and at all stages, is a lymphangitis or an arteritis, and very strong evidence would be needed to enforce the conviction that the reaction of nervous tissues to the presence of the spirochæte differs essentially from that of all other tissues of the body. Nor is this view supported by the morbid anatomy of the diseases concerned, for in every case of tabes and general paralysis, vascular and meningeal lesions can be found after death. Moreover, in the vast majority the increased number of cells in the cerebro-spinal fluid shows that the meninges are attacked even in the earliest stages.

For these reasons the trend of opinion is to deny the existence of primary parenchymatous syphilis, and to hold that the vessels and meninges are first injured in all forms of syphilis of the nervous system.

The contention that the virus of syphilis exists in two forms next demands consideration. Of all syphilitics the proportion in whom the nervous system is attacked is small. To explain this low incidence it has been assumed

that neuro-syphilis results from infection by a biological variant of the *Spirochæta pallida* with special affinities for nervous tissues—the "neurotropic virus," while other forms of syphilis follow infection by the "dermotropic virus." At first sight this attractive conjecture seems to be supported by numerous clinical observations. These are, that in some instances several persons infected from the same source have later developed syphilitic nervous diseases; that the superficial manifestations of syphilis are often mild or absent in those who ultimately develop neuro-syphilis, and that secondary and tertiary syphilis, outside the nervous system of these patients, is rare; also that in Oriental countries where syphilis is common, some forms of neuro-syphilis, namely, tabes and general paralysis, are seldom seen.

But it has never been shown that the persons who formed the source of infection for several cases of nervous syphilis have themselves developed this disease; it can no longer be held that tabetics and paralytics are free from secondary and tertiary lesions—witness the frequency of gummata and of aortitis in these cases; finally, Europeans who contract syphilis in the East are just as likely to suffer from tabes and general paralysis as if they had contracted it at home. It cannot be denied that the secondary phenomena are often so slight as to pass unnoticed by patients who later become tabetics or paralytics, or that patients with severe integumental lesions rarely develop tabes or general paralysis. These facts however, together with a large amount of additional evidence, suggest that the ultimate result of infection depends rather on the individual attacked than on any peculiarity of the infecting agent, and they lend no support to the notion of the duality of the syphilitic virus.

For the purpose of description it is still convenient to describe syphilitic diseases of the nervous system under two headings: Interstitial or meningo-vascular syphilis and parenchymatous syphilis. To avoid misunderstanding it must be emphasised that these are merely clinical aspects of one disease—neuro-syphilis, and that in both forms the primary lesion is in the vessels and meninges.

The Blood and Cerebro-Spinal Fluid in Syphilis of the Nervous System

A normal fluid may be regarded as one with a pressure equal to 150 to 180 mm. of water, a cell count not exceeding 5 per cm., an albumin content of from 0·025 to 0·05 per cent., and negative Wassermann, globulin and Lange's gold tests.

In primary and secondary syphilis, without nervous symptoms, changes are found in the fluid in 80 per cent. of the cases. Increased pressure, lymphocytosis, excess of albumin or a positive Wassermann reaction are found with a frequency which diminishes in this order. The fluid usually becomes normal under treatment, but these changes must be taken as an indication for very thorough treatment in the early stages. If the blood and fluid are both normal at the end of a year, neuro-syphilis is not likely to arise.

In latent syphilis, without nervous symptoms, the blood is positive in about 70 per cent., but changes in the fluid are found in 20 per cent. only. A fluid which is normal in the latent stage almost never becomes pathological later; if it deviates from the normal it is highly probable that neuro-syphilis will develop later.

In early cerebro-spinal syphilis the blood is usually positive, but it is sometimes negative when treatment has been thorough or recent. This indicates that an examination of the fluid is essential when the blood is negative in a case where the diagnosis is doubtful. Cells and albumin are usually greatly increased, the gold test is usually positive, and the Wassermann reaction is positive in almost every case when 1 c.c. of fluid is used in making the test. The blood and fluid often become normal after the first course of treatment, but a relapse occurs frequently and long before the recurrence of symptoms. Vigorous mercurial treatment and 4 or 6 full courses of salvarsan at intervals of 3 months, usually render the blood and fluid persistently negative. If both are normal a year after the fourth course, recurrence is unlikely.

In cerebro-spinal syphilis of longer duration, the reaction in the blood is almost always positive, and the fluid is seldom normal in active cases. A positive reaction in the fluid probably indicates an active process, even in the absence of recent symptoms. A normal fluid indicates a healed process. The inference is that all cases with a positive fluid and a history of cerebro-spinal syphilis should be treated energetically whether fresh symptoms are present or not. The treatment outlined above under early cerebral syphilis usually renders the fluid negative and the indications for prognosis are the same.

In *tabes* Wassermann's test is positive in the blood in about 70 per cent. of cases; it is often negative in the fluid when the test is done by the original method with 0·2 c.c. of fluid, but with 1 c.c. it is positive in almost 100 per cent. An increase in the number of lymphocytes in the cerebro-spinal fluid as well as an increase in the total albumin with a relative increase of globulin is almost constant. In some cases in which the disease had remained stationary for a long time the cerebro-spinal fluid is normal in every respect.

Lange's colloidal gold test gives useful information when the diagnosis lies between tabes and general paralysis, for the latter gives a typical reaction, but the test is of no value by itself in distinguishing tabes from other diseases of the nervous system.

Treatment by mercury and intravenous injections of salvarsan sometimes renders the fluid normal. It is stated that in such instances relapse is less likely to occur than in other cases, but no exact correlation has been shown to exist between the clinical course of the disease and the presence or absence of changes in the blood and fluid.

Most observers agree that intraspinal therapy has no advantages over intravenous injections—to the patient. The results are equally good with simple drainage of the spinal canal. Further, numerous experiments have shown that considerable quantities of arsenic reach the cerebro-spinal fluid after intravenous injections of salvarsan; indeed, the amount in the fluid may equal that in the blood. For these reasons it appears that the best mode of treatment is by intravenous injections of salvarsan, and spinal drainage, supplemented, of course, by mercury.

General paralysis of the insane.—The Wassermann reaction is strongly positive in the blood and in the fluid practically in 100 per cent. of cases, and an increase of cells and a positive globulin reaction are almost constant. Lange's gold test gives the characteristic paretic curve.

Treatment by mercury and salvarsan may produce slight modification in the reactions, but it has very little effect in checking the progress of the disease.

CEREBRO-SPINAL SYPHILIS

Ætiology.—Cerebro-spinal syphilis (excluding tabes and general paralysis) occurs in about 4 per cent. of all persons who acquire syphilis. The onset of symptoms is commonest from 1 to 5 years after infection, but it may be as early as 2 or 3 months, or as late as 30 or 40 years. The brain is affected more often than the spinal cord, and usually when the main symptoms point to the latter some signs will be found to show that the brain is also attacked.

CEREBRAL SYPHILIS

Pathology.—The disease may begin in the meninges, in the blood vessels or in the bones of the skull. In cases where the main incidence falls upon the *blood vessels*, the arteries at the base of the brain forming the circle of Willis or arising from it, together with their branches, are most often attacked. To the naked eye they show irregularities in size, due to thickening of their walls in circumscribed areas. Proliferation of the intima with a round-celled infiltration of the outer coats—*endarteritis obliterans*—is the characteristic microscopical change. The same changes occur in smaller arteries within the brain or on its surface, and these vessels, as well as those at the base, may be compressed or invaded by disease beginning in the meninges. In each case their lumen is narrowed or obliterated, thrombosis occurs readily, and softening may result in parts cut off from their blood supply. Obliterative changes also occur in the veins and lymphatics, and lead to further impairment of the nutrition of the brain.

The commonest form of *meningeal syphilis* is a diffuse gummatous lepto-meningitis at the base of the brain. On the convex surface of the brain it begins most often over the frontal and parietal lobes. The meninges may be affected alone, but more often the vessels are also diseased. In severe cases a gelatinous exudate fills the sub-arachnoid space and extends along the vessels and nerves. Later, the newly-formed tissue organises and forms sclerosed masses of thickened adherent membranes containing numerous small gummata.

Gummata arise in the meninges or spread to them from the skull. They may be numerous, diffuse and small, or large, circumscribed and few in number. Large tumour-like gummata are commonest on the convex surface of the frontal and parietal lobes.

Many important results of cerebral syphilis are due to impaired nutrition of parts not directly affected. Thus softening, hæmorrhage, cyst-formation, atrophy of cells and tract degenerations may occur, and non-syphilitic diseases may be simulated.

Symptoms.—The main incidence of the disease may fall upon vessels or membranes, the lesions may be diffuse or circumscribed, any portion of the brain or any cranial nerve may be affected alone, and every combination of lesions and, therefore, of symptoms, is possible. In many cases their multiplicity, their presence in unusual combinations, and the changes in their intensity and distribution from time to time give a clue to their nature.

Headache is a common prodromal symptom. It is often severe, and is usually worse at night. Sustained mental and physical effort becomes

difficult, the memory is impaired and the character changes. Irritability, intense excitement or delirium may follow, but more often the patient becomes lethargic. At this stage paralysis and localising signs may be absent. In many the pupils are unequal or irregular, or they contract sluggishly to light, and in some the optic disks show blurring of the edges and other signs of early papillœdema.

At any time, with or without prodromata, more definite signs of vascular disease or of paralysis of one or more of the cranial nerves may appear. *Arterial thrombosis* is usually preceded by prodromal symptoms, but it may come on in one apparently well. Its seat of election is the middle cerebral artery or its branches, and weakness of one arm or of one side of the body with or without aphasia is a very common early symptom. The weakness is often slight and transient. If hemiplegia occurs, it takes several hours or a day or two to develop. It is more often a paresis than a paralysis, and consciousness is usually retained. Sometimes the affected limbs are rigid and tremulous. The symptoms of thrombosis in other arteries are given on p. 1451.

In *vertical meningitis*, headache is usually severe, and the skull is often tender over the affected part. It frequently attacks the motor areas, and convulsions are common. They may be confined to one limb or to one side of the body, consciousness being retained, but more often they become generalised and consciousness is lost. In more chronic cases mental symptoms may predominate, the patient becoming slowly demented.

With *basal meningitis* severe deep-seated headache is almost always present. Later a characteristic lethargy with severe impairment of the mental functions may appear. Whilst in this stuporose state the patient can usually be roused, when he answers questions in a sleepy fashion and obeys simple commands, but his memory is bad, and he is unable to give an adequate account of himself. Variations in the degree of the stupor are a striking feature. In some cases profound torpor may persist for several weeks.

Soon after the onset, signs of implication of the cranial nerves appear. Any one of them may be affected alone, but, as a rule, several are attacked, where they lie close together after their exit from the brain, or as they leave the skull through the foramina. Ocular symptoms are rarely absent. Inequality in size, or irregularity in the outline of the pupils, may be the only sign, but diminution of the light reflex, ptosis, squint, diplopia and weakness of the movements of the eyeball are frequent, and papillœdema is common. It is characteristic of the cranial nerve palsies in syphilitic basal meningitis that the symptoms often show great variations in degree and distribution at different times.

The symptoms produced by large *gummata* are those of any cerebral tumour—headache, vomiting and papillœdema; and as the motor region of the cortex is a favourite site for these syphilitic tumours, convulsions are common.

Diagnosis.—Syphilis must be thought of in every case of nervous disease without an obvious cause—indeed no other diagnosis is justified until this has been excluded. The only hope for the patient may depend on its detection and treatment, for it is often curable while the diseases it simulates are not. A history of syphilis or signs of the disease elsewhere are of first importance. Obstinate headache alone should arouse suspicion, and when

signs of vascular or cranial nerve troubles follow a prodromal period of headache and mental impairment, syphilis is the most likely cause.

Jacksonian epilepsy or fits of any kind in patients without an epileptic history are strongly suggestive of syphilitic meningitis or gumma. As a rule, these convulsions are readily distinguished from those of idiopathic epilepsy, by their partial distribution, by the weakness which remains in the parts which were convulsed, and by the presence of papilloedema, of cranial nerve palsies, or of other signs of organic disease which are found in the intervals between the fits. Cerebral new-growths produce similar symptoms, but this diagnosis should not be entertained until syphilis has been excluded. In all cases an examination of the blood *and cerebro-spinal fluid* is essential (see p. 1484).

Prognosis.—The outlook in cases with mild symptoms is good if the treatment is efficient. In severe cases of syphilitic arteritis it is grave. The vessels most often invaded are large end-arteries, and the softening which results when their lumen is occluded is not amenable to anti-syphilitic remedies. Relapses are common, and patients apparently cured are often seized in a few months with fresh cerebral troubles. The lesions in the meningeal and gummatous forms of the disease are mainly cortical, and large areas of softening are not produced. The prognosis is much better in this form, and complete cure is almost the rule when treatment is begun early. It is often impossible, however, to decide from the clinical signs whether the vessels or the meninges have suffered the more. In the absence of this knowledge the prognosis depends on the results obtained by the use of appropriate remedies.

Treatment.—See pp. 1489, 1493.

SPINAL SYPHILIS

Pathology.—The disease may begin in the bony or membranous coverings of the cord, in the blood vessels on its surface, or in the interstitial tissues within its substance, and spreading from one to the other, usually attacks several of these structures in various combinations. As in cerebral syphilis, many of the changes in the cord are secondary to disease in the vessels or meninges, and appear in parts not directly attacked by specific processes. The commonest form of spinal syphilis is *meningo-myelitis*. The meninges are thickened and adherent, while the spinal and meningeal arteries and veins show obliterative changes, and are surrounded or infiltrated by small round cells. The same changes are apparent in and around the vessels and pial septa within the cord. In severe cases, the membranes are united to form a thick fibrous sheath around the cord, and the outlines of the nervous structures as seen in transverse section are almost obliterated by the presence of numerous small gummata or of myriads of small round cells. The nervous elements are compressed by the cell infiltration, or undergo softening or necrosis as a result of obliteration of the blood vessels. Meningo-myelitis is usually confined to a narrow area in the dorsal region, and is often associated with a more extensive meningitis.

In some cases with severe arterial changes, extensive softening results from thrombosis or hæmorrhage and produces severe paralysis of sudden onset—*acute syphilitic myelitis*.

Large gummata are rare. They occur in the cord, or on its surface, and produce the signs of compression.

In another rare form in which the membranes alone are affected—pachymeningitis and leptomeningitis—the dura and pia-arachnoid unite to form a thick fibro-gummatous sheath around the cord to which they become adherent.

Syphilitic disease of the vertebral column is not common. It produces changes which resemble those of tuberculous spinal caries, with osteitis and periostitis, and the formation of granulation tissue and gummata on the outer surface of the dura. Necrosis of the bones may lead to deformity of the spine. It is seen most often in the cervical region, where it begins in the spine, or spreads from a syphilitic ulcer in the throat.

Symptoms.—In *meningo-myelitis*, pain in the back, tenderness of the spine, and radiating pains or a feeling of constriction in the limb or around the trunk, are often present in the premonitory stage. After these have lasted several days or weeks, cord symptoms appear. They may come on rapidly, or very slowly. Often the first complaint is of numbness or tingling in the lower limbs, or of weakness or stiffness after exertion. Several attacks of temporary weakness may precede severe paralysis, and in different cases every degree is seen, from slight stiffness to complete paraplegia. When the paralysis comes on slowly the lower limbs become spastic, the knee- and ankle-jerks are exaggerated, and the plantar response is "extensor." In severe acute cases the limbs are flaccid and the tendon reflexes are at first diminished or lost, spasticity and increased reflexes developing later. In both forms the abdominal reflexes are diminished or lost below the level of the lesion. In most cases bladder control is impaired, and in some this is the first symptom. Sensory troubles may be slight when the paralysis is severe. Numbness and tingling are common, and some objective loss can usually be detected, the temperature sense, especially for cold, and the sense of vibration being most often at fault.

In one group of cases *Erb's syphilitic spinal paralysis* spastic weakness develops slowly in the lower limbs, without meningeal symptoms. The bladder is usually affected, and sensory loss is slight. In this form the spinal disease appears later after infection than is usual in meningo-myelitis.

Pachymeningitis and leptomeningitis as an isolated disease is commonest in the cervical region. The earliest symptom is pain in the neck, radiating down the upper limbs and between the shoulders. After a time, usually several months, weakness, wasting and loss of sensation appear in the arms. Still later, spastic paraplegia may develop from compression of the cord. When the lumbar region is attacked, the same symptoms appear in the lower limbs.

In *syphilitic caries* tenderness over the diseased bones, pain on movement of the spine, and radiating pain in the distribution of the sensory roots at the level of the lesion, are the chief symptoms. When the cord is compressed, power and sensation are diminished in the parts below.

Diagnosis.—Spinal syphilis appears in many clinical forms and often resembles other diseases. Hence it must be considered in every case of spinal disease without an obvious cause. The diagnosis may be founded on—(1) a history of syphilitic infection; (2) the presence of syphilitic lesions in other parts of the body; (3) Wassermann's reaction in the blood or patho-

logical changes in the *cerebro-spinal fluid* (see p. 1484); (4) signs of associated cerebral syphilis; (5) rapid improvement under treatment by specific remedies.

Prognosis.—The outlook for recovery of power is good when the meninges only are attacked, but bad when the symptoms are due to softening, hæmorrhage, atrophy of motor cells, or tract degenerations, for these are secondary changes and are not influenced by anti-syphilitic remedies. In a given case, however, it is not possible to assess accurately the amount of damage sustained by different structures, and the prognosis is always doubtful. Complete recovery occurs in about one-third of the cases of slight or moderately severe meningo-myelitis. The majority make a partial recovery, and are able to walk fairly well, in spite of the weakness and stiffness which remain. In cases with a sudden onset of severe paralysis, the prognosis is very bad, and death from bedsores or bladder and kidney infection is the usual result. On the other hand, the outlook for recovery of power is better when slight troubles come on rapidly than when they develop extremely slowly, as in Erb's form of the disease, in which many years pass before the paralysis becomes severe; for in the first case the lesions are interstitial and they respond well to treatment, whereas parenchymatous degeneration of the nervous elements themselves is present in the latter, and treatment is of less avail. The prognosis in early cases is determined by the effects of anti-syphilitic treatment. In cases of long standing, the most that can be expected is that appropriate treatment will arrest the course of the disease.

Treatment of Cerebro-spinal Syphilis.—As soon as the diagnosis is made, vigorous anti-syphilitic treatment should begin. The drugs used are mercury, potassium iodide, and the arsenical preparations, salvarsan and its derivatives. Of these mercury still stands first. Its use should never be omitted. However given it should be pushed until the gums become sore, or salivation is produced. When the treatment can be supervised, one of the best methods of giving mercury is by inunction. A drachm of the blue mercurial ointment, or of the oleate of mercury, should be rubbed into the skin daily for a week, and then on alternate days, until sixty inunctions have been made. By choosing hairless parts and by changing the site from day to day the requisite amount of mercury can be given in this way without trouble. Another method of giving it is by intramuscular injection. A grain of metallic mercury in the form of a cream is injected into the buttock at weekly intervals until seven doses have been given. This method, though useful when large numbers have to be treated, has many disadvantages and is not suitable for ordinary practice.

Subcutaneous injections of an aqueous solution of the biniodide of mercury are very efficacious. This method is much used in France. A solution containing 2 or 3 centigrammes of biniodide per cubic centimetre is prepared, and 3 or 4 centigrammes are injected daily in one or two doses. Twelve or fifteen consecutive injections are given. They are then stopped for a fortnight. Several successive series of injections may be given, if it is deemed necessary.

After a preliminary course of inunctions or injections, the treatment is continued most conveniently by the use of pills containing 1 gr. of grey powder and ¼ gr. of opium. For several months these pills should be taken daily up to the limits of the patient's tolerance. If the gums become sore, or if the digestion is impaired, the number can be diminished and then

again increased. Tolerance increases rapidly with continued use. The pills should be taken for at least 2 years after the onset of nervous troubles, and for several months in every year, during the rest of the patient's life. The teeth should be kept clean, and an alum mouth-wash should be used daily.

In view of the undoubted spirochæticidal powers of salvarsan and allied preparations in early syphilis, it is advisable also to give them in nervous syphilis. This, however, must not be allowed to interfere with the one essential part of the treatment, namely, the thorough and prolonged administration of mercury. The usual course consists of a series of 7 weekly injections of 0·6 gramme of neo-salvarsan. This may be repeated at 6-monthly intervals, if necessary. Potassium iodide is a useful adjuvant to mercury, but it is not an essential part of the treatment.

Massage and passive movements should be carried out daily, when the limbs are weak. When sensory loss is present, careful nursing is necessary to prevent the formation of bedsores; and when control of the bladder is defective, the usual precautions must be taken for the prevention of infection of the urinary tract.

GENERAL PARALYSIS OF THE INSANE

Ætiology.—As in tabes, the essential factor in the causation of general paralysis is previous syphilitic infection. Males are affected much more frequently than females. The onset is commonest between the ages of 30 and 50 years, from 10 to 20 years after infection. As a result of congenital syphilis or of early innocent infection, it may appear in childhood, youth or even adult life. It has been estimated that about 5 per cent. of syphilitics develop general paralysis, but the incidence in those who have been well treated in the early stages is not more than 1 per cent. The incidence varies in different races, and seems to be greater with increasing civilisation. It is more apt to occur in town and city dwellers, and in those who have led a strenuous intellectual or business life.

Pathology.—The skull-cap is thickened, especially in its anterior part, its density is increased, and the diploë is obliterated. The dura mater is thickened and adherent to the skull, and may show the changes of pachymeningitis hæmorrhagica. The arachnoid is tough and thick, and white lines are seen between the sulci and along the vessels. The pia is thickened, its meshes are distended by pale yellow fluid, and on attempting to strip it off portions of the cortex are torn away. The amount of cerebro-spinal fluid is increased. The brain looks wasted and shrunken, and its weight is abnormally low. The sulci are wide and the convolutions are narrow. The ventricles are dilated, and their ependymal lining presents a granular or a frosted appearance. On section the grey matter of the cortex is seen to be thinner than normal—decortication. On histological examination gross changes are found in the membranes, in the blood vessels, in the neuroglia, and in the true nervous elements. The earliest changes are found in the cortical vessels and membranes. Nuclear proliferation occurs in the walls of the smallest pial vessels and in the perivascular lymphatics. There is overgrowth of the endothelial cells in the capillary walls, and around them lie peculiar cells—the so-called plasma cells. Small lymphocyte-like cells,

mast cells, and many others of doubtful nature appear in and around the perivascular channels, and by blocking them interfere with the nutrition of the cortex. The larger vessels also show proliferation of the endothelium, degeneration of the muscular coat and perivascular infiltration. The spirochætes are readily demonstrated in the brain substance.

The fibres of the neuroglia proliferate, its cells multiply, and some assume an abnormal size or shape. These changes in the interstitial tissues are followed by degeneration of the cortical cells and atrophy of their processes. The changes are most marked in the cortical cells and association fibres of the anterior part of the cerebrum, but similar degenerations are found in the basal ganglia, the cerebellum, the brain stem and the spinal cord.

Symptoms.—The disease is characterised by progressive deterioration of the mental and physical powers.

MENTAL SYMPTOMS.—The most recent acquisitions are usually lost first. Hence the earliest sign of mental failure will differ according to the intellectual and emotional make-up of the individual attacked. Memory, judgment and reasoning are impaired from the first, the æsthetic, moral and intellectual attributes alter early, and changes occur in the domains of conduct and emotion which astonish or distress the patient's friends. To one who sees the patient for the first time the defects may not be apparent, but those who know him will speak of the *changes* in his intellectual capacity, character or behaviour. Cheerfulness has given place to depression or irritability, the quiet and unassuming man has become passionate and boastful, the good father has turned against his family, promises are no longer kept, a good business is neglected, money is spent unwisely, high artistic skill is lost, the moral code is transgressed, and so on. There is no end to the variety of the early symptoms, but in each case they represent a change for the worse.

In the classical form of the disease, elation and expansive delusions concerning health, wealth, social position or physical and athletic powers are prominent, but in a larger number of cases the patients are depressed in the early stages, and the delusions when they appear may be melancholic or hypochondriacal. Unlike the paranoiac, who may refuse to disclose his delusions or who may reason skilfully from his false premises, the paretic reveals his delusions readily, and can be made to betray their falseness by his own words. To the direct question regarding his occupation the Emperor, the possessor of untold wealth, the world's greatest general, will reply unconcernedly that he is a boot-black, or the champion athlete of the universe will give answers showing a complete absence of familiarity with any branch of sport.

In the course of time dementia increases, memory is abolished, delusions are forgotten, emotion disappears, and in a year or two the patient is unable to move from his bed where he lies speechless, paralysed, and incontinent. The various concomitants of the delusions are described in the following paragraphs.

The most constant and most characteristic signs are changes in the pupils, tremors of the face, tongue and hands, and disorders of speech. Changes in the pupils occur early, indeed they are often present as signs of past syphilis before symptoms of general paralysis appear. Inequality in

size, irregularity in outline, and the complete or incomplete Argyll Robertson phenomenon, are very common pupillary signs. Primary optic atrophy is frequent, but except in tabetic cases it is rarely complete. Paralysis of the external ocular muscles and papillœdema sometimes occur as a result of associated tabes or cerebral syphilis. Tremor is often an early sign. In the face and hands, though often present when the parts are at rest, it is best seen in speaking or when movements, such as showing the teeth and holding the arms outstretched, are carried out to order. The typical tongue tremor is a backward and forward "trombone" movement of the organ, when the attempt is made to protrude it. Speech is often affected early. The defects comprise disorders of articulation and of memory and ideation. At first it is merely hesitant. Later the lingual and dental consonants become blurred, syllables are omitted, interpolated or slurred, and the voice becomes feeble and lacks intonation. As the memory fails, confusion arises in the construction of long sentences, proper names are forgotten, the choice of adjectives and verbs becomes more and more limited, and the vocabulary diminishes until only interjections are left. Written language suffers in the same way, and may show defects of execution and of ideation before spoken speech is noticeably altered. At the onset voluntary power in the muscles is usually maintained, but undue fatigue after moderate exertion is a common early symptom. As the disease progresses, weakness appears in the lower limbs and soon affects all the muscles. Some of the signs of injury to the pyramidal tracts, such as increased tendon reflexes, diminution or loss of the skin reflexes, and Babinski's plantar response, are found sooner or later in almost every case. In a small number the tendon reflexes are abolished and other signs of tabes, such as sensory disturbances, are present. Retention of urine or incontinence sometimes occurs in the early stages. Towards the end, control of the bladder and rectum is always lost.

Epileptiform seizures of various kinds are common. They may be the first obtrusive symptom, and may occur at any time in the course of the disease. The attacks may have all the aspects of idiopathic epilepsy, or they may be local and of the nature of Jacksonian fits. Attacks resembling *petit mal* have also been observed. In the so-called "congestive" apoplectiform attacks, paralysis of one limb or of one side of the body comes on suddenly with or without convulsions and passes off in a few days or weeks. The patient may become comatose and breathe stertorously, or he may be merely somnolent or confused.

Insomnia is frequent in the prodromal period, but in the early stages sleep is often excessive. Later, sleeplessness and motor restlessness are often troublesome symptoms.

Clinical Types.—*Exalted or expansive form.*—This form includes the cases in which elation, euphoria and grandiose ideas are prominent.

Demented forms.—The patients often seek advice of their own accord, complaining of diminished mental and physical power or failing memory. Mental deterioration runs its course without marked depression or exaltation.

Depressed form.—This common form is characterised by melancholic and hypochondriacal delusions. Some have delusions of persecution. Very often the patient exaggerates his afflictions to a degree not seen in other forms of insanity, melancholic megalomania. Remissions are common.

Maniacal form.—The features of this form are attacks of acute maniacal excitement, which may resemble acute delirious mania. Remissions are common, and apparent complete recovery may be made; but the attacks recur, each one leaving the patient more demented.

Many other varieties have been described, the stuporose, the convulsive, the tabo-paretic, and so on. The characters of these types are sufficiently indicated by the names.

Course and Prognosis.—After an insidious onset, the disease progresses steadily and usually ends fatally in about three years. Acute forms may run their course in a few weeks. When convulsions are frequent, death usually results in about six months. When periods of extreme restlessness and excitement alternate with depression, one year is the average duration. In simple demented and depressed forms, the duration is usually about 3 years. The course is most prolonged in those who have attacks of wild excitement or mania, as remissions are very common in this form. During the remissions, patients may be able to return to work, and 10 years may elapse between the first attack and the fatal termination. The course is often prolonged in women, in congenital cases, and in cases of tabo-paresis.

Treatment.—As some cases of cerebral syphilis simulate general paralysis, in every instance where the latter disease is suspected rigorous anti-syphilitic treatment should be tried in the hope that the patient is suffering from the more curable condition. Admission to an asylum should not be delayed when mental changes render the patient a danger to himself or to his fellows.

Malaria therapy in general paralysis.—Encouraging results have been obtained by infecting paralytics with benign tertian malaria. Blood is obtained from a patient suffering from malaria (not necessarily during a rigor), and is injected subcutaneously or intravenously. The incubation period may be as long as a fortnight or more after subcutaneous injection, but failure to infect with 5 c.c. of blood is rare. If the blood has to be transported it should be received in a sterile test-tube containing glass beads; after defibrination it is transferred to another sterile tube and packed in ice, when it will remain active for 6 hours or more. The recipient is allowed to have six, ten, or more rigors, the number depending on his general condition during the treatment; the infection can be cut short at any moment with quinine; relapses never occur in this experimental malaria. In favourable cases a remission occurs, improvement continuing for several months; the end result of the treatment cannot be assessed until 6 months or more have elapsed. Several of Von Wagner-Jauregg's patients treated in 1917 are still perfectly well. This pioneer obtained 44 per cent. of complete remissions in a series of 141 cases. Gerstmann's figures are 45 per cent. complete remissions, 30 per cent. improved. Yorke and Macfie treated 80 asylum (*i.e.* advanced) cases and report 27 per cent. fit for discharge. These and many other equally favourable results are to be compared with the incidence of spontaneous remissions in this disease, namely, 11 per cent.; they indicate clearly that malaria therapy should be tried in every case at the earliest possible moment.

TABES DORSALIS

Synonym.—Locomotor Ataxia.

Ætiology.—Tabes is a common and important disease of the spinal cord. It is more frequent in men than in women (10 to 1), and begins most often between the ages of 30 and 45. The essential factor in its causation is previous syphilitic infection. The interval between infection and the onset of symptoms varies from 2 to 20 years; commonly from 5 to 10 years. As a result of congenital syphilis, or of infection in infancy, it sometimes begins in childhood, youth, or early adult life—infantile or juvenile tabes. Occasionally husband and wife are both affected—conjugal tabes.

Pathology.—The essential and primary spinal lesion in tabes is degeneration of the afferent neurones in the posterior (sensory) roots. Some of the degenerated fibres end around cells in the grey matter soon after they enter the cord, while all the fibres with a long intraspinal course enter the posterior columns, and ascend in them to the nuclei of Goll and Burdach in the medulla. As a secondary change the neuroglia around the degenerated fibres increases in amount and density. Hence the characteristic feature in sections of the cord in tabes is sclerosis of the posterior columns. The sclerosis usually appears earliest in the postero-lateral columns of the lower lumbar and upper sacral regions. In the dorsal and cervical cord it is confined at first to the postero-internal columns, which contain the degenerated fibres from the lumbar and sacral regions, but in advanced cases when the dorsal and cervical sensory roots are also affected the posterior columns are sclerosed throughout.

In advanced cases the endogenous tracts of the posterior columns show degeneration, and in some the afferent tracts in the lateral columns are also affected. In sections stained by the Weigert-Pal method the diseased areas are paler than the rest of the white matter. By the Marchi method parts containing recently degenerated fibres show numerous black dots, which represent fatty material in the degenerating myelin sheaths.

In cases of long standing, atrophy of the entire sensory root with degeneration in the peripheral parts of the sensory nerves, and atrophy of cells in the ganglia are frequent findings.

Optic atrophy and degeneration of the spinal roots of the trigeminal nerves are the most frequent cerebral lesions. Of the motor nerves, those supplying the muscles of the eyeball are most often affected. The degeneration is usually peripheral, the nuclei showing no changes. Occasionally the cells in the nuclei of the vagus and hypoglossal nerves are degenerated.

The frequency of excessive sweating on the face, and of ptosis and spinal myosis in tabes, indicates that sympathetic fibres are attacked in this disease. Degeneration of the intermedio-lateral tract in the upper part of the cord and in the medulla has been found in many cases. The sympathetic ganglia and nerves are almost always normal.

Certain as it is that tabes never occurs apart from syphilis the exact relation between them is still debated. For long the view prevailed that syphilis merely rendered the neurones vulnerable to influences which would not damage healthy tissues, that syphilis alone could not cause tabes, and that some other factor acts as an exciting cause. The term para-syphilis

was used to express this indirect relation between syphilis and certain of its nervous manifestations, particularly tabes and general paralysis. The discovery of spirochætes in the brain and cord of patients dying of these diseases, however, caused this view to be abandoned, and it is now agreed that all forms of nervous syphilis are a direct result of changes produced by the spirochæte or its toxins.

The researches of Richter have proved that the primary essential and constant lesion in tabes is a syphilitic inflammation which begins at that point proximal to the ganglion where the anterior and posterior roots approach one another and form the radicular nerve of Nageotte. Beginning in the lymph spaces of the sheath which is formed by the fusion of the dura and arachnoid, the inflammation spreads inwards along the septa between the nerve bundles, and as sclerosis occurs the nerve fibres themselves are slowly destroyed. The degenerations in the posterior columns are secondary to the lesions so produced. The anterior roots usually escape because they pierce the common sheath and leave the sub-arachnoid space before they reach the point at which the inflammation begins.

The reaction of the tissues to the spirochæte at the site of this tabetic lesion is mainly a *fibroblastic* inflammation which differs in nature from that which is seen in the pia mater, where a perivascular and diffuse *lymphocytic* infiltration occurs. Richter has demonstrated the spirochæte in the lesions.

Inflammation of the pia mater is a common accompaniment of tabes, but plays no part in its production.

The affection of the cranial nerves in tabes is a result of an interstitial inflammation which attacks the nerves in the proximal part of their extracerebral course. In all except the olfactory and optic nerves the inflammation has the same characters as that seen in the nerve roots. These two nerves differ entirely from the spinal roots and the remaining cranial nerves in that they possess a sheath derived from the pia mater and their supporting tissue is glial and of ectodermal origin, whereas the sheath and supporting tissue of the latter are derived from the arachnoid and are purely mesoblastic. The inflammation in these two nerves begins in the pial sheath, and the nerve fibres are damaged secondarily by the same mechanism which destroys the spinal roots; but in this case, owing to the different nature of the tissues affected, the histological characters of the lesions are different. They are, in short, the same as those produced by the action of the spirochæte on the pia and glia elsewhere, and vascular lesions and perivascular infiltrations are prominent.

Symptoms.—The inadequacy of current descriptions of the clinical manifestations of tabes is shown by failure on the part of those who depend upon them for guidance to diagnose the disease before it has reached an advanced stage. So long as tabes is described as a disease characterised by severe lightning pains, absent knee-jerks and Argyll Robertson pupils; so long as the diagnosis is withheld until these symptoms are found together; so long as patients without ataxy are stated to be in the *early* or preataxic state—just so long will valuable years be wasted, as they are at present, before patients receive treatment at a time when it may reasonably be expected to arrest the course of the disease. It is true that these important symptoms appear ultimately in a very large proportion of the cases, and they are often present when the patient is seen for the first time. It is equally

true, however, that many of these patients have complained of symptoms which, if they had been appreciated by the physician, would have betrayed the disease many years before, and that throughout these years they have presented physical signs which, although the knee-jerks and pupillary reactions were still present, would have made the diagnosis of tabes certain. In the following paragraphs stress will be laid on the signs that appear early and allow the diagnosis to be made at the onset of the disease. Chief amongst these early symptoms are disturbances pointing to interference with the functions of the posterior nerve roots.

Sensory Disturbances.—*Subjective.*—Following a general law the first manifestations of altered function are subjective—the patient complains of sensory troubles before any changes can be discovered by objective examination. The most important of these subjective troubles in tabes are the so-called lightning pains. These pains merit the closest attention. They are rarely absent, they often precede other symptoms by 5 or 10 or more years, and most important of all they possess peculiar features which render them pathognomonic of tabes and allow the diagnosis to be made in a syphilitic on their presence alone. Although they are rarely absent careful interrogation may be needed to disclose them. To the question, "Have you had any pains?" the patient may answer "No." He may even be led into denying stoutly that he has even suffered in any way at any time. If then he is asked if he has rheumatism, he will often answer "Yes," and proceed to give an account of characteristic tabetic pains of several years' duration. In other cases the patient mentions his pains, but their significance escapes notice because it is thought that they are too slight for tabetic pains. It must be made clear at once therefore that the peculiarity of the pains in tabes does not lie in their severity, for they vary from a trifling sensation of discomfort to almost intolerable agony, but in their distribution, in their direction of propagation and especially in their arrangement in time.

As a rule, they come on in attacks, in which single momentary pains are repeated at intervals of a few seconds or minutes for several hours, the whole bout lasting several days or weeks. Between the attacks there may be long intervals of complete freedom from pain. The pains are felt most often in the lower limbs, but any part may be affected. They may be referred to the skin, to the muscles or to the bones. They are very common in the bony prominences around the knee and on the foot. The direction of radiation varies. In some the pain seems to shoot up or down a limb, but in a larger number it seems to strike the limb vertically as if a sharp object were piercing it from without. Some patients experience both kinds of pains. The onset of each pain is always sudden. If it is severe the patient may cry out, and if it overtakes him whilst walking he is forced to stop and he may fall. The duration of each pain is usually momentary, but sometimes it lasts a second or two and fades away gradually. During a given bout the pains usually recur in the same place each time for several hours on end, and then appear in another part, say on the following day. In a few cases, however, they confine themselves to two or three points, now appearing in one and now in the other. In a still smaller number the site varies from moment to moment, so that the patient never knows where the next one will strike him. In one group the pains are repeated very rapidly in one

place for a few seconds, and then after an interval in another, so that the timing recalls the sound of a machine-gun firing short bursts—tap, tap, tap, pause, tap, tap, tap, pause, and so on with a longer interval now and then during which the gun is trained on a new objective.

Compared with the preceding characters the kind and intensity of the sensation experienced is of minor importance for diagnosis. It may be "a niggling under the skin," "like the prick of a pin," "like a hat-pin going in," "like a shock of electricity," "like being suddenly crushed in a vice," and so on. Almost every patient uses a different expression. Let it be repeated, therefore, that it is not the severity or nature of the pains that makes them peculiar to the disease, but their arrangement, place and direction.

After a bout the skin is often tender, and ecchymoses may appear over parts in which the pains were felt. Cold, changes in the weather, anxiety and especially over-exertion make the pains worse. They are often more severe for a day or two after treatment by intravenous or intrathecal injection of specific remedies. Other pains with characters which are not peculiar to tabes are common. They are described as aching, burning or gnawing pains. Like the lightning pains, they alter with changes in the weather and are usually attributed to rheumatism. Other common subjective sensory symptoms are "pins and needles" in the extremities, a feeling of walking on a soft substance, and of constriction around the trunk or limbs. More important than these, because it often appears very early, is hyperæsthesia of the trunk, especially in its lower part. Light touches or applications of water at certain temperatures are almost unbearable. This is well seen when patients are being placed in position for a lumbar puncture. On feeling gently for the bony landmarks, the patient squirms on the table, and the application of iodine causes such vigorous movements that the success of the operation seems to be in doubt. And yet the passage of the needle causes little or no pain, because the pain sensation is already much diminished when hyperæsthesia to other forms is well marked. This hyperæsthesia on the trunk is often associated with a degree of activity in the abdominal reflexes that is rarely seen in other diseases.

Objective sensory disturbances.—Signs of damage to the posterior nerve roots appear in the earliest stages of the disease, and are demonstrable in many cases long before the classical signs appear. The detection of this early sensory loss is of great importance, for its distribution is pathognomonic. The parts in which sensation is first impaired are—(1) a band on the chest and along the inner border of the arms; (2) the feet; (3) around the anus; (4) on the nose.

As the disease advances sensory loss extends upwards from the feet, downwards from the chest, and outwards from the nose and anus in concentric circles. Ultimately these areas coalesce, and in the later stages sensation is diminished all over the body. All forms of skin sensation are not equally affected. Sometimes the defect is first discovered on testing with light tactile stimuli, but more often pain and temperature are first impaired.

The senses of deep pain and of position and passive movement, as well as the vibration sense, are often diminished in the legs in the early stages. In advanced cases these defects are present in all the limbs.

In cervical tabes sensory disturbances occur first, and are most severe in the arms.

In severe cases sensation of all kinds may be almost completely abolished. No cutaneous stimuli are felt and the deep structures are insensitive to pain. To this is added loss of the sense of position, not only in the limbs but also in the trunk, so that the patient is unaware of their position when his eyes are closed. If he sits up with the arms outstretched, on closing his eyes the arms "wander," the fingers execute slow "piano-playing" movements, and the body sways. In extreme cases the patient falls on his side as soon as the eyes are closed.

MUSCULAR HYPOTONIA AND THE TENDON REFLEXES.—Loss of muscle tone occurs in lesions of various parts of the nervous system, and is not necessarily accompanied by changes in the reflexes in the limbs, but when it results from interruption of the spinal reflex arc the two signs are found together. Hence in tabes, where the afferent limb of the reflex arc is the first structure affected, hypotonia and diminution of the tendon reflexes are characteristic signs. The decrease in the tone of the muscles is often well marked when lightning pains are the only symptom of tabes, and loss of skin sensation the only other sign. It is shown by flaccidity of the muscles, and by an abnormal range of active and passive movement of the limbs.

The leg can often be raised to an angle of 100° from the horizontal, with the knee extended, whereas a normal person cannot raise it more than 60°, and excessive range of dorsiflexion of the foot is often a striking sign. In extreme cases the legs can be made to encircle the neck, the body can be flexed so that the head touches the bed between the knees, and the patient is able to imitate the tricks of the "double-jointed" man.

The knee-jerks are very often absent when the patient is first examined, and in the later stages they are almost always lost, but compared with the signs already mentioned this one is of late onset, and may be missing even in the ataxic stage. The position formerly held by the knee-jerks in the symptomatology of tabes should be given to the tendo achillis (ankle) jerks. Loss of the ankle-jerks is indeed an early sign in tabes, for it often precedes loss of the knee-jerks by many years. The tendon reflexes persist longest when optic atrophy appears early. Even in these cases it is unusual to find both ankle-jerks still present, whereas brisk knee-jerks are common. The tendon reflexes in the upper limbs are lost early in cervical tabes, and are frequently absent in cases of the ordinary type.

The skin reflexes are often exaggerated to a degree rarely met with in other diseases. This is best seen on the abdomen, and is usually associated with hyperæsthesia to touch and temperature. Later, when the tactile sense is lost, the skin reflexes are often diminished. The plantar reflex is usually normal. It is sometimes absent when sensory loss on the soles is severe, and in cases where sclerosis of the pyramidal tracts exists as a complication of tabes the response is "extensor."

ATAXIA.—The fibres conveying those afferent impressions which are essential for the equilibration of the body, and for the proper execution of voluntary movements, are more resistant than those with other functions, and inco-ordination, though extremely characteristic of tabes, is usually a late symptom, or it may be absent throughout the whole course of the disease. Its onset is marked by unsteadiness in walking and difficulty in maintaining the balance of the body. These troubles are first noticed when co-ordinated movements are performed without the aid of vision. As the defect increases

unsteadiness appears even with visual guidance. To maintain their balance the patients walk on a wide base with the eyes directed to the ground. At a later stage some raise the feet too high, throw them too far forward and bring them down forcibly, the whole sole striking the ground at once—stamping gait. Others reel from side to side like drunken men. Still later the support of one or two walking-sticks is required, and ultimately walking becomes impossible. The inco-ordination is not only present in walking, but can be seen in all voluntary movements, *e.g.* in the heel to knee test. The same defects occur in the upper limbs. At first there is merely clumsiness in performing fine movements such as picking up small objects and in adjusting the dress. In the end the ataxia may become so great that the patient is unable to feed himself.

By appropriate tests inco-ordination can usually be disclosed before the patient has noticed it. Some of the tests are: standing with the heels and toes together, standing on one foot, walking backwards, rising quickly from a stooping position and turning quickly in walking. In each instance the unsteadiness is greatest when the eyes are closed and when the feet are bare.

Sphincter Troubles.—Disturbance of the bladder functions is often the patient's first serious symptom. Difficulty in beginning micturition and incontinence, especially at night, are common complaints. Complete retention and paralytic incontinence are rare. In many cases emptying of the bladder is incomplete, and though this causes little discomfort it is serious, as it often leads to cystitis and ascending infection of the urinary tract, which causes the death of many tabetics.

Ocular Symptoms.—Changes in the reaction of the pupils and in their size and form are very frequent and are of great importance for diagnosis. The chief of these is the Argyll Robertson phenomenon, in which the pupil contracts on accommodation but not when exposed to light. This sign appears in both eyes in 70 per cent. of cases, and is one of the earliest to appear. It is sometimes found in one eye with a normal or diminished reflex in the other. It may be present in an incomplete form, the contraction to light being slight and sluggish when the reaction to accommodation is brisk, or the pupils may contract when first exposed to the light only to dilate again. Occasionally the pupils are fixed and do not react to either stimulus. In rare cases the reaction to accommodation is lost while the light reflex persists.

The size of the pupils varies greatly in different cases. Most often they are small, but pupils of moderate size are very common, and sometimes they are widely dilated. It is not unusual to see pupils which, when contracted on accommodation, are no larger than the head of a pin, but the "pin-point" pupils are extremely rare. Inequality of the pupils or irregularity in their outline is present in most cases. It is said that the pupils are sometimes normal in every respect even in the advanced stages of the disease.

External ocular muscles.—In the early stages transient palsies of the muscles of the eyeball often cause ptosis, diplopia or squint, lasting a few days. Permanent paralysis may come on at any time, but is most frequent in the later stages. A persistent drooping of the eyelids—tabetic ptosis—is a common sign. This is attributable to a lesion of sympathetic fibres. The patient tries to overcome the defect by contracting the frontalis muscles, and the wrinkling of the forehead with slight drooping of the lids

gives the patient an expression—the tabetic facies—by which the disease may be recognised at a glance.

Optic atrophy.—Defective vision from atrophy of the optic nerve is often the symptom for which the patient first seeks relief. It occurs in about one case in ten, and almost without exception ends in complete blindness. The loss usually begins in the periphery of the visual field, and is often unnoticed until central vision begins to fail. Occasionally central vision fails early. At first one eye suffers more than the other, but ultimately, after a period which averages 5 years, all vision is lost in both. Patients sometimes relate that their blindness came on suddenly, or in a few hours or days. In these cases optic atrophy has been present for a long time, but the fibres subserving central vision have escaped until the last. On the other hand, vision may fail very slowly, with periods of arrest or apparent improvement, and total blindness is sometimes delayed for 10 or 15 years. The atrophy is primary, that is, it is not preceded by papilloedema. Pallor appears first on the temporal side, whence it spreads over the whole disk. The edges of the disk are sharply defined and the lamina cribrosa is visible as slightly darker spots, so that the disk stands out clear and bright, like a full moon. When optic atrophy is the first symptom, it is often impossible to detect any incoordination in the lower limbs, and ataxia may be long delayed. The knee-jerks are often brisk, but some of the early signs—lightning pains, sensory disturbances or loss of one or both ankle-jerks—are almost always present, and the Argyll Robertson pupil is a constant accompanying sign. In a number of the patients with optic atrophy the signs of general paralysis are added to those of tabes (tabo-paresis), and the course of their illness is that of the more serious disease.

Other Cranial Nerves.—The senses of smell and taste are sometimes lost. Vertigo, tinnitus and nerve deafness are common. Lightning pains are often severe in the distribution of the trigeminal nerve, and loss of sensation on the nose, especially to pain, is one of the earliest and most frequent signs. Paralysis of the vocal cords, though rarely sought for, is present in many cases.

Visceral Crises.—Various peculiar disturbances of the viscera occur in tabes. They come on in paroxysms, often with great pain.

Gastric crises.—The organ most subject to crises is the stomach. Attacks of severe abdominal pain with repeated vomiting come on suddenly. They last a few days, or a week or two, and are often repeated every few weeks for long periods. Sometimes pain or vomiting alone is present. The patient looks very ill during the attack, but it is never fatal. They often occur before other symptoms of tabes appear, and are often mistaken for acute obstruction, and other conditions requiring urgent surgical treatment, but careful examination will rarely fail to reveal indubitable signs of tabes. If attention were paid to the ankle-jerks, and to sensory disturbances, instead of to the knee-jerks, unnecessary operations would be less frequent.

Next to the stomach, crises are most frequent in the larynx (*laryngeal crises*). In the commonest form there is spasm of the larynx, with noisy breathing, cough and dyspnœa. Sometimes the attacks resemble whooping-cough or laryngismus stridulus. They are much shorter than gastric crises, rarely lasting more than an hour. Death in an attack is extremely rare.

Attacks of tenesmus (rectal crises) are not uncommon. Attacks of

frequent painful micturition (vesical crises) and of pain like renal colic (renal crises) are rare.

Cardiac, nasal, bronchial, intestinal and other crises have been described.

VASOMOTOR AND TROPHIC DISTURBANCES.—The most important of these are changes in the joints and perforating ulcers. Rarer forms are local sweating, loss of hair, nails or teeth, attacks of herpes, hæmorrhages into the skin, necrosis, rarefaction and spontaneous fracture of bones, excessive callus formation and spontaneous rupture of tendons.

Charcot's joint disease.—Arthropathies may develop at any stage of the disease. Occasionally the patient seeks advice for the first time with this complaint. The first sign is usually rapid swelling in and around a joint, with effusion and œdema. The effusion, in slight cases, subsides slowly and the joint recovers, but more often the enlargement is followed by destruction of the cartilages, wasting of the ends of the bones, peri-articular new-bone formation and destruction of the ligaments. The joint becomes disorganised, the range of movement is increased, and crepitations of startling coarseness are heard and felt when the part is handled. The characteristic feature is the complete absence of pain. Dislocations occur readily, especially at the hip. The diseased joint sometimes becomes infected. This is commonest in the foot. The joints most often attacked are, in order of frequency: knee, hip, shoulder, elbow, ankle, small joints of the hands and feet, the spine.

Perforating ulcers are commonest on the sole of the foot. Patches of hard thickened skin are frequently seen on the soles of the feet. Sometimes blisters form beneath this thick epidermis, and on bursting leave an indolent sore. Once formed the ulcer is very indolent. It is usually painless.

Complications.—Tabes is frequently complicated by other syphilitic affections of the nervous system, of which the commonest and most important is general paralysis of the insane. Many tabetics develop general paralysis, and most paretics present some of the signs of tabes. Indeed, these conditions are merely different aspects of the same disease, and are named according to the predominant features. Sometimes it is difficult to decide the category of given cases, and the name tabo-paresis is used to describe them. Occasionally the pyramidal tracts degenerate and signs of spastic paraplegia are added to those of tabes. Atrophy of the anterior nerve roots and wasting of the corresponding muscles is a fairly common complication. Outside the nervous system the commonest complications are aortitis, aortic regurgitation and aneurysm.

Diagnosis.—Most tabetics come under observation for the first time when one of the many symptoms of the disease begins to cause serious trouble. The obtrusive symptom may be: lightning pains, failing vision from optic atrophy, double vision from paresis of ocular muscles, attacks of vomiting, tenesmus, unsteadiness in walking, painless joint disease, impotence, troubles with micturition, or some other less common complaint. In these the diagnosis rarely causes difficulty. A history of characteristic pains, or evidence of syphilis in the past, justifies the diagnosis of tabes on the symptoms alone. In almost all of these cases, moreover, unequivocal signs will be found which make the diagnosis certain. Two signs—the Argyll Robertson pupil and absence of the ankle-jerks or knee-jerks—are of supreme importance, for although one is often lacking, the absence of both in the kind of case we are discussing is rare. To one or both of these several of the following con-

firmatory signs are usually added: inequality or irregularity of the pupils, diminished sensibility of the skin on the nose, on the chest and feet, absence of pain on compressing the calf muscles, loss of vibration sense in the feet, muscular hypotonia, defective sense of position in the limbs and unsteadiness when the eyes are closed.

When the symptoms and signs are slight and few, or when suspicious signs are found during a routine examination, the diagnosis is sometimes difficult, and may require for its elucidation a careful inquiry into the history, an examination of the blood and cerebro-spinal fluid, and a meticulous investigation of the nervous system. These cases are discussed in the following paragraphs.

THE DIAGNOSIS OF EARLY TABES.—1. Since Westphal, some 60 years ago, described loss of the knee-jerks as an early sign of tabes, and established the existence of the pre-ataxic stage, the profession, apart from neurologists, has altered its views but little, and still hesitates to diagnose tabes while the knee-jerks are present. Consequently mistakes in diagnosis are common, and valuable years are lost before treatment begins. The diagnosis can and should be made when lightning pains are the only symptom. Pains with the characters already described occur in no other disease, and their presence calls for a careful investigation for evidence of past syphilis. In this first stage of tabes the diagnosis is founded on (1) characteristic pains; (2) evidence of syphilis in the past, obtained from the history or by examination of the blood and cerebro-spinal fluid (see p. 1184).

2. Only rarely need the diagnosis be made on these grounds alone, for in almost every patient with lightning pains careful examination will reveal confirmatory signs. The most important of these are sensory disturbances and alteration in the pupils. Hyperæsthesia to touch and temperature on the lower part of the trunk is very common, although few patients mention it until their memory is refreshed by careful interrogation. In a patient who has had syphilis and suffers from lightning pains, a clear demonstration of sensory impairment confined to the characteristic areas makes the diagnosis still more certain. Other signs to which a high value may be given are absence of pain when the calf muscles are compressed, loss of the vibration sense in the feet, and muscular hypotonia. Irregularities in the outline of the pupils without an obvious explanation, or pupils which react well to accommodation but sluggishly to light, are very strong evidence of past syphilis and should be duly appraised. This may be called the second stage of tabes in which the diagnosis is founded on (1) evidence of syphilis; (2) tabetic pains; (3) sensory disturbances with a characteristic distribution.

3. If to these sensory disturbances there is added an Argyll Robertson pupil, or if one ankle-jerk or knee-jerk is absent or definitely diminished when compared with its fellow, the diagnosis is established beyond doubt. This may be called the stage of the fully developed disease. The diagnosis rests on—(1) evidence of syphilis; (2) lightning pains; (3) characteristic sensory signs; (4) the Argyll Robertson pupil in one or both eyes; (5) absence of one or both ankle or knee-jerks, or a definite diminution in one of them.

Lightning pains indicate that the disease is active. In the absence of pains tabes would still be suggested by the combination of an Argyll Robertson pupil with an absent ankle or knee-jerk, or by the combination

of one or both of these signs with characteristic sensory loss. In such cases, however, it would be impossible to say whether the patient was suffering from tabes which was likely to progress, or whether the disease had been arrested in its earliest stage.

DIFFERENTIAL DIAGNOSIS.—*Peripheral neuritis.*—The signs common to both diseases are loss of reflexes, hypotonia, inco-ordination and sensory loss. Wasting, loss of power, changes in the electrical reactions of the muscles and tenderness of the calf muscles distinguish peripheral neuritis. A complete history and examination will usually reveal the cause of the neuritis, or disclose certain signs of tabes.

Friedreich's disease.—Loss of tendon reflexes and inco-ordination occur in both diseases, but the age of the patient, the family history, the speech defects, nystagmus and the deformities of the feet and spine make the diagnosis easy. Juvenile tabes is sometimes mistaken for Friedreich's disease.

Course and Prognosis.—In most instances the disease is well established before some serious symptom brings the patient under observation. For this reason it is usually impossible to determine the sequence and duration of the signs that are found, but if the onset of lightning pains and of ataxia are taken as landmarks, an idea of the extreme variability of the course of tabes in different cases will be obtained. In many patients the disease remains stationary in the earliest stage and causes no disability. In a larger number inco-ordination appears after a pre-ataxic stage of 10 or 20 years. Some become ataxic within five years of the onset of pains, a few within a year. Once ataxy appears, its rate of increase varies within wide limits. It may be so rapid that walking becomes impossible in a few weeks; it often increases very slowly, and only interferes seriously with walking after several years, and in a large number periods of increase in the ataxy alternate with long periods in which it is stationary or undergoes temporary amelioration.

The course of the other symptoms is equally variable. In general, irritative phenomena—pains and crises—tend to diminish, while the signs of destruction of sensory nerves—diminished sensation, hypotonia, etc.—increase. Ocular palsies are frequently of short duration, and bladder and rectal symptoms are often temporary. It is impossible to foretell how any given case will progress, but there seems to be some connection between the period which has elapsed since syphilis was contracted and the rate of evolution of the disease—the longer this period the more benign the course. If the symptoms have increased slowly in the past, the future course is likely to be slow, whereas cases of rapid onset often progress rapidly. When optic atrophy occurs blindness results almost invariably, and a proportion of these cases develop general paralysis of the insane.

The prognosis as to life is variable. Most tabetics die of intercurrent maladies or of some cardio-vascular complication, but life is constantly menaced by cystitis and ascending infection of the urinary tract.

Treatment.—This falls under three heads: treatment by anti-syphilitic remedies, general treatment, and treatment of individual symptoms.

ANTI-SYPHILITIC TREATMENT.—As soon as tabes is recognised or suspected in a patient who has had syphilis, thorough treatment by specific remedies should be given. Mercury is the most valuable drug. Several courses of daily inunctions should be given at intervals, until 60 inunctions have been applied. This is usually supplemented by injections of salvarsan. Between

the courses, which may be repeated at 6 monthly intervals, mercury should be taken by the mouth in a pill or mixture. Most observers agree that all forms of intraspinal therapy are useless.

GENERAL TREATMENT.—In early cases the patient should be encouraged to continue at his work and avocations, so far as this is consistent with the avoidance of undue mental or physical stress. Strict moderation in the use of alcohol and tobacco should be enjoined. Marriage should be forbidden. The diet should be generous, and efforts should be made to prevent the rapid loss of weight which is a feature of many cases. Strict attention to the bowels is necessary. In many tabetics the normal call to stool is not felt, and if regular efforts to open the bowels are not made, stasis develops readily. This should be treated by enemata or by glycerine suppositories. Purgatives should be used with discretion. They are of little use in stasis, and should not be given if there is any tendency to rectal incontinence, as this is always worst when the motions are soft. A change from purgatives to enemata or suppositories will often relieve this distressing symptom. The bladder should be emptied at regular intervals, regardless of the call which is apt to be less insistent than in normal persons. In general, rest in bed is to be deprecated. In some instances, however, where ataxy develops rapidly, it is advantageous, provided that daily treatment by massage and exercises is instituted at once.

TREATMENT OF SYMPTOMS.—*Pains.*—Of the many drugs that have been tried for the relief of pains the following either in single or in various combinations have been found useful: aspirin, phenacetin, antipyrin, exalgin, pyramidon, cannabis indica, colchicum, ammonium chloride and sodium salicylate. After one has lost its effect another will often give some relief. Morphine is the only drug that is certain in its action, but it cannot be allowed except on isolated occasions, when for some special purpose it is essential that the patient should be free from pain for a few hours. In no disease is the morphine habit more rapidly acquired or more difficult to break. External applications rarely do any good. Chloroform on lint sometimes gives relief. Hot baths, hot applications to the limbs and blisters to the spine are worthy of trial.

Intravenous injections of neo-salvarsan sometimes relieve the pains when other means have failed. The clothing should be warm, and sudden changes of temperature should be avoided. Residence in a warm country is an advantage. Attention to small details, such as the avoidance of constipation and abstinence from alcohol, often has a favourable effect.

Crises.—Gastric crises, like the pains, are very resistant to treatment. Chloretone in cachets containing 10 grains is often useful. It may be given twice or at most thrice in 24 hours. The effect of the drug should be watched carefully, as it sometimes produces alarming depression of the heart and respirations. When chloretone fails cerium oxalate and tincture of iodine should be tried. The use of morphine is not justified. Rectal crises are sometimes relieved by small doses of grey powder with opium or pulv. ipecac. co. The lower bowel should be emptied daily by enemata. In mild cases with morning diarrhœa an enema or a suppository should be used before the first evacuation. Thereafter the patient should try to resist the desire to defæcate, which soon passes away, and with a little training this troublesome symptom can usually be overcome. Laryngeal crises

though very alarming are practically never fatal. They are usually relieved at once by an inhalation of nitrite of amyl.

Bladder disturbances.—When there is any difficulty in passing water a mixture containing 5 minims of liq. strychninæ thrice daily will be found useful. When the bladder is imperfectly emptied the use of the catheter should not be delayed. Only too often neglect of this matter leads to death from pyelo-nephritis. It is well to remember that serious infections may run a painless course. Their presence must be sought for even when pain is absent. This entails an examination of the urine from time to time for evidence of inflammation in the urinary tract. If pus-cells are present in the urine, urotropine and acid sodium phosphate should be given by the mouth. If this does not remove them, the bladder should be irrigated daily until the urine becomes normal. True incontinence of urine is often diminished by 5 minim doses of tincture of belladonna thrice daily.

Ataxia.—Just as a normal person by practice and effort can learn to perform feats of balance and muscular co-ordination which are impossible for one untrained, so the tabetic by concentrating his attention on his movements can be taught to make greater use of his remaining powers. The results of appropriate re-educative treatment are often astonishing. It is no uncommon thing to see patients who had been confined to bed for months able to get about freely again. Permanency of the result is often a gratifying feature.

As long as the patient is able to get about the necessary re-education can be acquired, if he is taught to pay particular attention to each movement of his limbs, and to attempt to carry it out accurately. In more severe cases, and when the patient is confined to bed, re-education should be given along the lines devised by Frenkel. Constant supervision is necessary at first, and the treatment should begin in an institution, or under the supervision of a skilled attendant.

No remedy is of avail in checking the progress of optic atrophy. Subcutaneous injections of strychnine have been recommended.

The condition of the feet often requires attention. Corns should not be cut. Perforating ulcers should be curetted and dressed with a paste of iodine and starch. A cradle should be placed over the feet to prevent deformities, and over-extension of the knee-joint should be prevented by wearing a suitable splint.

Charcot's joints.—As soon as this condition is discovered, the patient should be put to rest, the joint immobilised, and those measures used which tend to relieve the œdema and the effusion into the joint; and if occasion demand, the joint should be aspirated. When the joint becomes dry it should be rested for a long period. For example, the patient with a Charcot's foot should use a peg stump for six months, when the condition will be found to have healed. The knee is a difficult joint to support, and the best treatment is excision of the joint, with the production of a stiff knee.

CONGENITAL SYPHILIS OF THE NERVOUS SYSTEM

Affections of the nervous system are much less frequent in congenital syphilis than in the acquired disease. Viewed broadly, the pathological

changes and the clinical manifestations are the same in both. Regarding the first, meningitis, endarteritis and gummata are common to both forms; but while *central softening* from arterial disease is characteristic of acquired syphilis, *cortical cell atrophy and subsequent sclerosis* are prominent features in congenital cases. As for the symptoms, mental defects, with convulsions and spastic weakness of the limbs, are typical of congenital syphilis in contrast to the hemiplegias and monoplegias, with or without convulsions, which occur in the acquired form. It is noteworthy that the combination of obvious visceral and integumental lesions, with parenchymatous degeneration of the nervous tissue, is very common in the congenital, but not in the acquired disease.

Symptoms.—Many syphilitic infants suffer from *convulsions* during the first two years of life and in many cases these are given as the cause of death. In those who survive, fits may continue or they may begin again towards the end of childhood. The latter is more common. The fits in some cases have all the aspects of idiopathic epilepsy, and may continue throughout life without the addition of any symptoms suggestive of local brain disease. In another group, convulsions are followed by symptoms of *hemiplegia* or of *spastic diplegia*. The same defects may appear apart from convulsions.

Mental impairment is one of the common features of the disease. Idiocy is rare. More often the defect is first noticed between the ages of 5 and 15 years. The child may merely cease to learn, and retain any acquirements he possess, or he may lose his memory and become slowly demented.

Vision is often defective as a sequel of atrophy of the optic nerve or of choroido-retinitis, and bilateral *deafness* is not uncommon. Affections of the remaining cranial nerves are rare.

Juvenile general paralysis appears most often between the ages of 10 and 17 years. It has been seen as early as the eighth, and as late as the thirtieth year. In some cases it results from congenital syphilis, in others from syphilis acquired in infancy or in childhood. The physical signs are the same as in the adult form. The mental symptoms, as might be expected, differ from those in adults, when mental decay sets in before the appearance of the instincts and passions which form the content of the delusions in older patients. A boy of 12, for example, is not likely to have delusions regarding his wealth or his intellectual capacity or his sexual powers, although he may well have grandiose ideas concerning his physical strength. Optic atrophy is very common in juvenile cases, and as in adults, signs of tabes are present in many cases.

Juvenile tabes presents the same features as in adults. It is important to remember that in rare instances, tabes in an adult owes its origin to congenital syphilis or to syphilis acquired in infancy.

The diagnosis of congenital syphilis of the nervous system rarely causes any difficulty, as the patients almost invariably present some of the stigmata of their malady.

Treatment by mercury should be carried out perseveringly. The results are disappointing.

DISSEMINATE SCLEROSIS

Ætiology.—Apart from syphilis, disseminate sclerosis is the commonest organic disease of the nervous system in English and Continental practice. It is said to be less frequent in America.

Cases have been recorded in which the disease was noticed after acute illnesses, such as scarlet fever, influenza and rheumatism; but it is probable that these simply made more prominent a condition already present. Febrile illnesses are always followed by increase in the symptoms, and many patients with disseminate sclerosis relate that they became much worse after an attack of influenza. There is no doubt that this so-called influenza has been in some instances at least a febrile phase of the disease itself. In the great majority of the cases there is nothing in the family or personal history to which the disease can be attributed. In one instance, confirmed by examination after death, it attacked a mother and her child, and a few similar cases, as well as the affection of several members of a family, have been recorded, but without pathological confirmation.

The onset is most frequent between the ages of 16 and 30, the sexes being affected equally. It is rare for the disease to begin after the age of 45.

The cause is still unknown, but the course of the disease as well as the inflammatory nature of the early lesions points to an infective origin, and recent research suggests that the causative agent is a specific transmissible virus, to wit, an organism resembling the *Spirochæta pallida*. It is certain that syphilis plays no part in the ætiology.

Pathology.—As indicated by the name of the disease, the lesion consists in patches of sclerosis scattered like seeds throughout the substance of the brain and cord. They vary in size from microscopic areas to large plaques, which sometimes extend over the greater part of transverse sections of the cord or brain stem, or occupy still larger areas in the white matter of the brain. Under the microscope the older patches are found to contain proliferated neuroglia and nerve fibres which have lost their myelin sheaths. The axis-cylinders in the sclerosed areas escape destruction for a long time. For this reason secondary degenerations do not occur in the spinal tracts, and sections of the cord between lesions at different levels present normal appearances. Ganglion cells are also spared; hence wasting of the muscles supplied by the affected segments is not a feature of the disease. In recent patches, œdema is present with infiltration by small lymphocyte-like cells, plasma cells and compound granular corpuscles around the blood vessels, especially in the adventitial sheath of the veins. It is highly probable that these inflammatory changes represent the initial lesion, and that the alterations in the nerves and in the neuroglia are secondary to them.

Symptoms.—The mode of onset as well as the course of the disease differs greatly from one case to another. This is explained by the nature of the early lesions, and by the extreme variations in their number and distribution. In the early stages the axis-cylinders in the diseased areas are not interrupted completely, but suffer partial and temporary impairment, which alters in intensity with the severity of vascular and other inflammatory changes in the tissues around them. Moreover, as the inflammation subsides in one patch a new one develops and produces a different set of symptoms. Again,

the first lesion may arise in any part of the brain or cord, and every conceivable combination of lesions and, therefore, of symptoms, is possible. Hence it is not surprising that the earliest symptoms are often slight and fleeting, or that they may first appear now in one part and now in another. In spite of this, however, certain symptoms and physical signs appear with remarkable regularity and render disseminate sclerosis, in the more advanced stages at least, one of the most distinctive and most easily recognised diseases of the nervous system.

In a typical case the most prominent features are—(1) spastic paraplegia or other signs of involvement of the pyramidal tracts; (2) tremor in the arms; (3) nystagmus; (4) pallor of the temporal half of the optic disc; (5) scanning speech. The triad formed by intention tremor, nystagmus and scanning speech is practically pathognomonic, and it is customary to give great prominence to these symptoms. It must be emphasised, however, that they are found together in a minority of the cases—say in 20 per cent.—and that some cases run their course without the appearance of any one of them.

Motor Symptoms.—Weakness in the lower limbs is the symptom for which many patients first seek relief. Beginning with a feeling of heaviness or stiffness in one or both limbs, the weakness, which may be limited at first to one group of muscles, increases, in some uniformly, in a larger number with remissions or with periods of apparent recovery, until at last, after a time which varies from a few weeks to many years, it ends in severe spastic paraplegia. The physical signs are those of pyramidal lesions in general—increased tone in the muscles and exaggeration of the tendon reflexes, diminution or loss of the abdominal and cremasteric reflexes, and Babinski's plantar response. They are of extreme importance, for some or all of them may be present when the patient's complaints are still trivial, and they are found so constantly in all stages of the disease that the diagnosis of disseminate sclerosis is rarely made in their absence.

The paralysis can often be distinguished from that of other pyramidal affections by the variations in its severity from time to time, and by the occurrence of remissions or of apparent recovery, the improvement sometimes lasting for weeks or months, and, in rare cases, for many years. In most cases, moreover, examination will reveal some other sign—nystagmus, intention tremor, or pallor of the disk—which betrays the cause of the paralysis. In one large group of cases, however, the symptoms are those of a steadily increasing spastic paraplegia without remissions and without any indication, either in the physical signs or in the history, of extra-pyramidal disease. The gait may be but slightly altered, even when the tendon reflexes are greatly exaggerated and the plantar responses are "extensor." Later, it becomes spastic or spastic and ataxic. Sometimes ataxy makes walking very difficult, when the power in the limbs is only slightly impaired. In the arms there is often loss of power associated with exaggeration of the tendon reflexes. In some cases the arms are affected before the lower limbs, when weakness or ataxy produces one of the commonest of the early symptoms—the "useless arm."

Tremor.—The characteristic tremor in the arms appears on voluntary movement only, and increases in rate and amplitude as the goal is approached. For these reasons it is called intention, volitional, or terminal tremor. It is sought for by causing the patient to touch his nose with the tip of one

finger. In its minimal form the tremor appears as two or three jerky movements of the finger just as the goal is attained, or the finger reaches the nose without any abnormal movement and then oscillates, so that it slips away from the nose again or depresses it several times before coming to rest. The tremor may be noticed first in writing or in performing other delicate movements, such as threading a needle. Later, the rate and amplitude of the movements increase, and the tremor, although still greatest at the end, appears almost as soon as a voluntary movement begins. In advanced cases it prevents all useful movements, and the patient is unable to do anything for himself. The arms are affected earliest and most often, but nodding of the head is common, and any part of the body may be affected. Beside intention tremor, other types of inco-ordination of the limbs are occasionally seen, such as those characteristic of lesions of the optic thalamus or of the mid-brain or of the cerebellum.

SENSORY SYMPTOMS.—*Subjective.*—Numbness and tingling in the extremities and alterations in the sensation of various parts are common complaints. They are often transient, and may be the only symptoms during the premonitory period. Severe pains are rare, but many patients complain of stiffness or of aching in the limbs and in the back.

Objective.—Severe sensory loss is not common, but careful examination will often reveal areas of skin in which sensation is impaired. Occasionally the loss is severe, and may show so sharp an upper level as to suggest the presence of a spinal tumour. In many cases the sense of position and passive movement in the limbs is seriously affected, in others loss of vibration sense is the only sensory sign. Like the other signs, the sensory disturbances often show considerable variations in extent and degree at different examinations.

OCULAR SYMPTOMS.—Attacks of *double vision* are frequent, and highly characteristic of the disease. Close interrogation, avoiding the leading question if possible, will often elicit an account of these attacks when the patient has not mentioned them at first, either because he has forgotten them, or because it does not occur to him that a symptom so remote or so transient can have any bearing on his present trouble. This diplopia is of the highest importance, because it is often the sole complaint when the patient seeks advice for the first time, and because its presence, or a history thereof, is often the deciding factor in the diagnosis of early cases with spinal symptoms. Double vision in a young person should always arouse the suspicion of disseminate sclerosis, and if it is associated with signs of pyramidal tract disease, the combination makes the diagnosis almost certain.

Strabismus is uncommon. Even when the patient is seen whilst complaining of double vision it is unusual to detect any limitation in the range of the ocular movements.

Ptosis is rare.

Still rarer is " nystagmus of the lids," a rhythmical up-and-down movement of the lids which appears on testing for nystagmus. It is usually associated with ptosis of the eyelids.

Nystagmus is present in more than half the cases, and is frequently an early sign. It is usually fine, rapid and horizontal, appearing only when the eyes are directed to the side. In some cases the eyes oscillate constantly whatever their position. Except in rare cases, there is no apparent movement of objects, even when the oscillations are of wide range.

Visual failure.—Diminution of visual acuity due to lesions in the optic nerves—*retrobulbar neuritis*—occurs sooner or later in nearly every case. As in the case of the other symptoms, it is subject to exacerbations and periods of improvement. In many cases, acute retrobulbar neuritis is the first alarming symptom of the disease. A young healthy person complains of rapidly increasing mistiness of vision, usually in one eye, sometimes in both or in one after the other, reaching its maximum in a few hours or days; this is often preceded or accompanied by pain about the orbit, which is increased on moving the eye. In the common unilateral case the signs are those of a lesion in one optic nerve; the pupil on the affected side is larger than its fellow; its direct reaction to light is impaired, but it contracts well consensually. Tests with a small object, preferably coloured, reveal a central scotoma. At the onset the disc is usually normal, but sometimes the inflammation reaches the nerve head, in which event the disc is blurred and swollen. Later the disc may be pale or normal. Rapid improvement of vision is the rule. Special tests may reveal a persistent slight loss of visual acuity, and a partial central scotoma, or, very rarely, a complete central scotoma. Subsequent acute attacks are common. In some cases the onset of visual failure is gradual. Usually the defect is slight, but it may be serious, although complete blindness never occurs. In these cases the disc is pale, especially in its temporal portion, and the field shows a central scotoma or narrowing at the periphery.

Papillœdema in one eye is common and the swelling is usually slight. Rarely it is bilateral, and may be great enough to suggest the presence of a cerebral tumour.

Mental Symptoms.—Defective memory and slight impairment of intellectual power are common. Some of the patients are morose and subject to fits of depression, but the majority are surprisingly cheerful, and do not seem to suffer mentally even when their physical state is most pitiable. In many cases there is considerable loss of emotional control, and ready laughter or weeping is fairly common. More often there is merely a tendency to laugh at trivial things. It is said that the mental changes sometimes resemble those of dementia præcox.

Sphincter Disturbances.—In the later stages defective control of the bladder is almost constant. Transient attacks of frequency of micturition or of slight incontinence sometimes occur in the earliest stages. In rare cases, control over the rectal sphincter is lost.

Other Symptoms.—Deafness, giddiness and tinnitus, sometimes with repeated vomiting, are common. Epileptiform convulsions are rare. As any part of the central nervous system may be affected, a patient with this disease may present the features of a lesion of any part of it. In most instances the distribution of the signs will indicate that the lesions are multiple; but sometimes, although the patches are numerous, the signs are those of a single lesion, say of the internal capsule, of the midbrain or of the cerebellum.

Cerebro-spinal Fluid.—The colloidal gold test is often positive. In a few cases the number of cells is increased. Otherwise the fluid is usually normal.

Diagnosis.—In a typical case the combination of spastic weakness in the lower limbs with nystagmus, intention tremor and optic atrophy, with or without scanning speech, makes the diagnosis easy. Typical cases, however,

are few in number, indeed cases in which all the cardinal signs are pronounced are labelled "text-book type," and are regarded rather as curiosities. It must be emphasised that most patients, when seen for the first time, present a very different picture.

1. The commonest early complaint is of some motor or sensory disturbance, of rapid onset, that causes difficulty in using the hand or in walking. This suggests disseminate sclerosis, and leads to questions that may elicit an account of an earlier attack of some kind, *e.g.*, of diplopia, retrobulbar neuritis, numbness, tingling, weakness or difficulty in using the limbs, or sphincter disturbance. A young person with weakness or numbness of one or more limbs, and a history of similar transient phenomena in the past, or of rapid failure of vision or of double vision, with complete or partial recovery, almost certainly has disseminate sclerosis. The history alone gives the diagnosis. It is confirmed by the presence of even one certain sign of pyramidal tract disease, such as Babinski's plantar response, absence of the abdominal reflexes, or a definite inequality of skin or tendon reflexes on comparing the two sides. Pyramidal tract disease without obvious cause in a young patient is probably disseminate sclerosis. The classical signs—nystagmus, intention tremor and scanning speech may all be absent. Nystagmus or intention tremor is a very important sign in a patient with the history outlined above, but its absence is not significant. Defective sense of position is commoner than intention tremor in early cases. In the finger-to-nose test the patient misses his nose because he is not sure of the position of his finger. Often, two defects are revealed by this test: difficulty in finding the nose and a few jerky movements of the finger as it approaches the nose—a highly characteristic combination.

2. In some cases the signs are those of uncomplicated spastic paraplegia, without anything in the history or the present state to indicate disease of any structures other than the pyramidal tracts. In some of these a history of similar attacks in the past or of periods of improvement will give the clue to the nature of the paralysis. In a smaller number the paralysis is steadily progressive, and its cause is a matter of conjecture based on probability—spastic paraplegia coming on in a young adult is probably due to disseminate sclerosis—or is arrived at by the exclusion of other possible causes, particularly of syphilis and compression. In these cases, frequent examinations must be made for nystagmus, intention tremor and optic atrophy.

3. Defective vision is often the first symptom. Optic atrophy or a central scotoma in a young person is probably due to disseminate sclerosis; likewise failure of vision, with improvement or fluctuations in severity. When the onset has been gradual, a history can usually be obtained of the characteristic transient motor, sensory or sphincter troubles, and some sign of pyramidal tract disease is found to indicate the cause of the eye trouble. Further, disseminate sclerosis is by far the commonest ascertainable cause of acute retrobulbar neuritis; hence, rapid failure of vision in a young person, without the accompanying symptoms which would be present with other possible causes, such as cerebral tumour, is probably due to disseminate sclerosis. Occasionally, in acute cases, a history of symptoms and the presence of definite signs give proof of the cause; often there have been no extra-ocular symptoms, and the signs, though suspicious, are not unequivocal, *e.g.* sluggish

or slightly unequal abdominal reflexes, or a doubtful plantar response ; often there are no symptoms or signs of extra-ocular disease, but later events prove the nature of the early eye trouble, thus, even fourteen years may elapse between the first attack of retrobulbar neuritis and the appearance of other symptoms of disseminate sclerosis.

4. To cover other modes of onset that vary with the site of the lesion, it is sufficient to remind the reader that, excepting cerebral tumour, disseminate sclerosis is the only common primary organic disease of the central nervous system. If a young person, free from syphilis, has unexplained organic nervous disease, disseminate sclerosis is the most likely cause.

Disseminate sclerosis has to be diagnosed from various diseases, of which we will consider the following:

Hysteria.—The serious mistake of attributing the early symptoms of this relentless disease to hysteria can be avoided by careful examination of the nervous system. Pallor of the disc, absence of the abdominal reflexes, or a distinct difference between them at corresponding points on opposite sides, unequal exaggeration of one or more of the tendon reflexes when compared with their fellows, Babinski's plantar response on one or both sides —any one of these signs alone would render a diagnosis of hysteria untenable.

Compression of the cord.—When the signs in disseminate sclerosis are purely spinal, the diagnosis from *spinal tumour* presents real difficulties. The first may be mistaken for the latter, when the paralysis increases steadily without remissions and is associated with sensory loss extending upwards to a definite level, while the reverse error may be made when the symptoms caused by a tumour are purely motor, or vary in intensity, or are associated with nystagmus.

Spinal caries may cause difficulty when paralysis appears before disease of the bone has been detected, and the same applies to new growths in the vertebral column. If the paralysis is due to compression, examination of the spinal fluid will usually reveal the loculation syndrome, and an X-ray of the spine will serve to distinguish disease of the vertebræ.

Friedreich's ataxy.—This may be suggested by the presence of ataxy in a young patient with disseminate sclerosis. The distinction can be made at once, for in the latter disease the tendon reflexes in the lower limbs are exaggerated, whereas they are lost early in Friedreich's disease.

Course and Prognosis.—Once the disease is established, a downhill course is the rule, and death usually occurs in a few years. In a fair number, life is prolonged for 10 or 15 years, and patients have been known to survive for 25 or 30 years. Remissions and periods of temporary improvement are common. Usually they are short, and the patient is considerably worse after each exacerbation; but sometimes a remission lasts for several years and raises the hope that the disease is arrested. In all but the very rarest instances, however, symptoms recur, and the disease pursues its course relentlessly. The outlook for life is best in older patients with signs of disease of the spinal cord alone. Death is often hastened by bed-sores and infection of the urinary tract.

Treatment.—No treatment is of avail in curing the disease. Arsenic appears to be the most useful drug. Iodide of potassium in small doses is of great service. Belladonna invariably improves the sphincter trouble.

Massage and passive movements of the spastic limbs are appreciated by the patients. They should avoid over-exertion, but should not be kept in bed so long as walking is possible.

SCHILDER'S DISEASE: ENCEPHALITIS PERIAXIALIS

Definition.—A malady characterised anatomically by a progressive and massive demyelination of the white centre of the cerebral hemispheres, proceeding from a single focus or from two symmetrical foci, and producing the clinical picture of progressively increasing failure of cerebral function, local at first, but advancing in terms of the functions of the contiguous regions which are next affected, by the spread of the disease from its original starting-point.

Ætiology.—Nothing is known of the essential cause of the disease, but from the nature of the lesions it seems probable that a local infection within the nervous system, of a spreading character, giving rise to an inflammatory reaction, and quickly followed by intense demyelination, is the fundamental cause. Many of the reported cases have occurred in childhood, even as early as the second year. The latest case was in the fifth decade of life. The sexes are equally affected.

Pathology.—The characteristic lesion consists of: (1) A primary demyelination and, later, destruction of the axis cylinders of the central white substances of the cerebral hemispheres, which till very late spares the subcortical zone of white fibres and the radial cortical fibres, and produces a translucent jelly-like appearance of the oval centres. (2) A very early and perhaps primary overgrowth of the neuroglia, forming a feltwork, which is particularly intense round the vessels. (3) A general infiltration of the white matter of the brain with round cells, all of which are of neuroglial origin, and most of which are engaged in the removal of altered myelin or in the formation of neuroglial fibres.

The process commences most commonly as a symmetrical patch of demyelination, in either occipital white centres, less frequently in both temporal white centres or in both prefrontal white centres, and spreads directly thence until the whole of the oval white centres become demyelinated. These present a very striking translucent, greyish or yellow-brown appearance. The corpus callosum is involved, and the demyelination spreads downwards through the crura into the brain stem. Sometimes, especially in the central regions, the disease starts on one side, and, after playing havoc with the white centre of one hemisphere, spreads across the corpus callosum into the other. Until the central demyelination is well-nigh complete, the subsulcine arcuate bands or white fibres and the cortex appear unaffected to the naked eye, and the resulting picture of a brain, normal on the surface, and on section with apparently normal cortex and intact subcortical white bands, but with the oval centre completely changed and translucent, is peculiar to this disease. Not unfrequently other patches of the disease may be scattered throughout the central nervous system. These have been found in the optic chiasma, in the cerebellar stalks, and in the white matter of the brain stem and of the cord. This scattered distribution and the prominence of demyelination bring Schilder's disease very close to disseminate sclerosis, and it has actually

been described as "disseminate sclerosis in childhood"; but the massiveness and mode of spread of the lesions, together with their distribution, with predilection for the brain and avoidance of the spinal cord, its incidence in childhood and its entirely different symptomatology, separate Schilder's disease sharply from disseminate sclerosis.

Symptoms.—The clinical aspect is precisely that which might be expected from a progressive destruction of cerebral function, spreading by contiguity from the initial seat of the disease. In many of the cases blindness—by which is meant blindness without any change in the optic discs and with pupils reacting normally to light—has been the first symptom, and is the result of the symmetrical demyelination of the occipital white matter. As the disease spreads forwards into the temporal regions, bilateral deafness appears; and, later, bilateral ataxy and astereognosis—due to parietal involvement, bilateral spastic paralysis—the result of central involvement, and complete amentia—due to callosal and prefrontal involvement, develop.

In those cases in which the initial seat of the disease is in the temporal, central or frontal regions, the first symptom to appear is obviously determined by the location, and the order of development of symptoms will be changed, but the mode of progress is the same in all. Where the disease starts on one side only, hemianopia or hemiplegia is the first symptom, and these are followed by the train of added signs produced by the extension of the disease into other regions. Complete mindlessness and paralysis always dominate the clinical picture in the end. The disease-process within the brain sometimes causes swelling with increase of intracranial pressure, and signs of the latter may appear in the form of headache, vomiting and papilloedema. Such cases are not common, and most of them have been regarded in life as cases of intracranial tumour. Fits are by no means uncommon. Sometimes they constitute the initial manifestion of the disease, and they may occur at any time during its course, and may be local or general. Fever is usually absent, but there may be irregular pyrexia and some of the more acute cases have been pyrexial throughout. The cerebro-spinal fluid is normal in the majority of the cases, but sometimes there is an increased protein content and a small excess of lymphocytes.

Diagnosis.—The onset with cerebral blindness or with bilateral deafness, followed by signs of progressive cerebral destruction, is so rare in any other disease as at once to suggest the diagnosis of Schilder's disease, indeed no less than two-thirds of the reported cases have shown this picture. When the disease begins unilaterally, and more particularly when headache, vomiting and papilloedema are present, the distinction from intracranial tumour is difficult or even impossible, for in both diseases the local commencement and the progressive destruction occur. In Schilder's disease, however, high-grade papilloedema is not met with, and consecutive optic atrophy does not occur. It should be borne in mind that any locally commencing progressive destruction of the brain may be an example of this malady.

Course and Prognosis.—In most cases Schilder's disease is regularly progressive to a fatal termination. In some, however, periods of standstill have been noted, while in a few others marked improvement for a time has occurred, as the result of administration of mercury, arsenic and iodides. The duration has varied from 7 days to 36 months, with an average of 9 months.

Treatment.—Beyond the fact that mercury, arsenic and iodides have brought about temporary amelioration in some cases, no treatment is at present known that will influence the course of the disease.

HEREDITARY ATAXY

Under the name of "hereditary" or "familial" ataxy are gathered together several clinical types of disease, which have many features in common, and between which almost every variety of transitional type may be observed. The common features of these diseases may be here expressed:

ÆTIOLOGICALLY.—They tend to develop during childhood, but in some families the incidence is late in life, often being in the sixth decade. They are hereditary, and the heredity may be direct or indirect, or the disease may suddenly appear among many members of the same child-rank at a certain distance from a common progenitor. As with all hereditary diseases, isolated cases in which no heredity can be traced are common.

CLINICALLY.—They are characterised by a slow, clumsy ataxy, which in the eyes appears as nystagmus, and in the speech is expressed by staccato and explosive utterance, slurring, drawling and general lack of articulatory precision. In the trunk and limbs the ataxy is shown by clumsy unsteadiness, intention tremor, titubation and by involuntary movements, somewhat like those of chorea. Disturbances of sensibility, both objective and subjective, are conspicuous by their absence, and the sphincters are not affected. Signs of involvement of the pyramidal system in the form of the extensor response in the plantar reflex, contractures or spasticity are present.

PATHOLOGICALLY.—The morbid change consists in a primary neuronic degeneration, with secondary glial proliferation in the following systems: (1) in the afferent neurons, comprising the posterior columns of the spinal cord; (2) in the neurons of the direct cerebellar tract and of Gower's tract; (3) in the neurons of the cerebellum and its direct connections; (4) in the neurons of the pyramidal systems in the ascending frontal convolutions; (5) in the neurons of the retina. While all these morbid changes may coexist in the same case, yet it is common for the degeneration to fall heavily upon some of these systems, while others relatively or entirely escape. For example, in the spinal form of Friedreich's disease, the degeneration is practically confined to the posterior columns and the spinal cerebellar tracts, whereas in the type of primary progressive cerebellar ataxy the degeneration is entirely confined to the cerebellum. And, again, in familial spastic paralysis the lesion is confined to the pyramidal system. All such pure types are rare; but combinations of these types make up the clinical and pathological entities of hereditary ataxy. Optic atrophy from degeneration of the retinal neurons is especially characteristic of Marie's ataxy; but it may occur in every other form of hereditary ataxy.

The following types of hereditary ataxy are sufficiently distinct to merit separate description, and with them is included familial spastic paralysis, as this latter condition seems naturally to complete a clinical and pathological series—(1) Friedreich's ataxy; (2) Marie's ataxy; (3) Sanger Brown's ataxy; (4) primary progressive cerebellar ataxy; (5) type of Dejerine and Thomas; (6) a type closely resembling disseminate sclerosis but familial in incidence; (7) familial spastic paralysis.

Many types exist which do not quite correspond with the usual descriptions of the above, and any transition between these types may exist. They may show striking peculiarities in the age incidence, in the clinical aspect, and in the course and prognosis of the malady. It is usual for the type to remain constant in the same family; but even to this rule there are notable exceptions, which prove the close relationship of these diseases. For example, in one family which came under my observation five children were affected, and of these four were very typical cases of Friedreich's disease, but the fifth was a typical case of Marie's ataxy.

Friedreich's Ataxy

In addition to the slow, clumsy ataxy, Friedreich's type is characterised by the absence of the knee-jerk and other deep reflexes, and by the presence of the extensor plantar response and of contractures, especially in the form of pes cavus, and by the presence of curvature of the spine in the later stages of the disease.

Ætiology.—The first signs of the disease usually appear in early childhood and before the sixth year; but symptoms may not be evident until a few years later. In a considerable number of cases, however, the onset is delayed until the time of puberty, while in a few examples the onset may be delayed until after the age of thirty years. As a rule the age incidence is approximately the same in each child-rank of the same family; but sometimes the phenomenon of "anticipation" is well marked, the disease appearing at an earlier age in each succeeding generation as a whole, or in successive children of the same parents. The disease is said to be slightly more common in males. Isolated cases in which no heredity can be traced are not rare; but the tendency to familial incidence is striking and characteristic. Indirect heredity is the most common, for the reason that the subjects of this disease are usually afflicted in childhood and incapacitated by the time adult life is reached, and that they therefore do not procreate. Transmission occurs both through the males and through the females. Direct heredity is, however, by no means so uncommon as has been supposed, and in one family under my observation the disease had been transmitted from father to son for seven generations.

Pathology.—Gowers considered that the malady was of an abiotrophic nature. He thought that the nerve elements which degenerate were hereditarily endowed with a much shortened period of vitality, after which they underwent a natural process of decay. The spinal cord is unusually small, and apparently this smallness may be congenital, and the posterior roots tend to be small, grey and poorly myelinated. The essential change is a primary degeneration of certain neurons in the dorsal column of the spinal cord, of the pyramidal tracts and of the spino-cerebellar tracts, both dorsal and ventral. This degeneration commences first in the periphery of the axon, which slowly dies back toward the nutrient nerve cell, as the branches of an aged tree tend to die back towards the trunk.

The degeneration of the dorsal columns is usually the earliest change, and remains the most prominent feature throughout. In the lumbo-sacral region degeneration is found in the whole of the dorsal columns, except the cornu-commissural zone and the fibres in the immediate vicinity of the dorsal

horn, but a certain proportion of the fibres of every region remain intact throughout the whole course of the disease. The degeneration of the fibres of the pyramidal tract appears later. It has its origin in the ascending frontal convolutions, where atrophy and disappearance of the giant pyramidal cells have been shown. But as the degeneration is a process of dying back towards the centre, it is always best marked in the lower part of the spinal cord, and is often not to be traced above the decussation of the pyramids.

The spino-cerebellar tracts are constantly degenerated, the direct cerebellar tract being the most seriously involved. The cells of Clarke's column, from which the direct cerebellar tract takes origin, and around which the pyramidal tracts end, degenerate and disappear, as does also the network of collaterals which surrounds these cells. Consequent upon these degenerations, and secondary to them, well-marked neuroglial proliferation or sclerosis occurs, and this is most marked where the degeneration is most severe, usually in the dorsal columns, where it may be in such great excess, and arranged in such irregular whorls, that it was formerly regarded as the primary pathological change. The cerebellum may be normal, or it may show varying degrees of atrophy of Purkinje's cells, or of any other of its cell elements, and of the tracts connected therewith.

Symptoms.—The onset is always insidious, and physical signs of abnormality usually precede any complaint on the part of the patient or his relatives. The first symptoms generally appear between the sixth and the tenth year of childhood; but if a careful examination be made of the younger members of the families upon which Friedreich's disease is incident, physical signs of the disease, especially the extensor response in the plantar reflex, the retraction of the great toe and some degree of pes cavus may often be found before the sixth year. Not infrequently the onset of symptoms does not occur until puberty, and in some families it is delayed until after the age of 30 years.

Ataxy is always the first sign to appear, and this is shown by an awkwardness of gait and a tendency to stumble and fall readily. Sometimes it is obvious from the history, that the ataxy dates from the earliest years of infancy, when it is said that the child was never strong on his legs from the time of learning to walk, and that he could never run properly or join on equal terms with other children at play. As the disease progresses, the gait slowly becomes more irregular and clumsy, and acquires a reeling and staggering character which resembles somewhat that of an inebriated person. The patient walks with his feet upon a broad base, and staggers and reels from side to side; but, notwithstanding this, he keeps a fairly direct line of progression. He takes short steps which are unequal, and which are irregular in relation to the line of progression, and the movement of each foot as it is raised is poorly co-ordinated. There is never the undue excursion and noisy stamping of the feet which is so characteristic of the gait of tabetic patients. The inco-ordination of both legs and trunk becomes very obvious in turning quickly, or in rising quickly from a seat. On account of the important effect of inco-ordination of the trunk upon the gait, the ataxy of the lower limbs, which is so marked on walking, becomes less evident in movements of the legs performed when the patient is lying in bed.

Static ataxy is very marked, and this results from defective co-ordination of the muscles required to maintain a fixed position against external forces,

and especially the force of gravity. Thus in standing the body oscillates from side to side in slow and clumsy fashion, and coarse tremors of the head and trunk are constant features in advanced cases (titubation). There is consequently considerable difficulty in balancing the trunk upon the feet in standing. Sometimes Romberg's sign is present; but this is never so well marked as in tabes, and it is frequently entirely absent. The ataxy invades the upper extremities, as a rule, later than the legs. There is first clumsiness with the finer movements, and then little by little with all the movements. It closely resembles the ataxy due to gross disease of the cerebellum, and differs from that which occurs in tabes, and that irregular breaking of a movement towards the end of its accomplishment, which has been long termed "intention tremor," is frequently seen.

Very characteristic of the disease, and highly important in diagnosis, is the occurrence of irregular involuntary movements, which are often described as like those of chorea or of myoclonus. They differ entirely, however, from the movements of chorea, etc., in that they occur only when the limb or some of its segments are unsupported, for they depend upon a loss of synergy between the muscles which maintain the postural tone. In advanced cases such movements are constantly seen in the head and neck as nodding movements and tremors, and in the trunk as swaying instability, when the patient is sitting unsupported or standing. Similar ataxy and irregular movements affect the muscles of the eyes, of the face, tongue, larynx, etc., and the respiratory muscles. In the eyes they are seen as fine, regular nystagmus and as coarse, irregular jerkings, chiefly upon lateral deviation. There is no other disease in which ataxy of the facial muscles is so conspicuous for, on engaging the patient in conversation, all the facial muscles may be observed in irregular contraction. Perhaps some of the spontaneous involuntary movements of the face are truly choreic in nature, and are indicative of involvement of the corpus striatum. The ataxy of these muscles causes an invariable impairment of articulation, which gradually becomes indistinct, clumsy, drawling and slurred. The syllables tend sometimes to be separated, adding a staccato element. Explosive utterance is almost constant, and from the irregularity of the respiratory movements short inspiratory whoops are not uncommon. Articulation thus closely resembles that of advanced disseminate sclerosis, the cause being identical in the two diseases, namely, interference with the cerebellar co-ordinatory mechanism of speech.

The strength of movements is at first little impaired; but as the disease advances and the pyramidal degeneration increases, the power is gradually lost in proportion to the degree of the pyramidal degeneration, which varies greatly in different cases. The lower extremities are affected first and most, and later the arms, and in severe cases at a late stage paralysis may be almost universal.

The condition of the muscular tone depends upon the relative degree of degeneration in the posterior roots and in the pyramidal tracts respectively, the former tending to abolish and the latter to increase it. As a rule the influence of the posterior root degeneration is preponderant and, therefore, the limbs are flaccid and hypotonic, but occasionally they are somewhat rigid. Contractures are the rule, but these are confined to the lower extremities. The most constant of these produces the deformity of the feet characteristic of Friedreich's disease, and known as "pes cavus." The great toe is

strongly retracted, the tarsus is pulled up, and the metatarsus is dropped and the plantar arch is increased. The outline of the inner border of the foot comes to resemble the letter Z, the tarsus, metatarsus and great toe forming the three limbs of the Z. Sensibility is but little affected; but in most cases minute examination reveals slight relative loss to touch, pain and temperature, most marked at the periphery of the limbs and diminishing upwards. Similarly there may be slight loss of sense of position in the limbs, with diminution of osseous sensibility to the slowly vibrating tuning-fork.

The ocular movements are almost always intact apart from the already described nystagmus. In rare instances strabismus, diplopia and ptosis have been recorded. In one family, which came under our observation, extreme slowness of the ocular movements occurred in three generations, all of whom were observed at the National Hospital. The pupils are not affected. Optic atrophy is a rare phenomenon in Friedreich's disease, yet it has been reported in quite a number of otherwise typical cases.

Mental symptoms are usually not conspicuous, but some of the patients are of poor mentality from the first, while others show a tendency to severe mental degeneration in the later stages of the disease. Emotional instability, irritability and outbursts of temper may occur.

Absence of the tendon reflexes is a most characteristic feature, and is often the first objective sign of the disease. When one considers, however, that the absence or presence of the tendon reflexes depends upon the relative degree of affection of the posterior columns upon the one hand, and upon the pyramidal degeneration upon the other, it is not surprising to find in cases where there is a major degeneration of the pyramidal tracts, that the knee-jerks may persist or even be brisk into the advanced stages of the disease. The abdominal reflexes gradually disappear. The plantar reflex is invariably an extensor response. The sphincters usually escape. The cerebro-spinal fluid presents no abnormality as regards cytology, albumin content or sugar reaction.

Spinal curvature is very common, and may reach a severe degree. It consists of a scoliosis of the dorsal region, and often with some kyphosis, and with a compensatory reverse lumbar curve. The cause of this deformity is probably the defect in the postural tone of the muscles, which occurs when the afferents subserving the function of postural tone, and which are contained in the spino-cerebellar tracts, are severed.

Diagnosis.—In uncomplicated cases the diagnosis is a matter of no great difficulty on account of the strikingly distinct nature of the symptoms. Friedreich's disease can hardly be mistaken for tabes since the history of heredity, the peculiar deformity of the feet and spine, the extensor response, the speech affection and the nature of the ataxy contrast strongly with the loss of pain sensibility and of deep sensibility, the pupillary changes, the sphincter trouble, the abnormal Wassermann reactions and the abnormal cytology of the cerebro-spinal fluid in tabes. The distinction from disseminate sclerosis presents more difficulty; but in this disease the onset never occurs in childhood, there is no heredity, the deep reflexes are never lost, and the spinal deformity does not occur.

Course and Prognosis.—The course of the disease is usually progressive in slow and irregular fashion, and the prognosis is therefore in every case serious; but the average duration of the disease is over 30 years, and in some cases it seems to have no tendency to shorten life. The prognosis is worse

and the course more rapid in those patients who have shown disability from the time of learning to walk. In some cases the disease appears to become arrested, as, for example, in one family which came under my observation, twelve members in three generations were affected with typical Friedreich's disease, yet none of them was incapacitated from following a normal life, and those that were deceased had all survived the age of 70 years. Similar examples have been recorded by Gowers. Intercurrent maladies, febrile illnesses and debilitating influences generally, may have a strong effect in hastening the advance of the disease, and bringing about a fatal termination. Confinement to bed from any cause whatever has a most derogatory influence upon the ataxy, and upon the capacity for walking. It is not an uncommon experience for a patient who is able to get about in comfort to be put to bed either for purposes of examination, of treatment or for illness, and permanently to lose his power of walking from the temporary deprivation of his usual exercise. It is therefore of great importance that these patients shall be kept off their legs as little as is possible. Cases in which the ataxy becomes extreme, or in which paralysis from pyramidal degeneration becomes severe necessarily become bedridden, and in this condition the patients may survive for many years. In other cases rapid increase of the symptoms of degeneration within the nervous system is followed immediately by drowsiness, asthenia and coma, and death occurs in that peculiar toxic state which is commonly the end result of all degenerative nervous diseases.

Treatment.—No treatment is known which specifically affects the malady. General tonic treatment, and all measures which improve the general health and mental well-being, often have a surprising effect in improving the ataxy. Re-educational training of the limbs and trunk in the form of Frenkel's exercises are most beneficial. Properly designed boots to ensure the most advantageous use of the deformed feet must be provided.

Marie's Ataxy

Under the name "hereditary cerebellar ataxy" Marie, in 1893, grouped together as a separate type certain cases which, so far as the nystagmus, speech and ataxy were concerned, exactly resembled cases of Friedreich's disease, but were characterised clinically by spasticity of the legs with an invariable increase of the knee-jerk, etc., and by the common occurrence of optic atrophy and by the occasional presence of the Argyll Robertson pupil. He showed that the incidence of the disease is at a later age than that of Friedreich's disease. He contended that the fundamental lesion causing this morbid entity was a progressive atrophy of the cerebellum, and that the spinal cord in these cases was either normal or only presented minor lesions.

Cases exactly corresponding to Marie's type are not uncommonly seen. It is certain, on the one hand, that the pathological anatomy of these cases is not confined mainly to the cerebellum as Marie argued, but that it closely resembles the pathological anatomy of Friedreich's type. And, on the other hand, it is equally certain that both Friedreich's and Marie's type may occur in members of the same family. It has been further contended that an onset in later years and after puberty occurs in this type; but while this may be the rule, some of the cases show symptoms from the first years of childhood.

Sanger Brown's Ataxy

This type, which is now commonly called "spino-cerebellar ataxy," is characterised anatomically by an outstanding primary degeneration of the spino-cerebellar tracts. Degeneration in the dorsal columns is present, but in less degree. The pyramidal tract is usually unaffected. The general clinical aspect of this type, as regards the slow, clumsy ataxy, the speech defects, and the involuntary movements, is exactly the same as in Friedreich's disease. The distinguishing features of the type are as follows: (1) The onset of the disease occurs after puberty, and may be delayed until late in life. In Sanger Brown's 25 cases in five generations of one family, the onset was between the seventeenth and the thirty-fifth year. In Neff's 13 cases in four generations, the onset always occurred about the age of 60 years. (2) Nystagmus is usually absent. (3) Ptosis, diplopia and extensive ocular paralysis may occur. (4) Optic atrophy is the rule. (5) Scoliosis does not occur. (6) The plantar reflexes are of the flexor type.

Primary Progressive Cerebellar Ataxy

In this type the characteristic pathological lesion is a degeneration of the cells of the cortex of the cerebellum and of the fibres connecting it with the central nuclei. The efferent cerebellar tracts are intact, as are also the afferent cerebellar tracts with the exception of the olivo-cerebellar fibres, which are markedly affected. The whole cerebellum becomes remarkably reduced in size. Clinically, this type is distinguished by the onset of ataxy of a cerebellar type shortly after middle life, but sometimes earlier. Nystagmus, affection of speech, ataxy and spontaneous involuntary movements, closely resembling those of Friedreich's type, dominate the clinical picture. Optic atrophy sometimes occurs. The reflexes are normal, and scoliosis and other deformities do not occur. The course of the disease is slowly progressive.

Type of Dejerine and Thomas; Olivo-ponto-cerebellar Atrophy

This malady, which shows many features in common with primary progressive cerebellar ataxy, was first described by Dejerine and Thomas, who showed that the pathological lesions consist in atrophy of the cerebellar cortex, of the bulbar olivary bodies, and of the grey substance and nuclei of the pons, while the middle peduncles of the cerebellum are completely, and the inferior peduncles partly, degenerated. This disease is neither familial nor hereditary, but it is here described on account of the similarity of its pathological and clinical features to the other types of hereditary ataxy. It commences late in life, and usually in the sixth decade, with clumsy ataxy of the limbs, marked ataxy of speech, intention tremors and spontaneous involuntary movements. Nystagmus may be well marked, or it may be absent. The reflexes are unaffected. The malady is a progressive one.

The Type resembling Disseminate Sclerosis

In this condition the symptomatology of disseminate sclerosis is closely imitated, and most of the cases which have been recorded have been described

as familial cases of disseminate sclerosis, as, for example, by Eichhorst. Several cases from a family in which three generations were affected, were shown by me before the International Medical Congress in London in 1913. The onset in my cases has been in early adult life, with a few exceptions of an onset in childhood. The clinical picture has been one of nystagmus, ataxy of speech, ataxy with intention tremors of the upper with spastic ataxy of the lower extremities, an extensor response in the plantar reflex and sphincter trouble. The retrobulbar neuritis and the exacerbations and remissions in the symptoms which are so characteristic of disseminate sclerosis, have not been noticed in these cases.

In some of the families which I have observed, sphincter trouble, loss of the abdominal reflexes and the extensor response in the plantar reflex have been entirely absent throughout, thus contrasting strongly with disseminate sclerosis, and coming somewhat to resemble the type of Dejerine and Thomas and that of primary cerebellar ataxy. When one considers that the elements of the nervous system which may be affected in the degeneration of hereditary ataxy are precisely those which are commonly affected in the lesions of disseminate sclerosis, it is not surprising that the clinical picture of the latter disease may be in some cases closely simulated by the former.

Familial Spastic Paralysis

This malady is here described with the hereditary ataxies, since it seems to fall naturally into the group of diseases in which primary degeneration of the pyramidal tracts is a usual anatomical feature, and of which a familial and hereditary incidence is the rule. Moreover, among the hereditary ataxies every grade of transition is seen to the type of pure familial spastic paraplegia. Whilst in the majority of the hereditary ataxies cerebellar, spinal and cerebral lesions coexist, yet there are the purely cerebellar and the purely spinal type; and the purely cerebral type, in the form of familial spastic paralysis, forms a natural end to the series.

Ætiology.—The disease is sometimes hereditary, but is more commonly familial and incident upon several children of the same parents. Sporadic cases are not very rare. The onset is gradual in early life, and usually occurs after the sixth year.

Pathology.—The pathological changes consist in a primary degeneration of the pyramidal neurons which apparently takes place in terms of the length; those supplying the lumbo-sacral region, being lower and longer, are earliest affected; those supplying the brain stem, being shortest, are the last to be affected. Degenerative changes in the neurons of the posterior columns of the spinal cord are often present, showing the transition to the pathological type of the hereditary ataxies.

Symptoms.—The clinical aspect consists in the slow development of spasticity and weakness, first and most in the legs, which gradually increases and progresses to the trunk and upper extremities, and involves the face last and least. The usual signs of pyramidal involvement are present in the loss of abdominal reflexes, increased deep reflexes and extensor type of plantar reflex. The malady is progressive, increasing to complete paralysis, and in its course contractures of the spastic muscles occur, that of the foot and leg producing some degree of pes cavus, while, above this, flexor contracture at

hip and knee is met with. Optic atrophy is by no means uncommon. Mental symptoms do not occur in uncomplicated cases, neither is epilepsy observed.

Diagnosis.—This malady is most easily confused with cerebral diplegia; but the latter disease appears much earlier, so soon after birth, in fact, as defective movement in the child can be ascertained. Further, cerebral diplegia is not a progressive disease in the majority of the cases, and it is often associated with mental deficiency and recurring convulsions.

PARALYSIS AGITANS

Synonym.—Parkinson's Disease.

Definition.—A progressive disease of insidious onset and slow course, usually occurring in the second half of life, and characterised by a peculiar stiffness of the muscles, which tends to fix the body in a certain posture, which can be changed less speedily than in health, and which gives rise to a distinctive facial expression, bodily attitude and gait. The stiffness is accompanied by weakness, and often by rhythmic tremors, which have earned for this malady the name "shaking palsy."

Ætiology.—Little is known of the causal factors of this malady. It is essentially a disease of the decline of life, and though in rare instances it is met with as early as the eighteenth year, the maximum incidence is from the fiftieth to the seventieth year. Men suffer twice as frequently as women. Heredity seems to play no part in the causation; but it is remarkable that longevity in one or both parents is common. Debilitating influences of any nature may be the immediate exciting causes of the appearance of symptoms. Overwork, mental shock and worry, and weakening diseases, such as influenza, and especially traumatism, are found in this connection. The latter not infrequently determines the limb in which the tremor first makes its appearance.

Pathology.—No naked-eye changes are to be found other than the vascular and degenerative changes which are common in senile conditions. The facts that tremors and rigidity, almost identical with those of this disease, may be met with in tumours involving the substantia nigra of the crura cerebri, two striking cases with autopsy having been under my own care, and still more importantly, the frequent appearance of a paralysis agitans-like end-result in lethargic encephalitis, where the subthalamic region and substantia nigra are conspicuously picked out by the lesions, make it probable almost to a certainty that the locus morbi of paralysis agitans is the basal ganglia. Gordon Holmes has found conspicuous cell degeneration in the substantia nigra in this disease, the pathogenesis of which must be considered to be a primary neuronic degeneration of the cells of the substantia nigra, and the condition one variety of extra-pyramidal paralysis.

Symptoms.—The onset is always insidious, and the muscular rigidity is almost always the first sign to appear. This rigidity affects the face, neck and trunk to a greater extent than the limbs, and when the limbs are affected then the proximal muscles present a greater degree of rigidity than do those of the periphery. The oncoming rigidity of the facial muscles does away with the usual play of the emotional movements in facial expres-

sion, and the face assumes a fixed, anxious and mask-like expression, with absence of the usual involuntary nictitation. The voice loses its inflexions, and becomes monotonous, from rigidity of the muscles of larynx, tongue and lips; but there is no other defect of articulation. Very striking is the effect of the rigidity of the muscles of the neck, for the patient carries his head and neck in one piece with his trunk as if he were a statue, never inclining or raising it in the customary expressive manner, and if he turn round to look at anything he tends to move the whole trunk round with the head. In looking sharply to one side the eyes move before the head, whereas, under normal circumstances, the coarse adjustment of this movement is done first by the neck muscles, and the fine adjustment subsequently by the eye muscles. The stiffness of the trunk muscles gives a stooping attitude with the head inclined forwards, while that of the upper extremities causes the shoulders to be rounded, and the arms carried with the elbow semiflexed, and pressed into the sides. The gait is highly characteristic in marked cases since, on account of rigidity of muscles, it is deprived of spring and suppleness; the patient, in the characteristic attitude above described, takes small gliding steps, displacing his centre of gravity as little as possible. If, by any circumstance, such as catching the feet against an unevenness of the ground, or a push, the centre of gravity is much displaced, the patient often has a difficulty in regaining it, and in moving to recover his centre of gravity is unable quite to catch it up, and so continues the movement of necessity until he fall or come in contact with some object by which he can arrest himself and restore his balance. This phenomenon is more often seen in advanced cases, and is known as "propulsion," "retropulsion" and "lateri-pulsion," according as the centre of gravity is displaced and the movement occurs in a forward, backward or sideways direction. Festination is the term used for the quickening of the pace sometimes seen in this attempt to overtake the displaced centre of gravity. In the hand the rigidity is greater in the interosseal muscles, and the hand therefore tends to assume the "interosseal position" with the fingers pressed together and the thumb adducted, the metacarpophalangeal joints being flexed, and the interphalangeal joints extended. From this rigidity of the hand the writing becomes small as well as tremulous, and the patient finds it difficult to write in a straight line. Muscular weakness always accompanies the rigidity and the tremors. It is slight until the late stages of the disease, when it may increase rapidly and render all useful movement impossible. On account of the rigidity and consequent slowness of movement, the sense of weakness which the patient experiences, is much greater than the actual weakness as tested by the dynamometer. Tremor is present in the majority of cases. It usually commences in the hand and forearm, and is most conspicuous in this situation; but it may be seen in the face, tongue, jaw, neck and feet, while, in rare cases, it may be universal. The nature of the tremor is peculiar, and is highly characteristic. It is a regular rhythmical contraction of the muscles, alternating in the opposing groups with a frequency of from four to seven oscillations per second with a range of from an $\frac{1}{8}$th to $\frac{3}{4}$th of an inch. Its rhythmic nature, its slowness and its coarse range distinguish it from other varieties of tremor. In the hand the characteristic movement of the tremor is the rolling together of the opposed thumb and fingers, cigarette-rolling, bread-crumbling or drum-tapping movement. There is nearly always in addition a peculiar pronator-supinator

tremor. The tremor is increased by excitement and by self-consciousness, and ceases during sleep. A highly characteristic feature of the tremor in about one-half of the cases is that it continues during repose, and is temporarily arrested by the execution of volitional movement. In the other half of the cases however the tremor appears or is increased on voluntary exertion, and tends to be less during repose. There seems to be an antagonism between the tremor and the rigidity, for in cases where the rigidity is very conspicuous the tremor is little marked or absent, and conversely, when tremor is universal or is of early onset, rigidity is a less noticeable feature. Moreover the tremor is always distributed where rigidity is least marked. Characteristic of this disease, as well as of all other Parkinsonian syndromes resulting from involvement of the substantia nigra, is a peculiar quick fluttering of the eyelids when these are gently closed, and which cannot be prevented voluntarily.

Other symptoms of the disease which are very commonly complained of are—(1) difficulty in turning over in bed, which is the obvious result of the rigidity of the trunk muscles; (2) flexion of the toes into the sole of the foot, so that they are trodden on, from spasm of the calf muscles; (3) pain of a dull aching character in the trunk and limbs, which is presumably produced by the long-continued traction of the rigid muscles upon their attachments; (4) abnormal sensations of heat and cold; and (5) hypersensitiveness to changes of temperature—the patient cannot bear to be near a fire nor yet in a cold room. Mental symptoms are conspicuous by their absence, except in the last stages of the malady, when profound physical asthenia overtakes both mind and body. The constant bodily discomfort, restlessness, sensations of fatigue, which the rigidity and the tremors engender, and the consciousness of a malady which is found only too soon to resist every effort to lessen or arrest it, often result in gloomy and lasting mental depression. Objective sensibility is unimpaired. The special senses and the cranial nerves are not affected. The sphincters and the reflexes are normal. Trophic changes in the periphery of the limbs, thinning and glossiness of the skin, with fluted nails and vasomotor disturbance, are common. Bed-sore is commonly met with in the late stages of the malady.

Diagnosis.—There are three points which can be surely relied upon to render the diagnosis of paralysis agitans certain in every case, namely—(1) the aspect of the patient when he is walking, when the fixed mournful expression, the stooping attitude with round shoulders, the elbows pressed into the side, and the hands carried across the abdomen in the interosseal position, the immobility of the head and neck, and the curious gliding gait which cannot fail immediately to arrest the observer's attention; (2) the rhythmic rolling tremor which is quite unlike any other form of tremor, and which often continues during rest; and (3) the absence of any of the usual signs of organic disease of the central nervous system. Difficulty may perhaps be experienced when the aspect is little marked, and the tremor is confined to some unusual situation, such as the face, tongue or neck; but, if the possibility of tremor in any situation being that of paralysis agitans be borne in mind, its rhythmic rolling nature will give the diagnosis. When paralysis agitans is confined to one side of the body, the appearance of the patient may superficially resemble that of hemiplegia; but in these cases the peculiar aspect of paralysis agitans is marked, and the organic signs of hemiplegia, such as the

extensor response in the plantar reflex, the increase in the deep reflexes, and the absence of the abdominal reflex upon the paretic side are not present. In senile tremor the rhythmic rolling quality is absent, and the aspect is not that of paralysis agitans. In post-hemiplegic tremor the organic signs of hemiplegia are present. Toxic tremor is irregular and never rhythmical, and is (mercurial tremor excepted) a fine tremor. The intention tremor of disseminate sclerosis, cerebellar disease and lesions of the red nucleus are so peculiar, and so widely different from the tremor of paralysis agitans, as to render confusion impossible.

The one clinical condition, which may so closely resemble paralysis agitans as to be superficially indistinguishable, is a not uncommon end-result in lethargic encephalitis, where from a lesion in the basal ganglia the same weakness, rigidity and tremors appear as occur in paralysis agitans. The distinction is not difficult, for the onset of lethargic encephalitis is usually acute, and the symptoms are definite. Moreover, the paralysis agitans-like syndrome of lethargic encephalitis sometimes shows a progressive amelioration, whereas paralysis agitans tends to a progessive downward course.

Course and Prognosis.—Paralysis agitans often begins in one limb, usually the upper, and spreads thence to the corresponding limb of the opposite, or to the other limb of the same side. In the latter case it has approximately a hemiplegic distribution, and it may remain for years much more evident upon one side of the body. The course is slowly progressive with variable rate. In some cases the malady may remain stationary for years, and this is more often seen in middle-aged subjects, before the disease has reached an incapacitating stage. Such arrest in the early stages is not often seen in young subjects, for in the latter the disease seems to take a more continuously downhill course. Real improvement in the symptoms is never seen. A fatal issue may occur in as short a time as two years; but this is exceptional, since paralysis agitans has little tendency to shorten life. The average duration is from 10 to 15 years, and since the major incidence of the disease is in the sixth decade of life it will be seen that many of the patients are of average longevity. Death may occur from intercurrent maladies, especially from bronchitis; but more commonly, after the lapse of many years, the patient becomes bedridden from increasing weakness and rigidity, and sinks into a condition of sleepy asthenia which is soon terminated by coma.

Treatment.—Paralysis agitans is one of the least tractable of maladies even as regards the relief of symptoms. Hygienic measures and tonic treatment, calculated to lessen the rapidity of the degenerative process, should be employed. Where there is much rigidity, gentle exercise, passive movements, massage and mild faradism are useful. Care should be taken to avoid the falls which the unstable gait is likely to engender, since these are often followed by a marked exacerbation of the symptoms. Pain is best treated with aspirin, and sleeplessness with a mixture of aspirin and small doses of barbitone (grs. ij to iij). Hyoscine, in doses of $\frac{1}{200}$ to $\frac{1}{100}$ of a grain, in chloroform water, given by the mouth thrice daily, sometimes gives great relief to the tremors and rigidity, and may be continued almost indefinitely without any ill effect. Morphine is badly borne. When the patient is bedridden great care must be taken with the skin, since the immobility of the trunk greatly increases the liability to the formation of bed-sores.

HEPATO-LENTICULAR DEGENERATION

Definition.—A progressive disease of the nervous system, often familial, characterised by involuntary movements, rigidity and hypertonicity, with contractures, without signs of pyramidal disease; and by dysarthria, dysphagia, emotionalism and progressive emaciation. Several closely related clinical forms of the disease bear distinctive names: *tetanoid chorea* (Gowers), *pseudosclerosis* (Westphal), *progressive lenticular degeneration* (Wilson), and *torsion spasm*, and *dystonia musculorum deformans* (Thomalla). Cirrhosis of the liver occurs in all forms. The Kayser-Fleischer zone of corneal pigmentation occurs in the first three forms, but has not yet been recorded in torsion spasm. The most constant nervous lesions are found in the corpus striatum.

Ætiology.—The disease often occurs in children of the same parents, but there is no evidence that it is congenital or hereditary. The age of onset has been as early as 7 years and as late as 26 years. The primary and essential lesion is in the liver; its cause is unknown. Syphilis is not a factor.

Pathology.—A multilobular cirrhosis, with "hobnail" liver, is always found after death. There is good evidence that the cirrhosis is not slowly progressive, but is the result of a number of attacks of acute hepatitis. The hepatitis has caused death in some members of affected families before nervous symptoms appeared. The nervous lesions are purely degenerative. In Wilson's cases, they were almost confined to the lenticular nucleus, especially the putamen. Every degree of degeneration was seen, from discoloration and sponginess of the nucleus in rapidly fatal cases, to shrinkage and atrophy, and even to complete disintegration and excavation of the ganglion. Later observers have described lesions in many other parts of the nervous system. The lesions are often most intense in the corpus striatum, but the noxious agent has no strictly selective action on any one anatomical group of ganglion cells, or on any limited area of the nervous system.

Symptoms.—In many cases there are no symptoms of disorder of the liver during life. In other cases an account is obtained of symptoms referable to acute hepatitis before the onset of nervous symptoms—attacks of diarrhœa and vomiting, pyrexia, jaundice, migrainous headaches, hæmatemesis and sometimes definite ascites.

The first nervous sign to appear is usually involuntary movement of the extremities, which may be of several kinds. In progressive lenticular degeneration, rhythmical tremors, increasing on voluntary movement, furnish the most common symptom. This is followed by rigidity of the face, the muscles of the neck, and later of the trunk, which rigidity increases steadily until the patient becomes helpless. The rigidity of the face and neck muscles gives rise to a peculiar expressionless appearance. Still later, extensive contractures, usually in the flexed position, in the upper and lower extremities, follow; but sometimes there is extensor contracture of the latter. During sleep the tremors cease, but the contractures do not relax. Dysarthria, of a slurring type, results from affection of the muscles of speech, and may end in complete anarthria. Progressive muscular weakness and general emaciation follow; and the patient becomes emotional, facile, docile and childish. There is no fibrillation or localised amyotrophy. The optic discs and pupillary reactions are normal. There is an absence of nystagmus, cerebellar

symptoms, and impairment of sensation. The reflexes are not altered, as in the case in pyramidal disease.

Prognosis.—The disease always ends fatally in a few months or years; the average duration is about 4 years.

Treatment.—None is known to have any effect upon the course of the disease.

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EPILEPSY

Definition.—A toxicopathic condition, characterised by suddenly occurring disturbances of cerebral function, which are prone to recur over long periods of time or even throughout life. The nature of the disturbance is probably in every case a loss of function, sometimes in a narrow region of the brain, at other times widely distributed. As the result of this loss of function, the lower centres of the nervous system may be released from control and may give rise to active phenomena, such as hallucinations, convulsions and mental disorder. In addition there may be gradually progressive cerebral and bodily deterioration in some cases.

Ætiology.—A familial tendency is often met with, but direct inheritance occurs much less frequently than would be expected, though epileptics often belong to families in which such maladies as migraine, hysteria, insanity, etc., are prevalent. Epilepsy may have its onset at any age in life from the day of birth to advanced old age. Its incidence is greater at certain periods of life, namely during the first two years, at the time of puberty, and at the commencement of the degenerative period of life round about the age of 50 years. Out of 1450 cases tabulated by Gowers, nearly one-third commenced before the age of 10, and three-fourths before the age 20. The incidence of the disease is almost equally upon the two sexes.

Exciting Causes.—In the majority of cases no cause whatever can be found for the occurrence of the first fit. When a direct cause is present, it is by far most frequently emotional excitement, in the form of sudden fear. Metabolic disturbances in early life, and especially rickets, are potent causes. Acute intoxications with absinthe, lead, bismuth and many other poisons may invoke epilepsy, as may also the poisons occurring in the specific fevers in childhood, in uræmia, cholæmia, hyperpiesia, puerperal eclampsia and Stokes-Adams's disease. And although in these intoxications the epileptic phenomena do not usually recur after the cause has disappeared, yet there is not one of the above-mentioned conditions which has not been followed by persistently recurring epilepsy. There seems, therefore, to be no adequate reason for separating these conditions under the terms "symptomatic epilepsy," "infantile convulsions," "febrile convulsions," "uræmic eclampsia," etc., as essentially differing from epilepsy; for they present phenomena of the same order which are clinically indistinguishable and which are almost certainly dependent upon the same order of causes as is epilepsy in general. Injury to the brain of any nature whatever, whether from violence from without or from disease within, may cause epilepsy. Traumatic cases in which the brain has been severely wounded are not associated with epilepsy in a greater percentage than 5 per cent. Cerebral tumours, agenesia, encephalitis, meningitis, cerebral syphilis and vascular

lesions give a higher percentage, which in children has been placed as high as 30 per cent. Again, there seems to be no useful purpose in separating the epilepsy which occurs in association with organic disease of the brain, as quite distinct from the epilepsy not so associated, under the term "organic epilepsy"; since every phenomenon which occurs in epilepsy is found in both these groups and the same treatment is appropriate for all.

Pathology.—No definite lesions of the brain nor of any other organs of the body have as yet been found to account for epilepsy. In severe degenerative and long-standing cases, widely-spread neuronic degeneration is found in the brain, but this is obviously a secondary and not a causal event, and is allied to the general degeneration of bodily nutrition which is met with in these cases.

The occurrence of epilepsy in the train of cerebral injury or disease led in past times to the belief that disease of the brain was the essential cause. It must be borne in mind, however, that epilepsy occurs only in a small proportion of these cases, and, taking epilepsy in general, the proportion in which any lesion of the brain has been found becomes infinitely small. Experimental work has shown that epilepsy cannot be produced in a susceptible lower animal by injury to the brain; but it can readily be induced by the introduction of a convulsant poison, such as picrotoxin, absinthe, lead and many others, into its anatomy, and it may also result by depriving the animal of some of its important metabolic organs, such as the thyroid and parathyroid glands. It is said even that animals "epilepticised" by absinthe may have epileptic progeny. It would appear that the same metabolic error is responsible for the appearance of epileptic manifestations in idiopathic epilepsy, in epilepsy from organic lesions of the brain, and in epilepsy which is symptomatic of other diseases, such as uræmia, rickets, etc., and that in organic lesions of the brain only those subjects develop epileptic manifestations who have a peculiar metabolism which makes them potential epileptics. Miller and Dendy have shown that in cats experimental lesions of the cerebrum which do not cause epilepsy can be rendered highly epileptogenous if metabolism be disturbed by the administration of a subminimal dose of a convulsant poison, such as absinthe, which would have no toxic effect at all upon the normal cat.

It seems probable that epilepsy results from some error of metabolism which allows of the development of a poison which has the effect of suddenly arresting cerebral function. In support of this hypothesis are the effects of poisons from without, such as lead, bismuth and absinthe, and of those developed within the body, as in the infectious fevers, and those occurring in metabolic dyscrasias, such as rickets, renal disease, hyperpiesia, hepatic disease, puerperal anaphylaxis, thyroid and pituitary disease, in producing manifestations in no way distinguishable from those of epilepsy.

The toxic effects of the serum of epileptic patients at the time of the attack has been investigated by Pagniez, Mouzon and Turpin, who have injected such serum into the circulation of animals, with the production of a series of convulsions, which lasted some half an hour and often ended fatally. No such convulsions occurred with the injection of serum from healthy persons.

Following the discovery of the poison choline in the cerebro-spinal fluid of epileptics by Donath, Sir F. Mott has shown the potency of this poison

in producing both convulsive and paralytic phenomena when applied in watery solution to the surface of the brain. It is at least possible that the liberation of some such poison locally from the degeneration of the tissues may be responsible for the epilepsy which results from local disease of the brain.

The leucopenia and the remarkable fall in blood-pressure which are known immediately to precede the epileptic attack have led Bossard to formulate "anaphylactic shock" as the immediate cause of the epileptic attack, and Tinel and Santanoise have shown in their patients the existence of alternating periods of sensitivity and immunity.

There are several clinical features of epilepsy which argue strongly in favour of a metabolic dyscrasia as its cause: (1) In the first place, there is the periodicity of epilepsy, with its often amazing regularity, the attacks occurring always at night or only in the day, or at regular intervals, or only at the menstrual epochs; and more strikingly still, those cases in which batches of fits occur at long intervals, sometimes many in one day—and during the long intervals nothing can induce the patient to have a fit. Such periodicity is more reasonably explained upon the grounds of a metabolic dyscrasia—now present, now absent—than on any hypothesis of disease, irritability, instability or functional derangement of the brain. (2) It is usual for the epileptic woman to have complete immunity from attacks during pregnancy, and this is intelligible on the grounds of the correction of a faulty metabolism in the mother by that of her fœtus. (3) Status epilepticus is perhaps only explicable on the grounds of an acute toxic process. It closely resembles experimental convulsions from the exhibition of poisons, and is akin to uræmic and eclamptic convulsions, and is the commonest event by which epilepsy in itself causes death. It often arises in a patient who has had no fits for a very long time, and whose cerebral condition may, therefore, be deemed to be more stable than in the epileptic who has frequent fits. Sometimes over-exertion is the immediate cause, sometimes discontinuance of medicinal treatment by the bromides or luminal. Often no cause is apparent. The attacks begin and recur with increasing frequency and severity, in spite of the complete abrogation of cerebral function, and death is the common result in spite of any treatment that may be adopted.

I have in several cases of status epilepticus arrested the convulsions, restored the patient to consciousness and secured adequate nutrition, and yet death has occurred in a few days from cardiac failure with a rising temperature. Autopsy showed the most acute and intense fatty degeneration of the heart muscle—the invariable finding in fatal status epilepticus which has lasted any time. Such fatty degeneration is surely the result of an acute toxæmia which causes concomitantly the external manifestations of status epilepticus.

Hyperventilation.—It has long been known that the simple procedure of breathing as deeply as possible, as quickly as possible, for as long as possible, will in some subjects evoke the phenomena of tetany, which pass off after normal respiration has been resumed. Tetany is a condition closely allied to epilepsy. Recent researches have shown that similar hyperventilation will at once produce an epileptic fit in at least 40 per cent. of all the patients in an institution for epilepsy, and sometimes the proportion is much higher. So

apparently simple a disturbance of metabolism as the alteration of the oxygen, carbon dioxide and buffer-salt relations in the blood is a potent cause for the appearance of the epileptic attack. Further, Izod Bennett has recently attributed uræmic epilepsy to calcium shortage, which is the proved cause of many of the tetany conditions.

The nature of the change which occurs in the function of the brain at the moment of the attack is little known. It seems in all cases to start locally and may remain locally confined, in which case the manifestations will be confined to one function or one region of the body, and this is termed "local epilepsy" or "Jacksonian epilepsy." Or, it may spread from one point of origin to other parts of the brain, and it does so in terms of tissue continuity and of the representation of function on the cortex of the brain. For example, a convulsion commencing in one side of the face will spread to the arm, trunk and leg of the same side, in that order, because this is the order of representation of these parts of the body from below upwards in the ascending frontal gyrus. It may spread slowly when the resistance to the diffusion of the change is high, and may become arrested at any point. But when the resistance is low it may spread with lightning rapidity to all the regions of the cortex, sometimes not so fast but that it leaves the patient with a memory of the local commencement—"general epilepsy with a local aura or warning"; sometimes so fast that no memory of local signs remains—"general epilepsy without a warning." In the latter case, the side of the brain in which the change commences can always be determined by the direction of the conjugate deviation of the eyes when convulsion is present.

Formerly the nature of the change was deemed to be an abnormal excitation, or a spontaneous disordered release of energy from an unstable and irritable cerebral cortex. Hughlings Jackson first drew conspicuous attention to the very numerous negative phenomena which occur in epileptic seizures, and which often constitute the whole of the epileptic attack—such as the sudden loss of consciousness, the coma, the paralysis, the incontinence, and the extensor plantar reflexes—as signs of loss or arrest of cerebral function. More recently Hartenberg has advocated what is now the generally held conception that the initial event in the epileptic attack is cerebral inhibition or arrest of function, and that the positive events which occur in the epileptic attack—such as hallucinations, aura and convulsion—are release phenomena due to the action of lower centres in the absence of higher cerebral control. He brings forward the well-known fact that in animals in which the cerebral cortex has been ablated, convulsant poisons produce epileptic attacks of the same nature and just as readily as when the cortex is intact. In the human subject also one sees convulsion occur when disease has reduced the cerebral cortex to a presumably functionless condition. Hartenberg affirms that when the cerebral loss of function is slight and brief there is simple loss of consciousness for a moment, as in the common type of *petit mal*. When it is more severe, the patient falls in his attack. When still more severe, the lower centres are released from control and convulsion appears. He explains all the phenomena of epilepsy, both on the negative and on the positive side, on this hypothesis of inhibition of cerebral function. He defines epilepsy as a paroxysmal abolition of the higher function of the brain by arrest and not by excitation.

Clinical Features of the Epileptic Attack

Prodromata.—The circumstances which immediately precede the occurrence of an attack are of some importance. Speaking generally, it is uncommon for an attack to occur when the attention is fixed, or when some act is being performed, and from this it follows that the epileptic is relatively or absolutely free from attacks when at work and doing, and only in the rarest cases comes to harm or injury from accident. Some patients are able, by an effort of will in fixing attention, or by the performance of some vigorous action, to arrest attacks which have already begun.

Sometimes a change in the general condition of the patient may make him aware, or may acquaint those around him, that an attack is pending, and such signs of altered metabolism may herald an attack for from a couple of hours to a week. Headache, irritability, restlessness, euphoria, lethargy, somnolence, unusual appetite and a peculiar vacant look may all be met with in this connection.

Not infrequently the attack is preceded by paroxysmal manifestations which are in reality minute attacks, such as partial lapses in consciousness, a sense of strangeness, "dreamy state," jactitations of any of the muscles exactly resembling those seen in uræmia, slight auras, giddiness, sneezing and yawning.

Description of the Attacks.—The varieties of the epileptic attack are legion, and several types may occur in the same subject—indeed, it is unusual for fits to be always of the same type in one subject. They tend to vary both in degree and nature. They are usually divided into the less spectacular "minor" attacks, in which spasm is not a prominent feature; and "major" attacks, in which spasm is conspicuous. This distinction is purely artificial, for most patients have attacks of both varieties, and the two merge by insensible gradations the one into the other. Further, the minor attack often is the initial manifestation of the major attack.

The following description will serve to illustrate the more definite manifestation of epileptic attacks:

1. *Simple jactitation.*—Single twitching of individual muscles or groups of muscles, occurring, now in one part of the body, now in another, are seen in the majority of epileptics at some time or other. They are conspicuous in the convulsions of childhood, where they often constitute the chief clinical feature. They are well known as the "carphology," or "subsultus tendinum," of uræmic and eclamptic attacks, and in the "typhoid state." They may be not infrequently noticed in the epileptic person when he is otherwise well, and engaged perhaps in conversation or other occupation. Gowers emphasised epileptic twitching as a prodroma of an oncoming severe attack; but while in some instances this is undoubtedly true, yet it frequently occurs when no attack follows. It has been called "epileptic myoclonus."

2. *Simple loss of consciousness.*—In this, the commonest of all minor phenomena, there is a simple break in the continuity of consciousness. The train of thought and action is suddenly arrested for a few seconds, and there is a sudden stillness of posture and facial expression which attracts the attention of a witness. The face may show sudden pallor, a vacant expres-

sion, and curious fixity of the eyes, with large pupils. The patient does not fall, or move, or drop anything that he is holding. In a few seconds the attack is over, leaving the patient unable to describe what has happened, perhaps a little confused for some seconds, sometimes emotional and even hysterical. More often he continues what he was about as if nothing had happened. Such attacks sometimes occur very frequently, even hundreds in a day. They are characteristic of pyknolepsy, in which the prognosis is absolutely good, and also of a form of epilepsy in which rapid mental degeneration occurs and in which the prognosis is equally bad. Further, they may occur in organic disease of the brain.

3. *Simple loss of consciousness with falling.*—The patient suddenly falls, without warning, in the extended position, and almost always prone, so that his head reaches the ground first, and his forehead receives the bruise. He regains consciousness immediately, and picks himself up as if nothing had happened. It is not uncommon to see the forehead one region of scars, as the result of repeated falls; to prevent these a pneumatic protector should be worn. This form gave rise among the ancients to the name "falling sickness," or "morbus caducens." In another form of this type the head, or the head and trunk, alone are affected. The patient does not fall, but simply drops the head forward—"nodding spasm," or "spasmus nutans"; or he drops the head and bends the trunk forward—"salaam spasm."

4. *Simple loss of consciousness with slight spasm.*—This forms a gradation from the above types to the definitely convulsive seizures. The spasm is seen as conjugate deviation of the eyes, and perhaps of the head also, or it takes the form of laryngeal and respiratory action, giving rise to a groaning noise, or may involve any part of the musculature.

5. *Local fits.*—First explained by Hughlings Jackson, these events are known by the name "Jacksonian epilepsy," and this term has unfortunately become coupled with three glaring errors of conception which were never in the mind of that brilliant pioneer. These are: (1) That Jacksonian epilepsy is distinct from epilepsy in general. Actually it is simply a variety of epilepsy. (2) That Jacksonian epilepsy is always the result of local disease of the brain. The truth is that every known form of epilepsy may result from local lesion of the brain, and that local epilepsy also occurs in this connection, but that in the vast majority of cases of local epilepsy there is no local disease of the brain. (3) That Jacksonian epilepsy consists of local convulsion. Whereas it may consist of phenomena involving every single function represented in the brain.

The local fit is determined by the local commencement of the disorder of function, and by a relatively high resistance to the spread of the disturbance in the surrounding regions of the brain. And since loss of consciousness is attributable to wide-spreading loss of function, it follows that local fits are usually associated with no loss and but little impairment of consciousness. But it must be remembered that there is great tendency for the cortical disorder to spread, and that almost every case of local fits will at times exhibit fits which, commencing locally, become general, with loss of consciousness. The nature of the local fit will be determined by the region of its origin, and may take as many forms as there are functions localised in the cortex of the brain.

Psychic fits.—These may take the form of peculiar mental states, of

instantaneous onset, remembered afterwards sometimes in exquisite detail, sometimes only in vague character. Emotional conditions of fear or horror, which may cause the patient to attempt with violence to escape from his surroundings—"cursive" epilepsy—may occur. Or, the attacks may take the form of a sudden feeling of misery, or an intense sense of personal wrong-doing, a sense of intense familiarity in surroundings which are unfamiliar, a sudden sense of strangeness, as in a patient whose fit was "suddenly seeming to be somewhere else," a sense of euphoria or of intense mental energy, a dreamy state, often associated with smacking of the lips and champing or swallowing movements, which often has a pleasurable emotional tone. Again, the psychic fit may take the form of a highly complex and detailed hallucination, as in a patient of mine who suddenly found himself approaching a level railway-crossing in a picturesque village in high sunlight. Out of a little guard-house on the farther side came a woman dressed in the conical beaver hat and scarlet cloak of the Welsh national dress, who greeted him with a smile. He hastened forward to meet her, but found the gates rapidly closing upon him. As they closed, but before they touched him, he lost consciousness. In this case the hallucination was always the same in every detail in each fit. The historical visions of the saints have often been claimed as epileptic phenomena, and in some cases at least on reasonable grounds.

Visual fits.—These may take the form of negative phenomena, such as dimness of vision, complete darkness or hemianopia, or of positive effects, such as flashes of light, scintillating stars or balls of fire, or of both together in the form of blindness with flashes of light. In the last case they may closely resemble the visual phenomena of migraine, and are not infrequently caused by a local lesion of the occipital region. Complex visual hallucinations may occur.

Auditory fits.—The hallucinations of sound may be of any nature—hissing, booming and elaborate musical sensations, as of bells, being common. There is usually a sense of coincident deafness or "far away" hearing, which passes off with or soon after the sound.

In one case the fits could always be produced by sounding the hallucination note upon the open diapason of an organ. No other note or sound produced the fit. (Such directly excited fits, though very rare, are well known in connection with olfactory, visual, auditory and common sensory stimulation, and have been termed "reflex epilepsy.")

Olfactory and gustatory fits.—These hallucinations are always described as of "flavour," usually unpleasant. Very often, movements of the lips, tongue and jaw, or swallowing movements are present, and the dreamy state already referred to may be associated. From the location of the functions of smell and taste in the cortex of the uncinate gyri, and from the common occurrence of fits of this character in lesions of these convolutions, this type of fit is often referred to as the "uncinate fit."

Sensory fits.—These hallucinations may have their seat of commencement in any part of the body. They may remain local, but more commonly they spread from the point of origin in terms of the local representation of the body in the cerebral cortex, and usually from the periphery towards the trunk and head, but a sensory fit may spread to the extreme periphery first. For example, commencing in the fingers, it may spread up the arm to the head, or on reaching the shoulder it may invade trunk and leg before ascend-

ing to the head. It may be bilateral, confined to the anterior or posterior aspect of the body.

The sensation may be described as "numbness," "tingling," "pins and needles," "vibration," "rushing," "as if the limb were withering," much more rarely actual pain. Sometimes the sensation is indescribable. The sensory attacks have their origin in a local disturbance of the parietal region of the cortex, and may indicate the presence of an organic lesion in that region. They may be accompanied or followed by temporary loss of sensibility, in the form of astereognosis, loss of sense of position, or anæsthesia.

Another group of sensory fits for which it is impossible to give any definite cerebral localisation at present, is that of the so-called visceral auras, which are mainly referred to the distribution of the vagus nerve. Such are the very commonly occurring "epigastric" sensation, and sensations of choking, dyspnœa, nausea and cardiac sensations.

It is quite possible that the sudden feelings of malaise or of faintness which may constitute the main feature of some epileptic attacks are expressions of the sudden lowering of blood-pressure which is known immediately to precede the epileptic attack.

Disturbances in the realm of the vestibular nerve are very common indications of epilepsy. Sudden giddiness may be the sole indication of epilepsy, and is perhaps the most common initial event in major attacks. It may be indicative of the sudden fall of blood-pressure, or the feeling of rotation may be consequent upon early spasm causing conjugate deviation of the eyes. When the sensation is that of falling, or of being wafted away, there must be some essential disturbance of the nervous mechanism of orientation.

It must be carefully borne in mind that all the phenomena which have been described above may occur as isolated events and so constitute the epileptic attack. Often, however, the disturbance of the cortex spreads widely, involving general convulsion and loss of consciousness; but the initial phenomena are remembered by the patient as the "warning" of the attack and have from ancient times been termed "auras," when preceding general convulsion. In reality, they constitute the essential part of the attack as showing the region of the brain in which the disturbance starts, and in every patient who has such "warnings" preceding his severe attacks, the warnings occur at times by themselves without any such sequel.

Motor fits (*simple paralysis*).—This is the rarest of all forms of the epileptic attack. It consists in a sudden inability, relative or complete, to use a limb or one side of the body or the whole voluntary musculature, with no preceding convulsion. There are the usual signs of cerebral paralysis—at first flaccidity with a tendency for the jerks to fail; a few moments later increased jerks, with absent trunk reflexes and extensor plantar reflexes, all of which signs soon disappear. It may occur as an isolated phenomenon More often a slight "minor" attack or a local sensory attack accompanies the onset of the paralysis. Sometimes such an attack may result from local disease of the brain. Gowers cites four examples which he observed, and I have treated two characteristic cases. Such attacks when involving the right face or right side of the body may occasion aphasia, or the aphasia may occur alone as the attack of simple paralysis. Such attacks of simple paralysis

without convulsion are well known in uræmia, hyperpiesia, metallic poisoning and general paralysis of the insane.

Local convulsion.—The spasm may commence in any part of the voluntary musculature, and may remain very narrowly confined throughout the fit or may spread in every degree to involve a whole limb, or one-half of the body, or to become general. It never affects the muscles of one eyeball alone, but the spasm is in terms of conjugate deviation of both eyeballs in one direction. The same rule applies when the neck is affected, for the head is then either rotated to one side or extended or flexed on the chest. With the other bilaterally associated muscles it is different, for the tongue is affected on one side only, as is also the face, and I have many times witnessed local fits in the muscles of the abdominal wall strictly limited by the middle line. The onset is with tonic spasm, which after a little while gives place to broken or clonic spasm, becoming more and more intermittent and finally ceasing. In some cases, but by no means in all, the convulsion leaves varying degrees of weakness in the affected muscles—Todd's paralysis or post-epileptic paralysis, with transient signs of loss of function of the pyramidal system, such as loss of trunk reflexes, increase of jerks, and extensor plantar reflexes. This paralysis was explained by Todd as due to exhaustion of the cerebral cortex from the violence of convulsion, and he was followed by Hughlings Jackson who surmised an exhaustion of the pyramidal system by which the convulsion was exteriorised. Such an explanation is, however, impossible, from the fact that a patient after a severe and long-lasting convulsion will often show no trace of paralysis, whereas another patient with a transient slight spasm of a limb may show severe paralysis lasting many hours. Hartenberg's explanation, that it is the local incidence of the cause of epilepsy upon the motor region producing inhibition, is much more probable. In other words, when the epileptic disturbance starts in the motor cortex there will be local inhibition and, therefore, less convulsion and more paralysis; whereas if the disturbance spreads to the motor function from elsewhere there will be no local inhibition and, therefore, more convulsion and no paralysis.

Epileptic spasm usually puts the hand in the position of extension at the interphalangeal joints, flexion and abduction at the metacarpo-phalangeal joints, flexion at wrist and elbow, and adduction at the shoulder. The feet are dropped and inturned, with extension at the knee and hip. Usually the trunk is in opisthotonus.

The sequence of tonic spasm at first, followed by clonic spasm, though usual in epilepsy, is not invariable. Purely tonic fits may occur with no clonic spasm, the tonic spasm remitting suddenly. Such fits are usually of slight severity and duration, and are almost always general and very rarely local.

On the other hand, the spasm may be clonic only. The simple jactitation already described may be taken as a simple clonic fit. Local fits, especially of the face and of the hand, may be purely clonic. Again, some of the most severe of all general epileptic convulsions are clonic throughout so far as the limb and trunk musculature is concerned, but some tonic conjugate deviation of eyes and head is usual.

Loss of consciousness in local fits.—This seems to depend upon the extent of the cortex involved. With narrowly confined fits there may be no

impairment at all, as in local convulsion of the face or hand, or as in a patient who vividly described to me a slow visual fit as it was occurring. When the fit spreads, consciousness is usually impaired, and when lost, it is lost late in the fit. For example, it is usual for a convulsion which spreads to one-half of the body to cause some impairment, and if it involves both sides generally consciousness is always lost.

General convulsive fits (*haut* or *grand mal*).—The general convulsive seizure in epilepsy does not differ from the local manifestations just described in any essential of causation and pathology, but simply in degree—as regards severity of manifestations, rapidity of spread to all regions of the brain, and rapidity of loss of consciousness. There is good reason for believing that every major attack has a local commencement in some region of the brain, and that it is in reality a local fit which rapidly becomes general. When such an attack commences with a local aura there is proof positive of local commencement. When it commences with conjugate deviation of head and eyes to one side, this is certain indication that the disturbance commences in the opposite hemisphere. When the spread of the disturbance is so rapid as to cause instant loss of consciousness there is no memory to retain the initial event of the attack. The seizure may begin with any of the local manifestations above described, the epigastric aura and giddiness being two of the most frequent. Or the patient may be only aware of his attacks from the condition in which he finds himself after their occurrence. The tonic spasm commences with conjugate deviation of both eyes to one side, followed by rotation of the head to the same side. The blood-pressure falls, the countenance is for a moment pallid, the eyes widely open, the pupils dilated, the corneæ insensitive. The march of the tonic spasm usually causes head retraction and opisthotonus; the upper extremities are stiff in flexion and adduction, the lower extremities in extension. If standing, the patient falls usually backwards, but the conjugate deviation of head and eyes may bring his face to the ground first. The respiratory muscles and larynx, going into spasm, produce the epileptic "cry," and the respiratory movements being no longer possible the face darkens with the asphyxia, and the sphincters may relax, with the evacuation of bowel or bladder. The protrusor spasm of the tongue and the closing spasm of the jaw may cause the tongue to be bitten. After the tonic spasm has lasted some seconds and perhaps has produced such a degree of asphyxia as seems hardly compatible with survival, it begins to break into a series of sudden shock-like, jerky movements—the clonic spasm—which continue for some seconds, becoming less regular and occurring at longer intervals until, with a final jerk, the muscles become perfectly limp. Meanwhile the relaxation of the respiratory and laryngeal spasm have allowed the respiratory movements to return and to churn up the saliva, often bloodstained, which escapes at the nose and mouth in the form of froth. At the end of the attack there is complete and unrousable loss of consciousness, the pupils are dilated and insensitive to light, the corneal reflexes absent, the knee-jerks absent, and the plantar reflexes extensor in type. In a short time the knee-jerks return, the plantar reflexes return to the normal, and consciousness returns. Usually the patient is dazed, feels ill, has marked headache, and if left to himself soon sleeps heavily for some hours. It must be noted that the general convulsive attack almost always leaves the patient face downwards, so that he has drowned in a

puddle an inch deep and has been asphyxiated by his own pillow. The latter event is by very far the commonest way the epileptic meets his death from accident in a fit.

The epileptic cry.—There are two quite different sounds that may occur at the commencement of an epileptic attack. The one is a natural, conscious cry of terror at the advent, as in the patient who alternated piercing screams with "It is coming! It is coming!" before the convulsion commenced. It is curious how rarely any memory of such cries or utterances remains with the patient. The other is the epileptic cry proper—a weird, unearthly, hollow sound, produced by inspiratory spasm drawing air over the nearly closed vocal cords. This cry occurs in a minority even of severe cases, for the obvious reason that it is determined by a particular march of the spasm. If the inspiratory spasm occur before the larynx has gone into spasm or after it is in spasm, there can be no laryngeal noise, but only the commonly witnessed pharyngeal and buccal grunting and gurgling. The spasm must be so timed that the inspiratory spasm must occur as the larynx is closing, and this only obtains in a minority of the cases.

Tongue-biting.—Some patients always bite the tongue, others never, and some now and again. The tongue is always bitten at the side and some way from the tip, because it is deviated to one side in the spasm and its thicker part brought between the molar teeth. The same side is always bitten. The tongue cannot be bitten unless protrusor spasm occur either before the jaw has gone into tonic spasm or after it has broken into clonic spasm. If any other march of spasm occur, the tongue escapes. It is remarkable how little scarring occurs even from severe and repeated tongue-biting unless a piece is bitten clean out. It should never be used as evidence for or against epilepsy for this reason, and because it was readily produced artificially by those wishing to avoid military service.

Incontinence.—Though common, incontinence is by no means the rule even in severe attacks. More often it is the urine alone that is evacuated, much more seldom the bowel alone, still more rarely both.

Secondary events.—The degree of asphyxia during the attack may be severe, and blood vessels may give way under the stress, with the production of surface ecchymoses or deep hæmorrhages, including cerebral hæmorrhage. The spasm is powerful and may give rise to much subsequent aching, as if the patient had been beaten all over. It may dislocate joints, rupture muscles and even break bones. A dislocation once produced in a fit always recurs with subsequent fits.

Duration of epileptic attacks.—Two minutes may be given as an outside time-limit for the duration of an individual attack, from its commencement to the end of the active phenomena, and in convulsive attacks to the end of the spasm. Usually the time is much shorter than this, and often is a few seconds only. Sometimes attacks are described as of much longer duration. When analysed, such attacks will be found to be a series of attacks with very short intervals, or slight attacks with post-epileptic functional spasm, or hysterical attacks.

Conditions after attacks. — The epileptic fit may leave no after-effects whatever, even though it be severe, but this is unusual. On the other hand, even the slightest attacks may cause conspicuous sequels. Sleep and headache are very common, especially following convulsive

attacks, and they may be alternative effects, in that if sleep occur there is no headache, but if it be prevented there is severe headache. The post-epileptic paralysis of Todd has already been described, and also the aphasia which may follow right-sided attacks. The mental state is usually affected by the attack, and returns to the normal—sometimes quickly, sometimes slowly. Commonly the patient is dull and dazed, speaking at random, inacceptive, irritable, and does not fully recognise his surroundings. During this state of impaired consciousness he may pass into a condition of mental automatism, in which various acts are performed in a conscious manner but of which no recollection is afterwards retained. One patient always prepared for bed after her minor attacks, and proceeded to undress in the stalls of a theatre. The acts performed during post-epileptic automatism may have a true relation to the life and mentality of the patient. He may do spiteful and criminal acts to those he dislikes. This fact has an important bearing as regards the criminal responsibility of the epileptic. In other cases a patient after recovering from the epileptic fit passes at once into a state of hysterical convulsion. Both these post-epileptic conditions occur commonly after minor attacks, but they may also occur after major fits ; they seldom occur when convulsion has been severe.

Vomiting may occur after any type of epileptic fit, but it is most often met with after a convulsive attack. As it occurs during the period of unconsciousness, there is some danger of the vomited material being drawn into the larynx. Though Gowers mentions a case in which this event proved fatal, I have not come across any accident from this cause.

Mental Deterioration and Aberration in Epilepsy.—Many epileptics, especially those who have frequent attacks, show signs of mental deterioration, which is often progressive, and which may become severe and end in chronic insanity; while others show no such mental troubles, and some of these fulfil a long life with the highest standard of capacity. There is another group in which epilepsy is engrafted upon an agenetic and, therefore, poorly developed brain which has never reached a high degree of functional activity.

There seems to be no correlation between the type of epilepsy and mental degeneration, and though the latter is widely held to be more frequent and more severe when many minor attacks occur, yet in the variety of epilepsy which will be later described as "pyknolepsy," though minor attacks occur in countless numbers, no mental degeneration ever appears. Mental degeneration seems to be the result of some peculiarity in the causal dyscrasia, which in this instance gives rise to epilepsy on the one hand, and deterioration of the higher elements of the nervous system on the other hand, as concomitant effects. Thus the epilepsy and the mental deterioration will have no factorial relation the one with the other, and this is true clinically.

The tendency to mental failure is greatest in the cases which commence in childhood, and lessens as age increases; while, again, in the epilepsy commencing in the degenerative period of later life, the incidence again increases. In its slighter form there is merely defect of memory, of attention and power of acquisition. In more severe degree there is greater imperfection of intellectual power, weakened capacity for attention, and often defective moral control. Mischievous restlessness and irritability may develop to vicious and criminal tendencies with advancing age. Every grade of

intellectual defect may be met with, to actual imbecility. Paroxysmal outbursts of mental derangement may be met with, sometimes transient and immediately following a fit, sometimes without a fit, and sometimes lasting for weeks or months. From what has been written above upon the cause of the mental disturbance in metabolic dyscrasia, these events will be easily explicable.

PERIODICITY.—While some patients may have fits at any time and at all times, yet there is a tendency in the majority for the attacks to occur at particular epochs and not at others. Epilepsy may be strictly "nocturnal" or "diurnal." It may occur only on rising in the morning, or solely at the menstrual epoch. The fits may come in batches of several in one day, at intervals of many months, while 7-, 14- and 28-day periods are common. A knowledge of the periodicity when present is of great value in the successful treatment of epilepsy. "Rare" fits, which occur at very long intervals, are apt to present the most severe convulsion ever witnessed.

SPECIAL VARIETIES OF EPILEPSY

EPILEPSY FROM LOCAL DISEASE OF THE BRAIN.—Any lesion whatsoever of the cerebral hemispheres may produce epilepsy. But not more than 5 per cent. of all such lesions do this. The convulsions which may occur in cerebral thrombosis, encephalitis and meningitis are examples of epilepsy incident with the onset of an acute lesion. Usually the epilepsy is incident when the lesion has been present some considerable time, suggesting that the element of tissue decomposition and the liberation of toxic substances therefrom may be an essential factor. Lesions of the brain in childhood seem to be more commonly associated with epilepsy than when occurring in adult life. Agenetic states of the brain of prenatal origin (cerebral diplegias) are associated with epilepsy in 30 per cent. of the cases, and infantile hemiplegia is followed by epilepsy in about the same proportion. The lesion may be situated anywhere in the hemisphere, but when occupying the white matter near to the cortex it is more likely to cause fits than when it actually involves the cortex or than when it is deeply situated towards the basal ganglia. Increased intracranial pressure alone seems capable of causing fits, as in hydrocephalus and subarachnoid hæmorrhage, and this may be a factor in the epilepsy of intracranial tumours and meningitis. Abscess seems very rarely to produce fits.

The fits caused by local lesions are in almost every respect identical with and indistinguishable from the usual type of epileptic manifestation, from the slightest momentary minor fit, all through the local sensory and motor fits, to the severe general convulsion of instantaneous onset and immediate loss of consciousness. There are the same auras and the same sequels. It may perhaps be said with relative truth that the splanchnic auras (epigastric, cardiac, etc.) are uncommon, and that there is a greater tendency for consciousness to be lost late.

The minor attack is the least common fit occurring as the result of a local lesion; the general convulsion by far the most common; while the local fit holds an intermediate position, and its nature is often indicative of the position of the lesion. Drug treatment is more potent in arresting this variety of epilepsy.

Pyknolepsy.—This is a form occurring in children, so called because of the great number of the fits which may occur daily. These are of the slight minor type, any sign of spasm being infrequent. It is rare for any major fit to occur. There is no mental impairment whatever, no deterioration of health, and no result is obtained by any form of treatment. The malady invariably ends in spontaneous cure, usually before or at the age of puberty.

Cardiac Epilepsy.—This is a convenient term for the epilepsy which occurs in Stokes-Adams's disease, and in paroxysmal tachycardia, and for the fits which may occur in congenital heart disease and in some forms of cyanosis. They cannot be the equivalents of asphyxial convulsions, for they are not met with in severe chronic cyanosis, and, on the other hand, there is usually no cyanosis at all when fits occur in Stokes-Adams's disease.

Myoclonus Epilepsy.—In this group are included: (1) Epilepsy of an ordinary type in which there is much simple epileptic jactitation of the muscles between the fits; (2) cases of Unverricht's myoclonus in which epilepsy is coincident.

Status Epilepticus.—In this condition severe convulsion succeeds severe convulsion at short intervals without any return of consciousness during these intervals. It is as if convulsion recurred so soon as the body recovered sufficiently from the exhaustion produced by the last convulsion. Meanwhile the temperature rises, and may reach a hyperpyrexia. The difficulty in feeding and watering, the severe muscular exertion and the pyrexia add the dangers of acidosis to those of exhaustion, and the patient is very apt to succumb. Acute fatty degeneration of the heart is invariably found at autopsy, presumably the result of an acute toxic process which is responsible for the convulsion. Status epilepticus must not be confused with frequently recurring fits in which there is some return to consciousness during the intervals, though it frequently develops from such a condition; for the latter are not accompanied by a rising temperature, are more readily subdued, and are not of nearly so severe a prognostic import. If the convulsions cannot be stopped by treatment, the patient usually dies from sudden collapse, or, the fits ceasing, he remains delirious for a while, with rapid heart and high temperature, and dies of cardiac failure. Status epilepticus may be met with in acute lesions of the brain, as in cerebral poliomyelitis and in chronic lesions such as general paralysis of the insane. It may occur in acute poisoning with lead, bismuth, absinthe and thujone. It may develop suddenly in any type of epilepsy whatsoever, sometimes without apparent cause, sometimes as the result of over-exertion and excitement, sometimes when medicines which have been regularly administered and which have kept the fits in check are suddenly cut off.

There is a second condition occurring in epilepsy to which the term "status epilepticus" may justly be applied. I have met with it only in epileptics who show mental deterioration. The patient, without cause or perhaps after signs of increasing mental aberration, becomes dull, ceases to take food, and lapses into coma, with terminal pyrexia, ending fatally. This is status epilepticus without convulsion, and if the convulsive form be comparable with uræmic convulsion, this non-convulsive form may reasonably be compared with uræmic coma.

Diagnosis.—The recognition of epilepsy requires a working acquaintance with the nature of its many manifestations and especially of the slight forms,

little exteriorised, which may be easily overlooked or misinterpreted. The sudden unexpected onset, without cause, the transiency, the recurrence, and the circumstances of the moment, are useful aids.

From syncopal and vaso-vagal attacks (rapid lowering of blood-pressure) epilepsy can often be distinguished by the slow onset, the gradually increasing pallor or greyness, the distancing of sound, the nausea and flatulence, the presence of an obvious cause, the length and the stillness of these attacks.

The hysterical attack is easily distinguished by the fact that only the convulsion of epilepsy can possibly be confused: the other manifestations of epilepsy are never simulated by hysteria. Hysterical convulsion has not the manner nor the march of epileptic spasm. It never begins with conjugate deviation of head and eyes to one side, there is not the orderly spread of convulsion, and there is never but a poor imitation of the sequence of tonic followed by clonic spasms. The movements in the hysterical fit are purposive, spectacular, violent, and are liable to be increased by restraint and are rapidly abolished by complete inattention. The functional fit never occurs except in the presence of an audience, for it would then be purposeless, and it never occurs during sleep. The tongue is never bitten, though other parts of the body and other people may be. The sphincters are never relaxed. Intense converging spasm of the eyes is a common feature of the functional attack, but this sign is not met with in epilepsy. When functional manifestations follow slight and rapidly transient epileptic attacks, the distinction between these and purely hysterical attacks is often difficult and sometimes impossible, except after long observation. For the initial epileptic attack may be practically unnoticeable, and the subsequent events may be typical of hysteria and are usually amenable to the same line of treatment. Often some point in the circumstances under which the attack occurs will settle the diagnosis. Any attack having occurred during sleep, or any attack in which the patient has fallen in circumstances of serious danger, as among the traffic of a London street, or any attack occurring when the patient cannot attract the attention of others, establishes the diagnosis of epilepsy. The best plan is to regard every hysterical fit as possibly epileptic, and every fit of doubtful type as probably epileptic, until time and circumstance bring definite conviction.

Migraine may sometimes closely simulate epilepsy when sudden paralysis, or sensory auras, or visual hallucinations occur without headache, and the diagnosis may be rendered more difficult by the fact that the migrainous attack may alternate with the epileptic attack, or may take its place in the same patient.

Careful search must be made in every case for all the bodily conditions with which epilepsy may be associated. Papillœdema, headache and vomiting may reveal increased intracranial pressure from some lesion of the brain; while local paralysis, sensory loss, visual or other defect may indicate a local lesion of the brain, past or present, and this may also be suggested by the nature of a local fit. The presence of rickets, infantilism, undue adiposity, etc., may indicate the presence of some definite metabolic dyscrasia or endocrine disorder. Renal function and the condition of the blood-pressure should always be examined, for even in early infancy fits may be uræmic and in the recurring epilepsy associated with small white kidney, and with cystic renal disease, the causal disease is frequently unrecognised. Where

syphilis is likely, the reactions in the blood and cerebro-spinal fluid should be examined. Lastly, any evidence of chronic intoxication by metals, alcohol, absinthe, etc., should be sought for.

Prognosis.—The outlook in epilepsy is so variable that it is difficult to indicate any but the broadest principles in prognosis. Nor can a definite forecast be made in any case until the result of treatment has been watched for some time; for cases apparently favourable may prove rebellious, and those most unfavourable may turn out brilliant successes. Speaking generally, a cheerful outlook is justified in all cases except those in which there is progressive mental deterioration, and in these the outlook is hopeless in proportion to the rapidity of the mental change. Naturally, in those epilepsies which are associated with serious bodily disease, such as brain tumour, renal disease and hyperpiesia, the prognosis involves that of the causal condition.

The danger to life from the epileptic attack itself, either directly or indirectly, is not great. However severe the fit, it is extremely rare for death to occur, and when this happens it is from turning over and smothering with the wetted pillow or from choking with the aspiration of vomited material. Injury, burning and drowning may cause death, yet the number of epileptics who meet their death in this way is so infinitely small as almost to remove the danger of accident from practical perspective. In the rare status epilepticus, however, the danger to life is very great. Spontaneous cessation of the attacks occurs often enough. It is said to be invariable in pyknolepsy. The convulsive attacks of infancy, which continue for some years after all cause to which they can be attributed has passed away, often cease for ever at the age of 4 to 6 years. Again, after 20 years of age spontaneous cessation is met with, and it becomes more frequent as life advances. It is, in my experience, a much more frequent event than writers upon this subject, with the exception of Gowers, have been willing to admit.

The probability of cure, arrest or amelioration by treatment is high in all cases where no mental deterioration exists and where no insuperable bodily disease determines the epilepsy, in proportion as the only method of cure—the securing arrest of the attacks for a considerable time by drug treatment—can be adequately administered over a long period. It is greater when epilepsy is hereditary than when it is sporadic. It is greater when periodicity in the occurrence of fits allows these to be anticipated by drug administration. It is much greater when the following out of education, or the continuance of regular employment, allows of a fully occupied and satisfying life, and much less when education is stopped, pleasures and sports forbidden, and the patient condemned to social inferiority and ostracism, and to a gloomy, narrow life of inanition because he has a few fits. It is perhaps smallest when severe attacks occur daily or at short intervals.

Treatment.—*General treatment.*—The general principles for the maintenance of health if good, or for its improvement if poor, should be adopted. Whenever possible, no change whatever should be made from the régime of life of a normal person. In childhood, education, discipline and pleasures and school life should be continued upon strictly normal lines, and the adult should continue with work and occupation. No advantage has accrued from the adoption of special diets, such as the abrogation of meat, the exclusion of salt or the use of purin-free foods. Alcohol seems to be an excitant of the epileptic attack and should be forbidden.

Avoidance of excitement is usually advocated, but as this curtails the joy of existence, especially in children, it is derogatory, and it is better to fortify the patient against the attacks by medicines to be given before any exciting events. The forbidding of such pastimes as may be fraught with danger should a fit occur, such as swimming, boating, cycling and car driving, is advisable, rather because it allays anxiety for the relatives and guardians and diminishes the responsibility of the physician, than that accidents are liable to occur from such causes.

Institutional treatment. — In cases where there is low mentality, much mental degeneration or insanity, and with frequent fits, where no adequate care and occupation can be provided at home, there is every advantage in a colony, institution or asylum for epileptics. In such patients little or no good can be done by medicinal treatment, whereas regular work, discipline and interest often mitigate greatly the burden of the malady.

Surgical treatment.—The opening of the skull is a very ancient remedy for epilepsy, dating from the early Egyptians, and coming again into great prominence in the nineteenth century with the development of knowledge on cerebral localisation, and there still remains a very widespread impression that local fits and fits following upon injury to the skull are likely to be benefited by decompression. There is, however, little evidence that such procedures benefit epilepsy of any kind. When a depressed fracture of the skull exists, and the patient, his relatives and perhaps his medical attendant also, are firmly convinced that this is the cause of the epilepsy, it may be advisable to remove the defect in the bone if only to satisfy the minds of those concerned and to secure adequate medicinal treatment subsequently. Pierce Clark sums up the position adequately when he writes that "all operative measures upon the brain in epilepsy are allowable only when they are indicated by definite physical signs other than the fits." Thus, in a case of cerebral tumour producing epilepsy, operation is justifiable for the relief of the papilloedema, headache, etc., and with the hope of possible removal or of obsolescence of the growth following the decompression.

Medicinal treatment.—Further than the measures above described, the treatment of epilepsy is purely medicinal. There are two groups of drugs which have a remarkable effect in arresting or mitigating the occurrence of the attacks in epilepsy in at least 80 per cent. of the cases. They seem to have much the same effect, and may conveniently be combined or alternated in the treatment of any given case. Sometimes one group is found to suit an individual patient better than the other. No advantage seems to accrue from administering these remedies more than twice in the 24 hours, nor from using large doses. Moderate doses, such as will cause no deterioration in bodily or mental health, even if taken regularly and for years, seem to bring about the best results. The first group is that of the compounds of bromine, of which sodium bromide seems to have an advantage over the others, both as regards efficacy and toleration. The organic compounds of bromine are not so useful. Sodium bromide should not be given in larger doses than 25 grains (1·5 grammes) to an adult, nor should more than 60 grains be given in the 24 hours. It is conveniently combined with arsenic (gr. $\frac{1}{30}$) in the form of liquor arsenicalis, since this has the effect of checking the occurrence of acne. If it be advisable to conceal the fact that bromide is being administered,

Gelineau's "dragees," each of which contains 15 grains of potassium bromide, may be prescribed.

Bromism.—Even in ordinary doses, the bromides may cause some acne of the skin, especially in subjects who are prone to acne, but this is the sole derogatory effect of this remedy, which is of common occurrence. The true bromide rash, which was met with in the early days of bromide treatment when huge doses (even an ounce thrice daily) were in vogue, is highly characteristic. It is hardly ever seen in these days, but I have twice met with it from moderate doses of bromides. Mental dulling and conditions of subcoma, which may occur from poisonous doses of the bromides, are never met with from appropriate medicinal administration. The mental deterioration due to the epilepsy in certain cases is often attributed by the laity to this cause, but this occurs, and sometimes in much greater degree, in the absence of bromides.

The second group is that of the malonyl-urea compounds, of which luminal, sodium luminal, and gardenal are examples. These are very powerful drugs, and must be used with care. Luminal has certainly the advantage over the soluble sodium luminal in being less toxic and more prolonged in its action. It is conveniently prescribed in cachets, in doses of ½ grain to a child, and 1 grain, with a maximum dose of 1½ grains, to an adult. In larger doses it is a powerful hypnotic, and in patients who have idiosyncrasy it may produce a troublesome kind of frenzy. It appears to be a more certain means of warding off attacks for many hours after its administration than is bromide.

Whatever remedy is chosen, whether it be the bromide or luminal or a combination of the two, it is essential if possible to anticipate the occurrence of the fit by the administration of the drug. Thus, if fits are nocturnal only, the remedy is given in a single dose at night, or if diurnal only, in a single dose in the early morning. Again, if, as often happens, the fits occur soon after waking, then the single nightly dose should be used. Or, if the fits occur or are more frequent at the menstrual epoch, they should be anticipated by increased dosage before and during that epoch. With fits that are diurnal and nocturnal, a night and morning dose should be used. As it is less important in patients who have employment when fits occur by night, and often most disastrous when they occur at work, for with the present Workmen's Compensation Act no company will insure a known epileptic, I prefer to give luminal as the morning remedy and bromide as the nightly remedy, since I consider luminal to be the greater safeguard against the occurrence of the attacks. The question at once arises, Why should two remedies be used? The answer is that these drugs are by no means identical in action, and that the nature of the cause of epilepsy certainly varies in individuals. Some patients do best on luminal alone, others on bromide alone, and others on a combination of the two, and the best course can only be determined after trial.

Many other remedies have been advocated in epilepsy; a few only have stood the test of time and are still in use, both as alternatives and adjuvants to the treatment above given. These may be placed in order of merit as zinc salts, belladonna, digitalis and allied drugs, especially adonis vernalis, opium and borax.

Zinc salts are sometimes very useful. In the form of the lactate (3 to

5 grains) they are easily introduced into bromide mixtures. The same may be said of belladonna, which has a marvellous effect upon a few isolated cases. It makes some cases definitely worse. Digitalis and adonis vernalis are commonly used as adjuvants, and I think sometimes with benefit. Opium and morphine, which were the standby in epilepsy in former days, are no longer used; but morphine given in careful doses is one of the most powerful means of preventing fits, and is of great use in status epilepticus. Perhaps hyoscine, advocated by Gowers, should also be mentioned in this connection. Thyroid extract is certainly of value in the epilepsy associated with cerebral agenesia (cerebral diplegia), mental and bodily backwardness and infantilism. It probably acts by rendering bodily metabolism more normal and in enhancing development.

STATUS EPILEPTICUS.—The treatment of this condition, and that of rapidly repeated fits which not infrequently merges into status epilepticus, is quite different from that of epilepsy in general, for the remedies useful in the latter condition are useless and even do harm in this urgent and dangerous state. The condition is one of acute toxæmia, exhaustion and acidosis from the violent convulsion, pyrexia, often proceeding to hyperpyrexia, and cardiac degeneration. The first thing to be done is to check the convulsion, and this is best achieved by the hypodermic injection of $\frac{1}{3}$th of a grain of morphine. (Gowers preferred hyoscine.) Another remedy is paraldehyde, in large doses (6 drachms), and this has recently been successful at the National Hospital. It has the obvious advantage that it is stimulating and not depressant. The remedies formerly used such as bromide and chloral by the rectum are worse than useless. The next measure is to secure that the patient shall be provided with adequate stimulants in the form of food, water and even alcohol. To which end a nutritious liquid meal of high stimulating value and containing sugar to combat acidosis should be given by means of the nasal tube at regular intervals. An action of the bowel should be obtained as soon as possible, with a rapidly acting aperient administered with the food, and by warm water enemata. The pyrexia should be controlled by sponging repeatedly, and if high by continuous immersion, and this alone will sometimes have a dramatic effect in checking convulsion when pyrexia exists. When consciousness returns, feeding and stimulation must be carefully continued, with a gradual resumption of the routine treatment of epilepsy.

NARCOLEPSY.—In this remarkable and by no means rare condition, two quite different kinds of attack occur. The one is the sudden onset of apparently normal sleep, which comes usually at a moment of inattention, several times a day. The sleep lasts from a few seconds to a few minutes; it is rousable, and the patient is wide awake at once and knows that he has slept, and sometimes that he has dreamed and can describe the dream. Many of the patients have a warning in the way of a feeling of intense fatigue and, thereafter, can so far repel the onset of the attack by an effort of will as to be able to get out of harm's way; but the attack is inevitable, and it is always the more severe the longer it is resisted. The second variety of attack is called the "cataplectic" attack, and this is produced mostly from a sudden emotion, which may be of any kind, but is usually an emotion which provokes laughter. There is a sudden feeling of intense weakness in the limbs, which become flaccid. The patient drops anything that he may be holding

and crumples to the ground, but often only into the sitting position. The eyelids drop and the head falls forward with the jaw dropped, and there is sometimes twitching of the muscles of the face, tongue and neck. There is complete inability to move the limbs and generally inability to speak, but consciousness is completely retained, so that the patient is afterwards able to recount every event and repeat every word spoken during the attack.

Usually an idiopathic malady, narcolepsy has been recorded in a few instances as a sequel of encephalitis lethargica. The malady appears never to be familial, and it does not occur before the age of puberty. Once developed, it usually continues throughout life, with variable frequency of the attacks. Notwithstanding the opinion of authority that narcolepsy is uninfluenced by treatment, I have observed several cases in which the medicinal treatment customary in epilepsy had the most remarkable effect in reducing both the frequency and the severity of the attacks.

JAMES COLLIER.

MIGRAINE (PAROXYSMAL HEADACHE)

Definition.—A common malady of which the only essential characteristic is recurring intense headaches, which usually commence on waking in the morning, and which may be unilateral, frontal, occipital or general. The attacks usually date from childhood, but sometimes commence during later life. The headaches are often associated with vomiting, which has given rise to the designation "sick headaches" or "bilious attacks," with which is associated much vestibular disturbance as in sea sickness, and with peculiar disturbances of vision. Less common symptoms of the disease are peculiar slow sensory auræ, which occur in no other malady, attacks of hemiplegia or monoplegia or of aphasia, and attacks of ophthalmoplegia. Some of these phenomena may accompany the headaches, but others occur in attacks quite apart from the headaches, and may for that reason give rise to difficulty in diagnosis.

Ætiology.—The malady often commences in childhood and even in infancy. It tends to lessen after middle life, and invariably disappears in old age. Heredity is often present, and the malady will often show the same clinical peculiarities in members of the same family. The subjects of migraine are nearly always of an active, capable and intelligent type. Sometimes epilepsy is present, and the attacks may alternate with attacks of migraine.

Many theories have been advanced as to the nature of the malady. It has been held to be the result of a temporary condition of intoxication from digestive, metabolic or internal secretory disorder, which recurs periodically. There is little evidence in support of this view, for it is a common experience to meet with patients who have restricted their diets to an amazing extent to avoid the "bilious attacks," with the result that the migraine has become much aggravated. Neither has treatment directed against such errors had the slightest effect in benefiting migraine. Local spasm of the cerebral arteries has been advanced as the cause of the phenomena, on the grounds of the pallor and constriction of the vessels of the skin and retina, which occur during the attacks. This theory is adequate to explain

the varying nature of the attacks in some cases, at one time a headache, at another teichopsia and hemianopia without headache, at another, aphasia or hemiplegia or sensory aura without headache. It is, however, entirely hypothetical and breaks down utterly as an explanation of the severe and lasting ophthalmoplegia, which may accompany very severe attacks, and will hardly explain those cases in which the headache lasts for weeks, or becomes continuous. Pallor of the surface vessels, it may be pointed out, is the constant accompaniment of every severe vestibular disturbance, and many sudden changes in blood-pressure, as in sea sickness, etc. It has been held that migraine is due to a functional disorder of the cerebral cortex in the way of combined inhibition and discharge, akin to epilepsy, solely on the grounds of the nature of the visual phenomena and of the sensory auræ, and that migraine occasionally occurs in epileptics. Very undue prominence has been given to the importance of errors of refraction as causes of migraine. Certainly, such errors when existing are likely to cause vestibular upset and may therefore be exciting causes of an attack, and should in all cases of migraine be corrected. The majority of the subjects of migraine, however, have no such errors of refraction, nor has the correction of such errors ever cured migraine. Spitzner examined the brains from several cases of long standing and severe unilateral migraine, and found in each case a unilateral distension of the lateral ventricle corresponding with the side of the headache, and an anatomical condition of the choroid plexus in its relation with the foramen of Monro, such as might easily cause plugging of that foramen from conditions of turgescence of that plexus. He attributed the attacks of migraine to temporary unilateral hydrocephalus, from temporary plugging of the foramen of Monro. His specimens are in the museum of the Johns Hopkins University at Baltimore. This theory is the only one based upon pathological evidence, and it will explain migrainous ophthalmoplegia, for surely some very gross anatomical disturbance must take place within the skull to account for such sudden severe and lasting paralysis of peripheral oculo-motor nerves. For the unilateral hydrocephalus may cause pressure upon the third and sixth of one side, at the free edge of the tentorium.

The subjects of migraine are almost invariably bad sailors and bad train travellers, and mental and bodily fatigue and emotional disturbances are commonly followed by an attack. It is important to remember that tumours of the occipital lobe may be associated with attacks exactly resembling migraine. In one such case under my care, typical attacks of migraine appeared at regular intervals of about a month for 3 years. Papilloedema never developed. The patient died suddenly and a tumour was found in the upper convexity of the occipital lobe, corresponding to the field in which the visual phenomena were wont to appear. Migraine of a typical order may also occur in connection with chronic nephritis.

Symptoms.—The subjects of migraine are usually otherwise quite healthy, and are often robust and strong. No peculiarities of blood-pressure are noticeable. Premonitory signs of the attacks are present in some cases, and these may take the form of an unusual feeling of well-being and intellectual acuity, or, on the other hand, of lassitude and depression. The attack commences most commonly on waking in the morning, when on raising his head from the pillow the patient experiences a sense of vestibular

disorientation with giddiness, ocular confusion and nausea, such as is commonly felt at the commencement of sea sickness. It is at this stage of the attack, and within a few moments of its commencement, that the visual phenomena occur when these are present. Often the patient vomits at once from the vestibular disturbance, but sometimes vomiting is delayed for hours, and the vomiting may be continued as long as the giddiness persists. The visual disturbances last but a short time, but leave, as a rule, some confusion of vision and discomfort throughout the attack. The headache follows shortly upon these initial symptoms. It is cumulative, and expansile in character, and often begins constantly in a localised spot in the temple, forehead or eyeball, as a sharp boring pain which gradually spreads, and may involve the neck and arm. The pain may be unilateral, frontal, occipital or quite general. As the headache increases the face becomes pale and grey, the patient becomes much prostrated and incapable of mental or physical effort, and is unable to take food. Light, noise and movement aggravate the pain. After remaining in this condition for many hours, he falls into a heavy sleep, and awakes next morning shaken by his illness, but otherwise well. The above description covers many attacks of migraine, but many variations occur. The attacks do not always occur on waking, they may come on at any time of night or day. They may be rapidly transient, lasting but a few hours only, or they may last for days and even as long as 3 weeks, and give much anxiety in the attempts to provide nourishment and sleep for the patient. In some cases of long standing, the attacks become less severe towards middle life, and a persistent aggravating headache may develop between the attacks. When such a persistent headache is complained of alone, it is very important to inquire about preceding migraine, for the same treatment is applicable to the two conditions. One of the most characteristic features of the headache is that when once it is in full swing, no remedies will relieve it except natural sleep. Those measures so efficient in relieving other forms of headache, such as phenazone, aspirin, caffeine, morphine and alcohol, leave migraine relatively untouched.

Visual phenomena.—Considering how very common migraine is, it must be clearly understood that any visual phenomena except slight confusion of vision accompanying the attacks, are rare. These may take the form of general mistiness of vision, floating spots, scotomata, bright stars and colours, hemianopia, double hemianopia with complete blindness, or psychic hallucinations of vision. In connection with scotoma and with hemianopia, the phenomenon of teichopsia may occur as follows: Upon the dark background of the scotoma or hemianopic field, a ball of light appears, which grows larger and becomes dark in the centre. This ring of light breaks at one spot, opens out and takes the form of a series of entering and retreating angles (castellation figure) which become gloriously coloured (fortification spectrum) and which later become fragmented and fade. These visual events usually occur at the very beginning of the attack, before the headache develops, and they are rapidly evanescent, but they may occur as isolated phenomena, when no headache occurs.

Aphasic attacks may take the form of confusion of speech, word-blindness, or even of loss of speech-acceptance and exteriorisation. They accompany the headaches and occur at the commencement of the attacks. They are not of common occurrence.

Hemiplegic and monoplegic attacks usually occur quite apart from the attacks of headache. They too occur on waking, and consist of a transient uselessness and weakness of limbs, which lasts a few hours only. They are characterised by their occurrence in young subjects who suffer from pronounced migraine; they are rapidly transient and are not accompanied by organic signs, and almost invariably other members of the family are migrainous, and suffer with similar attacks of paralysis. In Michell Clarke's cases, 11 members of one family in three generations were so affected.

Sensory aurœ.—These are rare events, but they are pathognomonic of migraine, and usually occur quite apart from the headaches. The aura commences upon the periphery of a limb and is likened to that which would be produced by a multitude of cold-footed insects creeping on the skin. It travels very slowly towards the proximity, taking half an hour or more to reach from the fingers to the head, and is very alarming to the patient. It disappears rapidly without further event. It is the only aura with an exceedingly slow spread.

Ophthalmoplegia.—This is a very rare but most important event. It occurs only at the height of the headache, in severe attacks. Indeed, the patients usually say that the headache, during which the ophthalmoplegia occurred, was the very worst they had ever experienced. It is a paralysis of the oculomotor nerve trunks, most commonly of the sixth nerve alone, but sometimes of the third or fourth nerves, or of a combination of these three. It is generally unilateral, but may occur simultaneously on both sides. Severe diplopia results. It passes off in from a few days to a few weeks. When once it has occurred, it is apt to recur with subsequent attacks. In one of my patients, paralysis of the sixth nerve persisted for 18 months, gradually lessening between the attacks, and becoming complete with each fresh attack of headache. It disappeared completely, with the cessation of the headaches, when adequate treatment was adopted.

Facial paralysis.—Peripheral palsy of Bell's type has been described by Rossolimo as occurring in the height of a migrainous attack, and I have recently observed a very striking case in which a similar event occurred.

Diagnosis.—This presents little difficulty, if it be borne in mind that long installed recurring headaches on waking in the morning are surely migraine. The condition of the urine should exclude those renal cases with migraine-like headaches. Each case should be carefully examined for signs of organic nervous disease, and especially for persistent hemianopia and papillœdema, which would indicate an organic lesion of the occipital lobe.

Treatment.—There are but few cases of migraine that cannot be materially benefited by treatment. Some are completely cured, while in others the attacks become milder and occur at much longer intervals. Careful attention should be paid to improvement of nutrition and general health, should these be defective. The avoidance of undue fatigue, and of worrying emotions, and of any factors which are known to produce the attacks, is important. Errors of refraction should be adjusted if they are important. Medicinal treatment is by far the most useful agent. A mixture containing ♏ i of liq. trinitrinæ, ♏ v of liq. strychninæ, ♏ x of tinct. gelsemii, and 10 grs. of sodium bromide, made acid to preserve the stability of the nitro-glycerine, and administered thrice daily for many weeks or months, was advocated by Gowers; and truly there are few cases of migraine which do not derive great

benefit or complete cure from this treatment. Luminal, in doses of 1 grain given every night, is most valuable, and may be used in addition to the foregoing prescription. The individual attacks are difficult to relieve. Sometimes a full dose of antipyrine, antifebrin, phenacetin or aspirin given at the very commencement of the attack will ward it off, but these are useless when the headache has fully developed. Sometimes a full dose of alcohol has the same effect. It remains to keep the patient as comfortable and quiet as possible till sleep occurs. Where the attacks last over the 24 hours, and especially when they last for days, the only remedies are to induce sleep and to keep the patient nourished, the latter object being difficult to attain in long-lasting attacks. To this end hypnotics, such as veronal or adalin, may be used, and in severe cases chloroform inhalations and morphine are of value, the latter especially if there be long-lasting vomiting, for it provides rest and enables the patient to retain nourishment.

JAMES COLLIER.

CHOREA

Synonyms.—St. Vitus' Dance; Sydenham's Chorea; Rheumatic Chorea.

Definition.—Chorea is a spasmodic affection of the nervous system caused by rheumatic infection, and characterised by the occurrence of spontaneous involuntary movements, irregular both in time and in place of occurrence and in nature; by inco-ordination of voluntary movements; by muscular weakness, and by a variable degree of psychic disturbance.

Ætiology.—Chorea is rare among negroes, Indians and coloured races, whilst it is especially common in Jewish races. It is much more common among the poorer classes than among the well-to-do. Its incidence is upon nervous highly-strung subjects rather than upon the phlegmatic, and this is probably to be explained by the fact that the rheumatic subject is likely to be nervous and highly strung. Chorea is practically unknown during the first three years of life, and is very rare before the fifth year has passed. Common between the ages of 5 to 10 years, it reaches its maximum incidence between 10 and 15 years. After the age of 20 it is rare, except in connection with pregnancy; but a few cases have been reported up to the age of 60 years which have certainly been examples of rheumatic chorea. Females are affected twice as frequently as are males. Heredity concerns the incidence of chorea in two ways: firstly, as regards the inheritance of the rheumatic tendency, which is the most important cause of chorea; and secondly, in respect of the inheritance of the neuropathic tendency, for it is when these two are coincident that chorea is most prone to occur. A history of chorea among antecedent relations is not uncommon; that of other rheumatic ailments is very frequent, whilst a history of neuropathic maladies such as epilepsy, hysteria and insanity is met with sufficiently often to be noteworthy. As early as 1802 rheumatism was regarded as the cause of chorea, but conclusive evidence of the connection of these maladies was first published in 1850 by G. See. In 1867, H. Roger put forward the opinion that rheumatism, cardiopathy and chorea were manifestations of one and the same disease, and all subsequent investigations have upheld this theory. The family history of a choreic patient generally brings to light the occurrence

of acute rheumatism, of cardiac disease and of other rheumatic manifestations among other members of the family. Often the patient has suffered with rheumatic erythema, purpura, rheumatic nodules, recurrent sore throat and growing pains before the appearance of the chorea; less often an attack of acute rheumatism or cardiac disease has occurred. Signs of rheumatism are very often present during the attack of chorea. Indeed, slight dilatation of the heart, with a reduplication of the second sound, may be said to be almost constant. Endocarditis and pericarditis are of common occurrence, and cutaneous rheumatic manifestations are sometimes seen, but acute articular rheumatism during an attack of chorea is unusual. A large percentage of those patients who have never shown any sign of the rheumatic state before or during the attack of chorea subsequently suffer with rheumatic symptoms. The British Medical Association Collective Investigation Committee found that rheumatism preceded the chorea in 26 per cent. of the cases, and that in 46 per cent. of the remainder rheumatic signs accompanied the chorea, or appeared subsequently. Among 115 children suffering with chorea, Dr. Batten found that rheumatic signs had occurred in 32 per cent. Three years later, he followed up those cases that had not suffered from rheumatism previously to the chorea, and among those, notwithstanding that he was unable to trace some of them, 11·3 per cent. of the total number had developed rheumatism in the 3 years following the chorea. Three years later, he found that a further 9·7 per cent. of the total had developed rheumatism. If to the total of choreic patients who present rheumatic signs at some time or other, one adds those with no personal history of rheumatism, but with a family history of rheumatism, it will be found that there are but few cases of chorea in which a personal or family history of rheumatism is absent. Pathological investigations tend also to prove that chorea is a manifestation of rheumatism. Drs. Poynton and Paine have isolated the same organism—the *Diplococcus rheumaticus*—from cases of rheumatism and from cases of chorea, and they have shown that intravenous injection of a pure culture of this organism into rabbits has produced all the characteristic lesions of rheumatism, and it has produced, in addition, the symptoms of chorea. These experiments have been repeated and confirmed by Beaton and Ainley Walker, and also by Beattie. The former observers also found that this diplococcus was present in the cerebral cortex and in the cerebrospinal fluid in cases of chorea.

Psychical disturbances.—The association of St. Vitus' dance with fright is so impressed upon the popular mind, that any event of this nature occurring shortly before the chorea is placed in unduly important relation to the disease. In such cases, careful investigation will often discover that slight choreic movements were present before the shock occurred, and became more noticeable afterwards. Any emotional disturbance, such as fright, anxiety, depression or overpressure in school, may sometimes act as immediate determining factors, but much more often these events simply aggravate symptoms which are already present in slight degree.

Pregnancy.—The relationship of pregnancy to chorea is very definite. It is generally met with in first pregnancies, and before the age of 25 years, and in most cases the pregnancy appears to be the only obvious cause for the chorea. Drs. Poynton and Holmes, however, have gone far to prove that the chorea of pregnancy is of rheumatic origin, for they have isolated

the *D. rheumaticus* from patients suffering from this disease. The onset of the chorea is usually between the first and third months of pregnancy. It is liable to recur with subsequent pregnancies.

Pathology.—The site of the morbid process which results in chorea is in the higher part of the nervous system. This is proved by the nature of the movements, for the physiological expression of emotion is often by movements which closely resemble chorea, and the shy and nervous child in the presence of a stranger will show movements almost choreic. Further, the emotional instability and depression of the choreic patient and the association of the malady with mania in some cases, suggest that the cerebrum is the seat of the malady. The paresis and the not infrequent hemiplegic distribution of the symptoms, the major affection of the upper extremity, and the fact that the choreic movements invade the body with the same march as does the paralysis in a developing hemiplegia, confirm this view. Much light is thrown upon the question of the seat of the disease by those cases of gross organic disease of the brain in which choreic movements occur, for they prove, in the first place, that choreic movements are never met with where severe paralysis has resulted from lesion of the pyramidal system—that is to say, a relatively intact pyramidal system is necessary for the appearance of choreic movements; and in the second place, that lesions both in the post-central convolution and in the region of the deep part of the optic thalamus and red nucleus, where the superior peduncle of the cerebellum has its ending, may give rise to movements of a choreic nature. The reasonable explanation is that a lesion of either of these regions may involve the same set of nerve elements at different places in their course. Bonhoeffer is of opinion that the manifestations of chorea are due to alteration of the nerve impulses which pass from the cerebellum to the motor cortex by way of the red nucleus and subthalamic region, and the observations of von Halben and Infeld support this view, which is now widely accepted, and has been rendered almost proven by the experiments of Economo and Karplus, who have produced choreic movements in cats by injuring the region of the red nucleus. Assuming, then, that chorea is the result of a functional disturbance of the nerve elements in the region of the red nucleus, brought about by rheumatic infection, the question arises as to whether this functional disturbance is brought about by the local action of micro-organisms in this region, or whether the disorder is the expression of a general toxic state, with an especial selective capacity for the nerve elements in the region of the red nucleus. There are facts in support of either of these alternatives. That the *D. rheumaticus* has been found massed round the smaller cerebral blood vessels, and that chorea may be local and confined to one-half of the body, support the former view; whereas the obvious general toxic state present in severe cases of chorea, and the widely spread affection of the nervous system shown by the psychic condition, support the latter view. Probably the truth lies in a combination of the two theories.

Chorea, therefore, is the expression of disordered action of the nerve cells of a particular region of the nervous system, and this disordered action results from an inherent condition of functional instability of the nerve elements, and from the deleterious effects upon these nerve elements of a specific micro-organism, the *D. rheumaticus*, which either acts locally or generally by producing a toxic blood state. The morbid anatomy of the

nervous system in cases of chorea presents no characteristic feature other than the presence of the specific organism in the vicinity of the smaller blood vessels. Alteration of the cells of the red nucleus and of the cerebral cortex in the way of swelling, distortion and tigrolysis have been described, but there is nothing characteristic about these changes. Vascular lesions—embolism and hæmorrhage—are sometimes seen when endocarditis is a complication.

Symptoms.—The onset is usually gradual, but it is sometimes abrupt, when emotional disturbance has been the determining cause. The appearance of choreic movements is often preceded by alterations in the mental and physical condition of the child. She becomes nervous and more impressionable than before; she is irritable, and often laughs and cries without apparent cause. She is increasingly unable to apply her attention, and she cannot do her lessons. She becomes clumsy in her movements—overturns her glass at table, and lets fall objects which she is holding. The inevitable reprimands, which she suffers for these faults, have an immediate effect in augmenting her clumsiness. Anæmia, apathy and languor and irregularity of appetite are commonly present. At this time, careful observation will discover slight involuntary movements of the face and fingers which are often unilateral in distribution. From day to day the movements become more marked and spread to the limbs and trunk. The face is constantly grimacing, and the hands and arms scarcely cease from turning about, and affection of the legs makes the walking irregular and clumsy. The child can no longer keep still, the respiration movements become irregular and spasmodic, and the chorea is fully developed. The characteristic symptoms of a well-marked case of chorea are—(1) involuntary movements; (2) weakness of voluntary movements; (3) ataxy or loss of precision of voluntary movement; (4) emotional instability and other psychic disturbances.

1. THE INVOLUNTARY MOVEMENTS are always irregular as regards time and as regards the nature of the movement. Similar movements are never repeated successively in the same part, and each differs from the one which preceded it, and from its successor. Each movement begins rapidly, and ends suddenly, and one frequently sees the involuntary movement complicated by the addition of a voluntary movement to cover the fault. The majority of the movements are complicated, involving several muscles and often more than one joint. They resemble volitional movements more closely than do the other involuntary movements met with in nervous disorders, and have been called "quasi-purposive." In the face, the movements are never confined to one side, even in hemichorea. The more simple movements take the form of asymmetrical twitches in the lips, and about the angles of the mouth and orbits. In more severe cases, the strangest grimaces may occur. At one moment the angles of the mouth are drawn downwards, then outwards, then the lips are pursed. The forehead is thrown into wrinkles, the eyebrows are brought together, then released, and the eyelids blink. Suddenly the face becomes still in a vacant, forlorn expression, to break into a quick, transient smile or ugly grimace a moment later. The tongue is thrust into one cheek, then projected just in time to escape the sudden snap of the open mouth. When asked to show the tongue, the child puts it out rapidly and holds it there by closing the teeth upon it. Smacking of the

tongue and palate may often be heard at a distance. Lateral movement of the jaw is common. According to the severity of the case, speech may be difficult, the words being articulated slowly in slurred monosyllables; or speech may be impossible, since no effective sequence of voluntary movements can be produced in lips, tongue and jaw, and since both palate and pharynx are involved in the involuntary movements. For the same reason, swallowing may be difficult or impossible in severe cases, and may necessitate nasal feeding. That the ocular muscles participate in the involuntary movements is shown by the fact that the eyes remain parallel and turn concomitantly when spontaneous movements of the head occur.

In the upper extremities the movements appear first in the hand. The thumb is more restless than the fingers, which are spread and pressed together, flexed and extended, alternately; the wrists twist about irregularly, the forearms are constantly agitated with movements of pronation and supination, flexion and extension; while all possible movements of the shoulder occur. When the upper extremities are outstretched, the hands assume the position of flexion at the wrist and over-extension at all the finger joints in so many of the cases as to make this a characteristic feature of chorea. The lower extremities are less severely affected than is the rest of the body, and here the movements are best seen when the child is lying down. The gait tends to be clumsy and insecure, the legs being thrown now too far out, now across one another, and in severe cases walking becomes impossible. Alteration of the rhythm of the respiratory movements is conspicuous and is highly characteristic of chorea. The breath is often taken rapidly and held for some time, then let go with a loud sigh. The trunk is always involved, and movements of a writhing nature are characteristic, and in severe cases these may be so violent as to throw the patient out of bed.

The face is usually the first region to present movement, and it is always affected bilaterally. The hand is the next to follow, and the left hand is said to be affected earlier and more often than the right. So far as the limbs are concerned, the movements may be confined to one side, more commonly the left side, and the condition is then called hemichorea; but the involvement of the face and trunk is always bilateral and is generally equal upon the two sides. In hemichorea, the movements are always of slight severity. Severe chorea is never confined to one side. Choreic movements cease during sleep, and, except in severe cases, can be controlled more or less by voluntary effort; the attempt to write, for example, will generally cause cessation of the movements in the right arm for the time being. They are generally increased by observation, emotion and self-consciousness, but in a few cases it will be found they are worse when the child is alone and unobserved. In severe cases, the whole of the voluntary musculature is involved and the movements are incessant. The violence of the movements of the limbs may cause the skin over the prominences to ulcerate from friction against the clothing, and the head and limbs may be badly bruised from contact with adjacent objects, and unless the patient be properly protected, wounds may occur, which are liable to infection with such grave consequences as abscess, erysipelas and pyæmia.

2. Loss of power is shown in the mild cases by incapacity for exertion and undue fatigue. More severe degrees of paresis may accompany or succeed the appearance of the movements. It may be observed that in one

limb, or upon one side of the body, the choreic movements are becoming less marked, and that the limbs are becoming progressively weaker. Soon the arm hangs loosely by the side, and the leg is dragged in walking. Though the paresis may become so severe as to make raising of the limbs against gravity impossible, yet it never becomes complete, and in almost all cases slight choreic movement persists in the paretic region. The degree of choreic paralysis bears no relation to the severity of the movements, for the former may be severe, when the latter are slight and vice versa. Choreic paresis is apt to return with successive attacks of chorea, but not always in the same region. In some cases, it constitutes the first noticeable symptom; in others, it appears late, and after the choreic movements have ceased; more commonly, both are concomitant.

Limp Chorea (*chorea mollis*).—This is a more severe degree of choreic paralysis affecting the whole musculature. It may be preceded by the usual symptoms of chorea. More often the paralysis is the first noticeable symptom, and this develops rapidly in from 24 to 48 hours. The paralysis is characterised by complete flaccidity of the limbs; the child lies upon its back and does not move, and if one of the limbs be raised from the bed and then released, it falls limp and lifeless. The head is no longer held in a natural position, but falls round on to the ear. Careful investigation, however, rarely fails to reveal some slight choreic movements, either in the face or in the fingers. Paretic chorea and chorea mollis run a benign course, and recovery is said to be almost invariable.

3. Inco-ordination of voluntary movement may be the first symptom of chorea to draw attention, and it may precede the appearance of the choreic movements. It may be very obvious when the movements are slight, and it is most noticeable in those of the hand and forearm, which lack precision, and in those of articulation, deglutition and respiration. The motor centres do not obey the dictates of the will, so that when the patient tries to relax certain muscles for the completion of an act, there is delay, which interferes greatly with the efficacy of the act. This interruption in the sequential flow of movements which make up an act, is responsible for the sudden dropping of objects which are being carried, and for overshooting the mark in the attempt to lay hold of an object.

4. Psychical disturbances are common, some degree of emotional instability, failure of attention and depression being present in most cases, and, generally, in proportion to the severity of the affection. The patient's behaviour may change; she may laugh or weep without reason. She may become capricious, irritable and obstinate. The attention and memory are usually impaired, and less interest is taken in the surroundings, and this condition may progress until marked hebetude exists. Severe mental disorders sometimes complicate chorea. Delirium may occur in acute and grave cases. It is usually violent and loquacious, and resembles other forms of toxic delirium, and it is of serious prognostic import. Hallucinations of vision of terrifying character may occur. Mania is quite exceptional in children, but it is not an uncommon complication in adolescents and adults. The form of the aberration may be acute mania, melancholia, moral perversion or delusional insanity. The psychical disorders, slight or severe, usually disappear with the chorea, and in all cases the prognosis as regards permanent mental recovery is good.

Ocular Phenomena.—The pupils are frequently dilated and may be unequal and excentric, and hippus may be present. Transitory squints from irregular spasm of the eye muscles may occur, and may make reading impossible. In a few cases optic neuritis has occurred and is to be attributed to the rheumatic state.

Sensibility is not usually impaired, though occasionally sensory loss of an hysterical type occurs. The sphincters are not affected. The skin reflexes are normal. The deep reflexes are also normal in a large proportion of cases, but often the knee-jerk shows an alteration which is peculiar to chorea. On tapping the patellar tendon, the resulting contraction of the quadriceps is unduly sustained, and the leg remains in a position of extension at the top of its excursion for several tenths of a second. In severe cases, the deep reflexes may be diminished and rarely may be absent for months. This loss of the deep reflexes in chorea has often been referred to the administration of arsenic, but it undoubtedly occurs in cases where arsenic has not been used, and in two cases the writer has observed a unilateral loss of knee-jerk which persisted for many months.

Rheumatic Manifestations.—Cardio-vascular changes are common in chorea. In nearly all the cases, careful and repeated examination of the heart will reveal slight dilatation and reduplication of the second sound, often with reduplication of the first sound, and increased rapidity of the pulse. Doubtless these are signs of a slight myocardial weakness, resulting from the rheumatic infection. Irregularity of the pulse is probably dependent upon the altered rhythm of respiration. Systolic murmurs are common, and these may be hæmic in nature, or may be the expression of cardiac dilatation, but in the majority of cases they are indicative of endocarditis. The researches of Sturges, Gowers and Osler have shown that endocarditis is present in 90 per cent. of the fatal cases. At least one-half of all cases present cardiac murmurs, which are suggestive of the presence of endocarditis, while some cases with no cardiac murmur during life are found post mortem to have endocarditis. The mitral valve is commonly affected, lesions of the aortic valve being quite rare. Pericarditis is a frequent associate of endocarditis, only in rare instances does it occur alone. The valvular affections which are met with in chorea may be the result of antecedent rheumatism, or they may develop in the course of the chorea; or while no signs of endocarditis are present during the attack, the patient may shortly afterwards present the signs of organic valvular disease. Cutaneous affections which occur in rheumatism are met with also in chorea, namely, erythema, purpura and subcutaneous nodules. Acute articular rheumatism is comparatively rare, and when it occurs it is usually accompanied by a cessation of the choreic movements. When rheumatic phenomena are present and in the acute mania of chorea, pyrexia is usually present, but uncomplicated chorea is an apyrexial disease.

Recurrence.—One-third of the subjects of chorea have more than one attack. Females are more prone to a recurrence than males in about the same proportion as they are more liable to original attacks. The average interval between the attacks is one year. If, therefore, a patient has remained well for 2 years, it is improbable that a recurrence will take place. The greater the number of choreic attacks, the more likely is the heart to be found affected, and, therefore, cardiac complications are more often met with

in recurrences. In a recurrence of chorea the symptoms are usually less severe and their duration shorter than in the original attack.

Course and Duration.—The disease tends to a spontaneous termination after a variable time, which is usually from 6 weeks to 6 months. The duration rarely falls short of the earlier period. The average duration of cases treated in hospital has been found to be 10 weeks. Cases which last for more than 12 months are not rare, and slight cases with remissions may last several years. The course of the malady is that after a gradual development of symptoms, there is a stationary period during which symptoms are well marked, followed by a period of gradual diminution. Almost unnoticeably, the disorderly movements become less intense and the legs regain their normal motility, then the upper limbs, and lastly the face. The last of the spasmodic movements are seen as very slight abnormal movements of the fingers and of the face. Inco-ordination and paresis usually disappear before the spasm, but in a few cases marked paresis persists after the movements have disappeared. In some of the more severe cases of chorea where deglutition is difficult the patient is likely to be insufficiently fed; and this constitutes a grave danger, since in the condition of semi-starvation so induced, the chorea develops apace. Articulation and swallowing become impossible, and the movements become ceaseless, so that both rest and sleep become impossible; the patient wastes rapidly, and is in danger of death from exhaustion unless prompt measures for restoring the depleted nutrition are taken. This is the condition known as "chorea gravis."

The proportion of fatal cases occurring in chorea is less than 2 per cent. Death is most often met with in first attacks, occurring about the age of puberty, and it is very uncommon in young children and in recurrences of chorea. Death usually occurs from a condition of "chorea gravis." The complications which are responsible for fatal results are endocarditis, pericarditis, myocarditis and rarely hyperpyrexia.

Diagnosis.—The nature of the involuntary movements of chorea is so characteristic as to make diagnosis easy, and to avoid any confusion with other maladies which present conspicuous involuntary movements. In the tics and in torticollis, for example, like movements are repeated in the same positions. In myoclonus, the movements are short and shock-like, while in athetosis they are slow and rhythmic.

The organic diseases of the nervous system in which movements very like those of chorea occur, are easily distinguished upon careful examination by the presence of the organic signs characteristic of these maladies, of which Friedreich's disease and cerebral diplegia are the most important. From Huntington's chorea the distinction can only be made by the age of the patient, by the progressive mental change, and by the familial incidence of the disease, for the movements are identical with those of Sydenham's chorea.

When, however, movements are inconspicuous or absent and the clinical aspect is dominated by some other symptom, such as paresis or acute mania, the nature of the disease may not be so readily determined. In paretic chorea, a history of the existence of spontaneous movements before the development of the paralysis is often obtained, and careful examination will reveal slight movements in the face, or in the fingers, when a sustained act is attempted, such as keeping the mouth widely open, or holding the hand

with the fingers spread. The paresis of chorea is in itself highly characteristic. It is of gradual onset, and is not associated with pyrexia or other febrile symptoms. It is a flaccid paralysis, which is never absolute; the arm is affected more severely than the leg, and the hand more than the shoulder, while the face generally escapes. There is no local muscular wasting and no pain, and while signs of spasticity are absent, the deep reflexes are in most cases present. Maniacal chorea may be mistaken for other forms of acute mania, since the choreic movements are prone to disappear when the mania is at its height. Here the history of preceding involuntary movement helps, and it should be remembered that the rheumatic state is a not uncommon cause of acute mania in young subjects. In all cases of difficulty, the presence of a slightly dilated heart with reduplicated second sound, or the presence of cardiac murmurs in addition to the former, should at once bring to mind the rheumatic state and chorea as possible causes.

Prognosis.—The large majority, even of severe cases, end favourably, the mortality being less than 2 per cent. Complications apart, the chief peril is exhaustion from interference with taking food and from want of sleep, and the never-ceasing movements. Death from chorea in pregnancy results most often from abortion, whether spontaneous or artificially induced. The presence of endocarditis seems not to affect the immediate prognosis, but it affects the ultimate prognosis, in that it may lead to chronic valvular disease of the heart, terminating in failure of compensation with its usual consequences.

The prognosis with regard to the duration of the attack is uncertain, for whereas the attack very often comes to an end within 10 weeks, it may sometimes last as many months.

Treatment.—It is all-important in the treatment of chorea, from the mildest to the most severe cases, that physical and mental tranquillity should be secured. It is well to commence treatment in every case with several days' absolute rest in bed, provided that such treatment can be carried out without entailing the fretting which enforced imprisonment may produce. A bright room, an interesting companion, and varied amusements during the period of rest, are desirable, and isolation from other children is advantageous. It is, however, better to abandon enforced rest than to allow it to become irksome to the patient, and result in mental depression and emotional upsets—conditions above all things to be avoided.

When absolute rest is considered inadvisable, or after it has been carried out, the ordinary periods of rest should be prolonged. The child should be well clad in woollen garments, especially at night, since the spasmodic movements are liable to leave her uncovered. Improvement in the condition of bodily nutrition is to be aimed at in all cases. Choreic children are mostly ill-nourished and thin, and the effect of a liberal supply of good and nutritious food upon the course of the disease is striking. It should be impressed upon those who have the care of the child that the ordinary diet must be supplemented with as much milk and farinaceous food as she will take. When swallowing is difficult, it is best to resort at once to nasal feeding, which rarely causes as much discomfort as the ineffectual and exhausting endeavours to take food with the spoon. A china feeding-cup must never be used, since the spout may be broken off and swallowed; an enamelled metal cup is safe.

It has been pointed out above that chorea gravis is dependent upon a condition of relative starvation, and here nasal feeding should be employed, and the meal should consist of strong beef-tea, Benger's food, lactose and milk; it should not measure more than three-quarters of a pint for a child of 8 years old. The addition of alcohol to the meal is of great value. Severe cases, in which the movements are violent, call for skilled attention, and a trained nurse is required night and day. Provision has to be made against injury from the violence of the movements. The patient should lie upon a water mattress, placed upon a large guarded bed, the sides of which are everywhere protected by pillows, which must be fixed. When a cot is used, it is easy to pad all the ironwork with cotton wool, over which bandages are wound. An excellent bed in cases of urgency can be made by placing the mattress upon the floor in a corner of the room, the walls being protected by the two halves of a straw mattress placed upright, and the other two sides surrounded by pillows. If the limbs are injured, they should be wrapped in cotton-wool applied with a light bandage.

When the patient is improving, measures calculated to enhance control of the limbs, such as exercises under supervision and simple drill, are very useful in hastening the disappearance of the movements. Warm and tepid baths and douches applied regularly and in such a way as to be grateful to the patient, and to produce no fright, are very useful adjuncts. The compounds of salicylic acid are of great value, and of these aspirin is the most useful. It should be given thrice daily after meals in doses of 10 grains for a child between the ages of 6 and 14 years, and 15 grains for an adult, and it should be continued until convalescence is complete. It is well borne and has no deleterious effect. A larger dose given at night is the best remedy for sleeplessness. The use of arsenic is followed by great benefit in some cases, but in many it fails to do good. It should be given in doses of not more than 5 minims thrice daily, as no increased benefit seems to accrue from larger doses. The value of antipyrine in chorea was first pointed out by Hubrecht, but of recent years it has largely been discarded in favour of aspirin. It may be given in doses of 10 grains three times a day. Chloretone has its advocates, but in the writers' experience it is depressing, and is much inferior to aspirin. It has the grave disadvantage that continued use, even for a short time, may induce a severe form of peripheral neuritis. Quinine in large doses has been much advocated by American physicians. In certain cases where restlessness is well marked, the administration of hyoscine is sometimes very useful. It should be given in doses of $\frac{1}{100}$th grain thrice daily. The administration is followed immediately by wide dilatation of the pupil and slight flushing, and by peaceful sleep. The bromides have little or no value as sedatives. In addition to the above remedies, tonics such as iron, glycerophosphates, hypophosphites, strychnine, cod-liver oil and malt are often valuable, especially in the convalescent stage.

Huntington's Chorea (Hereditary Chorea of Adults)

This is a somewhat rare disease, in which symptoms almost identical with those of rheumatic chorea, namely, involuntary spontaneous movements, ataxy, paresis and slow and slurring articulation, gradually appear

in adult life, and usually about the age of 40 years, and are accompanied by progressive mental failure, with delusions and suicidal tendency. The choreic movements are never severe, but the inco-ordination may be well marked. Maniacal outbursts are not uncommon. The disease always progresses slowly to a fatal termination in from 5 to 30 years, and treatment is entirely unavailing. It is a familial disease, and the transmission is direct from parent to child; but if a generation escape the malady, it seems not to reappear subsequently. Sporadic cases, in which no heredity can be traced, do, however, occur. The sexes are equally affected. Further than the heredity no causal factors are known. The morbid anatomy consists in a slow progressive degeneration of the nerve-cells of the cerebral cortex and basal ganglia, with consecutive atrophy of the convolution, neuroglial overgrowth and meningeal thickening.

Senile Chorea

A malady in which typical choreic movements constitute the chief feature is met with in elderly people, and is possibly due to a progressive neuronic degeneration in that region affected in the other forms of chorea. It differs from Huntington's chorea in the late onset, the absence of heredity, and in the absence of mental changes.

Electric Chorea (Dubini's Disease)

This disease, which has been met with only in Lombardy and Piedmont, is characterised by an acute onset, with pyrexia and severe pains in the neck and back, followed by spontaneous involuntary movements which are sudden and shock-like and often of wide range and powerful, resembling the movement which results from the stimulation of a motor nerve by a strong single induction shock, hence the name of the malady. Progressive loss of power occurs, the muscles waste and lose faradic excitability; the deep reflexes disappear. Convulsions are common and progressive mental hebetude occurs. The disease is invariably fatal within a period which varies from a few days to several months. It appears to be the result of an acute micro-organismal infection. Recent experience of lethargic encephalitis suggests that the epidemics of Dubini's disease which occurred during the nineteenth century may have been examples of the former malady.

MYOCLONUS (PARAMYOCLONUS MULTIPLEX)

The characteristic symptom of this condition is the occurrence of sudden shock-like contractions of the muscles, which may vary in intensity from simple fibrillary twitching to contraction which causes a violent movement of a limb. The movements are often symmetrical, and are especially incident in the proximal muscles of the limbs.

Ætiology.—The malady appears in children usually between the ages of 5 and 15 years, while in adults it commences between the ages of 25 and 40 years. Both sexes are liable to the affection. Many instances, in which

several children of the same parents have been affected, have been recorded, and in a few the malady has been transmitted through several generations. Nothing further is known as to the causation.

It is probable that the seat of the morbid process is in the cells of the cerebral hemispheres, since myoclonus is further associated with epilepsy and with progressive mental failure, and further because myoclonic movements are sometimes met with in atrophic sclerosis of the brain. Many observers, however, hold that myoclonus depends upon a disturbance of function of the lower motor neurons. Wagner-Jauregg having observed similar muscular contractions in animals after extirpation of the parathyroid glands, thinks that a disorder of internal secretion may be responsible, and records a case in which the malady was cured by thyroiodin.

Symptoms.—The movements of myoclonus are simple sudden movements, and may exactly resemble the movement resulting from a single faradic stimulus. Each movement commonly involves a single muscle only, and it may concern no more than a few fibres, resembling then the fibrillary twitching common in progressive muscular atrophy. Biancone has applied the name "Myokimia" to cases where the movements are all of this simple nature. In other cases, many muscles may be implicated in the shock-like spasms, which may be of so violent a nature as to throw the patient to the ground. The distribution of the contraction is never determined by that of the nerve supply, nor do the muscles contract according to their synergic association. Myoclonic movements are irregular as regards rhythm and range of successive movements. They are often strictly symmetrical upon the two sides of the body, and may then be isochronous. The upper limbs are more affected than the lower, and the proximal parts more than the distal, while the periphery, the hand and foot, often escape. Voluntary muscular effort usually checks the myoclonic movements, but in rare instances it excites or augments the spasm. Volitional movement is interfered with in proportion as the myoclonic movements have a locomotor effect. The electrical excitability of the muscles is unaltered, and there is no muscular wasting, but the mechanical excitability of the muscles is increased, and percussion of a muscle may evoke the spasms. The sphincters are unaffected. The reflexes, both superficial and deep, are normal. Sensory phenomena are, as a rule, totally absent, but in the cases described by Biancone as "Myokimia" subjective sensory disturbances occur. Speech may be seriously interfered with when the muscles of jaw, tongue, palate and larynx are implicated, and spontaneous laryngeal and pharyngeal noises may occur. The ocular muscles seem never to be the seat of the movements. Epileptiform convulsions are present in some cases, and for these the term "epileptic myoclonus" has been used.

Diagnosis.—This is not difficult since the simple shock-like movements in symmetrical muscles, without any resemblance to volitional movements and entirely destitute of rhythm, occur in this disease alone. Myoclonus is distinguishable from chorea by the nature of the movements, by the frequent exemption of the face, which is always involved in chorea, and by its association with epilepsy. Further, the rheumatic manifestations of chorea are not present in myoclonus. Movements of a shock-like nature may occur in hysteria, but the presence of hysterical stigmata, such as hemianæsthesia, crossed amblyopia, etc., will serve to distinguish this affection. The "tics"

can hardly be confused with myoclonus, for in the former the movements are like volitional movements, and the face is usually affected. The spasmodic utterances and fixed ideas of the severe forms of tic do not occur in myoclonus.

Course, Duration and Prognosis.—Myoclonus, as a rule, is a slowly progressive affection up to a certain stage, and when this is reached it may remain stationary for years, having little tendency to shorten life, death ultimately occurring from some other disease, without any period of freedom from the spasms. Rarely the disease has ended fatally within a few months of the onset, with progressive mental failure and coma.

Recovery may take place spontaneously, or as a result of treatment, but the affection is very prone to recur.

Treatment.—Of the first importance is the removal of any discoverable exciting cause, and the correction of any defective hygiene and mode of living. Secondly, every available measure should be used to improve the general bodily condition so as to bring about a more stable condition of the nervous elements, by improving their nutrition. The only drug which influences the disease is arsenic. It must be borne in mind that the malady is an intractable one in proportion to the time the symptoms have persisted, and that some cases recover spontaneously, and sometimes after treatment has been abandoned as useless.

SPASMODIC TORTICOLLIS

Definition.—A disease of the nervous system, characterised by tonic and clonic contraction of the superficial and deep muscles of the neck, causing the head to assume either a position in which it is turned to one side and upwards, or a position of marked retraction (retro-collic spasm).

Ætiology.—The disease is most frequently met with in middle-aged adults, but it may occur at any age from puberty onwards. It is twice as frequent in females as in males. The causation is most obscure. Not infrequently neuropathic heredity, such as epilepsy and insanity, exists, and the patients are often of highly-strung, nervous, irritable dispositions. Nervous shock, prolonged anxiety, and general ill-health have frequently preceded the onset of symptoms. Less often local strain, or injury and exposure to cold, have been the presumably exciting causes. In a few cases it appears to develop from an occupation neurosis; it developed, for instance, in a tailor who in drawing each stitch had the habit of making a short jerking movement of the head to one side. It occasionally occurs as a symptom of hysteria; but such cases should be carefully separated from those in which there is no hysterical manifestation, as being more susceptible to treatment and having no tendency to recur when once cured. A torticollic movement may occur as a variety of tic. In one case under our care typical torticollis was the end result of lethargic encephalitis.

Pathology.—No morbid anatomical changes have been found. On account of the involvement of several muscles, effecting special movements, in this disease (as is well instanced by the over-action of the frontalis in retro-collic spasm, for retraction of the head is always normally associated with raising of the eyebrows in the act of looking up), it is probable that

torticollis is due to disorder of those centres which direct such associated movements of the affected muscles.

Symptoms.—The onset is usually insidious, but in rare cases may be quite sudden, as in the case of a man aged 40 years, who, when walking along a London street, suddenly turned his head at the sound of an accident which shocked him severely; he was unable to turn his head back without using his hands to do so, and he subsequently developed the most severe torticollis. The initial symptom is always spasm, which may be either tonic or clonic, and frequently both forms of spasm are combined in the same case. In the tonic form, the head is retracted and the face turned to one side, usually the left, and owing to the retraction of the head the face is turned upwards. The shoulder on the side to which the head is inclined is usually raised. In severe cases all the muscles of the upper extremity, the scaleni and the face muscles, may become involved. The spasm, except in the earliest stages, always involves muscles of both sides of the neck. Where the bilateral involvement is general and equal, the rotation of the head does not occur, but it becomes strongly retracted, and the condition is then known as retro-collic spasm. Such retro-collic spasm is always accompanied by marked over-action of the frontales, the skin of the forehead being thrown into transverse wrinkles. In the clonic variety there is jerking movement of the same muscles, usually associated with some degree of tonic spasm. The eyes do not follow the movements of the head in the jerkings. The muscle primarily involved is the sterno-mastoid, the action of which is to incline the head forwards and towards the shoulder of the same side, and rotate the face to the opposite side. The next muscle involved is the splenius of the opposite side, which inclines the head backwards and rotates the face towards its own side, its rotatory action thus coinciding with that of the opposite sterno-mastoid. When the splenii of both sides act together, the head is strongly retracted. Next to be affected are the upper part of the trapezii, the trachelo-mastoids and other deep neck muscles, and with further spread of the spasm, any neighbouring muscles of the shoulder and upper extremity may be affected. Sleep causes cessation of the clonic spasm, but not always of the tonic spasm when the case is severe. The spasm is always increased by fatigue and excitement. There is no wasting of the muscles involved, but on the other hand, they may be even hypertrophied if the spasm has existed for long, and their electrical excitability may be increased. The amount of pain associated with the spasm varies greatly. There may be a slight feeling of cramp only, but usually there is a great deal of aching pain, which may radiate down the arm and into the side of the head, and make life unbearable to the patient. More rarely, sharp neuralgic pains are present.

The course of the disease, which has no tendency to shorten life, is chronic, exacerbations and remissions under treatment being common, and recurrence, after temporary cure, frequent.

Diagnosis.—This is usually quite simple. Fixed positions of the head associated with spasm occur in disease of the cervical spine, especially in spinal caries, and are also associated with enlarged lymphatic glands in the neck. The local signs of these conditions, however, are characteristic.

Treatment.—Temporary relief is often obtained by the administration of chloral and bromides; keeping the patient constantly asleep for a period

of three or four weeks by the administration of chloral hydrate in 10-grain doses administered 6-hourly, the patient being meanwhile isolated from noise and disturbance, has produced permanent benefit in several cases in the hands of Bastian. Morphine always affords temporary relief, but its use is fraught with the danger of the patient acquiring the morphine habit. In one long-standing case recovery followed deep etherisation repeated on several occasions. Hyoscine may be of advantage in some severe cases, but it must be used with care. Psycho-therapeutic treatment is often very useful, and that physician who most completely gains the confidence of the patient is likely to be the most successful in improving the condition. Massage and sedative galvanism and passive and active movements with retraining in control, are all helpful measures. Suspension by the neck, so arranged as to be more impressive than punitive or dangerous, is helpful.

Surgical procedures meet with temporary, sometimes with permanent, success. Tenotomy of the affected muscles rarely gives lasting relief, and the same may be said of the division of the nerves supplying the affected muscles, for such nerves rejoin. The operation of Keen, in which there is extensive exsection of the posterior branches of the spinal nerves supplying the affected muscles and of the spinal accessory nerves, has given encouraging results. Kocher recommends exsection of the whole sterno-mastoid muscle, and Chiene advises extirpation of that cortical centre (No. 12 of Ferrier) which is associated with the movements of lateral rotation of the head. The great disappointment with all surgical procedures is the tendency of the spasm to spread to other regions after operation. In a severe case of torticollis, it can readily be demonstrated that in the severity of the spasms all the muscles on both sides of the whole trunk, and even those of the leg, are involved.

There is a *congenital form of torticollis* which is of a very different nature. The disease is pre-natal and analogous to congenital talipes, the sterno-mastoid alone is affected, and nearly always that of the right side. Such a muscle is frequently ruptured during birth, and this has given rise to the opinion that the birth injury and subsequent hæmatoma of the muscle was responsible for the torticollis. In many of these cases there is marked facial asymmetry, the face being smaller on the side of the affected sterno-mastoid. This association points strongly to some defect in the nerve centres of the medulla.

Treatment.—This consists in tenotomy of the contracted muscle.

THE TICS

Definition.—A group of maladies characterised by the occurrence of either—(1) sudden, rapid, twitch-like, involuntary co-ordinated movements, always of the same nature and in the same region; or of (2) sudden psychical phenomena, imperative ideas and explosive utterances; or (3) of a train of deliberate highly co-ordinated actions produced by an imperative idea. Any combination of these phenomena may occur.

The tics are both ætiologically and clinically related to spasmodic torticollis, into which some of the motor tics gradate. A torticollic movement

may occur as a tic, and it may in rare cases pass over into an established torticollis.

The tics may be conveniently divided for clinical purposes into the following groups, between which any combinations may occur:

1. The clinical picture is made up by the occurrence of sudden twitch-like co-ordinated movements, which resemble reflex or defence movements. The movement is always of the same nature and occurs in the same region, though several different tics may occur in the same patient. The usual region affected is the face, with the pharynx and larynx, the neck and upper extremity. This form occurs chiefly in children, and usually runs a favourable course—Simple Tic.

2. The spasms are more severe and complicated than in simple tic, and imperative ideas and explosive utterances are common and important symptoms. The condition is met with soon after puberty, and more commonly in males—Convulsive Tic.

3. There is no spasm or other motor manifestation, but the psychic tic is expressed by uncontrollable imperative ideas, explosive utterances, arithmomania, etc.—Psychical Tic.

4. Under conditions of mental stress and embarrassment, and in conditions of boredom, the patient performs some highly complicated and co-ordinated act which relieves his nervous tension and fascinates him—Co-ordinated Tic.

The tics are expressions of unrest and of physiological embarrassment in consciousness in a nervous system which is highly sensitive and not too stable. There is always the desire to relieve the embarrassment by the occurrence of the tic, and a feeling of relief when it has occurred, coupled often with disappointment at the failure of its suppression.

While the more simple forms of motor tic from their pattern suggest strongly that they are caused by some peripheral irritation from the conjunctiva in the case of a blinking tic, from the nose in a case of snuffling tic, and from the larynx in a case of laryngeal tic, and that constant irritation from these regions has set up a habit, yet it cannot be too strongly pointed out that no such peripheral irritation precedes the onset of tic, for the irritation and cause come from within the nervous system. Severe peripheral irritation does not cause tic, nor does the correction of errors of refraction, the removal of tonsils and adenoids and of teeth, or circumcision aid in the cure of the malady, though it is only too common to see cases in which these procedures have been inflicted upon the tiqueur one after the other, to the detriment of his tic and of his general health.

Simple Tic. Habit Spasm

This is a common disorder of late childhood, the majority of the cases occurring between the fifth and the tenth year. Either sex is prone to the disease. The onset may be preceded by deterioration of health from any cause, and sometimes fright and emotion bring on the tic. Often the malady arises in perfectly healthy children without assignable cause. The children are usually highly strung and intelligent. It is a rare event to see a dull and backward child with a tic.

Symptoms.—The recurring tic appears somewhat suddenly, and may

reach its height in a few days. The movements are of the nature of a simple act. They occur suddenly and without warning, and are executed rapidly. Usually the movement is of one kind only; but sometimes several movements coexist. The common site of the spasm is the head, face and neck. Blinking, winking, alternate elevation and depression of the eyebrows, side to side movements of the mouth, tossing the chin in the air, sudden movements of the tongue, palate or larynx, accompanied by an unpleasant fidgeting sound, are of frequent occurrence, while any movement of the head upon the shoulder, torticollic movements, shrugging of the shoulder, and any movements of the arm may be met with. Respiratory movements are often associated with those occurring in the tongue and larynx. Tic affecting the legs is much less common. The movements cease during sleep. Generally a variable time of some length separates the individual movements, but in severe cases these may follow one another almost unceasingly. They are increased by excitement and by observation, and can usually be controlled by the will, but only for a limited time.

Diagnosis.—The movement of tic is so peculiar that it cannot be confused with any other spontaneous, involuntary movement. It is the same movement, repeated with very rapid execution, in the same place. It is short and sharp, like a twitch. In chorea the movements are slow compared with those of tic, and are irregular in nature, in time and in place.

Prognosis.—Most cases of simple tic recover, whether they are treated or not. They recover much more quickly under treatment, and two or three months suffices in most cases to see the end of them. The longer a tic lasts, the more difficult it is to cure. In the rarest cases only does a tic of this nature persist or merge into one of the more severe forms.

Treatment.—A scrutiny of the general health should be made, and any defects attended to. Matters of hygiene, diet, education, exercise and pleasure should be correct and normal. Observation and remarks upon the child's defects, and anything tending to increase self-consciousness should be avoided. The confidence of the child should be gained if possible, and any source of mental worry, or grief, or annoyance should be ascertained and comforted. Restraint and discipline should be kindly taught, and an orderly life followed in which the child is happy, and in which his time is fully and congenially employed. In severe cases only is it necessary to interdict all physical and mental exertion and excitement, and enjoin rest in bed, and these measures should only be employed for a short time. Aspirin in 10-grain doses 3 times a day is a most valuable remedy, hardly to be dispensed with in any case. Tonics are often useful.

Convulsive Tic

In this malady, which was first described by Gilles de la Tourette, and which bears his name, the same movements as are met with in simple tic occur; but these are more severe and more widely spread, and they may involve the whole body in spasm at one time. In addition, there are psychic tics, which cause irresistible impulses, among which are explosive utterances, repetition of words, sounds and gestures, and also imperative ideas.

Ætiology.—The stigmata of physical and mental degeneracy are rarely absent, neuropathic and sometimes direct heredity is often present. The malady is said to be more common in males, and is met with more often in France than in England—where it is a rare disease. The symptoms appear usually between the ages of 10 and 15 years, and commonly follow physical or mental shocks or acute illness of any kind.

Symptoms.—The spasmodic movements resemble at first those of simple tic in their nature and rapidity, and favour the same sites; but they are not restricted to the repetition of the same movement, but successive movements may vary widely in position and extent and sometimes involve the whole musculature of the body. The great variety of facial grimaces, head jerking, grotesque attitudes and ridiculous pantomime which may occur in this affection lead commonly to the belief that the patient is shamming. The tic is not continual as in the simple form. It occurs in the form of bouts in which the same pantomime is reproduced. These are often excited by observation and emotion. They can often be controlled, but with much fatiguing effort on the part of the patient, who becomes so worn out with half successful efforts to control them that he ceases to make the attempt. Between the attacks the patient seems quite normal. The psychic phenomena are the same as in psychical tic, about to be described, and the treatment of the two conditions is identical.

Psychical Tic

In this condition there is no muscular spasm: but the sudden event takes the form of explosive utterances, imperative ideas and impulsive acts. This condition often occurs as a part of convulsive tic. The exclamatory tic consists of some sound or word or group of either, which is habitually uttered, with complete irrelevancy of time, place or sense. Sometimes the words are of an obscene nature and cause the greatest distress to the patient, who, often of innocent mind, is never safe from putting herself to shame. The utterances may be single, or may be repeated over and over in rapid succession. Echolalia, which is an uncontrollable impulse to repeat sounds heard, or to repeat words which the patient or others have just spoken, may be met with. The great characteristic of the condition is that though the patient desires above all other things to prevent their occurrence he cannot do so by any effort of will. Other symptoms that are commonly met with in this condition are imperative ideas and impulsive acts of all sorts, and in addition insanity of doubt, agoraphobia, acrophobia, mysophobia, etc., and arithmomania. In severe cases grave signs of mental deterioration slowly supervene, judgment and memory fail, will power and attention are lost, and the patient becomes incoherent and insane.

Diagnosis.—Both in the convulsive and psychical tics the diagnosis is placed beyond doubt, both by the nature of the movements and by the peculiarity of the psychic disturbance.

Prognosis.—Permanent recovery has occurred from both these conditions; but such an event is rare. Most of the cases follow a downward course despite treatment, and many end in suicide or insanity.

Treatment.—General tonic treatment, with change of circumstance and kindly moral and physical discipline, with healthy pursuits and congenial intellectual and physical occupation are the most likely to benefit. When

fixed and imperative ideas are present the patient must be guarded, as one of unsound mind.

Co-ordinated Tic

In this condition complicated co-ordinated movements are habitually repeated without apparent cause or purpose—especially in conditions of mental stress. It can be best illustrated by the account of an individual case under our care: A brilliant scholar at a public school was noticed to absent himself for no apparent reason, and when sought for, on the occasions on which he could be found, was always discovered in some secluded place rapidly revolving the two index fingers round the inside of a loop of string. He explained to me that this act had always given him relief from mental stress and anxiety, and that he was ashamed of it, and did his best to overcome it, and often succeeded, but that sometimes the desire for relief from stress overcame him. He was treated, and had no return of the tic for some years. He had become head boy of the school and captain of the football team, and on the occasion of the match of the year with another great school, with much anxiety and responsibility upon his shoulders, at the moment of the commencement of the match the captain was not to be found. He was recovered from the act of revolving his index fingers round the inside of a loop of string in a secluded place, in time to perform brilliantly and win for his side.

CRAFT PALSY

Synonyms.—Occupation Palsy; Occupation Cramp.

Definition.—A peculiar malady determined by the habitual use of one set of muscles for the constant repetition of an act of short range, to the exclusion of acts of wider range and acts involving a different set of muscles. The symptoms are—(1) local pain in the muscles concerned; (2) local spasm of the muscles; (3) loss of volitional control of the range and nature of the movements; and (4) weakness of the movements. These symptoms may occur separately or together.

Ætiology.—This disease may be occasioned by any occupation which requires the constant repetition of movements of small range, and which necessitates the holding of the limb rigidly for the fine co-ordination, to the exclusion of free and wide range movements. Consequently it is almost confined to those employments involving finely co-ordinated movements of the fingers, hand and upper limb. A cramped, restricted and laborious method of using the upper limb for fine acts is more likely to bring about the condition than is a free and graceful style, and faulty methods of teaching and of learning a skilled occupation with the hands are doubtless factors in some cases. Heredity and neuropathic conditions have no causal connection with the malady, nor have local abnormalities in the form of arthritis, neuritis, or organic nervous disease. The malady is certainly of central origin, and the combination of pain, spasm and loss of control and tremor points to the region of the basal ganglia as the site of the breakdown in function which produces the disability. We have seen two cases in which, as the result of a vascular lesion involving the subthalamic region, a condition almost exactly resembling writer's cramp occurred.

A personal idiosyncrasy is more important than long years of occupation, owing probably to some inherent weakness in the nervous mechanism concerned. For this reason young people are apt to break down with the malady during their training. Two of our patients developed severe writer's cramp when learning to write in infancy, and the condition persisted throughout life, though their attainments in other directions produced brilliant careers. In the telegraph service breakdown during training is not uncommon. The highly skilled trained hand, who has had years of service, and has reached the acme of facility and perfection in his manipulation, is unlikely to break down under normal circumstances; but he is liable to develop the malady under conditions of general ill-health, or if he undertake excessive hours of work above his usual limit, and especially if he cease his work for a long period and again resume it at high pressure. This last factor was very evident after the Great War, to which many skilled telegraphists went, to be used for every other duty except telegraphy. On demobilisation many of these men resumed their work, not having touched a telegraph instrument for years, and proceeded at once, and without difficulty, to work full hours upon the most exacting of instruments, with the result of a breakdown with telegraphist's cramp within a fortnight. It must be especially borne in mind that the incidence of the disease is not in any direct relation either to the nature of the work or to the length of working hours, but that the personal factor is of high importance. The following is a list of some of the occupations in order of frequency in which this malady occurs: Telegraphists, writers with the pen, seamstresses, violinists, machinists, gold-beaters, cigar and cigarette rollers, dairy milkers, pianists and typists. While in some mild cases, and for a time in other cases, the disability may occur only when one act is being performed, yet it is usual in more severe cases for many acts to be interfered with, and in a few cases all finer actions in the affected limb may be severely affected. For example, it is the rule to find that a patient who is suffering from telegraphist's cramp is also affected with writer's cramp, and with inability to shave with the right hand and, if a woman, she will be disabled with her needle, and in severe cases there may be difficulty in using a knife and fork, doing up buttons and so forth. The very general use of the typewriting machine, with its free and multitudinous movements required for its manipulation, has made writer's cramp a very rare disease compared with years ago; but it must be borne in mind that when the malady is once installed it is likely to follow the sufferer from one occupation to another. As an example, a telegraphist developed cramp in manipulating the Baudot instrument. He was rested and transferred to lighter duties involving the use of the Morse instrument, where he after a time failed. He was then transferred to counter duties, involving the use of the pen, and became incapacitated with writer's cramp. He was then used to close envelopes, and developed cramp over that act, and ended his service as a messenger. Several of the occupations above mentioned are scheduled in an Act of Parliament as dangerous trades, owing to the liability to cramp, and the employer is bound to compensate for such disability arising in his employ. Other occupations are not so scheduled; the gold-beater, for example, has to bear the brunt of his own incapacity.

Symptoms.—It is usual to divide the symptoms into two groups—(1) the subjective, consisting of pain, discomfort and the peculiar tired, heavy feeling

in the muscles; and (2) the objective, consisting of the visible spasm, the slowness, the ineptitude in timing, the trickery in dodging the disability, the tremors and the defects in pattern of the work produced. In some cases subjective symptoms alone exist, and others pass through a subjective stage before objective symptoms develop. The subjective cases suffer greatly, and are too often looked upon as malingerers, neurotics, or are labelled with the diagnosis of neuritis. The pain varies from a discomfort such as every one experiences in the deltoid muscle if a weight be held out at arm's length for a considerable time, and which compels one to drop the arm, to a severe, heavy, boring pain. Its seat is in the muscles, and never in the joints. It occurs most often in the forearm and hand, but may frequently begin in the upper arm or shoulder muscles. In slight cases, it ceases so soon as the act is discontinued; in more severe cases it may last for hours, or even days, after strenuous work. As the disease progresses it is apt to appear sooner and sooner after work is commenced. Even in the worst cases free exercise of the arm, such as swimming, tennis playing, etc., never brings on the pain, but on the contrary, relieves it. The pain never spreads beyond the limb affected.

The objective symptoms may often exist without the subjective throughout the whole course of the disease. The first thing noticed is that the fingers stick down when they are required to be lifted, for a fraction of a second, making the movement late and throwing the timing of movement into disorder. The muscles will not obey the will at the right moment. This stiffness is referred to as the "cramp"; but it is not a painful cramp. It increases and spreads from the muscles of the hands to the rest of the arm, and is apparent to the observer as an awkward and clumsy attitude. In writer's cramp, for example, the pressing of the wrist upon the table, the raising of the elbow which is carried away from the body, and the tight clutching of the pen are characteristic. To evade the spasm the sufferer employs another set of muscles, often very cleverly. The penman alters his grip of the pen even in grotesque ways. The telegraphist at the Morse key substitutes his left hand, or keys with the outer side of his hand. These workers have innumerable tricks for dodging the spasm. In going round the telegraph galleries at the General Post Office it is perfectly easy to pick out all the cramp subjects, from the appearance of the limb during the performance of the work. The spasm may reach such intensity as in a writer to perforate the paper and break the pen. The result of the disability upon the pattern of the work produced is the lack of decision in execution that characterises all fine work; the timing becomes slower, the regularity becomes broken, the excursions become less free and, therefore, the work becomes smaller, while suddenly occurring spasm and tremors are apt to produce conspicuous irregularities. Tremor of a very fine order is present in some of the cases, but is not constant. It is a very curious fact that slight lowering of excitability to faradism is present in most of the cases. The varieties of this malady need but short description, for the symptoms and signs are the same in all.

Writer's Cramp

The subjective signs are usually well marked. The objective signs appear first towards the end of the day's work, when writing tends to lose its precision

and regularity, and to become smaller, and the writer finds that he has to grip his pen more firmly, and to take more support from his desk to write steadily. The difficulty appears earlier in the day as time goes on and spasm increases, with a gradual deterioration in the quality and size of the writing, there being especial difficulty in keeping the writing in line. The writing becomes angular from sudden spasm, and catching of the pen-point in the paper causes much ink spluttering. In severe cases even taking the pen into the hand may bring on the spasm.

Telegraphist's Cramp

There are four instruments commonly used for sending. The Morse instrument is a hard contact key provided with a spring and knob, and the manipulation is performed by making the contact against the spring pressure with the knob held loosely in the palm of the hand. The movements involved are flexion and extension of the wrist only. The arm is supported from the shoulder only. This is a bad cramp-producing instrument, but it has the advantage that it can be manipulated with either hand. If telegraphists are taught to be ambidextrous from the first the incidence of cramp falls to a very low level.

The Baudot instrument consists of a piano board with five keys, which are manipulated by three fingers of one hand and two fingers of the other, and with the permutations and combinations of these five keys all the signals are made. The movements have to be synchronised to the beats of the commutator. The forearms and wrists rest upon the table. This is the worst cramp-producing instrument that ingenuity could devise, for the movement is of the fingers only, and it is utterly restricted both in space and in time. The Hughes instrument is a piano keyboard with many more keys, and its use is not often productive of cramp. The Gell instrument is a typewriter keyboard, and the movements are free. It is the best instrument in so far as it is not a producer of cramp. Two points of interest stand out, especially in connection with cramp in telegraphy. The one is that, notwithstanding the discomfort, spasm and obvious disability, the subject is rarely reported for faulty sending, so great is his aptitude for dodging his disability. The second point is that so many subjects will work for years, and often to the end of their service, with very obvious cramp, which never proceeds to incapacity.

Gold-beater's Cramp

This condition is here described not because it is common, for the workers at this trade are very few, but because it emphasises the lack of precision in movement, which is so important a feature in occupation palsies. The work consists of tapping with a heavy round-faced hammer upon a pile of tiny gold discs separated by layers of gold-beater's skin. By repeated tapping the gold discs are pressed out into as many gold leaves. The contact with the hammer must be made with a precision greater than one-hundredth of an inch. With the onset of the cramp this precision fails, and the leaves are cut at the edges of the disk and the work is spoiled.

Diagnosis.—The peculiar and characteristic nature of the symptoms of craft palsy leaves no reason for any confusion in diagnosis. The production

of the symptoms only during work of a very special nature, and their cessation the moment it is finished, the fatigue phenomena and the absence of all signs of organic disease make up a sufficiently definite picture. It cannot be too forcibly pointed out that local conditions in a limb, such as arthritis, neuritis, etc., have no causal connection with craft palsy. They may coexist, but they cannot confuse even then the correct diagnosis, for they do not produce symptoms like those of craft palsy.

Course and Prognosis.—In a young subject, who shows signs of the malady during training or soon thereafter, the outlook is hopeless with regard to continuance of the occupation, and the progress is from bad to worse. In older subjects the course varies greatly. Some cases recover completely and permanently, even though they continue with the occupation. In others—and this class is much larger than is usually supposed—the condition of cramp becomes stationary, and persists though not in disabling fashion. In a third and numerous group it progresses to incapacity, and tends to reappear with every change of occupation. In a few cases the patients become incapacitated for all the finer movements of both hands. The prognosis is usually serious; but a correct forecast can only be made from the history and progress of each individual case.

Treatment.—The responsibility and costliness which the Compensations Act entails upon employers are slowly enough but surely leading to the abandonment of those instruments, the manipulation of which may produce cramp. Good teaching of unconstrained methods of manipulation and encouragement of ambidexterity in all the occupations concerned are important prophylactic measures. Long hours and the speeding up of work should be avoided. After long absence from work, the work should be gradually resumed and not recommenced at full pressure. When the malady appears, rest and change of work afterwards are absolutely essential. Long-continued rest, be it remembered, cuts both ways for, as has been pointed out above, resumption after long rest is actually a cause of cramp, for long unemployment decreases the stability and the aptitude of the mechanism. General hygienic and tonic treatment are important. It is doubtful whether local treatment, in the way of massage, electricity, etc., can do any good, except to satisfy the patient. Sporting exercise of any and every kind is most useful. The Post Office authorities adopt the very admirable plan of retraining cramp subjects by daily practice with the instruments for a few minutes, the time of practice being gradually lengthened as capacity increases.

Craft Atrophies

Under this title are described a medley of conditions in which local atrophy of muscles, pain, numbness and sensory loss occur in connection with regions which are habitually over-exerted. It has been met with in platers, filers, file-makers, locksmiths, rowers, glassworkers, etc. The condition seems to be really one of local traumatic fibrositis, involving the nerves, and produced in some cases by the continued pressure of the tools.

Many of the cases recover with rest and treatment appropriate for a local interstitial neuritis.

James Collier.
W. J. Adie.

HYSTERIA

Definition.—The term "hysteria," first introduced by Aretæus, who linked hysterical manifestations with disorders of uterine function, is used for a series of mental and bodily disorders which have peculiar and striking characteristics, and it must never be used as a mere limbo in which to place ill-understood maladies, or those that evade diagnosis, and which do not present its characteristic features. This is the more important since hysteria may occur in the presence of organic disease, and superficially it may simulate organic disease closely.

It has its origin invariably in psychical upset of a negative emotional tone, either determined externally, as by terror, grief and injury, or having some cause from within, in mental unrest, conflicting emotions, inability to cope with the environment, and failure to deal with the problems of life in general. The individual with nervous instability, hereditary or personal, certainly forms easy ground for the development of hysteria, but it seems unlikely from the experience of the Great War that any of us are immune to the causes of hysteria, provided they are applied forcibly enough and for a long enough period.

There is always a complete absence of any of the signs of such organic disease as could produce the symptoms. The nature of the latter is often highly peculiar and sometimes pathognomonic, and often "contradictory signs" are present. Hysterical attacks are characterised by never occurring during sleep, or unless an audience is present or within call, by an immediate emotional cause, by the fact that the patient works himself up into the attack, by the highly spectacular display, with expression of emotion, and absence of tongue-biting and incontinence, and by the effect of complete indifference on the part of the audience in causing the attack to cease. In hysterical paralysis, when this is incomplete, the attempt to perform an act to order is associated with the contraction of the antagonists before that of the prime movers, as if to prevent the act being performed, and the resulting movement has a peculiar broken and tremulous quality. The strenuous efforts to perform the act commanded produce visible effort and contortion of any or every part of the body, to the exclusion of the muscles concerned with the act required. The patient does his worst under favourable circumstances to obey the word of command, often with much emotional and noisy respiratory disturbance. In organic paralysis, on the other hand, it is usual for the patient to do his best under difficult circumstances, and the picture is in high contrast to that seen in hysteria. When functional contracture is present, there is the distinguishing feature that any attempt to straighten out the contracture passively is productive of such intense emotional disturbance as is hardly seen in painful organic conditions.

The mental condition of hysteria is that of functional lowering, dullness and lack of attention to the environment, and in severe cases this may amount almost to amentia. Lastly, hysteria is characterised by the possibility in every case of miraculous cure—even instantaneous—sometimes by accident, sometimes by events which raise the emotional tone, usually by some kindly, dominant and insistive personality who impresses the patient that he can cure him, demonstrates that the paralysed organ can be used naturally, and that the senseless limb can feel, and convinces him of these facts.

Pathology.—Neuropathic heredity is frequently found. It is said to be more prevalent among the Latin races and Hebrews than among the Saxon races. The condition is more common in women, but during the Great War it was infinitely more common in men, from the long-continued exposure to terror, stress and injury. As caused by accident, it is always more frequent in men. The incidence is in young adult life, from the age of puberty until the end of the fourth decade; but it occurs sometimes in childhood and also in the later years of life.

Predisposing causes often exist in the way of inadequate education and training in the development of a well-ordered, well-disciplined and well-employed mode of living. Feeble health, privation, long hours, overwork and debilitating influences, and the absence of the natural feelings of well-being which these entail, are often factors. By far the most important exciting causes are mental emotion, shocks, and physical injuries, while long-continued anxiety and tension, disappointments, money losses, frights and bereavements, and railway and carriage accidents are frequently the immediate precursors. The conditions of modern warfare, with constant aerial and high explosive bombardments and burials, are potent factors. Even the Workmen's Compensation Act, if not in causal relation, seems to be a factor in the maintenance of the condition when once developed. The emotional instability which occurs in some women at the time of the menopause is a factor in the production of some of the cases occurring at that age.

Charcot considered that hysteria was an abnormal condition of mentality, in which morbid states, such as paralysis, anæsthesia and fits, are ideationally induced, and he laid stress on the "fixed idea" in the genesis of the symptoms. He first demonstrated the possibility of producing hysterical phenomena by suggestion and also causing them to disappear by suggestion. He laid it down that some of the symptoms which he called the "fixed stigmata" usually develop without the patient's knowledge, such as the varieties of sensory loss, both special and general. Other symptoms which he called "transitory stigmata" developed under the influence of the patient's knowledge and emotion, and in this group he included fits, palsies, contractures and aphonia. The importance of the fixed idea in hysteria is great, and to remove such fixed idea is to cure the patient. The separation of the symptoms into the groups of fixed and transient stigmata is much too arbitrary, for symptoms of the second group will often be found to appear without the patient's knowledge.

Janet considers that hysteria is a functional disturbance of the cerebral cortex, which amounts to a severance or dissociation of some mental processes from the main personal consciousness, and this dissociation is the basis of both the temporary and the persistent signs of the malady. In the hysterical fit, the patient passes through a phase of movements and actions of which there is little or no subsequent remembrance; and in hysterical paralysis there is suppression which amounts to loss of consciousness of the existence of the paralysed limb or organ.

Babinski holds that the phenomena of hysteria are due to self-suggestion in an unstable mentality, and he would limit the phenomena, which he collectively calls "pithiatism," to those which can be produced by suggestion and removed by persuasion. When so-called hysterical phenomena cannot be so removed and reproduced, they are either matters of stimulation and

deceit, or they are real phenomena, brought about for purposes of deception, such as erythemata, ecchymoses, ulcerations, blisters, œdema, etc.

Freud, whose recent work upon this subject has attracted great attention, bases his theories upon the doctrine of psychogenesis; no mental event is undetermined and due to chance. He accepts Janet's ideas of dissociation and psychical automatism, and holds to Binswanger's insistence upon the ætiological importance of affect. He considers that mental phenomena are capable of a psychological explanation without reference to physiological processes occurring in the brain, and that it is possible to explain mental processes by scientific laws involving psychological terms only. He assumes the existence of psychical process of which the subject himself is entirely unaware. This is the conception of the "unconscious mind." The origin of hysterical symptoms is to be sought in ideational complexes, with marked feeling tone, which come about as the result of psychical and physical trauma. A "complex" is a system of ideas having a definite emotional tone and conative trend—that is, it generates thoughts and actions leading in some definite direction. The traumatic complexes in the hysterical subject are immiscible with the personality. He refuses to accept them, and instead of abreacting—and thus normally getting rid of them—he either "converts" them, whereby the emotional (affect) excitement brings about abnormal innervation, which is exteriorised as the various hysterical manifestations; or he "transposes" the effect through indifferent ideas with the result that "anxiety neurosis" arises. The affect thus remains shut in or hidden in the unconscious. His principle of "overdetermination" is the same as Cajal's physiological concept of "avalanche" action, and expresses the heaping action of an affect sufficient to determine the appearance of a symptom.

The term "conflict" is used for the immiscibility above mentioned and also for the condition in which two complexes, tending to produce effects which are out of harmony, or even in direct opposition to one another, are simultaneously present in the mind. The conflicts will mutually inhibit one another, and the mind is divided against itself. The conflict may be avoided by volitionally banishing one of the opposing from the mind, and forgetting its very occurrence. If this process is successful, a condition of "repression" is attained. The affect of the repressed conflict is shut in to the unconscious mind, and there remains active to pervert the physical action of the higher nervous system. To cure the patient, this buried complex has to be raised again into memory, and its affect again raised into memory by the process of "psycho-analysis."

It is a general opinion that Freud's attention has been too much and rather one-sidedly centred upon psychic trauma of a genital nature, but it is fair to remember that he uses the term "sexual" in reference to the instinct of race propagation, and not necessarily to matters of sensuality.

As White has clearly put it, the characteristic of the psychic traumata which produce hysteria is their large content of painful affect. A painful affect fully reacted to at the time may do no harm, but if for any reason reaction fails, the feelings become repressed and the possibilities of dissociation are created. Failure of reaction may be due to conditions which make reaction impossible: as an instance, an insult is "swallowed," a dear friend is lost; and no compensation is possible, this giving rise to "retention hysteria."

Again ideas, usually of a sexual nature, which are incompatible with the personal consciousness, are repressed. This produces the " defence " hysteria. Freud's general hypothesis is extremely able and intricate, and little justice can be done to it in the space here at disposal.

Symptoms.—*Mental State.*—In a majority of hysterical patients there is considerable mental abnormality, and this sometimes presents marked characteristics, which differ in their detail according to the ever-varying peculiarities of individual character. The mental state is always reduced, with a relative exclusion of the environment and perhaps an elevation of the consciousness of self. This reduction in severe cases may amount to mental dulling verging upon amentia. There is defective will-power, imperfect self-control, and inability to resist the impulses of inclination. Self-consciousness dominates more or less completely the thoughts and actions, and finds its expression in glance, manner and tone. Upon the emotional side, there is a tendency to depression, which is often very dominating and prolonged in male hysterics. At the same time there is lability of emotional life. The mood is constantly changing. They are readily hurt, have little emotional control, and are easily dominated by ideas, fears, desires, and by sense of injury. There is often obvious exaggeration in the description of the sufferings, and the sympathy that is excited is a source of gratification to the patient, and there is almost always marked suggestibility. It is doubtful, however, whether the feeling of emotion is increased in the consciousness of the patient. Probably it is greatly reduced, although the expressions of emotion may be excessive. The psycho-galvanic test reveals a very interesting difference in this connection between the normal person and the hysterical patient. If electrodes are applied to the surface of the body and joined up with a galvanometer and resistance circuit properly balanced, and some emotion-exciting stimulus, such as the unexpected firing of a pistol, or a painful stimulus, physical or mental, is presented to a normal individual, there is at once a lowering of the resistance to the passage of the galvanic current through the body, which is shown by a deflection of the galvanometer. This is known as the psycho-galvanic response. In the hysterical subject this response often fails or is much reduced. A severe hysterical attack has occurred in a patient as this test was being made, yet notwithstanding the violence of the apparent emotion, the physical reaction above described, which occurs in all normal people upon emotion, absolutely failed to appear.

Disorders of Vision.—Unilateral blindness is not infrequent, but bilateral blindness is rare, and hemianopia is very rare indeed, but it does occur, and I have seen it produced by suggestion. The peculiarities of this loss of sight are that the pupils are normal in size and reactions, the optic discs are normal, and a feint made towards the blind eye or blind field often produces a quite normal wince of the orbicularis, especially if the patient is unaware that the feint is going to be made. Sometimes the loss of sight is not complete, and the complaint is of mistiness of vision or that objects can be seen but not recognised. Limitation of the field of vision is very common. It never takes the form of a scotoma or sectorial defect, and, therefore, such losses are always signs of organic disease. There is usually concentric contraction of the fields in both eyes, more marked in the eye of the anæsthetic side when hemianæsthesia is present. This condition is known as " crossed amblyopia."

The associated contraction of the colour fields takes the reversed order to that observed in optic atrophy. When the crossed amblyopia is severe, the fields may be restricted almost to points, and the colour vision is always lost first in the most affected eye. In testing the visual field, it often becomes smaller and smaller during the test, so that the perimeter tracing shows an ever-diminishing helicoid. Sometimes the opposite condition of an expanding helicoid is found—in other words, the observer gradually removes the defect by suggestion during his examination of the fields. Spasm of accommodation is common, and is usually accompanied by converging spasm of the globes, which may be intense. Severe converging spasm is rarely of any but hysterical origin. Sometimes the spasm is divergent, and there may be dissociated movements of the eyes. The squints have the contradictory features of being inconstant, increased by examination, and unassociated with diplopia. Micropsia and macropsia may occur. Ptosis is often seen and is usually bilateral. Blepharospasm is common.

Disorders of Hearing.—Deafness may be unilateral or bilateral, and when the latter it is usually associated with mutism. Hysterical deafness disappears during sleep, and a sound that is only sufficiently loud to waken a normal person will awaken those hysterically deaf; but when once awake they cannot be made to hear.

Disorders of articulation are very common in hysteria which has its origin in sudden fright. Mutism is the condition in which there is total inability to speak, though the organs concerned are used naturally for other purposes, as in mastication, clearing the throat, and coughing. Aphonia is the inability to produce the laryngeal element in the voice, and the patient always speaks in a whisper. Laryngoscopic examination shows that the normal movements of the cords do occur during the whisper, but the cords are not sufficiently approximated to produce a sound. Stammering is very common indeed in the traumatic cases. Recurring laryngeal, pharyngeal and buccal noises are troublesome features in some cases. The commonest variety is "hysterical cough." The sound of birds or of animals may be imitated.

Disorders of Sensibility.—Sensory loss often accompanies hysterical paralysis, but it may exist alone and is occasionally entirely wanting. It is one of the most constant signs of hysteria, and it has the peculiarity that it is often unknown to the patient, whereas in organic disease the patient is usually aware that he cannot feel in the affected region. The common loss is to all forms of sensibility, but there may be loss to painful and thermal stimuli with retention of touch. The loss may be complete or partial, but even when apparently complete the patient can always be made to feel a strong faradic current applied for long enough. It may have any sort of distribution, which may vary from day to day, or it may be universal. The distribution is commonly hemiplegic and limited exactly by the middle line, or paraplegic, and when existing upon the limbs alone is often of stocking and glove pattern. Its limits are never exactly those of nerve trunk, nerve root, or of spinal segment sensory loss. The sensory loss is often of the greatest value in the diagnosis of hysteria, for it never has the correct distribution for organic disease. The "stocking" and "glove" loss may superficially resemble that of polyneuritis and subacute combined degeneration, but it has abrupt limitations proximally and is not deepest in the extreme periphery, fading off towards the trunk, as in these maladies. Janet's

test in determining the functional nature of sensory loss is often of value. If the patient is told to say " Yes " when touched and " No " when not touched, it will frequently happen that the answer " No " is given as often from the anæsthetic region as is " Yes " from the æsthetic region. It is difficult to bring this test off a second time upon a patient, for, thinking over it, he realises the discrepancy. Hysterical sensory loss sometimes involves the mucous membranes, and loss of smell and taste are common in conjunction with hemianæsthesia.

HYSTERICAL PARALYSIS.—Almost any part of the voluntary musculature of the body may be affected, and the disability may be slight or severe, but there is not often complete paralysis of the whole of a limb. In the slighter forms there may be weakness and tremulous movement. In the more severe forms the paralysis may be flaccid or spastic. The flaccid variety is the less common, and is usually of rapid onset and is almost invariably associated with complete loss of sensibility over the affected region. There is a limp, flaccid condition of the affected muscles, which are not wasted, and the electrical reactions are normal. The limb may be passively moved in all directions without discomfort to the patient, and hypotonia is not present and, indeed, as judged by the unvarying briskness of the tendon reflexes, the muscular tone seems to be increased. The paralysis is entirely one of volitional movement. As examples: when the shoulder is completely paralysed, yet the latissimus dorsi contracts well on coughing. Or, when the leg is paralysed, if the patient be commanded to sit up in bed from the supine position, with the hands folded across the chest, the paralysed leg remains stationary upon the bed, while the normal limb rises in the counterpoise action of the associated movement—that is to say, the paralysed limb is kept upon the bed by active contraction of its muscles; this phenomenon contrasts strongly with what is seen in organic hemiplegia, where, in the attempt to sit up, the paralysed limb rises much more than the normal limb.

More commonly hysterical paralysis is associated with stiffness of the muscles. Here the muscles are not wasted, and they may be hypertonic, as shown by the briskness of the tendon jerks and by the presence of foot clonus. The voluntary paralysis is less complete than in the flaccid type, some movement being usually possible, and this movement invariably shows the contraction of the antagonists before the prime movers in the movement commanded. If the patient is commanded to flex the elbow strongly while the triceps and biceps are palpated by the hand, the observer will feel first a strong contraction of the triceps—as if to prevent the movement commanded, followed by a feeble contraction of the biceps. From the prior action of the antagonists and their subsequent struggle with the prime movers, the movement in the paretic region shows a peculiar broken quality, which hardly occurs in any other condition and which may be considered pathognomonic of hysterical paralysis.

It is a usual feature of hysterical paralysis that when the patient is commanded to perform an act, he shows great outward signs of effort in the way of struggling and contortions—in any or every part of the body, except in the region commanded; with rapid breathing, sweating and every outward sign of emotion and subsequent exhaustion. It is also characteristic that the hysterical patient does his worst when commanded to use the affected regions, with much spectacular show, whereas the patient with organic paralysis

obviously does his best without any such fuss. The affected region is held stiffly from active muscular contraction, but there is no true spasticity, as is shown by the fact that if an affected hand be passively flexed at the wrist, there is no relaxation of the flexor tendons, such as always occurs in organic spasticity. When rigidity is marked, the limbs may show fixed attitudes, which are termed "contractures," and these may simulate organic spastic contractures; pes cavus, however, which is one of the commonest of organic contractures, is never simulated in hysterical contracture. The contractures are often characteristic of hysteria. In the upper extremity, the usual contracture is flexion of the elbow, wrist and fingers, with adduction of the arm to the side; but the fingers are sometimes extended and adducted, with the thumb across the palm, as in the "interosseal" position. In the lower extremity, the position is usually one of extension at the knee, with the foot dropped and inturned to an extreme degree. Flexor contracture at hip and knee are, however, sometimes met with. It is highly characteristic of nearly all hysterical contractures, and highly distinctive from organic contractures, that passive movement to overcome the contracture is productive of great emotional disturbance, which even the patient himself does not ascribe to any pain produced by the manipulation.

In distribution the paralysis may be monoplegic, hemiplegic, or paraplegic, or it may affect eyes, face, tongue, or trunk alone. Affection of the face is very uncommon. When the leg is affected on one or both sides, the gait is entirely unlike any gait seen in organic disease. Sometimes the feet are shuffled along the ground, no attempt being made to raise them or to swing them round in the fashion common in organic spastic paralysis. Sometimes the gait is obviously "constructed," and at once suggests the diagnosis of hysteria.

In severe cases, the feet are dragged more or less helplessly, with the dorsum resting upon the ground, and the soles looking upwards and backwards. It is unusual for the patient to fall when walking, unless he sees means of saving his fall, or has something comfortable to fall on. Hysterical spasm of the tongue may be seen, alone or as a part of a hemiplegia. The tongue is turned over to one side, often to the wrong side, and its appearance is unlike that produced by organic disease. Hysterical paralysis of the trunk muscles often results in most remarkable curvatures and deformities of the spinal column and trunk, which may simulate spinal caries and scoliosis and the paraplegia which either of these conditions may entail. This is one of the two common forms of "hysterical spine," the other being a painful condition, with local tenderness.

In every form of hysterical paralysis there is a complete absence of all those signs which we hold to be proofs of the presence of organic disease, such as wasting and change in the electrical reactions of the muscles, loss of the skin reflexes of the trunk, the extensor plantar response, loss of sphincter control, loss of knee-jerks, etc. Brisk tendon jerks and foot clonus are not signs proving organic disease, for these often obtain in the normal subject, and they are commonly found in hysteria. The plantar reflexes are often absent in hysteria, both when sensibility is normal and when it is lost.

Among the innumerable symptoms which may be present in hysteria should be mentioned the sensation of a lump in the throat—the "globus hystericus." Difficulty of swallowing may occur, presumably due to spasm

of the œsophagus. The food, though swallowed, may be again rejected before it has passed the œsophagus. Vomiting often occurs, and is sometimes severe, and may end fatally, with emaciation and acidosis. When dull and depressed, the hysteric is often antagonistic to food, and nasal feeding may be required. Air swallowing may lead to alarming abdominal distension, with severe general symptoms, and it is no uncommon experience to meet with a hysterical patient who has had more than one laparotomy performed for the relief of urgent symptoms so produced.

Alteration of thyroid function, in the form of relative hyperthyroidism, with fine tremor, tachycardia, sweating and even some degree of retraction of the lids, was very common in the military cases. Subnormal blood pressure is almost invariably present. Vasomotor and trophic changes may be met with in the paralysed regions, especially when the condition is of long standing. Relative cyanosis and œdema may occur, sometimes in patches, and these signs were referred to by Charcot as the "blue œdema" of hysteria. Changes in the joints, such as fixity and fibrosis and thinning of the skin, with "satin" change and wasting of the subcutaneous tissues, is sometimes seen in the fingers, where the nails may also be "reeded." All such changes are more common when there is much rigidity, and are explicable, at least in part, by the impediment to the blood and lymph circulation which unvarying rigidity of the muscles and immobility of the limb entail.

Tremor.—This is a very common symptom, and it often accompanies the paralysis and contracture. In its slight forms, it is seen as the broken movement which occurs when the affected limb is moved upon command. It is not often constant, but is usually evoked by movement and excitement. It is usually a fine quick tremor, varying in degree and in time, always increased and sometimes distinctly induced by attention, and when the mind is diverted the tremor may cease. Occasionally it may simulate the tremor of paralysis agitans or that of disseminate sclerosis so closely as to deceive at first sight. Hysterical tremor, widening in range into what deserves the name of clonic spasm, may come in paroxysms under the influence of emotion, and may easily pass over into an hysterical fit.

Hysterical Fits.—Just as emotion is naturally expressed by muscular actions, as in the dancing for joy of a happy child, the stamping with rage, and the wringing of the hands in distress, so the violent emotional discharges in hysteria may take the form of paroxysms of movement, always spectacular and impressive, but never occurring without the presence of an audience, and never occurring in a condition of sleep. Such attacks often have an exciting cause from within or from without, and, commencing perhaps mildly, work up into violence, which may be extreme. Rigid fixation of the trunk and limbs, often with such a degree of opisthotonus that the body is supported upon occiput and heels alone, alternates with wild movements, in which the limbs are thrown about with great force and rapidity; the arms strike out, the legs kick, and the head is dashed from side to side. The hair and clothes may be torn, the lips and limbs bitten, and any forcible attempt to restrain the patient increases the fury of the attack, whereas complete neglect, as by the departure of the audience, often causes the attack to cease abruptly. These phenomena may alternate with quiet intervals, often attended with hallucinations and delirium. Consciousness may be lost, and is often much perverted, and usually the patient retains no recollection of the

fit. The face may be deeply reddened by holding the breath, but there is not the pallor nor the cyanosis of the epileptic attack. There is never conjugate deviation of the eyes, but there is often severe converging spasm. The corneal reflex is retained. The pupils may be dilated, or, when there is converging spasm, contracted; but they always react to light. The eyes are passively opened with difficulty, for the patient resists. The tongue is rarely bitten, though the lips and cheeks may be. The pulse is quickened, but there is never that imperceptibility of pulse at the onset of the attack which characterises epilepsy. The movements are always purposive, and do not show any definite sequence of tonic and clonic spasm. The tendon jerks and plantar reflexes are unaltered. There is never incontinence of sphincters. There is usually marked diminution of sensibility and a disordered gait after the attack. The attack may cease abruptly, and there is not the apathy, headache and sleepiness thereafter which are so frequent in the epileptic attack. The hysterical attack can often be cut short by supra-orbital pressure, or by faradism, or by the application of cold water. These points will serve to distinguish the hysterical attack from the pure epileptic attack; but it must be carefully borne in mind that the post-epileptic hysterical attack differs in no way but in the associated circumstances from the purely hysterical attack.

Diagnosis.—The general features of hysteria are so definite as to cause little difficulty in diagnosis to the medical man who is conversant with them, and who appreciates the necessity of considering every case to be one of possible organic disease until he has convincing proof that it is one of hysteria. A most scrutinous search should be made throughout the organs of the body for signs of organic disease. For in some organic diseases of the nervous system the early signs may be reasonably suggestive of hysteria; they may come on suddenly as the result of emotion or shock, and may disappear rapidly, and, when at their height, may show little in the way of definite organic quality. Especially may this occur in disseminate sclerosis, and also in subacute combined degeneration, cerebral tumour, and many other organic conditions. A further difficulty is introduced by the fact that the presence of organic disease may determine true hysterical manifestations, and thus hysteria may be coupled on to organic disease. When no organic signs are present, due weight must be given to any history of previous signs of hysteria, to any causal factor which may have a powerful emotional effect, and to the age and personality of the patient. Often the nature of the paralysis and disability, and the presence of other associated signs of hysteria, are so evident as to leave no possible doubt; such as the distribution of the paralysis and of the anæsthesia, which no possible organic lesion could cause, the non-correspondence of paralysis with sensory loss, the prior contraction of the antagonist muscles and the broken movement, the contradictory phenomenon, the peculiarity of the contractures, and the often fantastic "constructed" gait, the unilateral blindness, the crossed amblyopia, aphonia, and the vomiting. The chief difficulty in diagnosis is the distinction of the early signs of organic disease from those of hysteria, especially the early manifestations of disseminate sclerosis, and this difficulty can only be overcome by the discovery of some definite organic sign of the disease, either in the previous history of the patient, such as transient diplopia, amblyopia, or dysuria, or the occurrence of similar attacks of paralysis in other parts of the body; or

the presence of some slight though suggestive sign at the time of examination, such as nystagmus, slight intention tremor, inequality or loss of the abdominal skin reflexes and the extensor response in the plantar reflexes.

The diagnosis of hysterical fits from epileptic, vaso-vagal and syncopal attacks depends upon a consideration of the circumstances of the occurrence of the fit and upon the manner of the fit. These have already been considered and are also referred to in the description of epilepsy. Certain valuable points in distinguishing hysterical hemiplegia from that of organic origin are here placed in the form of a table:

	Hysterical.	Organic.
Vision . . .	Unilateral blindness, or restriction of field, or crossed amblyopia.	Hemianopia or blindness of opposite eye or central scotoma.
Sensory loss . .	Hemianæsthesia, or stocking and glove loss, often deep.	Hemianæsthesia only, usually slight.
Face	Never paralysed; sometimes shows spasm	Often paralysed.
Paralysis . . .	Rarely complete.	Often complete.
Gait	The toes are dropped and the foot is dragged behind, or the gait is constructed and fantastic.	The foot is swung forward in a half circle.
Contracture . .	Knee usually extended. Foot dropped and inturned.	Knee often flexed. Foot: pes cavus.
Abdominal reflex on paralysed side	Brisk.	Diminished or lost
Plantar reflex . .	Absent or flexor.	Extensor.
Thigh phenomenon on sitting up	Absent.	Present.

Course and Prognosis.—The manifestations of hysteria, however severe, are practically without danger to life, for it is only a few cases that succumb to vomiting and its results. The disease is eminently curable and often permanently so, the difficulty being, when a cure is not permanent, that the ordering of the patient's life as regards the necessary education, occupation, satisfaction and achievements is not in the hands of the physician. The course of the disease is very varied and is often marked by partial recovery, followed by relapses. The symptoms may disappear suddenly, sometimes as the result of impressive therapeutic measures, sometimes without any definite cause. Such rapid recovery is more common in cases where the symptoms have been of short duration, but it is not to be dismissed as impossible, even in cases of very long standing. More often gradual improvement occurs, and the symptoms take weeks or months to disappear. The prognosis is worse, as regards rapid recovery and the occurrence of relapses, when the general signs of the disease are well marked, when the general conditions of health and nutrition are poor, when there is much mental dullness which prevents the patient from being dominated by his physician, and while litigation is in progress over compensation claims. It is also worse the longer the symptoms have been present. Yet I have witnessed complete and lasting recovery to occur rapidly after almost complete paraplegia had caused a patient to be bedridden for seventeen years. Practi-

cally all the cases ultimately recover so far as paralysis is concerned. The prognosis is rapidly favourable in proportion as definite causes can be traced and removed, and as adequate measures for treatment can be applied in good time.

Treatment.—1. *General.*—Where bodily nourishment is poor, and there is feebleness and exhaustion from overwork, stress or any other cause, those measures calculated to better the condition and to increase weight should be employed. Rest in bed, with a liberal mixed diet, is essential. Tonics, especially the combination of strychnine and bromides, are most useful, and due attention should be paid to securing adequate sleep. Removal from the usual surroundings and treatment in a hospital or institution, where isolation from business matters, friends and relatives can be secured, is highly advantageous. I never isolate my hysterical patients, but prefer to treat them in a general ward, where the scene enlivens and prevents boredom, and where the atmosphere of every patient getting better immediately brightens the prospect for the patient and enhances the curative power of the measures employed.

2. *Rapid cure by suggestion.*—The essential method of this treatment is for the suggestor to secure the profound liking and confidence of his patient, and so dominate his personality that he dare not disobey. The patient is brought into that frame of mind in which he both desires and expects to be cured. Those who have recently passed through great strain and those who are mentally dull are best kept at rest for some considerable time. For them to be kept waiting to be cured often brings about a useful increase in the desire and expectancy for the result. In this preparation for rapid cure, nurses skilled in this method often play so important a part as to make the final cure by the physician a matter of complete simplicity. When the decision has been made that the time for treatment is ripe, the suggestor demonstrates to the patient that he can feel and move the affected region, and that he can do so normally and continuously, and that his malady has disappeared. This task should be undertaken with determination on the part of the suggestor and agreement on the part of the patient, that however long the sitting, a completely successful issue must be brought about before it is ended. In one particularly difficult case which was under my care, which was of long standing, the most able curer of hysteria that I have met commenced his sitting at six o'clock one evening and carried it on continuously through the night, giving the patient no rest whatever until well on into the following day, when a complete and permanent disappearance of all the symptoms occurred. This treatment necessitates infinite resolve, energy and patience, and boundless resource and confidence on the part of its applicator, who must dominate, insist, cajole and bully the patient into complete discipline to his commands and instructions, without ever losing his temper, without ever losing the esteem of his patient, and without ever failing. The precise method of suggestion is immaterial so long as it is strong enough, and the line of treatment must be varied according to the mental attitude of the patient. All of us have to use those methods which suit our personalities and which we individually find successful. We should fail with those methods which others find successful. Some of us cannot storm with dignity, nor bully and cajole with patience and assurance. Others find it impossible to cure hysterical patients by any rapid method.

Faradism with a strong current is a useful adjunct in suggesting the return

of sensibility and in initiating movement. The suggestor gets rid of the sensory loss first, before proceeding to attack the paralysis. Such aids as electricity may not be necessary to a physician who is endowed with more than the ordinary personal force and powers of persuasion. As simple examples of this method of treatment, an electrode, placed upon the posterior wall of the pharynx in a case of mutism and set alive, will cause the patient to shout "ah." The electrode is withdrawn and he is commanded to say "ah." Having thus demonstrated to him that he can make a sound with the larynx, he is persuaded and re-educated to talk. Similarly, when there is paralysis in the foot, faradism is applied to the popliteal nerves, and the patient is commanded to watch the movement. He is then persuaded to make the same movements voluntarily. This rapid method of treatment has, under my observation, proved unvaryingly successful in the hands of every adept administrator, and it seems only to fail in those few cases in which there is mental dulling, and inability of attention and interest, and should, therefore, not be applied so long as a patient is in this condition. The remarkable change which takes place in the mentality, feeling of well-being, appearance and manners of the hysterical patient as the immediate result of this rapid method of cure is striking.

3. *The psycho-analytical method.*—This is the logical outcome of Freud's theory of the genesis of hysteria. Its aim is to determine the repressed complexes, the effect of which in the unconscious mind is interfering with the physical working of the brain. They are raised into conscious memory by the analysis and so freed from exerting their baneful influence, are freely discussed between the patient and his physician, and are interpreted by the latter. The result is a purging of the mind and a disappearance of the paralysis. I am sure that the success attending the use of this method depends largely upon the personality of its applicator.

NEURASTHENIA

Definition.—A condition of pathological weakness without discoverable lesion, manifest by too rapid and too great fatigue, physical or mental or both together, and by a loss of bodily and mental comfort which the normal person possesses, by emotional unbalance, and by undue irritability and too great a response to some stimuli in the nervous system. Bodily sensations are often abnormal, and tend to loom into consciousness unduly and to absorb the attention immoderately. There is disability or inability, rather than perversion, of function.

There must be few people who have not experienced such a train of symptoms as the above, whether during recovery from acute illness, or as the result of overwork, grief, or disappointment, or following upon physical and mental shocks. But usually the defective physical processes which allow of the development of these symptoms soon return to the normal, and the symptoms are transient and soon forgotten. If, however, the physical processes be congenitally defective or weak, or if they are so affected as not easily to return to the normal, or if the factors are continuing, then this train of symptoms may be lifelong, or may be recurrent, or it may require special measures of assistance for its eradication.

Ætiology.—Neurasthenia may be prenatally installed, and it may run in families. The congenital cases, which have been termed "primary neurasthenia," usually show symptoms throughout childhood, which become aggravated as life goes on. No age is exempt, but the malady is very rare in childhood. It appears more commonly after puberty, but has its greatest incidence in the third and fourth decades of life, when the stress, responsibilities and disappointments of life come to their full, and continues common so long as these are borne, diminishing almost to a vanishing point in old age. It is rather more common in men than in women. Neurasthenia may arise without any discoverable causal factor in cases which are certainly not congenital. The common factors are: (1) Any conditions of physical ill-health whatsoever which may lower the vitality of the nutritional processes. (2) Any conditions of education and upbringing which tend to render the subject unfit to cope with his environment in life. (3) Absence of occupation, scope, satisfaction and outlet in life. (4) Physical overwork. (5) Emotional stress of every kind is a much more important cause than overwork, according to the old saying that "it is not the work but the worry which kills," and consequently those occupations which involve work at high pressure cause more of the workers to break down with neurasthenia. (6) Sudden physical shocks and frights are potent causes, especially such as may occur in times of war, from bombardment, high explosives and aerial attacks. (7) Continued conditions of fear, such as may occur after syphilitic infection or after breaches of the law.

Nature of Neurasthenia.—The causation of the malady being concerned either with a congenital defect or with emotional disturbances with their provedly potent effect upon endocrine function and metabolism or with exhaustion conditions, it is reasonable to regard the essential defect as a metabolic error in which, from perversion or failure of chemical processes, the normal activation of the physical organs is defective or perverted. This perversion may be lifelong, as in the congenital cases, or may be very rapidly transient, as in the debility which may follow acute illness, or after reaching an extreme degree may return to the normal permanently. As regards the nature of the change or what organs are at fault we are entirely ignorant. It has been shown experimentally that animals exposed to repeated frights, as from bombardment, develop neurasthenia or "shell shock," just as do human subjects. Again, some animals in captivity present that listlessness, restlessness, inattention, sexlessness, negativism and emaciation, often ending in death, in the absence of organic disease, which can only be described as identical with the symptoms of neurasthenia. It is amazing, on the other hand, when we consider how many people pass their lives in conditions of ill-health, overwork, repeated child-bearing and harassing troubles and yet never lose a sunny temperament, a cheery optimism, and a boundless energy.

Symptoms.—The onset is never sudden, though there may be an acute outburst of symptoms at any time. Even in traumatic cases, the symptoms take a few days to appear and thereafter increase in intensity. They commence with feelings of weakness and exhaustion, and a loss of the sense of well-being, and as the days pass fatigue, both physical and mental, occurs after less and less effort, mental depression follows, and every sustained effort becomes burdensome. Mental effort too becomes difficult, and there is

especial trouble in concentrating. Interest either in work or in pleasures fails. Fatigue once produced does not pass away rapidly with rest, as in normal persons, and even sleep brings no refreshment. The sufferer is apt to sink into a monotonous condition of irritability and depression, with no desires or incentives, thinking only of himself and of his misery. He loses pride in his personal appearance, and quite commonly neglects the ordinary rules of personal cleanliness. He has lost the ordinary reactions, both of pleasure and of grief. Events may occur which satisfy the whole ambition of his life's work and arouse in the neurasthenic subject hardly a passing interest, or he may suffer the loss of one nearest and dearest to him with a selfish indifference which is hardly human. The appetites tend to fail, and sexual power is low or may remain entirely absent throughout the course of the disease. In the worst cases, continuous thought becomes impossible, and any continuous action equally so, and this often engenders a bedridden life. The difficulty of thought and concentration adds the fear of mental breakdown to the patient's misery, and he often has causeless terrors of impending evil or ruin. He cannot bear to be alone, or in a crowd. He cannot bear to be in a closed space, or he has the terror of death when in an open space. To remove him from his home and friends will make his illness irrecoverable. To cross the road alone is too dangerous for him. Such "phobias" may be multiplied indefinitely; claustrophobia (closed space) and agoraphobia (open space) are two of the commonly occurring varieties. There is never any serious change in the moral sense, and the neurasthenic patient is never led by his illness into acts of shameless crime or even to slight infraction of the moral law; but he is apt to become peevish, fretful, fault-finding, and supremely and childishly selfish and unreasonable. Nor does the neurasthenic person in my experience often fall into drug addiction. For the most, he is hopelessly valetudinarian according to his lights.

Paræsthesia.—Sensations of bodily discomfort are always present, and these may be vague and general or they may be localised. When vague and general, they may be both described and explained by lack of the feeling of bodily comfort which we in health possess—the satisfaction after a meal, the comfortable tiredness after healthy exercise and the pleasure of repose, the exhilarating feeling which accompanies work done and pleasures enjoyed, and which the anticipation of events brings. The feeling of fatigue is distressful, the body vaguely aches in general, and comfortable repose is out of the question. Cephalic sensations are the most usual of the local paræsthesias. These are described as a sense of weight or pressure upon the head, or as an aching tightness, especially apt to affect the back of the neck, and they come on with any effort, mental or physical. They are never described as pain, but as something worse and less bearable than pain. As a matter of fact, the neurasthenic patient bears actual pain with more fortitude than does the normal subject, and will sometimes volunteer that pain relieves him. Spinal discomfort, in the form of the back which always aches and is never out of consciousness, is frequent. Abdominal sensations are so usual as to have given origin among the ancients to the term "hypochondria."

Circulatory disturbances.—The blood-pressure is invariably low. I am of opinion that a high blood-pressure is incompatible with the development of neurasthenia. The low blood-pressure often entails sensations of giddiness, especially on sudden alterations of position, and is perhaps respon-

sible for the cold, moist, bluish skin often seen in the extremities, and for the facial pallor and unhealthy appearance.

Some of the patients, particularly those of the traumatic group, may show definite signs of hyperthyroidism, and perhaps tremors occurring in this disease are always of this nature. I have seen every gradation between a pure neurasthenia and a definite Graves's disease. Loss of appetite is usual, or the appetite may be capricious—to-day ravenous and gone to-morrow. Discomfort after meals and anorexia are frequent, and when severe may lead to great emaciation, such as may seem only compatible with serious organic disease. There is more or less insomnia, or distressful dreams and nightmare, after which the patient awakes still more weary and depressed. The morning is the worst period of the day with all neurasthenic subjects, and sometimes as the day goes on life becomes relatively tolerable. Neurasthenia is not infrequently associated with hysterical manifestation, which is not surprising, considering that so many causal factors, such as emotional upset, overstrain, fright, injury, etc., are common to the two diseases. In some cases the symptoms of these two conditions are so intimately blended that the patients might with equal justice be placed in the category of neurasthenia or of hysteria.

There are no objective signs in the nervous system, and the presence of any such signs should at once call into question this diagnosis. Every degree of the disease may exist. The slighter forms when transient are often expressed when we are tired out, overwrought and want a holiday; and when permanent, pass as individualities of temperament, or as gloomy, irritable and complaining disposition. The subjects of the slighter forms, especially of congenital neurasthenia, may be capable of very brilliant work and accomplishments. In its severest forms, neurasthenia may lapse into a condition in which all effort, mental and physical, becomes impossible, and the patient is bedridden and practically amentic. In this state there may be much negativism. Food is often refused and there may be constant vomiting, and the dejecta may be passed into the bed.

The term " psychasthenia " is in frequent use for those cases in which the manifestations are upon the mental side only. As every gradation occurs between these cases and those in which the symptoms are mainly physical, there seems to be no reason for regarding psychasthenia as other than a variety of neurasthenia.

Diagnosis.—With reasonable care and a sufficiently broad outlook, the diagnosis of neurasthenia presents no peculiar difficulties, except in the possible vagueness of the early symptoms. For the causes are, as a rule, definite and conspicuous, and the symptoms when well marked are pathognomonic, and there is a complete absence of any organic sign. Before entering upon a diagnosis of this malady, it should be fully realised that the loss of bodily feelings of well-being, and the easy fatigue and incapacity which characterise it, may be expressions of many organic diseases, and that these are also very prevalent as early symptoms of mental diseases. A careful search should therefore be made not on one occasion only, but repeatedly, for signs of organic disease. Addison's disease, when occurring in a fair subject without conspicuous pigmentation, has been repeatedly mistaken for neurasthenia, but can be at once distinguished by the extremely low blood-pressure. Any occult disease which interferes with bodily metabolism may produce neurasthenia-like symptoms. Those concerned with life assurance

are of opinion that tuberculosis in its earlier stages, and under the name of neurasthenia, often comes before them, but from the side of neurology I have not come across this error in diagnosis. Tumours of the brain, when involving the frontal and the temporal lobes, may cause little in the way of general intracranial symptoms, but marked symptoms of inattention, dullness and incapacity such as may be attributed to neurasthenia. The distinction here is to be made by repeated examination of the optic discs for definite signs of intracranial tumour. General paralysis of the insane often commences with depression, bodily discomfort and incapacity for sustained exertion. Examination of the blood and cerebro-spinal fluid will settle the diagnosis. The distinction for the early stages of chronic insanity may be so difficult as to be well-nigh impossible. The circumstances of the individual case and the presence of a definite cause for neurastnenia are important aids. The presence of exaltation and grandiose states excludes neurasthenia, for no neurasthenic is ever exalted or grandiose. Moral degeneration, as shown by shamelessness and criminal acts, always excludes neurasthenia, as does also any definite delusion. The disunction from hysteria is simple, for the symptoms of the two maladies are quite different. They, however, frequently coexist.

Course and Prognosis.—In all cases except the congenital ones, the prognosis as to both life and cure is good, and even when the disease is congenital it may be greatly benefited. Many men and women are mildly neurasthenic for years, and yet do their duty in the world, and not infrequently a great work. Much of the world's work has been done by invalids, many of them congenital neurasthenics. The usual event is gradual improvement so soon as removable factors can be eradicated and appropriate treatment applied. In the neurasthenia which may follow acute illness, recovery is usually rapid and permanent. The danger of recurrence is considerable where causal factors remain active, in congenital cases, and in the cases in which there have been many previous breakdowns.

Treatment.—*Prophylactic.*—Those children who may be handicapped by a defective heritage should be guarded during their development by the paying of strict attention to moral and physical hygiene, and to education, discipline and occupation. When later they enter actively into more strenuous work, limitation of mental and physical exertion should be insisted on, and anxiety and worry avoided. Healthy sports of all kinds are advantageous. In cases in which grief, fright or accident has severely shaken a person, rest and quiet with careful attention to nutrition, and an abrogation of all work and responsibility and the securing of adequate sleep, are certainly measures likely to avert neurasthenia. This prophylaxis is too often omitted after accidents and injuries, and when applied it should not be discontinued too soon.

Curative.—Rest, both physical and mental, the securing of peaceful sleep, the restoring of appetite, careful feeding, and the administration of stimulants, in the form of strychnine, glycerophosphates and thyroid preparations, together with the bromides, which by cutting off the edge of the discomfort lessen the distress, are the most important measures. The patient always improves more rapidly when nursed by strangers knowledgeable in his malady, and away from his own home. But isolation as laid down in the Weir-Mitchell treatment is strongly to be deprecated, except in rare

and special cases. Far better surround him with a wise, sympathetic and changing audience, to whom he can lay bare his troubles, and who are able to take his mind from himself. Again, the nature of the rest to be ordered is a matter for careful consideration. In exhaustion conditions, complete rest in bed is grateful to the patient and should always be adopted. To some people, however, idleness is torture, and to give them rest you must give them something to do. Inanition is one of the chief perpetuators of neurasthenia, and some cases are only to be cured by putting them back to work by degrees, and with encouragement and medicinal aid.

Massage is very useful in those patients who like it, and are soothed and comforted thereby. Its physical effect is important, and it serves both to pass time and to satisfy the patient that something active is being done for him. The personality of the applicator is, therefore, by no means negligible. To those patients who hate being touched and, therefore, dislike massage, it does more harm than good. Hydrotherapy and electrotherapy are useful, provided they are not distasteful to the patient. Organotherapy has been much vaunted and greatly employed. It is certain that all of the preparations which have been used, both orally and by injection, are stimulants of metabolism and, therefore, are useful. That they have any specific effect upon neurasthenia is far from proved. Some of them owe their value entirely to the thyroid content, usually very insufficient.

The patient should always be kept under observation and strict treatment until there is some sign of improvement. It is a mistake to order forthwith a change of air and scene when the patient is not well enough to make any advantage of it; often such a course will aggravate the malady. Once improving steadily, such measures are of great value, and in proportion to the joy of anticipation and the satisfaction that they may bring.

JAMES COLLIER.

LOCAL LESIONS OF THE SPINAL CORD

COMPRESSION OF THE SPINAL CORD

In compression the lumen of the spinal canal is reduced in a small part of its vertical extent, and the spinal cord is injured at this point, either directly by pressure, or indirectly by interference with its vascular supply. With the exception of acute inflammation of the membranes, all the extramedullary lesions of the spinal cord come under this heading. The characteristic clinical feature of compression is the combination of two sets of phenomena: local or root symptoms in those regions supplied by the roots arising from the cord at the level of the lesion, and remote or cord symptoms due to interruption of the conducting paths in the white matter. It is convenient to divide this subject into two parts—slow compression and compression of rapid onset.

SLOW COMPRESSION

The commonest causes are tuberculous spinal caries, vertebral tumours, meningeal tumours and cysts; rarer causes are aneurysm, gumma, leukæmia,

Hodgkin's disease, Paget's disease, syphilitic caries, spondylitis deformans, and other chronic inflammations of the bones and joints of the spine.

Ætiology and Pathology.—1. *Tuberculous spinal caries* (*Pott's disease*).—Spinal caries is the most frequent cause of slow compression. It occurs most often in children, but is common in adults, and may begin late in life. Signs of injury to the cord develop in about 1 case in 20, and are usually preceded by obvious deformity of the spine; but in many cases they appear before disease of the bone is suspected. Rarely paralysis comes on for the first time in an adult who has had a curvature since childhood.

The cord may be damaged by direct pressure of displaced bone, or by an abscess beneath the periosteum of the diseased vertebræ; but in almost all cases the injury is indirect, and results from œdema of the cord, arising from interference with its blood supply by tuberculous granulation tissue, which forms on the outer surface of the dura mater and fills the epidural space (pachymeningitis externa). The functions of the cord may be temporarily deranged for long periods by this œdema, without permanent damage to the nervous tissues; hence, when the disease is cured, the œdema subsides and the cord recovers. In cases of greater severity necrosis of the nervous structures follows thrombosis of the vessels, or prolonged pressure causes atrophy of nerve roots, and complete recovery is impossible.

2. *Tumours of the vertebral column.*—Vertebral tumours are about twice as common as all the other forms of extramedullary tumours together, and almost all of them are malignant. Carcinoma is always secondary, and is a frequent and distressing complication of cancer elsewhere. A very small primary carcinoma, *e.g.* of the breast, thyroid or prostate, may produce extensive disease of the vertebræ, and signs of compression may appear before the existence of the primary growth is suspected. On the other hand, they may appear several years after complete removal of the primary growth, and may be the first evidence of a recurrence. Sarcoma, the commonest form of primary growth, begins in the bone or periosteum of the bodies or laminæ, often in several at once, or simultaneously at different levels. Secondary sarcoma arises by metastasis from sarcoma elsewhere, or by direct extension from a growth in neighbouring soft parts, *e.g.* of tumours in the mediastinal and retro-peritoneal spaces.

The growth of vertebral tumours is usually rapid, and extensive portions of the spinal column may be completely destroyed. The cord is compressed by the growth itself, by displaced bone, or by a process of the growth which invades the spinal canal through an intervertebral foramen. As a rule, the dura mater sets bounds to its inward extension. Benign tumours of the spine are rare. They usually grow forwards, but occasionally an osteoma, a chondroma, or an exostosis produces signs of compression.

3. *Meningeal tumours.*—These are divided into two groups—intradural and extradural. The first are twice as common as the latter, and more than half of them are simple, encapsuled, and easily removable. Myxoma, fibroma, sarcoma, endothelioma, and psammoma are common. Other forms are rare. In most cases they lie posterior or postero-lateral to the cord, and are seen when the cord is exposed by laminectomy; but in a few cases they lie in front and may escape detection.

Sarcoma is the commonest extradural tumour. It is sometimes encapsuled, but more often it is a diffuse growth difficult to remove.

These tumours usually grow very slowly, and several years may elapse between the onset of the first symptom and the time when an accurate diagnosis can be made. They do not invade the substance of the cord, nor penetrate the dura, nor give rise to metastases.

4. *Cysts.*—Cysts, parasitic and non-parasitic, may compress the cord and produce symptoms indistinguishable from those of solid tumours. In some countries hydatid cysts form a high proportion of all spinal tumours. They may invade the spinal canal from adjacent soft parts or from the vertebræ, or arise primarily in the membranes. They are often multiple, and are nearly always extradural. Cysticercus cysts, which are very rare, are usually single and intradural. Non-parasitic cysts are collections of fluid contained within slightly thickened adherent membranes. They are among the most frequent of spinal tumours. They are most likely a result of circumscribed inflammation of the pia-arachnoid, and have been known to follow an injury; but their ætiology is obscure. The cyst is often opened inadvertently during operation, and the only evidence of its former presence is flattening of the cord and atrophy of the nerve roots at the point where a solid tumour was expected. Sometimes the position of the cyst can be inferred at operation, from the absence of normal pulsation below it. On puncturing the membranes in this position fluid escapes under pressure, and the pulsations reappear. The name *meningitis serosa circumscripta* is applied to this condition.

5. *Aneurysm of the aorta* is a rare but well-known cause of spinal compression. The dorsal region is most often affected, three or four vertebral bodies being slowly eroded until the dura mater is exposed. Rupture into the spinal canal has been observed.

6. *Syphilitic caries.*—Gummata and caseous masses of syphilitic origin in the bones of the spine may cause a condition not unlike that of tuberculous caries. It is very rare, and usually occurs in the cervical region where the cord may be compressed.

Symptoms.—EXTRADURAL COMPRESSION.—*Local or root symptoms.*—Pain in parts supplied by the sensory roots arising from the cord at the level of the lesion is often the first symptom. It may be a dull ache, a feeling of constriction, a sharp cutting pain, or pain so severe as to be almost unbearable. It is often brought on or greatly increased by movement of the spine or by coughing. The skin in the painful area is sometimes hypersensitive at first, but very soon its sensibility is diminished, while the pains persist (anæsthesia dolorosa). The nerve trunks are not tender as in ordinary neuralgia. Severe pains are rarely absent in cases of vertebral tumour. In spinal caries they are usually absent or slight. Injury to the motor cells or anterior roots leads to weakness, wasting and loss of tone in the corresponding muscles. In some cases root symptoms are absent throughout the course of the disease, and the first effects of compression are referable to interruption of the conducting paths in the cord.

Remote or cord symptoms.—Although all the tracts are submitted to the same degree of compression, their functions are not impaired at the same time. While variations are common, the symptoms usually arise in the following order: first weakness and spasticity in the lower limbs, then im-

pairment of sensation, position and passive movement, temperature, pain and touch being affected in this order. Defective sphincter control often precedes and sometimes follows sensory loss.

Motor symptoms.—Interruption of the pyramidal tracts produces spastic paraplegia in parts below the lesion. The clinical features are—(1) diminution of voluntary power; (2) alterations in the amount and distribution of muscle tone and in the attitude of the limbs; (3) changes in the tendon and skin reflexes; (4) the occurrence of certain involuntary and reflex movements.

To understand the phenomena of spastic paraplegia it is essential to remember that the muscles of the lower limb are divided into two distinct groups—the flexors and the extensors—and that the muscles which dorsiflex the foot and toes are physiologically flexors, while the corresponding plantar flexors are extensors. In all that follows these important muscles will be grouped according to this nomenclature.

1. Loss of voluntary power varies from slight weakness of one group of muscles to complete paralysis of both limbs, and depends on the degree of damage to the pyramidal tracts. It usually begins in the distal segments of the limb, and is greater in the flexors than in the extensors.

2. The tone in all the muscles increases early, and is greatest in the extensors. Hence an early symptom is general stiffness of the limbs, especially a difficulty in flexing them. If the limbs are handled passively, the resistance to flexion is found to be greater than to extension. As power diminishes spasticity increases, until at length the limbs are held constantly in an attitude of complete extension. This combination of weakness and spasticity with extended lower limbs is known as "paraplegia in extension."

3. Exaggeration of the tendon reflexes is a constant early sign. The abdominal reflexes below the level of the lesion and the cremasteric reflexes are lost early. The normal plantar reflex is also lost, and is replaced by a different kind of reflex—Babinski's sign, the "extensor" plantar response.

As the damage to the cord increases, and when certain extra-pyramidal motor tracts are affected, the extensor muscles gradually lose their tone, for which connections with the brain-stem through these extra-pyramidal tracts are essential, while the tone in the flexor muscles, which depends on a reflex arc which is purely spinal, is retained. The result is that the knee- and ankle-jerks, which indicate tone in extensor muscles, are lost while the reflexes from flexor muscles (hamstring-jerks) persist. At the same time, in some cases, the limbs are gradually drawn up by the unopposed action of the flexors. This combination of weakness and spasticity with flexed lower limbs is known as "paraplegia in flexion." At first the flexed position is occasional—flexor spasms—later it becomes constant, but is still due entirely to excess of tone in the flexors. Finally, contractures occur in the muscles, and the deformity becomes permanent. In many cases of compression the stage of paraplegia in extension gradually merges into one of complete flaccidity of all the muscles, without the occurrence of paraplegia in flexion, and all the tendon reflexes are lost.

4. While the limbs are still rigid in extension, the commonest involuntary movement is a spontaneous clonus of the extensor muscles, in which the whole limb trembles as it does when ankle clonus is elicited in a case with marked spasticity. In the later stages, where the extensor muscles are

beginning to lose their tone, a new kind of movement appears, in which the limbs are drawn up suddenly from time to time by an involuntary contraction of the flexor muscles—flexor spasms. Further, by appropriate stimulation many reflex movements can be produced in the paralysed limbs. The most important of these is the "flexion reflex of the lower limb." It is elicited most easily by stimulating the outer border of the sole by firm pressure or a pin-prick, and in its complete form consists in flexion of the hip and knee, dorsiflexion of the foot, and an upward movement—so-called extension but physiological flexion—of the great toe. When the damage to the motor tracts is slight, when the limbs are rigid in extension and the movement of flexion is prevented by the hypertonus of the extensors, or when almost all reflex activity has disappeared, the reflex appears in its minimal form. A part of this minimal response is an "extension" of the great toe. The normal plantar response is obtained from the sole alone. The pathological reflex, of which the "extensor" response is a part, may be obtained not only from the sole, but when well developed by stimulating the skin and deeper structures on any part of the lower limb. In the light of this the nature of many reflexes which have been described as isolated signs of pyramidal tract disease, *e.g.* the "extensor" plantar response, Oppenheim's and Gordon's signs, and many others, becomes clear. In all of them a stimulus is applied to some part of the lower limb, and the response is a flexion reflex, whose most obvious component is "extension" of the great toe. It is unfortunate that the term "extensor response" is commonly used to describe a movement which is physiologically one of flexion.

Sensory symptoms.—Sensory loss may appear first in the area supplied by the roots arising from the cord at the level of the lesion, or in parts below. As a rule motor disturbance is severe before any remote sensory loss is found. In some cases, especially of spinal caries, the limbs are completely paralysed before sensation is affected. The reverse condition, severe sensory loss with slight motor disturbance, does not occur in compression. Remote sensory loss appears first in one of two positions. In most cases the soles first become less sensitive, then the legs, and later the thighs. In a smaller number the loss appears first over the lower sacral segments, and extends upwards in segmental progression. When both sides are equally compressed all forms of sensation may suffer equally; but in most cases position and passive movement, temperature, pain and touch are impaired in this order.

If one side of the cord is more affected than the other the signs are those of a modified Brown-Séquard syndrome with the superficial sensory loss greatest in the limb in which most power is retained, and loss of position and passive movement greatest in the weaker limb. Ultimately, whatever the order of loss at the beginning, as the compression increases, sensation of all kinds is diminished or lost in all parts below the lesion. In exceptional cases the skin in the distribution of the lowest sacral segments retains its sensibility when the loss in all other parts below the lesion is severe. Such a distribution of sensory loss suggests a lesion damaging the more mesial fibres of the sensory path. Occasionally the onset of symptoms in extra-medullary compression is rapid, and severe paraplegia develops in a few days. This is seen most often in cases of sarcoma of the mediastinal or retro-peritoneal spaces where the growth, which has infiltrated one or more vertebral bodies, surrounds the dura and produces œdema of the cord In cases of rapid

onset the limbs are flaccid from the beginning, and the tendon jerks are diminished or lost.

INTRADURAL COMPRESSION.—When the pressure is equal on both sides of the cord, the symptoms are the same as in extradural compression. If one side is affected before the other, as by tumours growing from a nerve root, the symptoms are at first unilateral, and in many cases spasticity and weakness are confined for a long time to the lower limb on the same side as the tumour. Occasionally alterations in subjective sensation (paræsthesiæ) in the limb of the opposite side precede motor symptoms by a considerable interval, and form the grounds for the patient's first complaint.

At a later stage the following characteristic syndrome appears :

1. A band of sensory loss, on the side of the tumour in an area corresponding to the distribution of the sensory roots arising from the cord at the level of the lesion, often with root pains in the same area.

2. Weakness and spasticity confined to or greatest in the limb on the same side (pressure on the pyramidal tract).

3. Diminished sensibility to temperature, pain, and touch on the opposite side (pressure on the crossed sensory tracts).

4. Impairment of the sense of position and passive movement in the weaker limb (pressure on uncrossed sensory tracts in the posterior columns).

As the compression increases both limbs become weak, spastic and insensitive, and the symptoms progress as in extradural compression. Examination of the cerebro-spinal fluid often reveals a condition which is practically pathognomonic of compression—*the loculation syndrome.* This consists, in its complete form, in an increase in the amount of albumin with absence of or slight increase in the number of cells, and a yellow colour (xanthochromia) in the fluid. The normal amount of albumin is about 0·025 per cent. In compression it is often increased a hundredfold or more, and readings above 1 per cent. are very common. A low cell count and 0·1 per cent. of albumin is very strong evidence of compression, and as the amount increases the diagnosis becomes more certain. Xanthochromia is common; but it occurs in other conditions, and its value as a sign is slight. These changes are found in the fluid only below the site of compression.

Diagnosis.—A complete diagnosis establishes—(1) the existence of compression ; (2) its situation ; (3) its pathological nature.

1. When signs of injury to the cord or nerve roots are found associated with disease of the spine at a compatible level the diagnosis is obvious. When root pains are the only symptom the diagnosis is difficult. They are often falsely interpreted as referred pains, or as indications of disease in the painful part itself. Thus angina pectoris, gall-stones, pleurisy, renal colic, hip-joint disease and other painful conditions have been diagnosed, and unnecessary operations have been performed. Pain of root distribution should always arouse suspicion, and provoke a careful examination of the spine and of the nervous system.

If the signs are those of spastic paraplegia, spinal syphilis, disseminate sclerosis, syringomyelia and amyotrophic lateral sclerosis must be excluded. *In almost every case this can be done in one stroke by examination of the cerebro-spinal fluid.* Patients with removable spinal tumours are still allowed to develop incurable paralysis, because this examination is not made. Such

an omission in a case of paraplegia of doubtful origin amounts to neglect. The loculation syndrome in the fluid is almost pathognomonic. It is never absent in chronic cases, and is never found in any of the focal or system diseases, for which compression might be mistaken.

Spinal syphilis is detected by examination of the blood and cerebro-spinal fluid. Valuable time may be lost, however, or an irretrievable error made, when the blood of a patient with a removable tumour happens to react positively to Wassermann's test. In a series of cases operated upon by Sargent at the National Hospital, the reaction was positive in four patients from whom a non-syphilitic tumour was removed.

Disseminate sclerosis may present the picture of progressive spastic paraplegia with considerable sensory loss, and confusion between it and compression by slowly growing tumours is common, each disease being mistaken for the other. The more serious error is to mistake the curable for the incurable disease. It is advisable to feel dissatisfied with the diagnosis of disseminate sclerosis, so long as the symptoms are purely spinal, and to re-examine the patient at intervals in the hope of finding evidence of a simple tumour. The transient nature of the early symptoms and the presence of signs of cranial nerve troubles serve to distinguish disseminate sclerosis in most cases. Slight nystagmus must not be accepted as decisive evidence against tumour, as it is common in compression, especially of the cervical region.

Amyotrophic lateral sclerosis simulates compression in the cervical region, in that wasting in the muscles of the hands and arms is associated with signs of spastic paraplegia in the lower limbs; but is distinguished by exaggeration of the tendon reflexes in the wasted arms, by fibrillary tremors in the muscles, and by the absence of objective sensory disturbances.

Syringomyelia is easily recognised by the characteristic sensory changes. Dissociation of sensation to the degree which is common in this disease is never seen in extra-medullary lesions.

2. SEGMENTAL DIAGNOSIS.—As the motor sensory and reflex functions of each segment of the cord are known, the level of the lesion can be deduced by noting the highest point at which these functions are impaired.

Motor localisation.—Each segment of the cord contains nuclei for several muscles, and most muscles receive nerve fibres from more than one root; but as each muscle seems to have one main root of supply, the weakness, wasting and loss of tone vary in distribution with the segment affected. The muscles which suffer most when the corresponding segment is damaged are named hereunder:

C_4. Supraspinatus, infraspinatus. C_5. Biceps, deltoid, brachialis anticus, supinator longus. C_6. Pronators of forearm. C_7. Triceps, extensors of wrist and fingers. C_8. Flexors of wrist and fingers. D_1. Small muscles of the hand. $D_{2\text{-}10}$. Intercostal muscles. $D_{7\text{-}10}$. Muscles of abdominal wall. D_{12}-L_4. Ilio-psoas (mainly L_3). L_2. Adductors of thigh. L_4. Abductors of thigh, extensors of knee. L_5. Hamstrings. S_1. Glutei—calf muscles. S_2. Anterior tibial muscles—peronei—small muscles of foot.

Wasting of the muscles in an intercostal space is a valuable guide, as the muscles of each space are innervated from one segment alone. If the lesion is at the level of the ninth dorsal segment the rectus abdominis is paralysed below a point about an inch above the umbilicus. In such a case, when an

attempt is made to rise from the lying to the sitting position, the upper part contracts and the umbilicus is drawn upwards (excursion of the umbilicus). If the lesion is at the twelfth dorsal segment the entire rectus contracts, but the iliac regions bulge, owing to paralysis of the lower part of the oblique muscles.

Localisation by changes in the reflexes.—Above the lesion the reflexes are normal, at its level they are diminished or lost, below it the skin reflexes are diminished or lost, and the tendon reflexes are exaggerated. The segments on which important reflexes depend are:

C_5. Biceps and supinator-jerks. C_6. Pronator-jerks. C_7. Triceps-jerks. D_{7-12}. Abdominal reflexes. L_2. Cremaster reflexes. L_4. Knee-jerks. S_1. Ankle-jerks. S_2. Plantar reflexes.

Sensory localisation.—The sensory areas supplied by each segment of the cord are shown in the accompanying diagram (p. 1598). Root pains in the distribution of one or more of these areas form a sure guide to the affected segment. When they are absent, the level of the lesion is determined by ascertaining the highest point at which sensation is impaired. Very often when the two sides of the cord are compressed unequally the anæsthesia is confined to one side, or extends higher on one side than on the other. In these cases, when the segmental diagnosis is made from the sensory signs alone, the lesion, a tumour for example, is found several segments higher than the point indicated by the signs. The uppermost limit of sensory loss in these circumstances does not correspond with posterior roots injured by the tumour—if it did, the localisation would be accurate—but is a result of interruption of the sensory paths in the cord, and the discrepancy in the signs is due to the oblique course taken by the sensory fibres in crossing the cord. In the mid-dorsal region the decussation for pain and temperature is complete one segment above the point of entry of the root conveying these impressions to the cord, that for touch in two segments. As the cord is ascended, crossing takes place more slowly, until in the upper cervical region impulses which enter together in one root ascend on the same side of the cord for five or six segments before all of them reach the opposite side. At all levels pain crosses soonest, then cold, then heat, and touch slowest of all.

It follows that in unilateral lesions the upper level of the anæsthesia on the opposite side of the body, caused by injury to sensory paths in the cord, is below the segmental level of the injury. Also that the level is higher for one form than another. The fibres which cross slowly escape by ascending beyond the lesion on the uninjured side before they cross, while those which cross quickly are caught after crossing. Hence the level of sensory loss is highest for pain and lowest for touch, with temperature intermediate. Occasionally the tumour is found below the level predicted. In these cases the functions of the segments above the lesion are impaired by œdema.

Surface anatomy.—If the cord is to be exposed at the level of the affected segments their relation to the spinous processes of the vertebræ must be known. This is obtained as follows: In the cervical region to the number of the spine add 1—the fifth cervical spine lies over the sixth cervical segment; to the number of the upper five dorsal spines add 2—the fourth dorsal spine lies over the sixth dorsal segment; down to the tenth dorsal spine add 3—the tenth dorsal spine covers the first lumbar segment. The eleventh

dorsal spine corresponds to the third lumbar segment, and the twelfth to the first sacral. The cord terminates just above the level of the first lumbar spine.

Intrathecal injection of lipiodol.—The upper level of a lesion which narrows

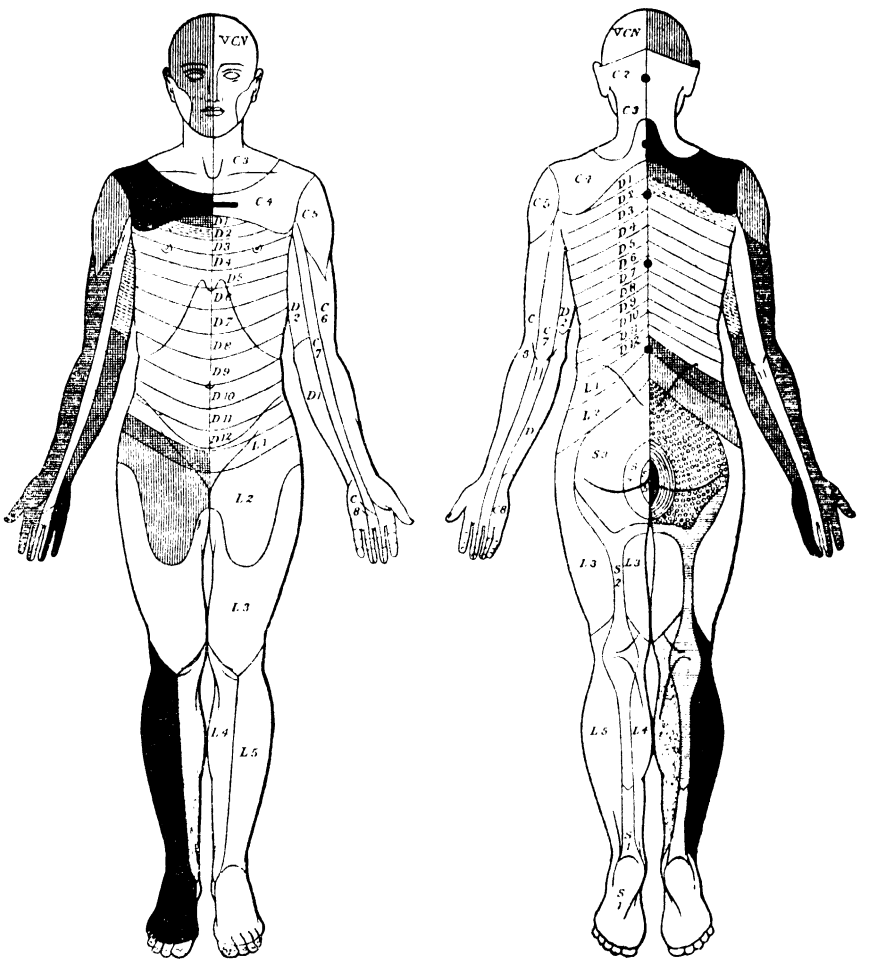

FIG. 115.—Diagram of cutaneous areas of posterior nerve roots (after Collier and Purves Stewart).

or obliterates the lumen of the spinal canal can be ascertained by injecting lipiodol through the occipito-atlantoid ligament into the subarachnoid space. The lipiodol falls rapidly to the point of constriction, where it is arrested and can be seen clearly by X-rays. If there is no constriction it falls to the dural cul-de-sac, where it remains indefinitely and does no harm. This

procedure is of great practical value when the existence of a compressive lesion or its exact site is in doubt.

3. Diagnosis of the Cause of Compression.—When spastic paraplegia develops in a patient who is known to suffer from *spinal caries*, the cause is obvious; but when it precedes the appearance of signs of bone disease the diagnosis is difficult. In all cases of compression the spine must be examined repeatedly for deformity, tenderness and limitation of movement. If tenderness is found constantly in the same place, and the nervous symptoms are compatible with disease of the underlying segments, disease of the bones is almost certain. In young persons disease of the spine is usually caries and in adults caries is also the commonest cause; but tumours of the spine and aneurysm must be excluded. Severe root pains are rare in caries but are the rule in vertebral new-growths. An aneurysm would present other signs. An X-ray picture will usually demonstrate the presence and nature of the bone disease.

Vertebral tumours.—When root pains occur in a patient with malignant disease, or from whom a malignant growth has been removed, the diagnosis is clear. Mistakes are easily made when pains are the first symptom, as their root origin is not recognised. Diminished sensibility in the painful area indicates the nature of the pain, and this directs attention to the spine, where tenderness or deformity is discovered. As most vertebral tumours are secondary, the next step is to examine the parts where carcinoma is common, remembering that a small primary growth, *e.g.* in the breast, thyroid or prostate, may give rise to widespread metastases in the bones. In the absence of a history or signs of new-growth in other parts, the diagnosis is founded on the combination of local tenderness or deformity and rigidity of the spine with root or cord symptoms. The severity of the root pains, and their great aggravation by movement, are characteristic.

Meningeal tumours.—Severe pain of root distribution is present in many cases, and when this is followed after some time by spastic paralysis of slow onset and steady uninterrupted progress, affecting first one leg and then the other, the combination and especially the course of the symptoms are almost pathognomonic. In caries the root pains are rarely severe, signs of bone disease are rarely absent, the paralysis is usually bilateral from the beginning, and is severe before any sensory loss is found. The distinction from vertebral new-growth may be impossible when the latter occurs without bone symptoms or X-ray signs. Practically the diagnosis between meningeal and intramedullary tumours is impossible. If the signs and symptoms in any case are those of compression, and an approximate indication of the level of the lesion can be given to guide the surgeon, then, if other obvious causes such as caries, aneurysm and vertebral tumour have been excluded, an operation must be performed. Until the lesion can be seen the diagnosis is in doubt.

Course and Prognosis.—*Spinal caries.*—The course of the bone disease does not always run parallel with the paralysis, and either may alter in severity independently; but if the caries undergoes cure the paralysis usually diminishes. Considering the severity of the paralysis, the prognosis is favourable and astonishing recoveries occur. The outlook is best in young people with disease in the dorsal region. Many recover completely, but more often, especially in adults, recovery, though considerable, is partial. So long as the lower limbs remain spastic in the extended position with exaggerated

tendon reflexes the prognosis for complete recovery of power is good; but if the limbs become flexed, if they become flaccid, if the knee- and ankle-jerks are lost, if sensory loss is severe, or if there is wasting in the limbs following damage to lower motor neurons, the outlook is very bad. Many patients live for years with severe paralysis; but life is constantly endangered by sepsis from bed-sores, ascending infections of the urinary tract, chest complications, and tuberculous disease in other parts.

Vertebral tumours.—When sarcoma or carcinoma spreads to the vertebræ from surrounding parts the duration of the disease is measured in weeks or months, and death is due to the primary condition. In primary sarcoma, and in some cases of carcinoma of the vertebræ, life may be prolonged for a year or two, and death is due rather to complications of the cord disease—bedsores, cystitis, etc.

The course of *tumours of the meninges* is often extremely slow. Root symptoms may precede paralysis by months or even years, and the weakness may increase gradually for several years before walking becomes impossible. Malignant growths are fatal, and simple growths equally so, if not removed. Most patients with simple tumours come to operation during the second year after the onset of the first symptom. The mortality after operation for the removal of simple tumours is very low in skilled hands. The prognosis for recovery of power depends in part on the duration of the weakness in the lower limbs. Complete recovery may be expected, if it has not lasted more than a year. When the paralysis is of longer duration recovery, though gratifying, is rarely complete. Nevertheless, full return of power has been seen after 3 years of severe paralysis.

Treatment.—*Spinal caries.*—This is to be directed to curing the bone disease in the hope that cure of the paralysis will follow. Complete rest on the back and fixation of the spine for many months is the routine treatment. The general condition of the patient is to be improved by fresh air, a liberal diet and cod-liver oil, iron and arsenic, and great care is to be taken to prevent bedsores, cystitis and deformities of the limbs. For adults, especially if they are bread-winners, a more rapid cure is desirable. This is provided by surgery in Albee's operation, or a modification thereof, in which a bone graft from the tibia is wired into a cleft made in the spines of the affected region. In this way fixation is effected, further deformity is prevented, and the time lost is reduced from a year or more to a few months. Adults sometimes recover after a short rest in bed, if a suitable jacket is worn to immobilise the spine.

Operation must be considered (1) when a sudden increase of deformity or severe root pains and great increase of paralysis come on together, and suggest pressure by displaced bone; (2) when an abscess forms; (3) when paralysis persists long after the bone disease is cured, or when in an adult there is no improvement after 6 months' rest; (4) when life is endangered by respiratory paralysis.

Vertebral tumours.—In slowly growing primary growths of the vertebræ laminectomy is indicated to relieve pressure, or to prevent pain by cutting sensory roots or dividing the antero-lateral columns of the cord. The operation is merely palliative, but is often followed by considerable temporary recovery.

Meningeal tumours.—If the symptoms suggest an intraspinal tumour,

and a segmental diagnosis has been made, an exploratory laminectomy should be done in the hope of finding a removable tumour.

Compression of Rapid Onset

Ætiology.—The commonest causes of rapid compression are fracture or dislocation of the spine.

Dislocations occur most often between the atlas and axis, or between the fifth and sixth cervical vertebræ. They are sometimes incomplete, and thus may cause compression of slow onset. More often they are complete, and the cord is compressed between the laminæ of the dislocated vertebra, which is displaced forwards, and the body of the underlying vertebra. Fractures are commonest in the lower dorsal and upper lumbar regions, and follow most often a fall from a height on to the feet or buttocks. They also occur apparently spontaneously in spinal caries and in vertebral tumours. A blow on the back may fracture the vertebral arches, and cause compression of the cord. The degree of damage to the cord varies greatly. In most cases it is very severe, the cord being completely divided or the damaged part transformed into a soft hæmorrhagic pulp.

Symptoms.—Sudden severe compression causes flaccid paralysis, sensory loss and loss of all reflexes in parts below the lesion. At first there is retention of urine, which is followed later by incontinence. Bedsores often develop with extreme rapidity.

Prognosis.—The prognosis is always extremely grave in severe cases, death resulting in high cervical lesions from paralysis of all the muscles of respiration, in lesions at lower levels from sepsis following bedsores, or from infection of the urinary tract.

Treatment.—When the signs are those of complete division of the cord, treatment by operation is directly contra-indicated. If some voluntary power is retained, or if sensory loss is not absolute, operation may be considered, especially if the compression is caused by fracture of the vertebral arches. The cord should be exposed in every case where the level of the fracture points to injury of the cauda equina. These roots being peripheral nerves have a chance of regenerating, and this may be enhanced by freeing them from compression by displaced fragments of bone. With skilled nursing, patients with complete division of the cord may survive and live for many years. Prevention of bed-sores, and of bladder infection is of first importance.

SYRINGOMYELIA

Definition.—Syringomyelia is a very chronic and irregularly progressive disease of the spinal cord and brain stem, dependent upon a peculiar lesion of the grey matter, glial increase and the formation of irregular cavities being the most conspicuous features of this lesion. Clinically, the malady is characterised by a deep loss of sensibility to pain and to temperature, other forms of sensibility remaining relatively unaltered, and by muscular atrophy and weakness of varying distribution in the upper extremities, and further by spastic weakness of the lower extremities, owing to involvement of the pyramidal tracts at the level of the lesion.

Ætiology.—Both sexes may be affected, and males are more prone to suffer than females. Heredity plays no part in its causation. Age is most important, in that this disease appears either to be congenitally installed, or to commence during the period of growth. It has been diagnosed with accuracy as early as the sixth year of childhood, and rarely if ever do the symptoms commence later than the age of 30 years.

Pathology.—The primary lesions of syringomyelia are always found in that region of the spinal cord which was originally occupied by the central canal, or in close connection with the ventricular system of the brain stem; and it is certain, therefore, that syringomyelia is referable to a pathological process affecting the central canal and its surrounding glia, and that this pathological process, in many cases at least, is installed before the completion of the development of the central canal of the nervous system. Two essential lesions and four other commonly occurring lesions make up the morbid process of this disease:

Essential lesions.—(1) Cavitation of the posterior part of the grey matter; (2) gliosis, with liquefactive degeneration of the abundant glia — *other lesions commonly but not invariably present*; (3) degeneration of lower motor and vasomotor neurons; (4) degeneration of lower sensory neurons; (5) distension of cavities producing pressure effects; (6) secondary ascending and descending degenerations.

The seat of commencement of the disease is invariably in the dorsal grey matter of the lower half of the brain stem and upper half of the spinal cord, and most commonly of all, in the lower three cervical and upper three dorsal segments. The cavitation occurs primarily always in that part of the grey matter which held the original central canal, namely, the region of the posterior commissure, posterior median septum and posterior horns. The cavities are roughly fusiform in shape, with the long axis in the length of the cord, and may be short or very long, single, multiple, or branched. When multiple, there is a tendency for the cavities to break into one another sooner or later. The contents of the cavities is a colourless or slightly yellow fluid, containing no cellular elements, and little or no albumin. Distension of the cavities may reach so great a degree as to cause the spinal cord to fill the spinal canal and press upon the bones, and in rare cases may cause such evascularisation as to produce complete transverse softening of the cord. It is the cause of extension of the cavitation, especially in the direction of length of the cord.

The gliosis consists of a thick layer of neuroglial tissue, which everywhere surrounds the cavities, and which at their upper and lower limits extends some distance farther than the cavity, as a solid mass. Farther than this, in the regions affected, solid masses of glial tissue of considerable size may be seen, and these appear from their position to have developed from the collections of undifferentiated neuroglia, which, normally, occupy the position of the obliterated lateral horns of the primitive central canal. In the medulla and pons, such masses may be found anywhere in the reticular formation, and are especially frequent in the lateral region of the medulla, mesial to the restiform body and ascending root of the trigeminal nerve, where the vagus-accessory nucleus and the main afferent paths for pain and temperature sensibility are situated.

Degeneration of the lower motor neurons occurs in at least half the cases.

It is most marked in the cervical and upper dorsal regions of the cord, and may be very local or extensive. It is commonly explained as caused by the extension of the gliosis and cavitation into the anterior horns of the grey matter, and by the distension of the cavities exerting pressure upon these regions, and causing atrophy of the cells. To the pressure exerted by such distended cavities, are also attributed the ascending and descending degenerations which are commonly found in the pyramidal tracts below the level of the lesion, and in the posterior columns above.

Tumour formation is not uncommon in cases of syringomyelia. Massive growth may be found in the pons and in the spinal cord.

Symptoms.—*Disturbances of sensibility.*—By far the most constant and characteristic feature of syringomyelia is a sensory loss of a peculiar kind which was named by Charcot "the dissociated sensory loss." This is a loss of sensibility to painful impressions and to thermal stimuli, while sensibility to touch, to vibration, to position, to passive movement and to the appreciation of location upon the skin, remain relatively or entirely intact. In other words, those forms of sensibility which travel by a path crossing in the posterior grey commissure of the spinal cord are lost, because the lesion of syringomyelia destroys especially the region of the posterior commissure, while those forms of sensibility which travel by paths which are uncrossed in the spinal cord and do not traverse the region especially affected by syringomyelia, but are conducted by the posterior columns, are not affected. Further, the lateral region of the dorsal reticular formation of the medulla, mesial to the restiform body and ascending root of the fifth nerve, and a little ventra to these structures, is especially prone to the lesion of syringomyelia, and it is this region which contains the whole path for pain and temperature sensibility from the opposite half of the body, and a lesion in this situation will produce hemianalgesia and hemithermanæsthesia, while the paths for other forms of sensibility, situated mesially on either side of the raphé of the medulla, escape. Again, the lesion excavating the ventral horn in any part of the cervical region may extend so as to interrupt the spinothalamic tract which lies immediately dorso-lateral to the ventral horn, and so cause loss of pain and temperature sense on the opposite side everywhere below the level of the lesion.

The destruction of the posterior commissure in the lower cervical and upper dorsal regions produces the dissociated sensory loss symmetrically over the thorax, upper extremities, neck and face, the distribution varying with the extent of the lesion. The sensory loss over the face is explained in that the sensory root of the trigeminal nerve has its ending in the upper three segments of the cervical spinal cord, and the pain and temperature sensibility of the face is interfered with, if the posterior grey commissure in the region of these segments is damaged. Only rarely does the symmetrical sensory loss extend below the thorax, for the reason that the spinal lesion does not often extend below the mid-dorsal region. The sensory loss will vary in depth, extent and symmetry of distribution according to the completeness, extent and symmetry of the lesion. Thus, in early and slight cases, the sensory disturbance may not amount to more than a relative loss of pain and temperature confined to the hands and ulnar borders of the forearms, while in an advanced case there is usually complete inability to appreciate painful and thermal stimuli over an area which would be covered

by a sleeved jacket, and this area often extends over the neck and the face. Combinations of the "sleeved jacket" sensory loss with hemianalgesia and hemithermanæsthesia often occur in cases where both the spinal lesion and the medullary lesion are present. The dissociated sensory loss makes its advent insidiously, and is often unnoticed by the patient and discovered for the first time on medical examination. Or, it may appeal to the patient, who on bathing finds that he appreciates heat and cold upon some parts of the skin and not on others. Not infrequently he finds that he injures himself or burns himself without noticing it at the time.

Subjective sensibility is not often affected, and for the most syringomyelia may be described as a painless disease; but there are very notable exceptions. Sensations of heat and cold, dull fixed pains, lasting neuralgic pains, and lightning pains in no way differing from those of tabes, may occur. These pains are confined to the regions which are the seat of the other symptoms. Especially important in this connection are those cases in which the distension of the cervical spinal cord is so great as to cause that structure to press upon the bones of the spinal canal. Here constant and often intolerable aching pain in the neck, upper extremities and thorax may result, with rigidity of the neck, and this may render life so insupportable as to necessitate surgical interference for the relief of the pressure.

Muscular atrophy.—This common clinical feature of syringomyelia is met with in considerably more than half the cases. It is wrongly described as a "progressive" muscular atrophy, for it is dependent upon the local lesions of the grey matter, and often does not progress beyond a certain degree, which may be slight. As may be gathered from the nature of the lesions, though usually bilateral, it is often not symmetrical, and may be entirely confined to one side. The intrinsic muscles of the hands and the muscles of the ulnar side of the forearms are first and most affected in the ordinary run of cases. The atrophy is often here confined, but it may extend up the arm; but it is unusual for the whole upper limb to be affected. Sometimes the shoulder muscles are first affected, and again the scapulo-thoracic and humero-thoracic muscles may be early involved. The upper intercostals, and that section of the muscles which support the spine, supplied from the upper six dorsal segments suffer, but the scalenes seem generally to escape. The muscular atrophy is strictly limited, and is apt to become complete in the muscles affected. The lesions of the medulla may involve the motor nuclei of the cranial nerves. Atrophic paralysis of the muscles supplied by the vago-accessory nerve is far from uncommon, and the discovery of this paralysis in a young subject should always arouse suspicions of the presence of syringomyelia. The paralysis is unilateral and involves palate, pharynx and all the muscles of the larynx upon the affected side. Similarly but in much rarer cases, atrophic paralysis of the face, of the trigeminal muscles, of the sternomastoid and trapezius or of the hypoglossal muscles may occur from a unilateral involvement of the corresponding motor nuclei. Fibrillation in the affected muscles is said by most writers to be of common occurrence. It has been conspicuous by its absence in most of the large number of cases which have come under our observation. One would expect it to be confined in syringomyelia to such times as the muscular atrophy is progressing.

Contractures resulting from the muscular atrophy are commonly seen in the hands, and the deformity resulting tends towards the "griffin's paw"

type, but hardly reaches the degree seen in ulnar nerve paralysis, and is often much modified by trophic and vasomotor changes, and by the results of injuries and whitlows.

The lower extremities escape so far as atrophy of muscles is concerned. Spinal curvature is present in many cases. It consists essentially in a kyphosis or kypho-scoliosis of the upper dorsal region, with a compensatory lordosis and lateral curve in the lumbar region. The upper convexity is to the left from the major use of the right hand. It is dependent upon paralysis of the trunk muscles, from involvement of the anterior horns in the upper dorsal region, and, in addition, dystrophic changes in the bones may be factors in its production. It is more marked the earlier it commences during the period of growth, and where heavy manual occupation has been followed.

Two other forms of paralysis may be met with in the upper extremity, either alone or combined with the atrophic palsy. The one is a spastic paralysis, usually incomplete and often slight, due to the involvement of the crossed pyramidal tract in the lateral column of the cervical spinal cord, anywhere above the fifth cervical segment. The other is a peculiar and usually complete flaccid palsy of the hand without muscular atrophy, and presumably this is the result of a local lesion in the region of Clarke's column and the posterior horn, which, on the one hand, destroys the terminations of the pyramidal tract in Clarke's column, thereby producing the local paralysis, and, on the other, cuts the reflex arc from the posterior roots to the anterior horns, thereby rendering the paralysis flaccid.

Trophic and vasomotor disturbances.—Thickening of the bones or a condition of osteoporosis and brittleness may be met with. More often Charcot's arthropathy occurs. It differs in no way from the similar condition in tabes dorsalis, and is confined to the joints of the analgesic region, and affects the joints of the lower extremity only when there is a hemianalgesia from a lesion of the spinothalamic tract either in the cord or in the medulla. In syringomyelia Charcot's joints are seen chiefly in workmen who are engaged in occupations which constantly expose the analgesic joints to jarring and bruising.

The most characteristic of the trophic changes consists in thickening of the subcutaneous tissue and of the skin itself, which is seen in the hands. The fingers become thick and swollen and lose their natural outline, the tips become blunted, and the knuckle-folds thick and coarse, and some vasomotor paralysis renders then unduly red, or even blue. They have been termed "sausage-like" fingers, and often stand out in contrast to the wasting of the intrinsic muscles of the hand. A similar condition affecting the whole hand is common, and was termed by Charcot the "fleshy hand" or "main succulente." The analgesic condition of the hands and the thermanæsthesia present expose them unduly to injuries and, since these injuries are likely to be unnoticed or disregarded, septic infection arises easily, and the results of injuries, burns and whitlows are frequently seen, giving rise to further deformity from scars, loss of the terminal phalanges, from whitlows and contractures, and from sepsis extending to the tendons.

The lower extremities usually present a slight spasticity, with the signs of involvement of the crossed pyramidal tracts. This does not often produce much disability in the use of the lower limbs. In cases, however, where the lesions involve the lateral regions of the cord, either by direct extension or by

the pressure of distended cavities, severe spastic paraplegia may result. And again, in very rare cases, such pressure may lead to total evascularisation and total transverse lesion of the spinal cord with the appearance of a complete flaccid paraplegia with incontinence, total sensory loss and absent deep reflexes.

Sphincter trouble is usually absent, or slight and occasional; but in cases where paraplegia is severe any degree may occur.

The skin reflexes of the trunk are diminished or absent, and the plantar reflexes are of the extensor type, according to the degree of pyramidal involvement. Some degree of pes cavus is often present. The knee-jerks and ankle-jerks are increased, and foot-clonus, etc., is present.

Considering that the efferent neurons of the cervical sympathetic system have their origin in the brain stem, and their exit from the spinal cord in the lower cervical and upper dorsal segments, thus traversing the whole of the region usually affected by the lesion of syringomyelia, the frequency with which paralysis of the cervical sympathetic occurs is easily understood. It may be complete or incomplete, unilateral or bilateral, and is recognised by smallness of the pupil, narrowing of the palpebral aperture (sympathetic ptosis), enophthalmos, and a peculiar flatness of expression on the side of the face affected, with decrease or loss of sweating. These signs are much more obvious when unilateral than when bilateral, for, in the absence of the contrast which a normal side of the face gives, they are often overlooked when bilateral.

Papilloedema has been recorded in several cases. It may be due to the occasional massive tumour formation within the skull case, to which reference has already been made; but more often it is the result of the enlargement of the cervical region of the spinal cord, which may tightly fill the theca and completely obstruct the spinal outflow of the cerebro-spinal fluid, and so give rise to a relative hydrocephalus. Ophthalmoplegia is very rare, but it may occur, since the syringomyelia lesion may be found as high as the region of the third nucleus. Nystagmus is an almost constant feature of syringomyelia, as it is also of most lesions of the cervical spinal cord. It may be due to pontine lesions of the brain stem, which interfere with the cerebellar connections, or to lesions of the cervical cord which involve cerebellar afferents, and which interfere with the physiological connections between eye movements and neck movements.

Morvan's Disease.—This variety of syringomyelia is so peculiar in its clinical aspect as to need especial description. In addition to the lesion of the spinal cord characteristic of syringomyelia, there are intense changes in the periphery of the nerve trunks of the limbs. Instead of the usual loss of pain and temperature sensibility, distributed in jacket form upon the upper limbs and trunk, there is absolute loss of all forms of sensibility in the hands, wrist high, and in many cases also in the feet, ankle high. Progressive atrophy of the intrinsic muscles of the hands and feet occurs. Severe vasomotor paralysis brings about permanent cyanosis of the hands and feet, with much thickening of the skin and subcutaneous tissues, to which is added the effects of injury and septic processes in insentient regions, in the form of whitlows, necrosis and loss of digits. Gowers states that the affection of the feet is rare, but in three cases which we have had under our care, the hands and feet were equally affected; the loss to all forms of sensibility was sharply limited at the wrist and ankle; while the presence of abnormalities

of the pupils and of the palpebral apertures, as well as spinal curvature, were certain indications of the lesion in the cervical cord. These three cases had been diagnosed as Raynaud's disease. Another peculiarity of this malady is that the extremities are exceedingly painful in the early stages and until the sensory loss becomes deep. Morvan's disease resembles Raynaud's disease in the cyanosis and tendency to necrosis of the fingers and toes, but it is easily distinguished by the complete absence of intermitting vascular spasm and by the peculiar loss of sensibility. Anæsthetic leprosy may be distinguished from Morvan's disease by the characteristic skin lesions in other parts of the body, by the palpable thickening of the nerve trunks, and by the less definitely limited areas of sensory loss. Every transition between typical syringomyelia and Morvan's disease has been described.

Course and Duration.—The malady, commencing insidiously, progresses very slowly, and often ceases to progress for periods which may amount to many years. The tendency to the destruction of life is not great; but when rapid extension of the physical signs, and especially of paralysis and muscular atrophy of the upper extremities and respiratory muscles, occurs, the end is likely to come quickly. Signs of great distension of the cavities, such as pain and rigidity of the neck, and also severe and increasing paraplegia, with sensory loss of all forms of sensibility below the level of the lesion, point to a rapidly fatal termination.

It is not unusual to meet with well-marked cases in which the signs develop and increase during late childhood and early adult life, and then remain more or less in a stationary condition, allowing an occupation to be followed until well after middle life has been reached; but with the advent of the degenerative period of life, from the age of 45 years onwards, there is always a slow increase of the disability which puts an end to useful capacity. Many of the cases become incapacitated in early life, after which the disease becomes arrested, and the patients live on for many years, sometimes in a bedridden condition. Few reach the age of 60 years. Rapid extension of the physical signs leads to death from involvement of respiratory muscles. Otherwise the patients succumb to intercurrent disease. Sudden and unexpected death sometimes occurs, and it is especially to be remembered that this is likely to occur after the administration of anæsthetics, and as a result of surgical procedures. In three patients under our care, in whom laminectomy and incision of the distended cavity were performed, two survived and were much relieved, while the third, after he had apparently borne the operation well, died suddenly and unexpectedly on the third day. Another patient, who underwent operation for a surgical condition unconnected with the syringomyelia, and not of a serious nature, died suddenly and quite unexpectedly after recovering from the anæsthetic.

Diagnosis.—Syringomyelia has to be differentiated, in its early stages, from those diseases which cause slowly progressive muscular atrophy in the upper extremities, and, in its later stages, from other lesions of the central region of the spinal cord. Those cases in which the lesions are chiefly in the ponto-medullary region must be distinguished from other slowly oncoming lesions of the brain stem.

The age of onset, during the later years of childhood and the earlier years of adult life, is important, and during this period slowly developing paralysis, with or without muscular atrophy and with sensory loss, should always

suggest the possibility of syringomyelia. Other causes, which may produce this symptom group, and which may be confused with syringomyelia, are local lesions of the peripheral nerves, local lesions of the brachial plexus, and, especially, the lesion produced by the presence of cervical ribs, root lesions, lesions of the central grey matter of the spinal cord, especially central tumours of the spinal cord, hæmatomyelia, and lastly certain general diseases of the nervous system, progressive muscular atrophy, peroneal atrophy and myotonia atrophica. That the sensory changes of syringomyelia of peculiar nature are usually the first signs of that disease is important; but unfortunately is not without many exceptions, both as to the nature of the sensory changes and as to their time of appearance.

Local lesions of the peripheral nerves produce signs which are confined to the distribution of the nerve involved; the sensory loss is to all forms of sensibility, and the condition is commonly unilateral. In syringomyelia, however, the lesion in the early stages may be confined to one side of the cord, and to one posterior horn so far as the production of sensory loss is concerned, and the muscular atrophy may be so narrowly confined to the distribution of the ulnar nerve as to cause close resemblance between the two conditions. Any sensory loss over the trunk, or signs outside the distribution of the peripheral nerve, will, if present, clearly divide the two conditions.

Cervical ribs may produce slowly progressive atrophy of muscles, pains and sensory loss, very difficult to distinguish from those resulting from syringomyelia. The diagnosis in these cases is beset with peculiar difficulties, for so frequently do cervical ribs produce no nervous symptoms at all that their presence, when demonstrated, does not argue that they are the cause of the symptoms. Again, cervical ribs are among the commonest of the developmental peculiarities which are so frequently seen in the subjects of syringomyelia. Moreover, it has been proved, by several observers of the French School, that cases regarded as examples of cervical rib paralysis during life have shown the lesions of syringomyelia upon pathological examination, and it has been argued by these observers that many of the cases accepted as cases of cervical rib paralysis, are in reality cases of syringomyelia. And, further, it must be admitted that the course of some of the so-called cervical rib paralyses, and the unsatisfactory results of surgical interference in others, do not contradict this point of view. Slow muscular atrophy and slowly oncoming sensory loss and perhaps pain characterise both syringomyelia and cervical rib paralysis, and the distribution may be unilateral or bilateral in either condition; but it is only when the signs and symptoms are strictly confined to the upper extremities and neck that difficulty arises. The slightest definite physical sign outside of this region at once turns the diagnosis in favour of syringomyelia, and of these signs cervical sympathetic paralysis, sensory loss on the trunk, and alteration of the abdominal and plantar reflexes are most important. A very careful search must be made for any such signs, and the patient observed over a considerable time before a certain diagnosis is made.

Lesions of the nerve roots, either from inflammatory conditions, bone disease, pachymeningitis or neoplasms give rise to more severe pain than does syringomyelia, and the development of the symptoms is much more rapid. Lesions of the central grey matter of the spinal cord may produce a symptom

complex, closely resembling that of syringomyelia. Central tumours of the spinal cord, when of slow growth, are hardly distinguishable, inasmuch as the lesion of syringomyelia is in reality a central tumour of the cord. The majority of central tumours however are of more rapid development, and speedily produce severe paraplegia. The presence of Froin's syndrome (hyperalbuminosis in the cerebrospinal fluid) is much in favour of tumour.

In hæmatomyelia the symptoms and signs are usually identical with those of syringomyelia; but they are of sudden onset, and reach a maximum intensity in a short time, which is rarely longer than a few hours, and may be as short as a few minutes, after which the symptoms tend to lessen from the absorption of the blood extravasation, or at least to remain stationary. Those cases of hæmatomyelia which have been recorded as subsequently progressing, as does syringomyelia, are certainly cases in which hæmorrhage has occurred into the lesion of syringomyelia, which may have been early or symptomless, and has there lighted up a progressivity in the primary pathological lesion.

Progressive muscular atrophy in its early stages may cause considerable difficulty in diagnosis, and this is easily intelligible when it is realised that the muscular atrophy in syringomyelia may in rare cases precede the appearance of any sensory loss or may be well marked when the sensory loss is slight. Further, some cases of progressive muscular atrophy do show sensory loss at an early stage, and especially over the ulnar sides of the hand and forearm. Fibrillation, which is characteristic of this disease, also occurs in syringomyelia, when the atrophy is progressing, and such signs as slight spasticity of the legs and the extensor response in the plantar reflexes are common to both diseases. It must be pointed out also that progressive muscular atrophy is by no means rare at the age when the symptoms of syringomyelia commence. In this connection widely distributed fibrillation is of great importance in indicating a diagnosis of progressive muscular atrophy, particularly if it be seen in muscles not conspicuously wasted. Uncertainty in the diagnosis between these two diseases is soon dispelled by the lapse of time, which either brings undoubted signs of syringomyelia in its train, or a progressive muscular atrophy with conspicuous absence of such signs. In peroneal atrophy the atrophy of the intrinsic hand muscles is always preceded by a more extensive atrophy of the muscles below the knee, which are never atrophied in syringomyelia.

Dystrophia myotonica is distinguished in that the atrophy of hand muscles is associated with conspicuous difficulty in relaxing the grip, and by the weakness and atrophy of the facial muscles, sternomastoid and quadriceps muscles.

Syringomyelia of the brain stem may be distinguished from other lesions of this region by its insidious onset and the special tendency to the involvement of the lateral region of the medulla containing the vago-accessory nucleus and the central pain and temperature path, so giving rise to a unilateral paralysis of palate, pharynx and larynx with hemianalgesia and hemithermanæsthesia on the opposite half of the body. Often some signs of cervical syringomyelia coexist; but the medullary lesion may exist alone, and it cannot be too prominently borne in mind that any very slowly progressive lesion of the brain stem of insidious onset may be of the nature of syringomyelia.

Prognosis.—Recovery never occurs; but arrest of the disease for long periods is frequent. Those disabilities, which are the result of pressure or distension, may abate spontaneously or as the result of treatment, and in arrested cases training may bring about lessening of the disability. Increasing symptoms, especially if the increase be rapid, are always a cause for anxiety, and increasing involvement of the respiratory muscles is the gravest of events.

Treatment.—Both mercury and iodide of potassium appear to have a definite effect in benefiting the disease when the symptoms are progressing, and are the best measures we have in attempting to influence the course of the disease. Mercury should be administered vigorously for periods of 2 months at a time, and preferably by inunction. Iodide of potassium should be given in moderate doses. Application of X-rays to the cervical and upper dorsal regions of the spinal cord has been followed by beneficial results in the way of arrest of the progress of the disease and improvement of symptoms. Where severe cervical pains, rigidity and pain on moving the neck, or rapidly increasing paraplegia point to great distension of the cavities, surgical measures alone afford relief. Laminectomy with incision of the posterior column, and evacuation of the fluid in the cavity, has been performed with conspicuous success and lasting relief of symptoms. The danger of all operations under an anæsthetic, which has been pointed out above, must be taken into consideration, as it is not likely that more than 50 per cent. of the patients would survive. Cervical puncture is perhaps in skilled hands a preferable measure, but it does not ensure the permanent draining of the cavity as does incision into the posterior columns. Pains are to be relieved with the common analgesics. Massage, exercises and training are all likely to make some improvement in the disability in arrested cases.

HÆMATOMYELIA

Hæmorrhage into the substance of the spinal cord may occur in several forms and in widely separate clinical relations. It may occur without recognisable physical signs. It may result as a secondary event following severe damage to the spinal cord either by injury, inflammation, softening or tumour formation, and is here in the relation of an exacerbator of the physical signs due to the original lesion. If the original lesion be a very severe one, even massive hæmorrhage may produce no addition to the clinical aspect, and so remain unsuspected. Primary hæmorrhage into the spinal cord is, however, of not very infrequent occurrence, and cases of this nature constitute hæmatomyelia as a clinical entity.

The experiments of Goldscheider and Flatau have proved that fluids, when slowly injected into any parts of the transverse area of the intact spinal cord (the posterior white columns conspicuously excepted), tend always to seek the grey matter and there to take up a situation of fusiform shape, especially in the regions of the anterior horns locally, and in the regions of the posterior commissure and posterior horn at a distance.

Massive effusions of blood into the spinal cord may be round or oval in shape and nearly as broad as long, and this happens when clotting occurs rapidly after effusion, and when the bleeding takes place into an area of

softening caused by myelitis, thrombosis or pressure. Much more commonly they are fusiform in shape and occupy the planes of the least tissue resistance. Sometimes the blood is found distending a congenital cleft or cavity in the spinal cord, and it seems clear that in many of such cases the bleeding is determined by the presence of such a cleft or cavity.

Small Hæmorrhages.—These may be found scattered throughout the spinal cord after death from asphyxia, tetanus, phosphorus poisoning, any hæmorrhagic disease, pernicious anæmia, and after many infective processes. They are found chiefly in the white matter, and may be very numerous. In all these conditions such hæmorrhages seem to be terminal events occurring very shortly before death, and are not associated with any definite symptoms.

Traumatic Hæmorrhages.—Since bleeding is a sequel of every severe injury, massive hæmorrhages may be found in cases where gunshot and other penetrating wounds, impact lesions from missiles, bruising from the jar of high explosives, or falls and fracture dislocations have injured the spinal cord. They are of pathological rather than of clinical interest.

Secondary Hæmorrhages.—Bleeding may occur as a secondary process in poliomyelitis, lethargic encephalitis, myelitis, and in softening of the spinal cord from any cause whatever. In this connection it may be met with following the relief of pressure, when a spinal tumour has been removed. Grainger Stewart has recorded two cases in which hæmatomyelia was secondary to the pressure of an extradural tuberculous abscess.

Primary Hæmorrhage.—In this group are included those cases where no cause for the bleeding can be discovered, those in which the factors associated with the onset seem trivial, and where any injury received seems inadequate to account for the result. They form a striking and characteristic group to which the clinical entity of hæmatomyelia is in reality restricted.

Ætiology.—Nearly all the cases occur between the ages of puberty and 30 years. The age incidence falls among young adults, when the mobility of the spinal column, the muscular development, and the possibility of spinal clefts, still persistent, are all likely to be factors in the production of hæmatomyelia. The condition may, however, occur in children at any age. The sexes are equally affected. The most careful investigation often fails to reveal any cause whatever for the onset. Not infrequently a comparatively trivial cause seems responsible, such as straining, coughing, lifting a heavy weight, suppression of menses, exposure to cold and diving into water. The raising of the blood-pressure during moments of intense excitement is certainly the cause of the hæmorrhage in some of the cases. The instantaneous onset of the paralysis, which is so striking a feature where a sudden jerk of the neck, as in diving, coughing, etc., may have been the immediate antecedent, is very suggestive that actual bruising of the cord by the sudden strain is responsible for the lightning-like onset of the paralysis, and that the hæmorrhage is a secondary result of such bruising, for it is difficult to conceive that a hæmorrhage could produce a complete abrogation of the functions of the spinal cord in the space of one second, whereas this might easily result from a slight bruise.

Symptoms.—Hæmatomyelia is characterised by sudden onset, usually without any pain, but commonly with a sensation of numbness, "pins and needles," or an electrical sensation in the region affected. The paralysis

may be instantaneous, as from a sudden bruise of the spinal cord, or rapidly ingravescent, such as would result from a quickly gathering hæmorrhage, the local segmental signs appearing first and the paraplegic signs subsequently. The clinical aspect is that of a lesion of the central grey matter of the spinal cord. There is local atrophic paralysis of the muscles supplied by the segments involved, from extension of the hæmorrhage into the anterior horn-cell region with involvement of the sympathetic system, vasomotor paralysis, sweating, and, if the lesion is in the cervical region, with cervical sympathetic paralysis in addition. These signs will be unilateral, bilateral or irregular according to the extent of the damage to the anterior grey matter. There is bilateral loss of sensibility to pain and temperature from destruction of the posterior grey commissure in which the path for these forms of sensibility crosses. The vertical extent of such loss upon the body is determined by the vertical extent of the hæmorrhage in the region of the posterior commissure. There is frequently loss of sensibility to pain and temperature on the opposite side of the body below the level of the lesion, when the latter is more extensive upon one side of the cord, from involvement of the crossed path for pain and temperature, lateral to the ventral grey horn. The posterior columns are conspicuously exempt in most cases, and there is consequently neither loss of touch, nor of position or muscle sense. There is sometimes a zone of hyperæsthesia at the upper limit of the sensory loss. On account of the obliquity of the crossing of the paths for pain and temperature in the posterior commissure, the upper limit of the sensory loss is always a few segments below the upper limit of the muscular wasting.

The general distension of the spinal cord by the increasing hæmorrhage, and the resultant œdema, causes a spastic paralysis below the level of the lesion and interference with sphincter control, with the usual loss of abdominal reflexes, briskness of knee- and ankle-jerk and extensor type of plantar reflex. In this early stage of the malady, cystitis and bedsores may give trouble. Death may occur before the bleeding has ceased, from extension of the hæmorrhage as high as the fourth cervical segment, and consequent paralysis of the diaphragm. Such a fatal result is, however, very rare, for it is most unusual for the hæmorrhage to extend as high as the fifth cervical segment. The intercostal muscles are usually paralysed in cervical hæmatomyelia, either from a downward extension of the hæmorrhage, which is very common, or as a part of the paraplegia.

When the bleeding has ceased and absorption of the clot commences, the symptoms gradually clear up. As the distension of the spinal cord lessens, the spastic paraplegia and the sphincter trouble abate, and in the course of time great improvement may occur and even complete recovery, so far as the paraplegic symptoms are concerned. The initial local atrophic paralysis narrows down somewhat as the local effects of the pressure and œdema produced by the hæmorrhage upon the ventral horns pass off, leaving a permanent atrophic paralysis, with vasomotor paralysis and sympathetic paralysis, corresponding with the regions of the ventral horns which have been irrecoverably damaged. The analgesia and thermanæsthesia resulting from the local destruction of the posterior commissure, remain permanently. The similar sensory loss, due to involvement of the crossed tract in the antero-lateral region of the cord, is transient or permanent according as the lesion in that region is destructive or recoverable.

A few of the cases after making considerable improvement progress as do cases of syringomyelia. Here the explanation is either that a hæmorrhage has occurred in the lesion of a previously symptomless syringomyelia, or that the irritation produced by the hæmorrhage is capable of starting a central gliosis of the spinal cord. The cerebro-spinal fluid shows no abnormality during the first few days following the onset. The hæmorrhage seems never to burst into the meninges. Later on the fluid may present a yellow colour (xanthochromia) from the gradual discharge of the blood pigments from the clot.

Diagnosis.—The diagnosis of primary hæmatomyelia rests upon the sudden onset, the rapid development of symptoms which soon come to a standstill, and the physical signs of a central lesion of the spinal cord, namely, local atrophic paralysis of the muscles, loss of pain and temperature sensibility with a conspicuous escape of other forms of sensibility, and, when the lesion is above the lumbo-sacral enlargement, spastic paraplegia from the general pressure exerted by the hæmorrhage upon the structures of the spinal cord.

The distinction has to be made from acute myelitis and acute poliomyelitis. Acute myelitis, though rapid in onset, does not show the sudden development of symptoms seen in hæmatomyelia. Prodromata often precede the onset. This disease is rare in the cervical and lumbar enlargements, where hæmatomyelia is most common. It usually affects the whole transverse area of the cord and, therefore, does not give the peculiar dissociated sensory loss. It is nearly always of syphilitic origin, and the Wassermann reaction in blood and cerebro-spinal fluid is positive, and the latter shows a lymphocytosis. From acute poliomyelitis, hæmatomyelia may be distinguished by the initial febrile symptoms of the former disease and by the absence of sensory loss and by the lymphocytosis in the cerebro-spinal fluid.

Course and Prognosis.—Following the sudden onset and abrupt development of symptoms, the hæmorrhage ceases in the majority of the cases, and with the gradual absorption of the clot the symptoms abate, leaving the patient permanently crippled to a greater or less extent with atrophic paralysis, spastic paralysis and loss of pain and temperature sensibility, the degree of which varies according to the region of the spinal cord which is affected, and according to the amount of permanent destruction of tissue in the affected segments. During the early stages of the disease there may be danger to life in the cervical cases, from interference with the respiratory muscles and later on from cystitis, bed-sores and pulmonary complications.

Treatment.—Absolute rest is all-essential. It has been often urged that the prone position, or a position lying upon the side, supported by pillows or plank covered with a blanket arranged vertically in the bed, and against which the patient rests, should be secured so that the seat of the hæmorrhage may not occupy the dependent part of the trunk. Such a position, however, must not be maintained at the expense of any respiratory embarrassment, nor involve any possibility of the production of bedsores. Measures should be adopted to allay panic, to keep the blood-pressure from temporary elevations, and to check the hæmorrhage. Morphine, calcium lactate and turpentine are the most likely to be of use in this connection. Ergot in full doses and other vaso-constrictors have been advocated, but it is not certain whether

the increased blood-pressure produced by these drugs may not more than counteract any local vaso-constrictor effect that they may have. Great care must be taken from the first that no distension of the bladder shall occur, for this is the primary cause of cystitis. If cystitis has set in, it is essential to resort to suprapubic drainage at once. The most scrupulous attention must be paid to the skin in the way of cleanliness, hardening and avoidance of pressure, lest bedsores should develop. If lumbar puncture is requisite for diagnosis, a minimal amount only of fluid should be drawn off, and this should be done slowly. Subsequently, the administration of mercury and of iodide of potassium may aid the absorption of the clot. Belladonna in moderate doses is always helpful in aiding the return of sphincter control. Ultimately massage, passive movements, exercises and the application of supporting apparatus are to be employed, as in all other cases of spinal paralysis.

MYELOMALACIA; SOFTENING OF THE SPINAL CORD

The term "myelomalacia," which implies softening of the spinal cord, has been applied by some authors to those conditions of local destruction of the spinal cord consequent upon the cessation of blood supply, and especially upon thrombosis of its blood vessels, as apart from the extensive local destructions which may result from inflammatory conditions. Such a distinction does not rest upon any logical, pathological or clinical basis, for thrombosis and ischæmia make up a part of the pathological process of all traumatic, inflammatory and pressure lesions of the spinal cord, and may occur as terminal events in certain diseases of the spinal cord where vascular lesions are otherwise conspicuous by their absence. Therefore, since softening of the spinal cord may be the result of widely different pathological processes, and since it does not constitute a definite clinical entity, it will suffice in this place to refer to those maladies in which it is chiefly observed.

Traumatic Conditions.—As a result of the intense vibration set up by the lines of force of high explosives bursting in the neighbourhood of the spinal column, even without signs of external injury or signs of damage to the bones, the spinal cord may be found to be completely diffluent over several segments. The same result may be met with from the passage of a high velocity bullet through the spinal canal, whether the spinal cord be touched by the bullet or not; and again, the same condition occurs from the vibration of an impact when a missile hits and lodges in the surrounding bone, without directly involving the spinal canal or cord. A slighter degree of the same condition may be seen in fracture dislocations. When, as the result of injury to the spinal column, the spinal cord is torn across, the distal segment may soften completely.

Pressure Lesions.—Pressure upon the spinal cord abrogates function chiefly by producing ischæmia and, if the pressure be prolonged or severe, necrotic softening occurs, and the more readily, if there be strangling of the segmental vessels which supply the cord and accompany each nerve root, as in cases of syphilitic, tuberculous or cancerous pachymeningitis, or if there be coincident disease of the vessel walls as in syphilis and atheroma It must be borne in mind that the pressure may be exerted from within

the cord, as, for example, by the acute œdema of the cord which is so important a factor in producing the rapid onset of paralysis in acute myelitis and in syringomyelia, where complete transverse softening may occur from the distension of a cavity. Local patches of softening from strangling of segmental vessels are one of the chief causes of non-recovery from the paraplegia of spinal caries when pressure has been relieved. In intrathecal hæmorrhage, where the blood has been allowed to form a massive clot round the lower part of the spinal cord, extensive softening may occur.

Inflammatory Conditions.—In acute spreading myelitis, in which the spinal cord is infected with micro-organisms secondarily to a general blood infection, as may occur in small-pox, gonorrhœa, dysentery, etc., the cord softens and may become diffluent. In acute transverse myelitis, softening depends upon the severity of the initial œdema and its duration, the degree of obliterative arteritis, and the consequent thrombosis that may occur. It may be largely avoided by the energetic and early application of anti-syphilitic treatment.

Terminal Softening in Progressive Diseases.—In certain progressive diseases of the spinal cord, extensive thrombosis of the vessels with softening may occur. For example, in a case of subacute combined degeneration, which had been under my observation for several years, complete flaccid paraplegia occurred a fortnight before death. The most extensive thrombosis of the cord was found below the eighth dorsal level, with complete necrosis of the distal segment throughout. A similar condition is not infrequently seen in paraplegia from spinal caries.

Senile Paraplegia.—This condition, which is not very rare, and in which spasticity of the lower extremities with weakness comes on gradually in later life, and does not, as a rule, reach a severe degree, has been attributed to ischæmia and even to softening of the spinal cord from arterial disease and the failing circulation of old age, by Moxon, who first described it. The pathology of these cases seems by no means certain, and there are few records of the anatomy. It seems certain that no appreciable softening can occur, on account of the slightness of the paraplegia and the absence of any sensory loss. Gowers doubted whether they were spinal in origin at all, and attributed some to the occurrence of cortical changes in the brain, while others he placed in the category of paralysis agitans. From the occurrence of definite mental failure in some of the cases, a cerebral site for the lesion is likely. Dr. Greenfield has recently examined for us a very typical case and found no changes in the spinal cord, but extensive degeneration of the pyramidal cells of the motor cortex. In one case, clinically belonging to this class, laminectomy revealed ivory-like exostoses narrowing both the spinal canal and the intervertebral foramina, and the case was obviously one of a slow-pressure lesion.

SUBACUTE COMBINED DEGENERATION

Synonym.—The Anæmic Spinal Disease.

Definition.—Subacute combined degeneration is a disease most common in the second half of adult life, of which the onset is usually insidious and the course progressive to a fatal termination. The lesions in the nervous system consist of a primary demyelination, commencing in the centre of the

white columns and affecting the long fibres first and most, and the short intersegmental fibres which lie close to the grey matter last and least. Neuroglial condensation follows very slowly upon the demyelination. The posterior and lateral columns of the spinal cord are early affected, and it is to the affection of both these columns that the term "combined degeneration" alludes. The clinical features are usually strikingly distinct, in that subjective sensations, such as tingling, numbness and burning, occurring usually at the periphery of the limbs, are early, obtrusive and persistent, and are accompanied or followed by the development of a paraplegia which may be of a spastic, or a flaccid and ataxic, or of a mixed type, according to the degree of affection of the lateral and of the posterior columns in each case.

The deep reflexes are present, exaggerated or absent, according to the relative affection of these columns. The superficial reflexes are remarkably brisk, in sharp contrast to the diminution of these reflexes which usually obtains when the lateral columns of the cord are affected. Loss of sensibility of peculiar distribution occurs, which has a "glove and stocking" distribution upon the limbs and a segmental distribution upon the trunk. In the late stages of the malady, the paraplegia tends to become complete and of the flaccid type, with loss of the deep reflexes. Anæmia accompanied by a peculiar "biscuit-like" discoloration of the skin is present in all cases at some period of the disease, with the exception of some few of the cases of short duration. This anæmia tends in every case, if life is prolonged, to develop into a pernicious anæmia which is typical, both clinically and pathologically.

Ætiology.—First met with in the third decade of life, the malady becomes increasingly frequent until a maximum incidence occurs in the sixth decade, while cases commencing in the seventh decade are not uncommon. The sexes are equally affected. Familial incidence in this disease, as also in pernicious anæmia, has been recorded by Hurst, Piney and others. Little is known of the causal factors of the disease, and in the majority of the recorded cases the patients have been strong and healthy until the onset of symptoms. In a considerable number of cases, however, symptoms pointing to gastro-intestinal infection, such as vomiting, diarrhœa, anorexia or constipation, sometimes accompanied by fever and occasionally by jaundice, have been prominent before the onset of the nervous symptoms.

Pathology.—The essential lesion is confined to the white matter of the spinal cord and brain stem. The grey matter is unaffected, except for the changes which result from destruction of certain tracts in the white matter. The meninges and the anterior and posterior roots are normal, but some degeneration is always found in the peripheral nerves. In macroscopic appearance the spinal cord is larger than normal, since the nature of the lesion is œdematous, and there is no neuroglial condensation; and in this respect the disease differs widely from other forms of postero-lateral and scattered degeneration, for in these latter conditions shrinking of the spinal cord is always conspicuous. The degeneration usually commences in the lower dorsal region of the cord, and is first seen in the centre of both posterior columns, and soon afterwards in the centre of either lateral column, as small areas of a darker and more translucent appearance than the normal white matter. It is only at an early stage of the disease that the anatomical picture is strictly one of postero-lateral degeneration, for soon after, spots of degenera-

tion appear on either side of the anterior median fissure and in other parts of the antero-lateral columns. The degenerated areas increase in size centrifugally, coalesce with one another, reach the surface of the cord and eventually involve the whole of the white matter of the cord as seen in transverse section, with the exception of the narrow zone of short internuncial fibres which everywhere clothe the grey matter. This "annular or ferrule-like" degeneration in the lower dorsal region is highly characteristic, and occurs in no other disease.

From its starting-point in the lower dorsal region the degeneration spreads upwards and downwards in the white columns of the spinal cord, and for this reason the term "funicular myelitis" was applied to it by Henneberg. This extension depends upon the occurrence of small isolated spots of degeneration in the posterior, lateral and antero-lateral columns, which increase in size and thus join the area previously degenerated. The degeneration tends to extend upwards indefinitely, and in severe and advanced cases has been found as high as the internal capsule in the pyramidal tract.

The lesions of the white columns entail the usual secondary degenerations, both ascending and descending; but these occur late, and are often much less obvious than might be expected from the severity of the local lesions. The destruction of the axons by the local lesions also causes a series of retrograde changes in the corresponding nerve-cells, and tigrolysis, vacuolation, shrinking and neurophagy may be conspicuous, especially in the cells of Clarke's column and in the cells of Betz, which give origin to the pyramidal fibres. Kattwinkle considers that the primary spots of degeneration are determined by the vascular distribution, and that they result from disease of the perivascular lymphatics. In the development of these spots the following sequence of changes can be seen. The earliest is swelling of the medullary sheaths over a small area of the white matter. The swollen sheaths then break up by fatty degeneration, and the axis cylinders become no longer recognisable. The degenerated contents of the swollen medullary sheaths now gradually disappear, leaving nothing but the fine connective tissue of the spinal cord surrounding vacuolated spaces of varying size filled with fluid, some of which represent the spaces originally occupied by the nerve fibres, but others are formed by the fusion of several such spaces. However long standing the case may be, there is practically no neuroglial reaction with condensation or shrinkage of the spinal cord, and consequently the spinal cord remains large. Occasionally the disease is entirely confined to the posterior columns of the spinal cord. The peripheral nerves may show considerable degeneration. The muscles are conspicuously wasted in the later stages, and the muscle fibres show great diminution in size and poor striation. There is not any considerable increase of the muscle nuclei, and little or no fibrosis occurs.

Blood.—In a few instances, anæmia has been absent throughout, the hæmoglobin content and the cytology being normal; this has occurred chiefly in cases which have run an acute and fatal course in a few months. Usually the blood shows an anæmia of varying severity; the hæmoglobin ranges from 35 to 75 per cent., the lower of these figures being common: the colour index is usually above the normal, and may be as high as 1·6. Anisocytosis, poikilocytosis and polychromatophilia are common. Normoblasts are often numerous and megaloblasts may be found in numbers. A relative lymphocytosis is almost always present, and may reach as much as 55per cent. This

change occurs early, and is helpful in the confirmation of the diagnosis of the nervous disease.

A careful investigation of the blood-changes at various stages of the disease and of the post-mortem findings in a large series of cases has proved beyond any possible doubt that the blood-changes in every case are identical with those met with in the various stages of pernicious anæmia, and that a typical post-mortem picture of pernicious anæmia occurs frequently in subacute combined degeneration. The cerebro-spinal fluid presents no abnormalities either as regards albumin, sugar or cells.

The early writers believed that the anæmia was the essential part of the disease, and that the degenerations in the nervous system were the result of vascular changes consequent upon the anæmia. This view is negatived by the facts that some cases progress to a fatal issue without any evidence of anæmia, and that in others the nervous manifestations may become severe long before any anæmia is evident; and, most importantly, no case has been recorded in the literature, nor has one occurred in the very large series examined by the writers, in which the nervous manifestations developed in a patient already under observation for anæmia. The researches of William Hunter upon the causation of pernicious anæmia suggest that a gastro-intestinal toxæmia is responsible for that disease. Rothmann has subsequently shown that the intravenous injection of pyridin in dogs produces a pernicious anæmia, and, in addition, a postero-lateral degeneration of the spinal cord. Recently Orr and Rows have shown that a similar degeneration can be produced by the local action of bacterial products upon the spinal cord, and their results have been confirmed by E. Long.

The experimental evidence and the clinical and pathological features of the disease suggest, therefore, that the anæmia and cachexia and the degeneration of the nervous system are not dependent the one upon the other, but that they are the concomitant but not necessarily synchronous results of one and the same cause, which is a toxic agent of gastro-intestinal origin. Hurst and others have shown that achlorhydria is present in nearly all the cases, and Hurst is of opinion that consequent upon the achlorhydria an infection of the duodenum with the *Streptococcus longus* occurs, and that from the resulting toxæmia both the hæmolytic anæmia and the myelolytic degeneration occur.

Symptoms.—In a large majority of instances the symptoms appear insidiously and without any exciting cause. Sometimes the onset is more rapid, and may be preceded by severe gastro-intestinal symptoms such as vomiting, diarrhœa, jaundice, malaise and pyrexia. In a few cases the onset has been so rapid as to suggest the diagnosis of acute myelitis, and in one of these which was under our observation and pathologically verified, two attacks of temporary paraplegia had preceded the onset by 8 and by 4 months respectively.

The cardinal signs may be summarised as follows: peripheral subjective sensations, which occur early and are remarkably obtrusive, are complained of in the periphery of the limbs in most cases, but may occur in the perineum, neck and back of the head and in the tongue. Sensory loss is found, which commences upon the limbs with peripheral "stocking and glove" distribution, and reaching on to the trunk ascends in segmental distribution. Astereognosis occurs in the upper extremities. Paraplegia may be (*a*) flaccid from the first, with loss of deep reflexes; (*b*) spastic, remaining spastic throughout

(rare); (c) spastic, changing to flaccid paralysis with loss of the deep reflexes. (This change from the spastic to the flaccid condition may take place at any stage of the disease.) Both forms of paraplegia are accompanied by marked ataxia. Girdle sensations, lightning pains, fixed pains, gastric crises, exaggeration of superficial reflexes, are all encountered. Sphincter paralysis is late. Loss of sexual power is early. There are muscular wasting and lowering of electrical excitability of general distribution in the paraplegia region. Anæmia, which may be absent throughout or may become apparent at any period in the course of the disease, is conspicuous at the time of the onset of the nervous symptoms in about one-half of all cases.

Peripheral subjective sensations are so constantly the earliest symptom, so discomforting to the patient and so persistent, as to form a most distinctive feature of the disease. These sensations are variously described, but tingling and numbness are the most common. Creeping sensations, smarting, burning, icy coldness, tightness and pain are all common. These sensations are usually felt first upon the tips of the fingers and toes, and subsequently spread up the limbs. Lightning pains, indistinguishable from those of tabes, occur in many of the cases. A girdle sensation is the rule, and it is sometimes painful.

Sensory loss commences at the periphery and is distributed in "glove and stocking" fashion. It extends on to the trunk as time goes on, and there seems limited by the intersegmental lines. The muscle sense and sense of position are among the earliest of the sensory perceptions to disappear. Generally speaking, sensibility to pain and temperature are lost earlier, and to a greater extent than is sensibility to touch, and, as the sensory loss spreads up the trunk, the loss to pain precedes the loss to touch. In the late stages of long-standing cases, the sensory loss is likely to become absolute to all forms.

The paraplegic signs usually follow the appearance of the subjective sensations, but they may be the first evidence of the disease. They appear most often insidiously, but sometimes rapidly. The patient first notices that the legs are easily tired, that he drags the feet in walking, or that he walks unsteadily in the dark, or that he falls forward into the basin when washing himself. Slight rigidity of the lower extremities, with weakness, especially of the dorsiflexors of ankles and toes will be found, with increase of the knee-jerks, ankle-jerks, foot clonus, a tendency to pes cavus and an extensor type of plantar reflex. The defects of co-ordination are shown by the loss of sense of passive movement and of position, by ataxy of movement and by Romberg's sign. Some cases, however, form an exception to the rule that spastic ataxy is a characteristic feature of the early stages of the disease, for the knee-jerk is diminished or lost early, and the clinical picture is one of ataxy with flaccid weakness throughout. Implication of the lateral column of the spinal cord is shown in such flaccid cases by the presence of the extensor type of plantar reflex. This type of case is especially rapid in course.

Very rarely the disease is confined to the posterior columns, and when this is the case, there are no signs of involvement of the pyramidal tract. In this condition of slight paraplegia the patient may remain for years able to do some work, and he may even improve, but no case has been reported in which the signs of the organic spinal disease have disappeared. We have had many patients in whom the signs have remained stationary or improved for a period of from 3 to 6 years. Such cases, however, are the rare exceptions; for,

in most cases, the paraplegia increases in severity as time goes on, but the progress is rarely uniform. Sudden exacerbations of the symptoms may occur at any time, and these are uncommonly associated with malaise, pyrexia, vomiting or other signs of gastro-intestinal disturbance and by an increase in the anæmia, as if there had been a sudden increase in the toxic condition, which is responsible both for the anæmia and for the spinal degeneration. As the disease advances, the paraplegia involves more and more of the trunk, progressing upwards. In some cases the upper extremities are affected early, and may even be the first regions to show signs of the disease. In the course of time the paraplegia becomes complete, with great wasting of the muscles and reduction of their faradic excitability, and, when this occurs, it is usual for the spasticity to disappear with the onset of a flaccid paraplegia with diminished and finally absent knee-jerks, the extensor plantar response and the superficial reflexes persisting. On the other hand, the spastic state sometimes persists to the end in spite of absolute paraplegia and total sensory loss of months' duration, and in such cases reflex flexor spasm is likely to be a most troublesome feature.

The paraplegia does not, as a rule, reach the upper limits of the region supplied by the cervical enlargement of the spinal cord, and even in the most severe cases the condition of the upper extremities is one of partial paralysis, most marked in the periphery and associated with considerable wasting of the muscles of the hands and forearms. The faradic excitability of the muscles is much reduced, and it is diminished in proportion to the wasting. In addition to the muscular wasting, there is usually conspicuous wasting of the subcutaneous fat. In late stages of the disease the general bodily wasting becomes extreme.

Loss of sexual power in the male is often an early symptom. Dysuria generally appears when the paraplegia becomes pronounced. It does not often occur in the early stages of the malady, and sometimes its appearance is delayed until remarkably late. When once established, it does not show any tendency to improve with treatment. Finally, the control of the rectum and bladder becomes completely lost.

Superficial reflexes.—The persistence of a high degree of reflex excitability from the skin of the limbs and trunk, even sometimes in the last stages of the malady, is remarkable, and contrasts strongly with the general lowering or loss of the skin reflexes which obtains in other conditions of paraplegia where the pyramidal tract is involved. This easy excitability of the skin reflexes is highly characteristic of the disease. The plantar reflexes assume the extensor type early, and this remains throughout, and in most cases this extensor response is the first unequivocal sign of organic disease to appear.

Deep reflexes.—These are usually increased and may persist in active state until the end. More commonly they are increased at first and become lost when the paraplegia becomes severe. Less commonly they are absent throughout the course of the disease, and in rare cases they may be absent at first and subsequently reappear and become brisk. The reasons for this variability in the deep reflexes in different cases are not difficult to understand. The lesion in the posterior columns tends to abolish the deep reflexes, and if the lesion be major in these columns or confined to these columns, the deep reflexes will be diminished or absent. The lesion in the lateral columns causes exaggeration of the deep reflexes in greater degree than the diminu-

tion caused by the posterior column lesion, so that with lesions of both these columns the deep reflexes are still exaggerated. When the degeneration destroys all the long white columns of the spinal cord, the deep reflexes are lost as in total transverse lesion of the cord, and the change from the spastic to the flaccid state, with loss of the previously exaggerated deep reflexes, occurs when all the long white columns are involved. The reappearance of the deep reflexes, at first absent, means that the lesion was first confined to the posterior, and subsequently attacked the lateral columns.

Trophic changes in the nails and skin, vasomotor disturbances in the periphery of the limbs, and bedsores, are of common occurrence. Soft translucent œdema of the extremities and trunk is frequent, especially when the anæmia is severe, and is dependent upon the anæmia and upon the impaired innervation of the paraplegic region. Severe and painful local œdema, disappearing within a few hours, has occurred in three cases under our observation.

General mental deterioration, mild delirium, drowsiness and torpor frequently occur in the later stages of the disease, and are referable to the anæmia and the toxæmia, and possibly also to widely spread cell changes in the cerebrum. General convulsions have been reported in a few cases.

Dimness of vision is common when anæmia and debility are severe. Papill-œdema of slight degree is sometimes met with, and doubtless in relation to the anæmia. Optic atrophy has been reported in a good many cases. Small retinal hæmorrhages are not uncommon. A minor degree of nystagmus is the rule, and may depend upon the involvement of the cervical spinal cord, all lesions of which seem to be regularly associated with nystagmus, or this may be attributed to affection of the cerebellum, for changes in the Purkinje cells of this organ have been repeatedly found. The pupils may be small, irregular, unequal, and react poorly to light, and there may be narrowing of one or both palpebral apertures and sometimes marked enophthalmos, all these signs resulting from interference with the sympathetic mechanism in the lower cervical region of the cord. Herpes is not infrequent. It may occur anywhere, and has several times affected the distribution of the trigeminal nerve. A hæmorrhagic lesion of the sensory ganglion has been found.

Although anæmia is one of the most characteristic features of subacute combined degeneration, since it occurs in every case of long duration at some time or other, and since it is sufficiently striking as at once to suggest the diagnosis in at least two-thirds of all the patients when they first come under observation for nervous symptoms, yet it may be absent throughout the course of the disease in a rapid case, and its appearance may be delayed until several years after the disease of the nervous system is manifest. The anæmia in almost every case is identical in every respect with pernicious anæmia. Of those cases in which the blood picture is not typical, nearly all show megalocytosis, with a relative lymphocytosis and a high hæmoglobin index, as do early cases of pernicious anæmia, and it may be said with certainty that the longer the patient survives, the greater the likelihood of typical pernicious anæmia developing. The spleen has been enlarged in many cases, and the marrow of the bones is typical of pernicious anæmia, as may be also the iron reaction in the liver and the changes in the myocardium and other muscles. As in pernicious anæmia, the tongue is clean, and this occurs so

regularly that any appearance of furring of the tongue may justly be said to exclude the diagnosis of this disease. Fractional test meals show an absolute achlorhydria, or a relative achlorhydria, in the same proportions as do cases of pernicious anæmia. The colour of the skin is often peculiar and striking, even when anæmia is not severe, and is best described as "biscuit-coloured." A bright malar flush upon this yellowish biscuit-coloured background gives a characteristic and vivid facial aspect in the earlier stages of many of the cases. The symptoms and signs common to all anæmic states, breathlessness, headache, cardiac and venous murmurs and œdema, are commonly present, but hæmorrhages are uncommon. Syncopal attacks may occur. Irregular pyrexia is almost invariably present at some period in the course of the disease, and this quite apart from fever-producing complications, such as cystitis and bedsores. In the later stages progressive emaciation is constant, and if life be prolonged it becomes extreme.

Course.—The duration of the disease varies within wide limits from 6 weeks to 10 years or more. The average duration is under 2 years. In cases of long duration the symptoms remain slight during a large proportion of the time, and such patients may improve somewhat and continue light employment for years. Other cases show a rapid downward course with no tendency to temporary arrest. Rapid exacerbation of the symptoms with a quickly fatal issue, may occur at any time. It is unusual for any improvement to occur when once the patient is bedridden. Not infrequently a patient who has reached the stage in which the disease is usually fatal, survives in a pitiable condition for many months. Death occurs from general exhaustion consequent upon the toxic state. Cystitis and bedsores can hardly be avoided in the later stages of the disease, for the vitality of the tissues seems too low either to resist the advent of micro-organisms or to allow of any healing process.

Diagnosis.—In the earliest stage, and before the appearance of any definite sign of organic spinal disease, there may be such disability as to suggest the diagnosis of functional paraplegia. This statement is true of many organic diseases of the spinal cord, and especially of disseminate sclerosis and spinal tumour. When organic signs appear, it is especially from disseminate sclerosis, spinal tumour and tabes dorsalis that the diagnosis has to be made. The preponderance of the peripheral subjective sensations, and the presence of a florid complexion with anæmia, should always suggest the diagnosis. Slight spastic ataxy is the common clinical picture of subacute combined degeneration, of disseminate sclerosis and of spinal tumour. Peripheral sensations and peripheral numbness are not features of disseminate sclerosis, and the presence of peripheral sensory loss should always challenge that diagnosis, whereas diplopia, nystagmus, transient amblyopia and intention tremor are not early symptoms of subacute combined degeneration. Spinal tumour is especially distinguished by a sharp line of sensory loss, transverse to the axis of the body, which does not spread up from below in slow fashion.

When subacute combined degeneration commences with flaccid ataxy and loss of the deep reflexes, the distinction must be made from tabes dorsalis. The extensor plantar reflex, which is almost always present in the former disease and which is rare in early tabes, the entirely different distribution of

the sensory loss in the two diseases, the loss of power in subacute combined degeneration, and the results of the examination of the blood and cerebro-spinal fluid for syphilitic reactions and of the latter fluid for lymphocytosis, are important aids in the differential diagnosis.

In the well-developed stages of the disease, its recognition presents no great difficulty. Attention is quickly attracted by the conspicuous anæmia and biscuit-coloured skin. Following a period of slight paraplegia, often lengthy, the steadily increasing paralysis of the lower extremities, with perhaps sudden exacerbations, producing complete and lasting helplessness, the characteristic distribution of the sensory loss which spreads upwards towards the cervical region, the severe lightning pains, the irregular pyrexia, the anæmia and the relatively late onset of sphincter trouble serve to separate this disease from other forms of paraplegia. The change from the spastic to the flaccid type of paraplegia with loss of the deep reflexes and persistence of the extensor response, which occurs in many of the cases in the late stages, is highly characteristic.

The distinction from the following diseases which are grouped together as conditions of postero-lateral degeneration does not, as a rule present much difficulty: (1) Friedreich's disease and other forms of hereditary ataxy; (2) tabes dorsalis with diffuse sclerosis; (3) tabes dorsalis with pyramidal degeneration; (4) amyotrophic lateral sclerosis with posterior column degeneration; and (5) other forms of systemic combined sclerosis. The symptomatology of most of these conditions departs so widely from that of the disease under consideration, as to leave little possibility of confusion. The forms of tabes with pyramidal degeneration, however, require very careful differentiation as so many clinical features are common to the two diseases. The peculiar distribution of the pain sensory loss in tabes, the manner of advent and the general grouping of the symptoms and signs, the positive Wassermann reactions in blood and cerebro-spinal fluid, and the presence of lymphocytosis in the latter fluid, will usually serve to prevent error. It must be borne in mind that very profound anæmia may occur where there is syphilitic disease of the liver. In one case under the writers' care, the advent of lateral column changes and of syphilitic hepatitis with profound anæmia, in a case of tabes, gave a clinical picture closely resembling that of subacute combined degeneration.

Prognosis.—There is no evidence that recovery from this disease occurs in any of its stages. The temporary improvements which may occur are improvements in the general health and in the anæmia, rather than any lessening in the gravity of the nervous manifestations. Speaking generally, the duration of the disease is inversely proportional to the rapidity of the onset and development of the symptoms. Many cases remain for a long time with slight symptoms, able to follow light occupations, but in every case a rapid exacerbation may occur, heralding a quickly fatal issue. The more severe the anæmia, the sooner may the fatal result be expected. Those patients in whom a spastic state persists, survive longer than those who become flaccid.

Treatment.—In those cases which show anæmia, the administration of liver or liver extract has its customary dramatic effect in restoring the blood, and it certainly has also the effect of lessening and delaying the signs of degeneration within the nervous system. Previous to the introduction

of liver feeding we found that thyroid extract had a remarkable effect in removing the anæmia, and that it could be tolerated by patients suffering from subacute combined degeneration in very large doses, even as much as sixty grains a day. Careful attention to any septic conditions of the mouth or pharynx and to any form of gastro-enteritis or possible source of toxic absorption from the intestine, seems to yield some result in slowing the progress of the disease. To this end the use of intestinal antiseptics should never be omitted. Naphthalene tetrachloride, in 10-grain cachets thrice daily, and hexamine are of the greatest value. The more advanced the stage of the disease is, the less result may be expected from any form of treatment. Any suppurative condition of the body should be energetically treated. Every care should be taken to delay the advent of bedsores and cystitis. When present, these are often amenable to treatment in the early stages of the disease and in less acute cases, but in the more acute cases and in the later stages they are inevitable and the bodily vitality is too low for any reparative process to take place. Lightning pains and other pains are relieved by such analgesics as aspirin, acetanilide, pyramidon, phenazone, etc. Reflex flexor spasms are among the most troublesome of the symptoms, since their frequent occurrence denies sleep to the patient, and they are most important factors in the occurrence of bedsores. The remedy which seems to have most effect in checking these spasms is veronal.

PROGRESSIVE MUSCULAR ATROPHY

Definition.—A disease of gradual onset which may develop at any age from puberty onwards, and in which the anatomical findings consist invariably, whatever be the clinical picture, of three orders—(1) a progressive degeneration, shrinkage and disappearance, cell by cell, of the upper motor neurons or cells of Betz in the ascending frontal convolution, with consequent degeneration of the corresponding fibres in the pyramidal tracts; (2) a similar atrophy, cell by cell, in the lower motor neurons with corresponding degeneration of motor fibres in the peripheral nerves and atrophic degeneration of the muscles innervated by the affected cells; (3) a diffuse atrophy of the white matter of the spinal cord, the posterior columns conspicuously excepted.

A most mysterious feature of the disease is the non-correspondence between the anatomical findings and the symptomatology. In the first place, though the upper motor neuron lesion is constant in all cases, many cases run their course without the slightest external evidence that the pyramidal system is involved. Secondly, no symptoms develop corresponding with the very extensive degeneration of the anterior and antero-lateral columns of the cord in any of the cases.

The clinical picture is one of gradually oncoming weakness and disability, due either to atrophy of the muscles from the lower motor neuron lesion, in which case the paralysis is flaccid and atrophic, or to spastic paralysis of the muscles from the upper motor neuron lesion, in which case the paralysis is spastic without atrophy, or to the combined lesion of both upper and lower motor neurons, in which case the paralysis is both spastic and atrophic, and the muscular atrophy never becomes complete. Fibrillary twitchings of

the muscles are always present, and form an important diagnostic feature. Any of the skeletal muscles may be affected from the ocular muscles to those of the feet.

The clinical aspect varies greatly according as the incidence of the palsy is upon the muscles supplied by the brain stem, or upon the muscles of the trunk and limbs, and again, according as the atrophic element or the spastic element is present alone, or as both coexist in the same region or in different regions of the body.

The following are the usual clinical types, but it must be borne in mind that every transition between these types may be met with:

(A) With incidence upon the muscles supplied from the brain stem; Progressive bulbar paralysis: 1. Pure atrophic bulbar paralysis. 2. Spastic atrophic bulbar paralysis. 3. Pure spastic bulbar paralysis.

(B) With incidence upon the muscles of trunk and limbs: 1. Pure atrophic type—(*a*) Local and slowly progressive; (*b*) general and rapidly progressive. 2. Spastic atrophic type; amyotrophic lateral sclerosis—(*a*) The spasticity and atrophy are coincident in the same muscles; (*b*) the atrophy affects the upper limb and the spasticity the lower limb. 3. Pure spastic type. This is more commonly seen as an early stage of amyotrophic lateral sclerosis, where the spasticity of the lower extremities precedes the atrophy of the upper extremities by some months or years.

(C) Mixed bulbar and spinal forms.

Ætiology.—The earliest age incidence has been at 12 years, and several cases have been recorded which developed the disease at that age. As age advances the incidence of the malady becomes more frequent, until it attains a maximum between the ages of 30 and 40 years, after which there is a slow decline. It does not commonly commence in advanced age, but one case has come under the writers' observation which commenced at the age of 77 years. Males are affected three times as frequently as females, but in the cases occurring before the age of 25 years, the females predominate. Heredity only rarely influences the disease. Injury has often been alleged to be an exciting factor in the development of this disease, and there are very many cases recorded which seem to support this contention. We have made a careful analysis of many cases in which there has been a history of injury which have come under our observation and also of those in the literature, and have found that it is always a trivial injury, such as a slight knock, bruise or strain, and never a severe injury, which has preceded the appearance of progressive muscular atrophy. This one fact clearly proves that injury cannot truly be in causal association with the disease, and, further, there is no conceivable pathological process by which a trivial injury unaccompanied by any infective process, can bring about a universal and rapidly fatal dissolution of the nervous system. The probability is that the injury is in many cases due to the slight clumsiness and disability often produced by the oncoming disease, and that in other cases it is simply coincidental. Syphilis seems to be in definite causal relation with some of the cases. A positive Wassermann reaction, both in the blood and in the cerebro-spinal fluid, is found in a much larger proportion of the cases than give any history of syphilitic infection. Further, quite a number of instances of the supervention of a typical progressive muscular atrophy in cases of tabes has been observed and recorded at the National Hospital,

London. It has been freely stated that progressive muscular atrophy of syphilitic origin differs from the non-syphilitic forms in its lack of symmetry and in its course; but this certainly does not hold good for very many of the cases which show a positive Wassermann reaction. In a large majority of all cases of progressive muscular atrophy, no causal factors whatever can be discovered.

Pathology.—To the naked eye, a cross-section of the spinal cord may show some diminution in size of the ventral horns, which often present a curiously pink or rose-coloured appearance. The essential lesion is a primary degeneration of the cells of the ventral horns of the spinal cord and in the homologous motor nuclei of the brain stem, namely, the hypoglossal, facial, trigeminal and oculo-motor nuclei. Coupled with the degeneration of the lower motor neuron, is a degeneration of the upper motor neurons of the pyramidal system. In the ventral horn cells the degeneration is evidenced by a gradual shrinking in size of the cells, which lose their dendrites and become oval or spherical in shape. The Nissl bodies slowly disappear, and only in rare and rapid cases is definite chromatolysis seen. The nuclei dwindle and become irregular and distorted. Very striking and constant is a great increase of the yellow, intracellular pigment, which is usually present in a single mass near the nucleus or at the pole of the cell. As this pigment increases in bulk, it gradually displaces the nucleus and the other elements of the cell, until the degenerate cells come to consist of a mass of pigment contained within the cell wall, with a distorted nucleus lying to one side. Invasion of the pigmented cell remnants by neurophages completes the destruction, and in a late stage groups of such neurophages laden with nerve-cell pigment alone mark the site from which the nerve cell has disappeared. Consequent upon the degeneration of the ventral horn cells the reticulum of myelinated fibres in the grey matter of the ventral horn disappears, the collaterals coming from the dorsal roots alone remaining intact.

The dorsal and lateral horns are almost invariably intact, but degenerative changes are sometimes seen in the cells of Clarke's column, from which degeneration of the spino-cerebellar tracts necessarily results. The affection of the motor nuclei of the brain stem in the bulbar cases is in every way similar to that of the ventral horns. The degeneration of the motor nerves which take origin from the degenerate ventral horn cells, often proceeds *pari passu* with the degeneration of the cells. But in some cases this is conspicuously and very mysteriously not the case; for, though there may be intense degeneration in the ventral horn cells, in the intramedullary motor roots and in the muscles, there may be complete absence of any signs of degeneration in the motor fibres of the extramedullary roots and peripheral nerves.

The affected muscles are soft and toneless, and the muscle fibres are found irregularly degenerated, bundles of normal and of degenerating fibres, until the atrophy is complete, being found side by side. The characteristic change is shrinkage of the affected fibre to a calibre much less than normal. The transverse striation usually persists, and the muscles stain much more deeply with logwood than is normal. The nuclei are much increased, and as the degenerating fibres waste and disappear completely, the positions which they originally occupied are marked by clumps of such nuclei which remain in the connective tissue. As is usual in all slow tissue degenerations, fibrosis and local arterial disease accompany the atrophy of the muscle fibres.

The pyramidal neurons (cells of Betz), which characterise the precentral cortex, undergo a degeneration very similar to that of the ventral horn cells, but with this difference, that the earliest structural changes are found in the most distal part of the pyramidal fibres, and that subsequently these fibres die back towards their cells of origin in the cerebral cortex. The degeneration of the upper motor neurons never proceeds to the complete destruction of anything like all the pyramidal fibres.

As has been emphasised above, there is invariably a very considerable diffuse atrophy of the ventro-lateral columns of the spinal cord, and this is usually more marked in the shorter fibres which surround the ventral horn, and which take origin from the smaller cells of the dorsal portions of that horn, and connect the segments of the spinal cord at different levels one with the other. Degeneration of nerve fibres is found also fairly constantly in the ventral commissure, in both spino-cerebellar tracts, in the fillet, tecto-spinal tracts, rubro-spinal tracts, in the dorsal longitudinal bundle and in the mesial part of the corpus callosum, the degeneration in the latter position being presumably that of collaterals of the pyramidal fibres.

The pathological nature, therefore, of progressive muscular atrophy is a widely scattered degeneration of nervous elements not even confined to the motor systems, though these are in the main affected, since the afferent spino-cerebellar tracts are constantly found degenerated, from some unknown cause.

Symptoms.—The following description of the clinical features is based upon an analysis of 500 cases which have come under observation at the National Hospital, London. The onset is in most cases very gradual, but it may be more rapid, and severe incapacity may result in the course of a few months. In rarer cases, a severe degree of paralysis may develop in the course of a few days, and in such cases it is not uncommon to see the most remarkable temporary improvement. The nature of the onset, as a rule, indicates the course which the malady will pursue. A very slow onset is followed by a very slowly-advancing disease, often interrupted by long stationary periods, whereas the more rapid the commencement, the quicker will be the advance and the sooner will a fatal issue occur. Accompanying and sometimes preceding the onset, and not infrequently conspicuous during the early states of the disease, are certain sensory symptoms which, from the confusion in diagnosis they may cause and from the scant attention which has been paid them in descriptions of the malady hitherto, deserve emphasis. These symptoms are confined to the regions where the wasting first appears, and consist in a subjective feeling of stiffness and uselessness, much increased when the limb or the body is cold. Or there may be dull aching pains, intermittent neuralgic pains which may be severe, or a sensation of coldness or numbness which may be intense. Less commonly, tingling may be present. Painful cramp in the muscles which are about to be affected is comparatively common. These sensory symptoms, though confusing at first, are always transient, and disappear as the disease progresses, with the exception of aching pain and painful cramps, which may recur from time to time.

The *muscular wasting*, which constitutes the most characteristic feature of the disease, may commence in any group of the skeletal muscles whatsoever. It may be first manifest in such rare situations as the facial muscles, intercostal muscles, muscles of the back and abdominal muscles. The

commonest situation is in the muscles of the upper limb, where the distal (intrinsic muscles of the hand) or the proximal muscles (deltoids, spinati, etc.) are first affected in about an equal number of cases. In the hand, the muscles of the thenar eminence are the first to waste, and this is followed by atrophy of the hypothenars, of the lumbricals and of the interossei with the usual flattening of the palm, exposure of the flexor tendons in the palm from loss of the bulk of the lumbricals, hollowing of the interosseal spaces and a tendency to the "griffin's paw" attitude of the hand. The *main en griffe* is never so marked in this disease as in paralysis of the ulnar nerve, syringomyelia, etc., because the wasting soon affects the long flexors of the fingers, and further contractures of the affected muscles are not well marked in progressive muscular atrophy. As the wasting spreads to the muscles of the forearm, the flexors are usually affected before the extensors.

When the upper arm is primarily affected the wasting is first seen most often in the deltoids, whence it spreads upwards, involving the spinati and the muscles attaching arm to scapula, and arm and scapula to trunk. Among these muscles some tend to escape the atrophy relatively, or to be affected much later than others, and these are the triceps, the latissimus dorsi, the lower half of the pectoralis major, the levator anguli scapulæ and especially the upper half of the trapezius, which for this reason was called "ultimum moriens" by Duchenne. In the limbs the wasting always commences in one limb, but soon spreads to the corresponding limb of the opposite side and tends ultimately to become symmetrical. The attention of the patient may be first drawn to his malady by the altered appearance produced by the atrophy, and this is more common when the commencement is in the hands, where the subcutaneous tissue is thin and the region constantly in view. Or the disability consequent upon the weakness may be noticed first, and this is always the case where the commencement is in the bulbar muscles, and usually also where the muscles of the legs, proximal muscles of the arms and trunk muscles are first involved. Lastly, the fibrillation may be so marked as first to attract notice.

The *loss of power*, which accompanies the muscular wasting, is, as a rule, commensurate with the wasting, and does not become absolute until the atrophy is complete. To this rule, however, there are two very important exceptions. In the first place, when the affected muscles are both tonic from the upper motor neuron lesion and atrophic from the ventral horn-cell lesion—the tonic atrophy of Gowers—the loss of power is always much greater than can be accounted for by the degree of wasting present. It is a remarkable and entirely unexplained fact that when this tonic atrophy is present the muscles never completely waste, whereas in flaccid atrophy they waste completely, if the patient survives sufficiently long. In the second place, and in a minority of cases, a complete flaccid paralysis, often of considerable extent, involving perhaps all the muscles of the hand and forearm or all the muscles of the shoulder and upper arm, occurs as the initial phenomenon, and precedes any sign of wasting. This initial flaccid paralysis without wasting, generally comes on rapidly. It is not accompanied by any fibrillation, and often it remits to a very considerable extent before any wasting or fibrillation appears. When the disease commences with initial flaccid paralysis without wasting, it is usually rapid in its course, any temporary improvements notwithstanding. This initial flaccid paralysis without

wasting, especially if it improves temporarily, may give rise to great difficulty in diagnosis, for it generally occurs in one limb only, and its rapid development, and in some cases a conspicuous improvement, may give rise to the impression of a gross organic lesion of the ventral horn or ventral roots, and to hopes of recovery which are falsified later.

The disability which progressive muscular atrophy produces in the limbs is always much more marked when the limbs are cold, and conversely. There may be an appearance of vasomotor paralysis, redness, blueness and some swelling of the periphery, but this seems to occur much more as the result of the continual pendent position of the hands, when the muscles, which flex the elbow and which raise the shoulder, are affected, than as the result of any definite vasomotor palsy. In the regions where the muscular atrophy is apparent, the fat and subcutaneous tissues also waste slowly and progressively, and in all but the rapidly progressive cases this wasting is conspicuous.

Next in order of frequency to initial wasting in the upper extremities, comes the incidence of the disease upon the muscles concerned in facial expression, articulation, mastication and deglutition, and in lesser degree upon the muscles of phonation; and the disease may be confined to these muscles throughout the whole of its course. From the widely different clinical picture resulting, and from the fact that all these muscles are supplied from the brain stem and upper two segments of the spinal cord, this form of the disease has borne the name of "progressive bulbar paralysis," or "labio-glosso-pharyngeal paralysis." Here the wasting commences in the intrinsic muscles of the tongue and spreads thence to the orbicularis oris, to the extrinsic muscles of the tongue, pharynx and larynx, to the muscles of mastication and, eventually, but in less degree, to the facial muscles generally; but only in rare cases are the oculo-motor muscles affected.

The intrinsic muscles of the palate, the constrictors of the pharynx, the intrinsic muscles of the larynx, and the muscle of the œsophagus are little affected. We have, in a series of cases, examined microscopically all the muscles concerned in the acts of deglutition and phonation, and have found these muscles conspicuously exempt from atrophy. This seems at first an anomalous and astonishing fact, considering how great and important are the troubles with deglutition in bulbar paralysis. But the anomaly disappears at once when one considers that the muscles which are concerned with buccal deglutition are the muscles of the tongue, those forming the floor of the mouth, including the mylohyoid and the digastric, the muscles which raise and lower the jaw, and those of the lips. Further, the muscles which are most important in pharyngeal deglutition are those which raise and lower the hyoid bone and larynx as a whole, and these are the stylohyoid and stylopharyngeus, the palatoglossus and palatopharyngeus, the geniohyoid, thyrohyoid, sternohyoid, sternothyroid and omohyoid. All these muscles are early and severely affected in bulbar paralysis; and when they fail, the intrinsic muscles of the palate are unable to shut off the naso-pharynx, the constrictors of the pharynx are entirely unable to perform the act of deglutition, and the intrinsic muscles of the larynx—though phonation is never lost—are unable, since the larynx is unfixed by the extrinsic muscles, to modulate the tone of the voice. The very active pharyngeal reflex and the well-known great difficulty in using the laryngoscope on account of spasm of

the pharynx in the subjects of this disease, are very good clinical evidence that the pharyngeal constrictors are not affected.

The earliest physical sign of bulbar paralysis is the loss of the finer movements which are essential for correct articulation, and consequently a slurring dysarthria develops and increases, and the consonants become less and less distinct until they are inaudible. The failure of the palate to close upon the posterior pharyngeal wall begets a nasal element in the voice. Later, the patient becomes unable to interrupt his blast at any of the stop positions, and his utterance becomes a long, moaning, monotonous, inarticulate sound. His phonation remains, but he cannot alter its pitch nor divide it into parts of speech, except by taking a fresh breath. The orbicularis oris is early affected, and the lips lose their firmness and become thin, and as they weaken, the unopposed retractors of the angles produce a wide, straight mouth, both at rest and in emotional action. Whistling and pursing up the lips become impossible, and ultimately there is much dribbling of saliva, for this can neither be retained by the lips nor swallowed. The tongue shows fine fibrillation, and as it wastes it loses its point, becomes rounded, and is protruded with difficulty. Its surface becomes dimpled and faceted, and in the end consists solely of the covering mucous membrane, the glands and the fibrous tissue, and lies motionless in the floor of the mouth, resembling a crinkled mushroom. The muscles of mastication all become affected. The bite becomes feeble and the mouth cannot be opened against resistance. In the late stages the jaw drops and the mouth is constantly open. The combined weakness of tongue and buccinators makes it very difficult for the patient to keep his food between his teeth in mastication, and often he aids his disability by digital pressure upon the cheeks. Nasal regurgitation is not uncommon. The difficulty in swallowing is greatest with fluids, for these require quick action, and is next greatest with lumpy solids, for these necessitate powerful action. It is least with food of a porridge-like consistency, and this should be carefully borne in mind in feeding the patients.

The other muscles of the face are affected later and to a much less severe degree than is the orbicularis oris. It is as if there were a physiological selection on the part of the disease for the nervous mechanism subserving mastication and deglutition. Still in the majority of cases there are bilateral general facial weakness and wasting which, with the peculiar mouth and dropping jaw, produce a characteristic facies which can be instantly recognised. If the upper facial muscles are tested by raising the eyelid with the finger against resistance, invariably they will be found to be weak. Only in very rare cases does the atrophy extend to the oculo-motor muscles. As in the paralysis of the limbs, so also in bulbar paralysis, concomitant signs of both upper motor neuron and of lower motor neuron lesion may exist. When such tonic atrophy of the bulbar muscles is present, the symptomatology and clinical appearance are the same as have been above described for the simple atrophic form, with the exception that the jaw-jerk and the other muscle-jerks of the bulbar region, which are absent in the latter condition, are brisk in the tonic-atrophic form. And, further, it must be remembered that the additional element of spastic paralysis adds greatly to the degree of the paralysis as a whole.

In less common cases of progressive bulbar paralysis the upper motor

neuron lesion alone is in evidence, and the bulbar paralysis is purely spastic. Here the symptomatology as regards articulation, deglutition, etc., is the same, and the facial aspect identical with that of the simple atrophic and tonic-atrophic forms. The muscle-jerks are brisk. The appearance of the tongue, however, is quite different; it is smooth, narrow, stiff and drawn into a narrow compass by the spasm of the muscles composing it. It appears too small for so large a mouth. There is no fibrillation, and the muscles are nowhere wasted.

The muscles of the back of the neck, the splenius, complexus, etc., are not uncommonly the first muscles to be affected with the wasting of progressive muscular atrophy. There is increasing difficulty in extending the head, which drops forward, causing a characteristic attitude, which is associated with a constant overaction of the frontales which raise the brows to clear the line of vision when the head is dropped forward, so giving rise to a permanently furrowed brow. The loss of substance in the muscles of the back of the neck, together with the dropping forward of the head, causes the lower cervical and upper dorsal spines to stand out in undue prominence, and to give an appearance approximating to that of an angular curvature.

Primary affection of the lower extremities is much less common than that of the upper extremities, bulbar region or neck muscles. The anterior tibial and peroneal muscles are usually attacked first, and less commonly the quadriceps. The clinical type is that of flaccid atrophy in most of the cases. Tonic atrophy, which is so common in the upper limbs and in the bulbar region, is rare in the legs. Spasticity without atrophy from the upper motor neuron lesion alone is very common in the lower extremities. It forms a characteristic part of the frequently occurring clinical type of amyotrophic lateral sclerosis, in which the upper extremities or bulbar region are affected with atrophic paralysis, and the legs with spastic paralysis. In this common combination the atrophic paralysis is usually of the tonic and much less frequently of the simple flaccid type. Spasticity from the upper motor neuron lesion may develop in the lower extremities long before there are any signs of atrophic paralysis elsewhere from the lower motor neuron lesion, and such cases present the physical signs of a primary lateral sclerosis. Therefore, it cannot be too strongly borne in mind that any case presenting the features of a primary lateral sclerosis in an adult may eventually prove to be one of progressive muscular atrophy.

Wherever the site of commencement of progressive muscular atrophy may be, it invariably spreads to other regions, sometimes slowly and with periods of arrest which may last for years, sometimes with remarkable rapidity. The manner of spread is usually in terms of the contiguity of the affected elements in the nervous system; but it is sometimes in terms of the physiological association of the muscles as is commonly seen in the bulbar forms of the malady. When the disease is definitely installed the appearance of fibrillation, in any muscles otherwise unaffected, is a sure sign that atrophy will shortly commence in those muscles.

According to the method of advance shown by the disease, cases of progressive muscular atrophy fall into two groups which it is important to distinguish. In the first group, the atrophy spreads locally and slowly and remains confined to one region of the anatomy during most of the course of

the malady. These cases are always of the simple atrophic type, and they usually survive a long time. Such cases, however, tend to become general just before the end. In contrast with the local type of the affection is the group in which the manifestations, commencing locally, spread within a comparatively short time to many parts of the anatomy, or even become universal. The spread may be very rapid, and the end may occur in a few months, or it may be slower; but it is unusual for any of the cases forming this group to survive for more than eighteen months. This group comprises (1) the generalised cases of simple flaccid atrophy; (2) all the cases of amyotrophic lateral sclerosis; and (3) most of the bulbar cases.

Fibrillation is a most important symptom of the disease, and is an associate of the muscular atrophy. It seems to be the expression of degeneration which is occurring in the yet living and functioning nerve cell. It precedes the wasting of the fibres, and is a sure herald of the advent of wasting in this disease. It ceases to occur when the muscle is completely wasted, and is not seen when the atrophy is not progressing. On account of the importance of fibrillation as a diagnostic sign of progressive muscular atrophy it is important here to consider those other conditions in which it is met with clinically. It occurs in syringomyelia and in peroneal atrophy, but only when the muscular atrophy is progressing, and, therefore, it is only an occasional symptom in either disease. It is often very marked in cases of interstitial neuritis (sciatica, etc.). It occurs in a most magnified and conspicuous form in certain conditions of gastro-enteritis, and is presumably due to an intoxication, and to this form of fibrillation the term "myokimia" has been applied. It is not met with in polyneuritis, poliomyelitis, myopathy, nor in the common gross lesions of nerve trunks, nerve roots or spinal cord.

The *electrical reactions* of the affected muscles vary according to the degree of degeneration. Since normal and degenerate fibres are stimulated side by side in the affected muscle, there will be some lowering of the response to faradism with a tendency to a polar change. This is known as the "mixed reaction," and it is common to all diseases in which muscle degenerates fibre by fibre. Faradic excitability lessens as more of the muscle fibres degenerate, and when degeneration is complete all electrical excitability is lost. The excitability of the affected muscles to direct mechanical stimuli, such as percussion, is increased so long as any living muscle remains.

Contractures are conspicuous by their absence in this disease, which is thus strongly contrasted with peroneal atrophy and some other muscular atrophies. If the atrophy becomes complete in a whole limb the end result is that the limb is flail-like and without contracture.

Mental alterations are constantly present in the cases in which the bulbar region is affected. Emotional instability and hyperexcitability are the usual change. The patient is easily excited to tears or to laughter by trivial causes, and when so excited cannot control his expression of emotion. He himself feels little joy or grief during the paroxysms of laughing or crying.

Sphincters.—In the majority of the cases these are not affected, but every now and then dysuria in any of its forms occurs, and it may occur early in the course of the malady, and it may be severe. Loss of sexual power is very common.

Reflexes.—The superficial reflexes are modified in this disease, on the one hand by spasticity, when this is present, and, on the other, by the muscular

atrophy which may prevent response in the affected muscles. The pharyngeal reflex in bulbar cases is usually brisk, notwithstanding the statement to the contrary, which most antecedent writers upon this subject have recorded; but the response is not the normal response, involving all the muscles concerned in deglutition, for these are atrophied and paralysed; it is confined to the constrictors of the pharynx and the muscles of the palate, with the feeble co-operation of such of the somatic bulbar muscles as are still able to act. The abdominal reflexes are diminished or lost in the spastic cases, and in those cases where the atrophy is incident upon the muscles of the abdominal wall. The plantar reflexes are usually of the extensor type when the legs are spastic; but this does not always obtain, for there may be definite rigidity of the legs with brisk knee-jerks and foot-clonus with a persistent flexor response. The muscle-jerks disappear from the affected region in simple atrophic cases *pari passu* with the wasting of the muscles. In cases of tonic atrophy they are everywhere increased, even in regions where the atrophy is severe, and in this type of the malady they never disappear. The same increase of the muscle-jerks occurs in the purely spastic cases.

Diagnosis.—The malady has to be distinguished from the many conditions in which progressive weakness and wasting of the muscles occur, from those in which muscular wasting and spasticity are conspicuous clinical features, and lastly from other diseases, in which bulbar symptoms are early evidenced. Peroneal muscular atrophy very closely resembles progressive muscular atrophy, in that slow wasting and fibrillation of the muscles are the chief clinical features. The points which distinguish the two conditions are that peroneal atrophy is often a familial disease, and is apt to commence in childhood, when it is unusual for progressive muscular atrophy to begin. The location of the atrophy is peculiar, and when well marked in the periphery of all four limbs, as is common in this disease, cannot be confused with progressive muscular atrophy since the latter disease never has this distribution. Syringomyelia is easily distinguishable by the early and striking loss of pain and temperature sensibility. Cervical rib not uncommonly produces atrophy of the intrinsic muscles of the hand, and, though this is usually confined to one hand, it may be bilateral. Pain in the distribution of the eighth cervical and first dorsal roots, and some loss of sensibility, may be present. The atrophy remains local, and is never accompanied by fibrillation. The abnormal rib is easily discoverable on radiographic examination. It must be borne in mind that cervical ribs are not uncommon, and that their presence does not necessarily prove the cause of atrophy of the hand muscles, for cervical ribs may be present in progressive muscular atrophy, in syringomyelia, and in any other disease.

Arthritic muscular atrophy occurs in the regions of joints which show easily recognisable disease. Fibrillation does not occur, nor are there alterations in the electrical excitability of the wasted muscles. Myotonia atrophica is at once separated from progressive muscular atrophy by the myotonus, when this latter symptom is present. When myotonus is absent, the characteristic wasting of the sternomastoids, and of the muscles of the thighs, the age of the subject, and sometimes the presence of cataract should suggest the diagnosis.

Lesions of peripheral nerve trunks may be diagnosed by the history of a local cause, by the discovery of a palpable local lesion upon the course of

the nerve, and by the confinement of the atrophy to the distribution of one particular nerve, while often pain and sensory loss occur in that same distribution.

Lesions of the nerve roots, and especially those produced by pachymeningitis and by neoplasm in the vertebræ may cause signs and symptoms so closely resembling those of the more rapid forms of progressive muscular atrophy, as to render correct diagnosis very difficult. Such a lesion in the cervical region, for example, may give rise to wasting of the hand and forearm muscles, and a spastic condition of the legs, resembling exactly a condition of amyotrophic lateral sclerosis, without deformity or rigidity of the spine, and without pain or sensory loss. In such cases of difficulty the course of a little time will bring the advent of the conclusive symptoms of a local pressure lesion. It is important in this connection to remember that pressure upon the spinal cord results in hyperalbuminosis of the cerebro-spinal fluid, and if the lesion causing the pressure is syphilitic, there is likely also to be lymphocytosis in that fluid, neither of which conditions is found in progressive muscular atrophy. Symptoms resembling those of amyotrophic lateral sclerosis may arise from tumour involving the cervical enlargement. The latter condition becomes easily diagnosable from the not long delayed appearance of sensory loss both upon the arms and upon the trunk below the level of the lesion. Fibrillation is never present in any pressure lesion of peripheral nerve, nerve root or spinal cord.

Diagnosis is most difficult in those cases where spasticity in the limbs is the first sign of progressive muscular atrophy to appear, and where such spasticity precedes the appearance of any muscular atrophy by a long time. If it be clearly borne in mind that spastic paralysis may be the earliest, and for a time the only sign of progressive muscular atrophy, and that among the many diseases of the nervous system, which commence with the same clinical picture of spastic paralysis, a certain diagnosis cannot be made until further distinguishing signs appear, error will be avoided. The importance of the examination of the cerebro-spinal fluid in all cases cannot be too strongly emphasised.

Course and Prognosis.—The nature of the disease is to progress, and to extend its area of invasion until a fatal issue is reached. The progress may be rapid, and the end may be reached in a few months, or it may be slow, and many years may elapse before death occurs. The local types of slow onset are the most gradual in their development, and these are often characterised by periods of arrest in the progress of the disease. The generalised simple atrophic type of the disease is the most rapid, especially when it commences with severe initial flaccid paralysis without atrophy.

In the bulbar types of the disease, and in amyotrophic lateral sclerosis, the course is for the most steadily progressive. Every type will show, however, upon occasion, exacerbations and remissions, and the exacerbations are the most important, and in the bulbar types may bring about the end in a few hours. Of particular interest are rapid extensions of a flaccid paralysis, which may occur in a few hours, and which resemble, and indeed are identical, with onset of the disease with initial flaccid paralysis without atrophy, which has been already described. Whatever type of the disease be present, it tends in the end to spread and to become general.

Involvement of the respiratory muscles or severe bulbar symptoms, and

the pulmonary complications which may accompany either condition, may bring about the fatal issue. It is usual, however, for death to occur in a manner which is common to so many degenerative nervous diseases, a rapid increase of the paralysis is associated with an increasing lethargy, which soon deepens into a rapidly fatal coma. It is as if an acute toxic process occurs when the nervous degeneration becomes rapid. It is uncommon for death to occur from intercurrent maladies. The average tenure of existence after definite signs are present is under 1 year in the generalised flaccid type, and it may be as short as 2 months. Bulbar symptoms are not generally survived for more than 12 months. Localised cases of simple atrophy may live for many years. Some of the patients in whom a positive Wassermann reaction is found improve, and the disease is sometimes arrested by anti-syphilitic treatment.

The progressive character of the disease renders the prognosis grave in every case. There are some cases occurring in middle life, which are presumably cases of progressive muscular atrophy of local distribution and slow onset and course, which become finally arrested or even improve; but in the absence of pathological verification the true nature of such cases is open to doubt. Slowly progressive local cases usually last 5 years, and may live as long as 25 years from the onset. In these the malady becomes general in the end. The possibility of the occurrence of rapidly advancing generalisation always renders the prognosis uncertain.

In amyotrophic lateral sclerosis the average duration of life is not more than 2 years from the onset. When bulbar symptoms are present the average duration is under 2 years. In the generalised cases the average duration is under 1 year. Widely spread fibrillation in muscles, which are neither weak nor wasted, is the constant herald of generalisation, and renders the immediate prognosis serious. In cases where syphilis is present the prognosis is more favourable, and there is even a possibility of arrest and improvement if energetic treatment of the associated condition is provided. Rapid extension of the weakness, the advent of bulbar symptoms, involvement of all the respiratory muscles, and especially general asthenia and drowsiness are the signs which usher in the fatal result.

Complications.—By far the most common complication which is met with in cases of progressive muscular atrophy is the presence of some syphilitic lesion of the nervous system, and this may be of any nature, both local or general. Tabes dorsalis, associated with progressive muscular atrophy, is not uncommon. General paralysis of the insane has been noted in a few cases, as has also paralysis agitans.

Treatment.—For the most this malady seems to be entirely uninfluenced by any treatment that has hitherto been adopted. Even where syphilis is a factor in the causation, although appropriate treatment for these conditions has been applied, and improvement and even arrest may result, it is no rare thing to see no amelioration, and in some cases such treatment seems actually to hasten the progress of the disease. The value of treatment by the hypodermic injection of strychnine, which was claimed by Gowers, has not been borne out. It remains, therefore, to secure favourable conditions of life for the patient, and to maintain the general health in as perfect a state as possible. Cold, fatigue and traumatic influences, such as falls, are carefully to be avoided, as likely to increase the disability and incite extension

of the disease. Absolute rest is not essential, and adherence to light occupation where possible seems to hinder rather than to advance the progress of the disease. All tonic remedies are useful. Organotherapy has been largely vaunted; but any advantage gained therefrom is from the tonic effect upon metabolism. It has no specific effect upon the malady. Electricity, massage and passive movements are useful as giving bodily comfort to the patient, and satisfying him that something is being done for him, and that nothing has been left untried. Electricity, when strongly applied, does harm, and faradism must not be used in spastic cases. In bulbar cases, the dysphagia must be aided by avoiding liquids and solids, and by serving all the articles of diet in pultaceous form. Salivation, which is so troublesome in this condition, may be greatly helped by the administration of hyoscine by the mouth. In the rare cases where sphincter trouble is prominent, the regular administration of belladonna is of signal service. In the bedridden state cleanliness and careful attention to the skin, and to regular shifting of the patient, will always prevent the formation of bed-sores.

PERONEAL MUSCULAR ATROPHY; CHARCOT-MARIE-TOOTH TYPE OF MUSCULAR ATROPHY

This is an absolutely distinct and peculiar form of muscular atrophy, with a frequent tendency to occur in several members of the same family. It usually commences in mid-childhood, and after progressing for some twenty years or less, comes to a final arrest. The atrophy always commences in the intrinsic muscles of the feet, and is throughout strictly distal in distribution. The muscles of the face and trunk and the proximal muscles of the limbs are never affected. The atrophy leaves a peculiar elastic fibrosis in the affected muscles, so that the incapacity caused by this disease is much less than in any other form of muscular atrophy of like degree. Sensibility is often slightly affected, and there may be deep sensory loss. The essential morbid anatomy is a primary neuron atrophy of the anterior horn cells and of some of the afferent neurons in certain regions of the spinal cord.

Ætiology.—The disease usually commences between the fifth and tenth years of childhood, but it may appear as late as the fourth decade of life. Males and females are both affected. Heredity plays an important part in the incidence, although isolated sporadic cases are not uncommon. The malady often occurs in families, and has been traced through five generations; it may skip a generation and then reappear.

Pathology.—The anterior horn cells of the affected regions show a slowly progressive atrophy and disappearance, with corresponding atrophy of fibres in the peripheral nerves. The cells of Clarke's column show signs of degeneration, as do also some of the fibres of the posterior columns of the spinal cord, and especially those of the postero-lateral column. Slight degeneration in some of the fibres of the pyramidal tracts is usually found. The affected muscles show a simple atrophy of the muscle fibres, indistinguishable from that seen when a motor nerve is divided. There is a simple shrinking of the fibres, which stain progressively and more and more deeply with hæmatoxylin, lose their striation and finally disappear. Secondary fibrotic

changes accompany the atrophy, together with sclerosis of the arteries of the muscle.

Symptoms.—Muscular atrophy always dominates the clinical picture of this malady. It is always strictly distal in distribution, and this feature will almost always serve to distinguish peroneal atrophy from any other form of muscular atrophy. This is to say it does not affect one particular muscle, but the distal ends of all the muscles below a certain level on the limb, leaving the proximal ends of the muscles normal, and it advances up the limb inch by inch, the separation of the wasted portion of the muscle from the normal portion being always transverse to its length. In other words, the muscle fibres seem to waste in terms of the length of the spinal axons which supply them. The wasting commences always in the intrinsic muscles of the feet, and hollowness of the instep and thinness of the feet, together with retraction of the toes and the difficulty which the pes cavus so produced entails in fitting boots, first draws attention to the disease. As the process advances, the lower segments of the anterior tibial, peroneal and calf muscles become affected, and the limb is subsequently involved until the lower third of the thigh is reached, at which stage the disease is invariably arrested. This slow spread of the atrophy from the distal towards the proximal portion of the limb, gives rise to a most unique and characteristic feature in the appearance of the legs at the several stages of the disease. As an example, the complete atrophy of all the muscles below the middle and a well-developed musculature in the upper half of the leg, give rise to the inverted "fat bottle" calf. When the atrophy has involved the lower third of the thigh, the lower end of the femur, bare of muscle and covered only by skin and tendons, contrasts strongly with the well-developed muscles of the upper thigh, and causes the thigh to resemble an inverted champagne bottle.

Some years after the atrophy has become marked in the lower extremities, and in the usual run of cases just before the age of puberty, the intrinsic muscles of the hands and first those of the thenar and hypothenar group begin to waste, and this wasting may extend as high as the middle of the forearm. It must be borne in mind that the disease may become arrested at any period of its spread, and especially that the upper extremities often escape altogether. With the exception of the lower part of the thighs, the proximal segments of the limbs do not become involved, and the muscles of the head, neck and trunk remain unaffected.

The affected regions of the muscles waste absolutely, and leave a very elastic and not strongly contracturing fibrous tissue. The electrical excitability in the wasted regions becomes first lowered and then lost, and, in the earlier stages, may show a mixed reaction, in which there is lowering of excitability to faradism, with a tendency to an inverted polar reaction. Fibrillation of the muscles is an important sign. It is seen only when the disease is progressing, and in the muscles which are obviously wasting. It is never general, as in some cases of progressive muscular atrophy. And since peroneal atrophy is at times advancing and at other times stationary, fibrillation may be in one case conspicuous and in another never seen. It disappears entirely when the progress of the malady becomes finally arrested, and is, therefore, useful as a clinical indication of active advance of the disease. Contractures always occur, and from the nature of the distribution

of the atrophy are necessarily confined to the feet and the hands. In the feet, pes cavus with retracted toes is the rule; but sometimes, and in some stages of the disease, the feet and toes may be dropped and the feet inverted. The sphincters are unaffected. The ankle-jerks are diminished or lost in proportion to the wasting of the calf muscles. In the final arrested stage they are usually lost. The knee-jerk is always retained and is usually brisk. The plantar reflexes are usually lost early so far as any response in the foot is concerned, but some response in the upper thigh muscles, upon stimulating the plantar region, often remains. Pain, tenderness and cramp are entirely absent. Conspicuous loss of sensibility is uncommon, but slight loss of deep sensibility, loss of the vibration sense and relative tactile loss, may often be detected upon careful examination; but in rarer cases all forms of sensibility may be severely affected, or even entirely lost. As an example of the latter condition, a patient came under the writers' care in the arrested stage with complete atrophy of all the muscles below the knees, with complete loss of all forms of sensibility below the knees. Notwithstanding this complete motor and sensory loss, he was able to get about upon his legs and work, guided by sensations which reached his consciousness from the articular surfaces of the lower ends of his femurs. Perforating ulcers may be met with upon the soles of the feet, and are explained by the thinness of the feet and their deformity, which, coupled with the clumsiness of the use of the feet, lead to the formation of severe corns which break down into perforating ulcers. Loss of sensibility also is a factor in their production.

The most striking of all the clinical features of peroneal atrophy is the comparatively slight disability which the wasting of the muscles and consequent paralysis, and even the sensory loss, when present, cause. This is due to the peculiar quality of the fibrosis which succeeds the wasting. The fibrosed muscles support the joints in such a condition of unchanging, elastic stability as renders locomotion and other acts possible in a degree that is not met with in any other condition of muscular wasting. Even when a rapid increase of wasting has caused great disability, it is almost invariable to find that the advent of fibrosis in the course of time greatly lessens the disability. Thus, in a patient aged 16 years, who was unable to walk without assistance on account of the severe paralysis below the knees, a lapse of 4 years found him able to earn a good wage, working upon his feet, though there was no change in the degree of paralysis during this time.

Course.—The course is irregularly progressive for a number of years only, and the advance of the disease ceases usually in the third decade of life. Exacerbations of the weakness are likely to be followed in every case by considerable improvement, owing to the secondary fibrosis in the muscles.

Diagnosis.—Peroneal atrophy in the early stages is easily confused with progressive muscular atrophy, in that wasting of muscles and fibrillation are the conspicuous features. The onset usually in childhood and the fact that the feet are affected first, the peculiar distal distribution and the presence of any familial incidence, are important. But the only distinction which is absolute is the distribution, for progressive muscular atrophy may begin in childhood and peroneal atrophy may not appear till after middle life, and often familial relations are absent in the latter malady. In the course of time the diagnosis always becomes clear, for progressive muscular atrophy

never keeps to the classic distribution, nor is it followed by the peculiar fibrosis which characterises peroneal atrophy.

Dystrophia myotonica when commencing in the peroneal muscles may for a time closely simulate peroneal atrophy. The presence of the least sign of myotonia, the involvement of the face and the atrophy of the sterno-mastoids, will establish the diagnosis.

The usual forms of myopathy are at once separated from peroneal atrophy by the distribution of the muscular weakness and wasting, which in the former group of maladies is conspicuously upon the face, trunk and proximal muscles of the limbs, and in the latter upon the distal muscles. Peripheral neuritis is more rapid in its onset, and is apt to be associated with marked sensory disturbances, both objective and subjective, and the paralysis is in terms of individual muscles, which is not the case in peroneal atrophy.

Prognosis.—The disease has no tendency to destroy life. Complete arrest always occurs. There is invariably a tendency for the amount of disability to improve, for the reasons that the fibrosis of the paralysed muscles, which occurs in the course of time, renders the affected limbs more serviceable, and, further, that the patient learns to overcome his defects. There is never any real recovery in the affected muscles.

Treatment.—The general health should be carefully maintained, and the nutrition of the affected muscles aided by the application of massage and electricity. Care must be taken, on the one hand, to avoid over-fatigue of the affected muscles, and, on the other, to ensure such regular exercise as is compatible with their capacity. Bicycling, for example, since it employs chiefly the thigh muscles, is a better form of exercise for these patients than is walking. In no circumstances should tenotomies be performed for the deformity of the feet, for such measures tend to destroy the effect of the conservative fibrosis, so essential to the production of a useful limb. The use of any heavy mechanical supports is to be avoided above all things. Light, well-fitting boots, so as to interfere as little as possible with the exercise of the damaged muscles, are essential. Light, celluloid splints may be worn at night to assist the deformity of the feet in the advancing stages of the disease. Administration of thyroid gland and other polyglandular extracts has been recommended.

PROGRESSIVE SPINAL MUSCULAR ATROPHY OF CHILDREN; THE WERDNIG-HOFFMANN DISEASE

This is a malady of the first year of infancy, often incident upon several children of the same parents, and characterised by the gradual development of progressive muscular weakness and atrophy, which affects the proximal muscles first and most, increases to a complete paralysis of trunk and limbs, and finally affects the bulbar muscles. The disease is invariably fatal in from a few weeks to several months. The most striking pathological changes are a progressive degeneration and disappearance of the ventral horn cells of the spinal cord, and of their analogues in the brain stem.

Ætiology.—In some of the cases the paralysis is noticeable at the time of birth, and the disease is obviously of pre-natal development. In others the children are quite healthy at birth, and the disease develops some time

during the first year of life, and most frequently within 8 weeks of birth. Though sporadic cases may be met with, yet in the majority of instances several children of the same mother are affected. Both the pre-natal cases and the post-natal cases may be met with among the children of the same mother. The sexes seem to be equally affected. No maternal ill-health during pregnancy has been noticed, and nothing is known about any other ætiological factor.

Pathology.—The most extensive changes are found in the ventral horn cells throughout the spinal cord and brain stem, and at many levels no normal cells whatever are to be seen. Tigrolysis, swelling and glassiness of the cells, extrusion of the nuclei, disappearance of the dendrites, shrinking of the cells and final disappearance is the sequence of the changes. Degeneration of the anterior roots and of the peripheral motor nerve fibres consequently occurs. These changes are not confined to the lower motor neurons, for in our cases examination by the Marchi method showed extensive degeneration throughout the posterior columns of the cord, indicating that lower sensory neurons were also considerably affected.

The muscles show intense degeneration with hypertrophy of fibres and atrophy of most of the fibres, waving, moniliform shape, hypernucleation of the spindles, general nuclear increase and fibrosis.

Symptoms.—In the cases which are pre-natal, the malady is noticed at the time of birth on account of the tonelessness, flaccidity and the poorness of movement in the trunk and proximal muscles of the limbs. In the post-natal cases there is a gradual onset of similar weakness and flaccidity in the trunk first, and in the limbs afterwards, which usually commences within six weeks of birth, but which may not appear until towards the end of the first year of life. The weakness seems always to be least marked in the periphery of the limbs, where curious, slow, involuntary movements of the fingers and toes have been noted in a good many of the cases. The paralysis is followed by a rapid and extensive wasting of the muscles, accompanied by occasional fibrillary twitchings. Since these children are not only well nourished, but often put on much fat during the illness, wasting of the muscles may not be apparent on inspection or palpation. It can, however, immediately be detected by radiography, which distinguishes sharply between fat and muscle.

As the malady progresses the trunk muscles become completely paralysed, the intercostal muscles being always paralysed before the diaphragm. The limbs become progressively weaker, and, lastly, bulbar paralysis supervenes in those cases where death has not already occurred from respiratory paralysis. The reaction of degeneration is present in the affected muscles. Sensibility may be unimpaired; but in several of my cases there has been conspicuous loss of pain sensibility over the limbs and trunk. The sphincters are unimpaired until the very last stages of the disease. The superficial and deep reflexes are lost. The ocular muscles have not been affected, and intelligence is preserved throughout.

Diagnosis.—The peculiar and striking features of the disease make the diagnosis easy, if the symptomatology be known. Amyotonia congenita presents the same helplessness and flaccidity of trunk and limbs as does the Werdnig-Hoffmann disease, and further resembles it in being sometimes congenital, and sometimes having an onset very early in life. In amyotonia

congenita, however, the paralysis is not complete, and it tends to improvement and not to progressive increase. Contractures also occur, which are not found in the Werdnig-Hoffmann disease, and, lastly, the definite spinal cord changes of the latter malady are not found in the former.

Course and Prognosis.—The course is invariably progressive, and is more rapid the earlier in life the disease commences, and it is most rapid of all in the pre-natal cases, which are usually fatal within a few weeks. With an onset some weeks after birth, life is usually continued for several months, and a few cases have been reported with an onset towards the end of the first year, in which death has been delayed until the third or fourth year.

Treatment.—No treatment is known to influence the course of the malady.

LESIONS OF THE PERIPHERAL NERVES

LOCAL LESIONS OF NERVE ROOTS AND NERVE TRUNKS

PHRENIC NERVE.—This nerve is formed by the junction of fibres arising from the third, fourth and fifth cervical segments of the spinal cord. It supplies the diaphragm. Paralysis results most often from disease of the spinal cord, but the roots may be implicated in disease of the spine, and the trunk may be injured in its course through the neck and thorax, by wounds or tumours. Bilateral paralysis occurs in lesions of the cord and spine, and in alcoholic, diphtheritic, saturnine and other forms of peripheral neuritis. Other causes usually affect one side only. When the diaphragm is completely paralysed, the normal inspiratory protrusion of the upper part of the abdomen disappears, or is replaced by retraction of this part with each inspiration. During rest, so long as the lungs are healthy, the respiratory rate does not increase, but if bronchitis or pneumonia arises as a complication, or if the patient exerts himself, the diminished reserve of respiratory power is seriously felt. When one nerve only is affected the diaphragm does not descend on that side. This is rarely detected by observation of the abdominal movements, but is easily seen on the X-ray screen. It produces no discomfort.

THE LONG THORACIC NERVE.—This nerve is formed in the substance of the scalenus medius muscle, by the union of fibres arising from the posterior aspect of the fifth, sixth and seventh cervical roots. It supplies the serratus magnus muscle. When all the fibres of this muscle contract, the scapula moves upwards, forwards and outwards. It contracts with the pectoralis major in the action of pushing forward the point of the shoulder and in the rapier-thrust movement. It also assists the deltoid in raising the arm. When it is paralysed alone, the position of the scapula at rest is unaltered, but if the trapezius and the rhomboids are paralysed as well the scapula drops, and its lower angle is displaced inwards. Paralysis of the serratus magnus is best demonstrated by causing the patient to hold the arms outstretched before him. The arm is not raised so high on the affected as on the normal side, because the scapula is not fixed and the deltoid works at a

disadvantage. Viewed from behind the deformity is characteristic. The vertebral border of the scapula stands out prominently and the hand can be pushed between this bone and the thorax—"winged scapula." On raising the arm from the side, there is difficulty in attaining the horizontal position, but the winging of the scapula is less apparent.

The nerve may be damaged by carrying heavy weights on the shoulder, by falls or blows on the shoulder, and by continued muscular effort with the raised arm. The nerve may be injured alone in gunshot wounds, but as a rule it is associated with lesion of the brachial plexus. In the cases caused by compression, severe neuralgic pains in the neck precede the onset of paralysis. Recovery is always very slow and the defect may be permanent.

BRACHIAL PLEXUS.—The brachial plexus is formed by the union of the anterior division of the lower four cervical nerves and the first dorsal nerve. It may be injured by stabs in the neck, by penetrating missiles, by dislocation of the shoulder or fracture of the clavicle, or by pressure of a tumour, aneurysm or cervical rib. Further, the nerves may be torn by forcible dragging on the arm in accidents or during delivery. In most cases the lesion is partial and the symptoms conform in the main to one of the following types.

Upper plexus paralysis.—This results from an injury to the fifth and sixth cervical roots. The muscles paralysed are: biceps, deltoid, brachialis anticus, supinator longus, supraspinatus, infraspinatus, rhomboideus, subscapularis, clavicular portion of pectoralis major, serratus magnus, latissimus dorsi, teres major. The arm cannot be flexed at the elbow (flexors of forearm), nor raised and abducted (deltoid). The movements of the wrist and fingers are not impaired. Adduction of the arm is weak (pectoralis major), and rotation is feeble or absent (spinati). On attempting to oppose the shoulders, the scapula on the affected side passes further from the middle line (rhomboideus). The hand of the affected side cannot be placed on the buttock of the sound side (latissimus dorsi).

The reaction of degeneration is often complete in the deltoid and flexors of the forearm and nearly so in the spinati. It is usually incomplete in the other muscles. Sensation is diminished or lost along the outer border of the whole limb immediately after the injury, but improvement sets in rapidly. For some time the patient experiences pins and needles and burning sensations in the affected area, which last longest in the thumb and index finger. The biceps reflex is lost. Percussion of the styloid process of the radius, instead of causing a contraction of the biceps and supinator longus, produces flexion of the fingers—inversion of the radial reflex. In this form the tendency to complete recovery is great. As a rule all the symptoms disappear completely in from 6 months to 2 or 3 years. Weakness persists longest in the deltoid and supinator longus.

Lower plexus paralysis.—This results from a lesion of the eighth cervical and first dorsal roots, or of the common trunk of the median and ulnar nerves. The intrinsic muscles of the hand and the flexors of the wrist and fingers are paralysed, and the inner border of the forearm and hand is anæsthetic. When the roots are damaged, sympathetic fibres may be implicated with the production of myosis, narrowing of the palpebral aperture, enophthalmos and alterations in sweating on the face, neck, arm and upper part of the chest, on the affected side.

Middle plexus paralysis.—This form of paralysis is a common result of gunshot injuries of the plexus. It affects the muscles supplied by the musculo-spiral and circumflex nerves—posterior cord. As the nerve to the latissimus dorsi arises from the same trunk, this muscle is often paralysed as well. In addition to these simple types, more complicated paralyses occur, in which various parts of the plexus are injured together.

In *paralysis of the inner cord of the plexus*, atrophy is confined to the intrinsic hand muscles.

Lesions of the brachial plexus show a remarkable tendency to spontaneous recovery. In many cases recovery is complete in 6 months to 2 years, in others it is partial, and some muscles remain paralysed.

THE MUSCULO-SPIRAL NERVE.—Owing to its long course, its position in relation to the humerus, and its peculiar vulnerability to compression, paralysis of the musculo-spiral nerve is one of the commonest peripheral palsies; although it is a mixed nerve containing sensory, motor and vaso-motor fibres the symptoms of an injury are almost entirely motor. In the upper arm the nerve supplies the triceps and the anconeus, in the forearm the supinators, the extensors of the wrist and fingers, and the extensors and long abductor of the thumb.

Symptoms.—Injury to the nerve is followed by dropping of the wrist and fingers. The wrist and the first phalanges are flexed. The flexion is limp and easily reducible.

When the lesion is in the axilla the whole of the *triceps* is paralysed, and extension at the elbow is lost. Occasionally in wounds of the posterior aspect of the arm the nerves to the triceps are injured, whilst the main trunk escapes. The patient is then able to extend the arm powerfully by means of the anconeus, but if he is made to raise the elbow as high as possible with his fingers on the point of the shoulder, extension of the bent forearm is impossible.

In most cases the nerve is injured in the middle third of the arm and the triceps escapes, but the supinator longus and *all* the extensor muscles in the forearm are paralysed. Partial paralyses, such as are seen in lesions of the median and ulnar nerves, are very rare. The *supinator longus*, so-called, is not a supinator. Its action is to flex the forearm, whilst the hand is in a position intermediate between pronation and supination. Paralysis of this muscle is detected by the absence of contraction when the pronated forearm is flexed against resistance. Owing to paralysis of the *supinator brevis* supination is abolished. During the movement of flexion of the forearm the biceps acts as a supinator, during extension the external rotators of the shoulder, but feebly.

Paralysis of the *extensors of the carpus* abolishes both extension and lateral movement at the wrist. The flexors of the carpus play no part in lateral movements. The *extensors of the fingers* extend the first phalanges *only*. Extension at the distal joints is carried out by the lumbricals and interossei. Paralysis of the *extensors and long abductor of the thumb* renders abduction of the thumb and extension of the phalanges impossible. On attempting to abduct the thumb, it passes no further than the radial border of the hand. In some cases, the second phalanx of the thumb can be feebly extended by the muscles of the thenar eminence.

Many muscles not supplied by the musculo-spiral work at a disadvantage

when the extensors are paralysed. These defects must not be mistaken for signs of injury to other nerves. Owing to the flexed position of the hand the grasp is feeble, but if the wrist is extended passively the grasp is improved. The patient cannot make a fist properly, as the thumb does not oppose the index finger and the fingers cannot be flexed into the palm, until the thumb has been moved aside by the sound hand. The movements of the interossei in abducting and adducting the fingers are also feeble while the wrist is flexed, but are much stronger when the hand is resting flat on a table with the wrist and fingers extended. The complete reaction of degeneration is often found in all the paralysed muscles from the onset. Atrophy becomes obvious in a month or two. Its extent and severity give important evidence for prognosis.

Sensory disturbances.—Subjective symptoms are rare. In a few cases, paræsthesiæ are felt on the posterior aspect of the forearm and on the dorsal aspect of the thumb. They are of brief duration, and are commoner with partial than with complete lesions. Severe causalgias are almost never seen in lesions of this nerve. Sensibility to light touch, superficial pain and temperature is impaired over a small area on the radial border of the hand, including the proximal joints of the thumb and first two fingers. The defect is often very slight, and is only discovered on very careful examination. Deep sensibility is rarely affected. Considering the extensive distribution of the external cutaneous branch of the musculo-spiral nerve, it is rather surprising that the sensory disturbances are so slight, when the nerve is injured above the origin of this branch.

Recovery.—It might be thought that recovery would take place in the order of the length of the branches to the various muscles. This, however, is not the case. As a rule the extensors of the wrist recover first, then the extensors of the middle, ring, little and index fingers in this order, next the supinator longus, and the extensors and abductors of the thumb last of all. On palpation of the muscles during attempted extension, contractions can be felt before any movement is produced. Other signs of impending recovery are the disappearance of automatic pronation and of the flail-like drop of the hand, also diminution of automatic flexion of the fingers after passive extension. Recovery of movement is complete when the patient is able to extend the wrist and all the fingers simultaneously or separately. After this becomes possible, restoration of power is rapid.

THE MEDIAN NERVE.—Whilst the clinical individuality of the musculo-spiral nerve is shown in the preponderance of motor symptoms and in the uniform completeness of the paralysis that follows an injury, that of the median is seen in the frequency of partial and especially of painful lesions. Isolated palsy of this nerve is infrequent except as a result of gunshot wounds and other injuries. It may be damaged by repeated violent contractions of the pronator radii teres, as in one of the forms of "tennis elbow."

Total paralysis.—The muscles paralysed are the pronators, the radial flexor of the wrist, the flexors of the fingers except the ulnar half of the deep flexor, most of the muscles of the thenar eminence (opponens, abductor brevis and outer head of the flexor brevis pollicis) and the two radial lumbricals. Stated briefly the symptoms are: inability to flex the phalanges of the index finger and the second phalanx of the thumb; difficulty in flexing the phalanges of the middle finger; defective opposition of the thumb. The appearance

of the hand in total lesions is fairly constant. The hand inclines to the ulnar side, the index and middle fingers are more extended than is normal, and the thumb lies on a level with the fingers—the ape-hand.

Pronation is incomplete and defective. The patient tries to overcome the defect by rotating the whole limb at the shoulder. Paralysis of the *flexors of the wrist* is seen when an attempt is made to flex against resistance. The tendon of the ulnar flexor alone stands out, and the hand is drawn towards the ulnar side. Even at rest, the flexor tendons are more prominent on the sound than on the affected side.

Flexion of the fingers is good in the two ulnar fingers, though weaker than normal. The index cannot be flexed at all, and the third finger only incompletely. Flexion at the proximal joint is usually good in all the fingers including the index, and flexion at this joint with extension at the last two joints is usually well done by the interossei and lumbricals. If the proximal phalanx of the thumb is immobilised, it will be seen that flexion of the terminal phalanx is abolished, owing to paralysis of the *flexor longus pollicis*.

Paralysis of the *thenar muscles* renders opposition and abduction of the thumb defective. By means of the adductor the thumb can be drawn into the palm, but as the radial fingers cannot be flexed nor the thumb opposed, it is impossible to place the tip of the thumb on the tips of the fingers. Atrophy of the muscles becomes obvious in a few weeks. The outer part of the thenar eminence is flattened, and the bulk of the muscles arising from the internal condyle is greatly diminished.

Sensory disturbances.—In almost every case there is complete anæsthesia to all forms of sensation in the two terminal phalanges of the index and middle fingers. The skin outside this area may be unaffected even in complete lesions, but in most cases sensibility is diminished in the terminal phalanx of the thumb, and to a less extent over the remainder of the radial half of the palm, including the radial side of the ring finger. The stereognostic sense is lost in the outer fingers. This defect, together with the loss of power, renders the thumb and index finger useless, and makes paralysis of the median the most serious single nerve lesion of the upper limb.

Vasomotor and trophic changes.—In many cases the skin in the distribution of the median nerve is red, dry and chapped, and the nails white or purple. It is possible that these changes are due to an associated vascular lesion.

Recovery is extremely slow and is rarely complete. Sensation begins to return before power, but the stereognostic sense is often defective, long after movement in the fingers has returned. The pronator and the flexors of the wrist recover first, then the flexors of the thumb and middle finger. Flexion of the index finger and opposition of the thumb, if it is regained at all, remains defective for several years. In searching for signs of recovery, care must be taken lest some " trick-movement," due to contractions of healthy muscles, is misconstrued. For example, when told to flex the terminal phalanx of the thumb, the patient first over-extends and abducts, and then relaxes suddenly. The terminal phalanx then makes a slight passive movement of flexion, which may be mistaken for true active flexion. Recovery is complete when the patient is able to make a good fist with the fingers flexed well into the palm, and the thumb pressed firmly upon the dorsal aspect of the second phalanx of the middle finger.

PARTIAL LESIONS.—Partial paralysis of the median nerve is much commoner than the complete form.

Motor symptoms.—Flexion of the index finger and opposition of the thumb are most impaired. The flexors of the middle finger and of the terminal phalanx of the thumb may suffer also, but to a less degree, whilst the pronators and the flexors of the wrist often escape entirely.

Sensory symptoms.—Apart from the painful lesions to be mentioned later, sensory troubles are usually slight in partial lesions. Anæsthesia is rare, but sensibility to all forms may be diminished in the areas mentioned under complete lesions.

Vasomotor symptoms.—The skin is often cyanosed in the distribution of the injured nerve, and it may perspire more freely than in healthy parts. These changes are more distinct when the paralysis is complicated by a vascular lesion.

Recovery is naturally more rapid than in complete lesions. The order in which the muscles recover and the tests for complete return of function have been mentioned above.

PAINFUL LESIONS OF THE MEDIAN NERVE.—*Causalgia.*—In many cases the most prominent symptom of injury to the median nerve is *pain.*

Motor disturbances are always present, but are usually slight, the weakness affecting mainly the flexors of the index finger and the thenar muscles.

Vasomotor changes are a feature of this type. In many cases perspiration is diminished over the radial half of the palm, and the skin becomes dry and scaly. In others, perspiration is increased over the median area.

Sensory disturbances.—Pain comes on about a month after the injury, at first as tingling or pricking in the finger-tips and palm, later as a constant severe smarting, dragging or *burning* pain—hence the name causalgia. Added to the constant pain which never ceases day or night, paroxysms occur, in which the pain increases suddenly in intensity. The application of cold water gives temporary relief, and patients often wear bandages or gloves which they keep constantly moistened. Many develop a phobia of dryness. They will not touch dry objects, even with the healthy hand, the sight of another person handling a dry object increases the pain, and any rustling or crackling sound, suggestive of dryness, may bring on a paroxysm.

In severe cases the limb is held flexed at the elbow and wrist, with the hand constantly raised and the fingers extended or hyper-extended. The whole hand atrophies, and irreducible ankylosis occurs with the limb in this position. The skin of the hand is thin and dry. The fingers taper, and the nails are long, brittle, blackened and striated longitudinally. The pain reaches its acme 4 or 5 months after the injury, and then slowly declines, but the limb remains useless. Even in slighter cases, without much deformity, recovery of function is extremely slow, and is rarely complete.

THE ULNAR NERVE.—Arising from the inner cord of the brachial plexus, the ulnar nerve receives its fibres from the eighth cervical and first dorsal segments of the cord. It supplies the ulnar flexor of the wrist, the ulnar half of the deep flexor of the fingers, the muscles of the hypothenar eminence, the interossei, the two inner lumbricals, and the adductor and inner head of the short flexor of the thumb. Its sensory area is the ulnar border of the hand, the little finger and the inner half of the ring finger.

Total paralysis.—Paralysis of the *flexor carpi ulnaris* may be detected by palpating the tendons when the wrists are flexed against resistance. The limpness on the affected side contrasts strongly with the firmness on the sound side. Lateral movements of the hand are unaffected, as these are carried out by the extensors.

Paralysis of the ulnar portion of the *flexor profundus digitorum.* In making a fist flexion of the index finger is perfect, and that of the middle finger good, whilst in the ring and little fingers it is absent or very feeble. This weakness is best seen when flexion is attempted with the index and middle fingers extended. Even when the fingers can be flexed by the action of the flexor sublimis, the power of resisting passive extension is completely lost in the terminal phalanx of the two ulnar fingers. Paralysis of the *hypothenar* muscles abolishes lateral movements of the little finger, and diminishes the power of flexion at the proximal joint. Paralysis of the interossei and of the inner two lumbricals leads to the production of the "claw-hand."

The action of these muscles is to flex the fingers at the proximal joints with the distal joints extended. In the "claw-hand" the posture of the fingers is just the opposite of this, namely, extension at the proximal joint with flexion of the distal joints. Although all the interossei are paralysed, the defect is only seen in the ulnar fingers, as the radial lumbricals supplied by the median are still healthy. It is produced by the action of the long extensors, which being now unopposed, over-extend the proximal joints, and by the flexor sublimis, which flexes the second joint and draws the distal joint down with it. The clawing of the fingers is greatly accentuated when the nerve is paralysed below the point of origin of the fibres to the long flexors of the fingers. Other features of the "ulnar hand" are atrophy of the interossei and of the hypothenar eminence and persistent abduction of the little and ring fingers. The movements of abduction and adduction are lost in the inner two fingers, and often in the middle finger. Further, these fingers cannot be flexed at the distal joint, whilst the proximal joints are extended.

Paralysis of the *adductor pollicis* and of the inner head of the *flexor brevis pollicis* produces peculiar disturbances in prehensile movements. If the patient is asked to grasp a folded paper between his thumb and index finger, and to resist efforts to remove it by pulling, it will be found that this movement, which is normally very powerful, is grossly defective. He cannot grasp the object beneath the thumb with the second phalanx extended; but presses the tip of the flexed thumb against the outer margin of the index finger.

Sensory disturbances.—In complete lesions, all forms of sensation are abolished in the little finger, and along the ulnar border of the hand. Beyond this there is usually diminished sensibility on the ulnar side of the ring finger, and over a narrow area towards the centre of the hand on both aspects. Spontaneous pains are rare, and vasomotor changes are usually slight.

Partial paralysis.—In partial lesions the same symptoms are found in a less degree. The small muscles of the hand suffer most. Clawing may be slight or absent. Neuralgic pains may be felt in the distribution of the ulnar nerve; but causalgia is never seen in lesions of this nerve alone.

Recovery of sensation is usually complete before movement is regained.

The flexor carpi ulnaris recovers first, then the long flexors of the fingers, and last the small muscles of the hand. In these recovery is extremely slow. When recovery of movement is complete the patient can abduct and adduct the middle finger with the palm flat on a table, and he can also scratch the table with the nail of the little finger without moving his wrist.

THE MUSCULO-CUTANEOUS NERVE is derived from fibres arising from the fifth and sixth cervical nerves. It is rarely affected alone, but is often implicated with the brachial plexus. It supplies the biceps, coraco-brachialis and brachialis anticus. Flexion of the forearm can still be carried out by the supinator longus; but the power of flexion is greatly diminished. Sensation may be diminished or lost along the radial border of the forearm.

THE CIRCUMFLEX NERVE derives its fibres from the fifth and sixth cervical nerves. It supplies the deltoid and teres minor, and the skin over the deltoid. It may be injured alone in injuries to the shoulder and by pressure of a crutch. The chief symptom is paralysis of the deltoid with almost complete inability to raise the arm.

INTERNAL CUTANEOUS NERVE.—Division of this nerve produces a narrow area of anæsthesia on the inner side of the forearm.

THE LESSER INTERNAL CUTANEOUS supplies the skin on the inner aspect of the upper arm.

In war injuries lesions of the nerves of the lower limb are very frequent; but in civil practice, apart from sciatica, local lesions of these nerves are rare.

THE LUMBO-SACRAL PLEXUS.—The *lumbar plexus* is formed by the union of loops from the anterior branches of the first three lumbar nerves and a part of the fourth. The rest of the latter unites with the fifth to form the lumbo-sacral cord, and joins the sacral roots to form the *sacral plexus*.

The lumbar plexus may be damaged by abdominal tumours, and its roots by new-growth or other disease of the vertebræ. In a certain number of cases signs of inflammation of the lumbar plexus are found in association with sciatica or neuritis of the sacral plexus.

ANTERIOR CRURAL NERVE (L_2, L_3, L_4).—This is the largest branch of the lumbar plexus. It supplies the psoas, iliacus, pectineus, sartorius, adductor longus and quadriceps femoris. It may be injured alone by fractures of the pelvis or of the femur, by dislocations of the hip, or by implication in wounds, psoas abscesses or new growths.

The most prominent symptoms are loss of power to extend the knee, loss of the knee-jerk, wasting of the quadriceps, and sensory disturbances over the anterior surface of the thigh and inner surface of the leg. The psoas always escapes, unless the plexus itself is also damaged; but flexion at the hip may be imperfect through paralysis of the iliacus. Owing to the rapid dispersion of the branches in the thigh, wounds in this part often cause partial lesions. *In these the nerve to the quadriceps is most often injured.* The resulting paralysis causes serious disability in walking as the knee gives way at every step, especially in going down stairs, and lameness lasts for a long time after complete return of voluntary movement.

OBTURATOR NERVE (L_2, L_3, L_4).—This nerve is rarely damaged alone. It supplies the three adductor muscles, the obturator externus and the gracilis. The symptoms are weakness of adduction and internal rotation at the hip.

External Cutaneous Nerve (L_2, L_3).—This nerve supplies an area of skin on the buttock, and through its femoral branch the skin on the antero-lateral aspect of the thigh. As a result of injury, but more often without obvious cause, the skin in the territory of this nerve may show peculiar sensory disturbances, which have been described under the name of *meralgia paræsthetica*. Most cases occur in men. In women it is usually associated with pregnancy. The nerve is tender on pressure at the point where it passes from under Poupart's ligament, and neuralgic pain or numbness and tingling is felt in the skin, which may be slightly insensitive on objective examination or extremely hyperæsthetic, so that the slightest touch causes pain. The symptoms, which are always unilateral, are made worse by walking and may cause serious incapacity by their persistence and severity. In severe cases the nerve should be excised.

The *sacral plexus* may be damaged by growths or inflammation in the pelvis, by compression during parturition, and by penetrating missiles. It is also often the seat of spontaneous neuritis.

The Great Sciatic Nerve (L^4, L^5, S^1, S^2).—This nerve supplies the flexors of the leg and all the muscles below the knee. It may be involved in pelvic new growths, or injured by fractures of the pelvis or femur. Next to the musculo-spiral it suffers in gunshot wounds more often than any other nerve.

Total paralysis.—The foot drops, and the toes point downwards. Walking is possible, but the patient cannot stand on the heel or toes of the paralysed foot. The knee is raised high, but the steppage is not so marked in total lesions as when the external popliteal alone is paralysed. All movement below the knee is abolished. When the wound is in the buttocks flexion of the knee is very weak. The foot becomes œdematous if allowed to hang down. Sweating is often absent on the sole and dorsum of the foot, but is normal on the inner side of the foot, which is supplied by the anterior crural. The skin is dry and thin, and may be scaly. Hyperkeratosis of the sole is common. Subjective sensibility is rarely affected. The skin is completely anæsthetic over the entire foot, except the inner border of the sole and around the internal malleolus. The anæsthesia extends upwards on the postero-external aspect of the calf in its lower two-thirds, embracing the tendo Achillis and external malleolus. Beyond this area of complete anæsthesia *there is a wide zone in which sensibility is diminished. The sense of position and passive movement is abolished in the foot and toes. The knee-jerk is* present. The ankle-jerk is always lost. Stimulation of the sole may produce a contraction in the tensor of the fascia lata; but there is no response in the foot.

Partial paralysis.—In wounds of the sciatic nerve it often happens that *the fibres of the external popliteal alone are wounded, since the sciatic trunk often divides into the internal and external popliteal branches as* high as the great sacro-sciatic notch. The symptoms are described below under paralysis of this nerve. In other cases, the fibres of the internal popliteal are damaged either alone, or with some of the fibres of the external popliteal. In this case the outstanding clinical feature is pain of the same nature as that already described in lesions of the median nerve.

External Popliteal Nerve.—This nerve may be injured as it winds

round the fibula by wounds or fractures or by compression of a tight bandage. The paralysis is usually severe, all the muscles being equally affected. The foot is dropped and inverted, and the toes are slightly flexed. Dorsal flexion of the foot, extension of the proximal phalanges of the toes, and abduction of the foot are impossible. The patient can walk, and he can stand on tip-toe, but he cannot run, and walking is made difficult by the foot-drop. Subjective sensory disturbances are usually absent. The skin is anæsthetic over a narrow band which extends from the outer surface of the leg in its middle third, downwards beside the outer border of the tibia, and along the middle of the dorsal aspect of the foot as far as the base of the toes. For an inch or so, on both sides of this band, the sensibility of the skin is diminished. The knee-jerk and ankle-jerk are present. The plantar response is always flexor. Vasomotor changes are slight, and trophic changes are absent.

Internal Popliteal Nerve.—This nerve is rarely injured alone. It supplies the popliteus, the calf muscles, the flexors of the toes and the intrinsic muscles of the foot. When it is paralysed, the patient is unable to stand on tiptoe, or to extend or invert the ankle, or to flex his toes. Paralysis of the interossei leads to a claw-like deformity of the foot, associated with lowering of the heel and raising of the metatarsus—talipes calcaneo-valgus. The calf muscles are flabby and the ankle-jerk is abolished. Sensation is lost on the sole, except along its inner border, on the outer border of the foot, and on the plantar surface of the toes. Causalgia, similar to that in paralysis of the median, is very often present.

Posterior Tibial Nerve.—This nerve may be injured by a penetrating missile or a deep wound in the calf. Movements of the ankle are unaffected, and anæsthesia is confined to the sole of the foot and heel, or merely to its inner half. The paralysis of the intrinsic muscles of the foot may escape detection, and the lesion may easily be overlooked, especially when the nerve is injured below the origin of branches supplying the flexor longus hallucis and the flexor longus digitorum. The symptoms then are pain in the sole of the foot, anæsthesia on the sole, and paralysis of the plantar muscles.

Treatment of Local Nerve Lesions.—Treatment must depend on the nature and degree of the lesion. During the long period which elapses between the onset of paralysis and the first signs of recovery, even in cases of simple physiological interruption of the nerves, every effort must be made to prevent degeneration of the muscles, to keep the circulation of the limb active, and to prevent the occurrence of contractures and deformities. Massage, movements, electrotherapy and suitable appliances all have their uses. With regard to operative treatment, it must be remembered that more than half the cases of nerve injuries undergo spontaneous cure. It is advisable, therefore, to wait three or four months before an operation is undertaken. If, at the end of this time, the wound is soundly healed and all signs of sepsis have disappeared, and if, as a result of repeated examinations, no sign of recovery has been detected, no harm can be done by exposing the nerve. If it is found to be divided completely, the ends should be "freshened" and sutured end to end. If the nerve is notched laterally, the edges of the notch should be pared and sutured, care being taken to preserve the bridge of uninjured tissue. Sometimes the nerve at the site of the lesion appears as a fibrous, flattened band between two swellings on the nerve. In most of

such cases the nerve is completely divided, and the condition calls for resection of this fibrous tissue and end-to-end suture. Another common finding, when the nerve is exposed, is a nodule or cicatricial swelling in the course of a nerve which has maintained its continuity. In these cases the continuity of the nerve should not be interrupted. It should be freed from adhesions, and incised in the long axis of the swelling. All operations which involve grafting of nerves are futile. For an account of the great advances in the technique of the surgical treatment of nerve injuries which have been made as a result of experience gained in the Great War, special treatises must be consulted.

The treatment of painful forms of nerve lesions is extremely difficult. In severe cases external applications and internal medication entirely fail. Simple freeing of the nerve sometimes gives relief. Where this fails, it may be advisable to practise complete division followed by immediate suture. Alcoholisation of the nerve trunk often gives immediate and lasting relief. Under general anæsthesia the nerve is freed, and then injected with 1 c.c. of weak alcohol at a point two or more centimetres above the lesion. This, of course, is followed by motor paralysis; but recovery occurs in about six months.

Interstitial Neuritis

Synonym.—Neuro-fibrositis.

Definition.—A malady which commonly attacks the large nerve plexuses or nerve trunks, but which may affect any peripheral nerve trunk, and which is characterised anatomically by an inflammation of the connective tissues which surround and bind together the nerve fibres into the nerve trunks. This fibrositis, which may be local or diffuse in the affected nerves, is the result of the causes of fibrositis in general, and is frequently associated with fibrositis elsewhere, as, for example, when sciatica is associated with lumbago. The symptoms are those of irritation of the nerve fibres, namely, pain in the distribution of the nerve trunk, tenderness of the nerve trunk, muscular fibrillation and cramp. Loss of function of the nerve fibres in the way of loss of sensibility or muscular paralysis is the rarest of events in interstitial neuritis, and is seen only as the result of terminal cicatrisation in severe cases. Muscular wasting is the rule, but it is a general wasting of muscles of the painful region, not confined to the distribution of the nerve involved, and therefore resembling the muscular wasting which is seen in joint disease.

Pathology.—The malady is met with soon after puberty, and is incident chiefly upon the first half of adult life, being unknown in childhood and rare in old age. It is often associated with other forms of fibrositis such as lumbago. Often it arises spontaneously, without external cause: but exposure to cold may directly cause it, as also may injury such as stretching, bruising or wounding of the nerve trunk. Gout and diabetes are well-known clinical associations.

The morbid anatomy is well seen when the nerve is exposed during operative procedures for the relief of the condition. The affected nerve trunk is swollen and pink in colour; the sheath is distended, and droplets of fluid exude when it is incised, and sometimes the nerve is adherent to the surrounding tissues. This inflammatory condition may be local and appear as a

pink bulbous enlargement of the nerve trunk, or it may spread widely over a long stretch of the nerve trunk and its branches. When the inflammatory process subsides there may be cicatrisation of the peri- and endo-neurium. Only in the rarest cases does the morbid process become so severe as to interfere with the more important functions of the nerve trunk with the production of motor and sensory paralysis, and even in these cases complete ultimate recovery is the rule. The local inflammatory condition causes a slight shortening of the nerve trunk, and this causes the affected limb to be held in that position which will keep the nerve trunk most relaxed. It is also the cause of the severe pain which occurs on any movement which stretches the nerve trunk.

Interstitial neuritis is sometimes an associate of arthritis. For example, in arthritis of the shoulder-joint it is not uncommon to meet with definite involvement of the brachial nerves, and again in chronic arthritis of the hip-joint the inflammatory process may extend from the capsule of the hip-joint directly into the contiguous sciatic nerve.

The malady may affect any of the nerve roots or nerve trunks, and sometimes several of these may be co-involved. When the nerve roots are affected "radicular neuritis" results. The sciatic nerve is by far the most common seat of the disease, producing the condition known as "sciatica." Next in order of frequency come the brachial plexus, causing "brachial neuritis," the anterior crural nerve causing "anterior crural neuritis," the upper part of the cervical plexus producing "cervico-occipital neuritis," and the intercostal nerves producing the so-called "intercostal neuralgia."

Symptoms.—These are the same whatever nerve is affected, and consist in—(1) Pain radiating in the area of distribution of the affected nerve, of a dull, aching character with acute exacerbations and often very long lasting. (2) Tenderness of the affected nerve to pressure and stretching. (3) Subjective peripheral sensations such as tingling, burning or numbness. (4) General wasting of the muscles of the surrounding region with marked hypotonus, not confined to the muscles supplied by the affected nerve and akin to arthritic muscular atrophy. This wasting may reach a very remarkable degree. (5) Increase of the deep reflexes of the limb. (6) Diminution or loss of the deep reflex in the supply of the affected nerve. This is a valuable indication of the severity of the lesion. In a case of sciatica, for example, all the muscles of thigh and leg are wasted, the knee-jerk and the adductor-jerks are markedly brisk, whereas the ankle-jerk, which is in the sciatic supply, is diminished in slight cases and lost in severe cases. (7) The affected limb is held in a characteristic position to avoid stretching of the nerve, and the gait is similarly modified. (8) Trophic and vasomotor changes are not uncommon. (9) Fibrillation is often present.

Diagnosis.—There is sometimes considerable difficulty in the diagnosis of cases of interstitial neuritis on account of the almost identical clinical picture which may occur in the early stages of pressure upon nerve roots or nerves by tumours. The following points are of value in distinguishing the two conditions: The pain of pressure lesions is rarely so severe as that of interstitial neuritis. Tenderness on pressure or stretching of the nerve trunks is absent in pressure lesions. Signs of loss of function—paralysis and sensory loss—come on early in pressure lesions. The most

careful search should be made in every case for any possible cause for local pressure, such as primary and secondary neoplasms, spinal tumours, spinal caries and diabetes. To make a diagnosis of interstitial neuritis in the presence of a mammary or testicular carcinoma, removed or not, is to advocate the highly improbable, whatever the symptoms may be.

Brachial Neuritis.—This form of interstitial neuritis is somewhat rare, and is met with chiefly in women over the age of 35 years. Sometimes it follows injury to the brachial plexus from any violence causing undue separation of head and shoulder. More often it arises spontaneously. The pain, which is often of sudden onset, may be of great severity, and may be at first referred to the region of the plexus itself, the back of the scapula, the axilla, the forearm or the hand, is at first intermittent, but it soon becomes continuous and spreads over the whole upper limb. Tingling and numbness in the hand and trophic changes in the skin and nails of the fingers are the rule.

One of the great difficulties in this malady is that in the upright position the weight of the arm and shoulder carry the shoulder downwards and stretch the inflamed plexus, adding greatly to the pain. Therefore it should be treated with the recumbent position upon the back in bed. Further, every movement of the hand or arm tends to increase the pain. Splints which keep the arm in the abducted position and the shoulder raised so as to prevent tension upon the plexus are invaluable.

There is little difficulty in diagnosis, the only confusable conditions being arthritis of the shoulder and cervical rib, in neither of which conditions is there any tenderness of the nerve trunks of the plexus.

Cervico-occipital Neuritis.—This condition, which is by no means rare, is characterised by pain in the upper part of one side of the neck, radiating over the branches of the upper cervical plexus, the great occipital being the most common and the supra-sternal, supra-clavicular and supra-acromial branches less common seats for the pain. The fibrositis not infrequently co-involves the fibrous structures in the region of the articular and transverse processes, giving rise to pain and stiffness of the neck on movement. When the pain is confined to the great occipital distribution alcohol injection is sometimes most efficacious.

Sciatica.—This term is here confined to interstitial fibrositis of the sciatic nerve to the exclusion of every other variety of sciatic pain resulting from pressure on nerves or nerve roots or other lesions of the nervous system which have sometimes been included under the term "secondary sciatica." It has been said that true sciatica as here defined is never bilateral, and that bilateral sciatic pain is always the result of gross lesions involving the nerve. It is important that this error, which has crept into so many text-books, should be contradicted, for sciatica is not infrequently bilateral and the sciatica which occurs in glycosurics is usually bilateral.

The malady is not met with in childhood, but it begins to be common soon after puberty, and its incidence is greatest upon early middle life. In the majority of the cases it arises without assignable cause, sometimes injury to the nerve of any nature, as from a twist of the leg, a bruise or a fall is responsible. Only in rare cases does exposure to cold and wet seem to have excited the onset. It is important that the urine should be tested in every

case of sciatic pain, for glycosuria is more often found in cases of sciatica than is usually believed.

Symptoms.—The chief symptom is pain along the course of the nerve or of its branches, and since the sciatic nerve often divides within the pelvis into the great internal and external popliteal branches, the pain may be confined to the distribution of one of these alone. One feature of the pain valuable for diagnostic purposes is that it never reaches above the crest of the ilium, but in this connection it must be borne in mind that fibrositis of the back (lumbago) not infrequently precedes or accompanies the onset of sciatica. The pain may be partly intra-pelvic, for the sciatic nerve is formed within the pelvis. Where the interstitial neuritis is entirely intra-pelvic, tenderness of the nerve trunk to digital pressure fails as a physical sign. The onset is occasionally sudden, and associated with slight pyrexia and constitutional disturbances as in other forms of fibrositis: but, as a rule, the malady sets in gradually with pain in the buttock, back of the thigh or leg, in movements and in postures which make the nerve tense, or cause pressure upon it. The pain gradually increases in severity. It may be both gnawing and burning and sharp and darting in character. It is usually continuous, with occasional severe exacerbations which occur spontaneously or are excited by movement. Its intensity generally increases at night. The seat of the pain often varies from day to day.

Extreme tenderness of the nerve on pressure is rarely absent, except in those cases where the neuritis is intra-pelvic, and the tender region usually indicates the situation of the lesion of the nerve trunk. Stretching the nerve by extending the knee with the thigh flexed is productive of great pain which may be lasting. The best method of testing the sensitivity of the nerve to stretching is to put gentle pressure with the thumb on to the popliteal space as the patient sits in a chair with the knee bent at a right angle. Sometimes there is considerable tenderness of the muscles. The muscles waste not only in the sciatic supply, but throughout the whole lower limb and buttock, surely from reflex irritation as in arthritic atrophy. Cramp in the leg and reflex spasm are common, and muscular fibrillation is often seen. Paræsthesia in the form of tingling, burning and numbness is the rule; but loss of sensibility only occurs in the rarest and most severe cases, and its presence should always suggest the presence of a pressure lesion.

Peculiarities of stance, gait and position arise from the tenderness of the nerve to stretching, that position being assumed by the patient which keeps the nerve slackest. In standing, the weight of the body is placed upon the sound limb, and the other limb is flexed at hip and knee and extended at the ankle, with the toes only resting on the ground. In walking, the patient limps in this same position without straightening his knee or extending his ankle, and in bed he lies with knee flexed and ankle extended.

The knee-jerk is always markedly increased notwithstanding the wasting of the quadriceps, the only exception being when sciatica is complicated with anterior crural neuritis. The ankle-jerk being in the sciatic supply tends to be diminished in proportion to the severity of the neuritis, and in severe cases it is always lost.

Slight trophic and vasomotor changes in the periphery of the limb are commonly seen.

In very rare cases the cicatrisation which follows the inflammatory pro-

cess may cause motor and sensory paralysis of all the region below the knee. Such a case came under our care 2 years after the onset, and was explored by Sargent, who found the nerve in the gluteal region densely cicatrised and widely adherent to the muscles. The nerve was freed, and incised longitudinally in many places, and this patient made a complete recovery. Every degree of severity may be met with from the mildest to the most acute, and from the most rapid lasting but a few weeks to the most chronic lasting 2 or more years.

It is a most remarkable fact that severe sciatica never occurs twice in the same limb. One severe attack seems to free the affected nerve from subsequent liability to the affection, and it is comforting to be able to assure the patient that he will never have the trouble again in the same limb. In a very large experience we have never met with an exception to this rule.

Diagnosis.—Sciatica must be distinguished from other causes of sciatic pain. Arthritis of the hip is at once recognised by the limitation of joint movements. Disease of the sacro-iliac joint and ilium is distinguished by pelvic deformity and tenderness and by radiography. Pressure upon the nerve roots or trunks by neoplasms must be excluded by the most careful search for such growths in the spinal column, the pelvis, and in the course of the nerve, and generally throughout the body. A diagnosis of sciatica is almost certainly an error in any case in which a generalisable neoplasm is present or has been removed. Such pressure lesions producing sciatic pain soon produce motor and sensory paralysis, which is infinitely rare in sciatica, and, on the other hand, tenderness on pressure and on stretching, which is so conspicuous in sciatica, does not occur in the pressure lesions.

The pains of tabes and other nervous diseases when confined to the sciatic distribution are distinguished by the presence of other physical signs of those diseases.

Course and Prognosis.—Sciatica commencing acutely tends in the course of time to lessen in severity and become chronic, but some acute cases cure rapidly. When the malady has a slow commencement it usually lasts longer than does an acute case, and it is much more liable to exacerbations than when commencing acutely. The traumatic cases show no essential difference from the spontaneous, except that in the former adhesions of the nerve to the muscles from bruising is likely to prolong the duration of symptoms. The prognosis is always absolutely good as regards recovery, and in severe cases there is no likelihood of relapse. In slight cases, however, subsequent attacks are not uncommon.

Treatment.—The first essential in the treatment of all recent cases is to secure rest and to avoid all those things which excite or increase the pain. Sometimes the fixation of the limb in a semiflexed position by means of Liston's or Macintyre's splint gives great relief. The use of the bed-pan is advisable to avoid flexion of the hip and stretching or pressure upon the nerve in the act of defæcation. On the other hand, towards the end of a chronic case, active exercise with massage and passive movements are necessary to restore the shortening of the nerve. The application of heat in the form of hot-water bottles, poultices and radiant heat is invaluable for the relief of pain, and for curative purposes. Counter-irritation is very useful, and is best used in the form of the strong tincture of iodine which should be painted in a broad strip over the course of the sciatic nerve, from

sciatic notch to heel, daily until the skin becomes inflamed, just short of blistering. Massive injections of from 4 to 8 ounces of sterilised normal saline solution, made slowly into the region of the affected nerve at a temperature of 104° F., are often valuable both in acute and chronic cases. Massive injection of oxygen into the region of the affected nerve is a simple and harmless process which gives no pain and often brings most conspicuous relief. The injection is made direct from the cylinder by way of a thick piece of rubber tubing, a needle fitting and a hypodermic needle, until a considerable cushion of gas has been introduced. Acupuncture of the nerve with a series of specially designed needles is a useful and ancient remedy which acts by puncturing the sheath of the nerve, and allowing the escape of inflammatory exudation. Exposure of the nerve and incising the sheath by longitudinal incisions, and subsequently stretching it with the finger is a most proper method of treatment in acute recent cases where the pain is so severe as to prevent sleep for many nights, and where other palliative measures fail. This operation is often followed by immediate cure. It is not advisable in chronic and long-standing cases. Attempts to stretch the nerve by flexion of the thigh and extension of the knee may do great harm, and rarely do good. Among medicinal remedies, iodide of potassium has had a great reputation, but in our experience it is very disappointing. The salicylates are of great service, especially in the form of aspirin, which may be given liberally, and may be usefully combined with hexamine. Urodonal in doses of 1 drachm thrice daily is also often valuable. In the more chronic cases sulphur and guaiacum are serviceable. For the relief of pain heat is generally beneficial, but in some of the most acute cases the application of heat increases the pain, and in these an ice-bag will sometimes give great relief. All the analgesics of the coal-tar series, pyramidon, antifebrin, phenacetin, etc., are valuable adjuvants to relieve pain, and these may be conveniently prescribed with aspirin, or if sleep be difficult with barbitone or adalin. When pain is very severe and rebellious to the above-mentioned remedies, opium or morphine is indicated. It is essential from the exhausting quality of the pain that the patient should be well fed, and alcohol is often of service.

Cervical Ribs

Ætiology.—The development of the ribs at the thoracic inlet depends on the mode of formation of the brachial plexus, for the nerves are large and powerful structures in the embryo at a time when the ribs are soft and pliable. When the plexus is "normal," a well-formed first rib springs from the first dorsal vertebra. If, however, the plexus is "post-fixed," that is, when the contribution to the plexus from the fourth and fifth cervical segments is small and the fibres from the first and second dorsal segments form a powerful cord, this cord in rising over the first dorsal rib may compress and deform it to such an extent that it presents the characters of a rudimentary rib. On the other hand, and this is more frequent, when the plexus is pre-fixed, that is, when the contribution from the upper cervical segments is relatively large and that from the dorsal segments is small, a supernumerary rib is allowed to develop from the seventh cervical vertebra.

When this prefixation is pronounced, the seventh cervical rib is often very large and is easily felt in the neck. In these cases symptoms are usually absent. In a certain number of cases in which the abnormality is intermediate in degree, symptoms are caused by compression of the lower cord of the plexus as it passes over the supernumerary rib, or over the deformed first rib. This compression may be exercised by the bony portion of the extra rib, but more often the nerves are damaged by a fibrous prolongation of the rudimentary rib which connects it with the first rib.

But these abnormalities in the ribs only cause symptoms in some 10 per cent. of the cases in which they are present. Further, the symptoms are often unilateral with bilateral supernumerary ribs, and the symptoms are often most prominent on the side of the smaller extra rib. Again, the onset of symptoms is usually delayed until adult life is reached. It is clear, therefore, that some contributory cause must come into play. This is found in the dropping of the shoulder girdle, which is normal in adolescents, and is often excessive in persons whose muscular tone is low. In a child the clavicle rises boldly as it passes outwards. In a normal adult male the clavicle is almost horizontal, in women it droops slightly, and in those who develop symptoms of pressure on the nerves, the outer is usually distinctly lower than the inner end. In the latter, the lowest cord of the plexus is submitted to constant rubbing against the extra rib which rises and falls during respiration, and it is compressed by any movement of the arm which depresses the shoulder girdle. Relief is obtained by raising the shoulders, and patients soon learn to support the limb and to assume attitudes in which pressure on the nerves is relieved.

Women suffer most often, the right arm being affected more often than the left. The onset is usually gradual, but occasionally it comes on suddenly after childbirth, or on lifting a heavy weight.

Symptoms.—These may be sensory, motor, or vasomotor, either singly or in combination. Subjective sensory disturbances are most frequent. They take the form of numbness and tingling or neuralgic pains. Paræsthesiæ are most often unilateral, and are frequently confined to the ulnar or to the radial side of the hand and fingers. It is rare for all the fingers to be affected. Pain, when present, is usually felt below the elbow. It is often neuralgic, darting down the arm, and again confining itself to one border of the limb. It hardly ever radiates from the neck.

Objective sensory disturbances are usually slight or absent. They may be found over the ulnar or radial border of the distal portion of the limb in an indefinite area, which does not conform to the distribution either of the ulnar or radial nerve.

Muscular atrophy is not so frequent as sensory disturbance. In the "median type," wasting is confined at first to the abductor and opponens pollicis muscles, and the outer part of the thenar eminence shows a remarkable reduction in size, which contrasts strongly with the inner part, which retains its normal bulk. In the "ulnar type," wasting appears first in the small muscles of the hand supplied by the ulnar nerve. In some cases all the muscles of the hand and, to a less degree, the flexors in the forearm show considerable wasting. The atrophy is frequently bilateral and symmetrical.

Vasomotor disturbances are very common. The hands feel hot or cold,

they may be œdematous or discoloured, and the changes may suggest Raynaud's disease. Pressure on the subclavian artery sometimes causes inequality of the pulse. This disappears when the arm is raised.

Diagnosis.—The presence of pain, paræsthesiæ or vasomotor disturbances in the upper limbs, or wasting in the muscles of the hands, should always arouse the suspicion of supernumerary or rudimentary ribs. When pain is the only symptom, its distribution along one border of the arm or hand, and the patient's account of the manner in which it may be increased or diminished by raising the shoulder girdle or performing movements which depress it, usually direct attention to the cause. Symmetrical atrophy in the hands may suggest progressive muscular atrophy of spinal origin, but this diagnosis is usually rendered untenable by the association of sensory troubles or vasomotor phenomena, or by the findings on X-ray examination of the neck. For the differential diagnosis from syringomyelia, see page 1608.

Treatment.—Pain may be relieved by rest with the arms suitably supported. Atrophy calls for immediate operation to remove the offending rib. Pain is always relieved by operation, either immediately or after an interval of some months. The progress of atrophy is always retarded, and complete recovery may occur if an operation is undertaken early.

Obstetrical Paralyses

It is important and useful to group together under this heading all those conditions of paralysis occurring, either in mother or child, which are the result of the processes of labour in the passage of the fœtal head through the pelvis. Autopsies upon the still-born and upon children who have survived birth for a few days only, have shown that hæmorrhage into the meninges is of common occurrence, and it has been argued that such meningeal hæmorrhages are the cause of many of the conditions of cerebral paralysis which are present immediately after birth, or which appear during the first year of life, and especially the cause of cerebral diplegia. The pathological conditions found in the brain in cases of cerebral diplegia, however, are such as make it absolutely impossible that they could be caused by meningeal hæmorrhage, for no sign of old hæmorrhage is ever found, nor could hæmorrhage cause a general cell atrophy of the brain without signs of any local lesion. It seems clear, then, that though meningeal hæmorrhage may be of common occurrence during birth, and may be the cause of still-birth, yet there is no clinical or pathological evidence to show that it gives rise to any lasting cerebral defect.

The following condition may occur: (1) In the child: facial paralysis; hemiplegia from laceration of the brain substance; fracture-dislocation of the spine with transverse lesion of the spinal cord; injury to the brachial plexus from the separation of head and shoulder in traction; and injury to peripheral nerve trunks at the elbow, axilla or groin, in using traction with the finger.

(2) In the mother: paralysis of the supply of the lumbo-sacral cord and obturator nerve from prolonged pressure of the head against the sacrum and pelvis.

Facial paralysis.—This is usually caused by the pressure of the forceps

upon the facial nerve as it crosses the ramus of the jaw, but it has been known to occur where instruments have not been used. When unilateral, as is the common event, it gives rise to little or no difficulty with sucking, and is evidenced by the unsightly deformity of the face, which is drawn over to the sound side. When bilateral, it is one of the causes of complete inability to suck, and on account of the flaccid symmetry of the face may easily be overlooked. It necessitates spoon feeding for a considerable time. Obstetrical facial paralysis invariably recovers within a few weeks and does not give rise to after-contracture. Gentle stretching and massage of the face with the finger is the only treatment required.

Hemiplegia from laceration of the brain may occur during delivery in contracted pelvis from the pressure upon the sacral promontory, and has been caused by the use of forceps. It is exceedingly rare, and is generally rapidly fatal from the associated hæmorrhage. It may occasionally be survived, with an irreparable hemiplegic condition.

Fracture-dislocation of the spine is produced by traction upon the aftercoming head by pulling upon the trunk. We have seen it associated with injury to the brachial plexus. It occurs most often in the lower cervical region, and the transverse lesion of the spinal cord is usually complete.

Injury to the brachial plexus may occur in traction either upon the head, or upon the trunk, if the head is aftercoming, and is caused by an undue separation of head and shoulder on one side rupturing or straining the brachial plexus. The paralysis is usually of the upper arm or Erb type, the fifth and sixth roots being most affected, and the deltoid, biceps and supinator longus muscles being paralysed, but the whole plexus may be involved and even torn completely across. Traction upon a prolapsed arm has caused lower arm or Klumpke type of paralysis, in which the first dorsal and eighth cervical roots are most affected, and the intrinsic hand muscles and the flexors of the forearm are paralysed. The obstetrical lesions of the brachial plexus are for the most part serious lesions, many of the cases making no motor recovery at all, though sensibility is usually regained. The prognosis depends upon the severity of the damage to the plexus, as to whether the roots are actually torn or only bruised. The slight cases recover well enough.

Injury to the peripheral nerves from pressure or traction upon the flexures is seldom severe enough to prevent a rapid and complete recovery.

Paralysis of the lumbo-sacral cord and of the obturator nerves in the mother, immediately after parturition, is an exceedingly interesting clinical condition. In the first place, the lumbo-sacral cord is in a much more exposed position as regards the fœtal head engaging the pelvis, than are the other nerves of the sacral plexus, and may be subjected to such severe pressure as causes paralysis, and in the second place, the obturator nerve actually crosses the brim of the pelvis and must of necessity be pressed upon by any large fœtal head which passes the pelvic brim. The lumbo-sacral cord paralysis is evidenced by dropped foot and paralysis of the anterior tibial and peroneal muscles, and if it is severe, by loss of sensibility over the distribution of the fourth and fifth lumbar roots. Sometimes the third lumbar root area is affected. The obturator nerve involvement is shown by weakness or paralysis of the muscles supplied by the obturator nerve, namely, all the adductor muscles of the thigh. The paralysis may be noticed directly after parturi-

tion, or when the patient begins to get about upon her legs. The lumbo-sacral paralysis is usually unilateral, and is nearly always upon the right side. The obturator paralysis is not uncommonly bilateral, and both forms of the paralysis may coexist. There may be numbness, but no pain. This condition nearly always occurs with a first delivery, and often the child's head has been unduly large. It may recur with subsequent deliveries, but this is not a common event.

The prognosis is absolutely favourable, every case making a complete recovery in from a few weeks to a few months. The treatment is rest in the first place, with gentle massage and passive movements, and when power begins to return the patient may commence to get about.

POLYNEURITIS

Under the heading of peripheral or multiple neuritis, a group of maladies is described in which the main effect of the action of various noxious substances on the nervous system, is shown by symptoms pointing to injury of the peripheral motor and sensory nerves.

The more important of the many possible causes of peripheral neuritis may be classified as follows: (*a*) Metallic and organic poisons: *lead*, *arsenic*, mercury; *alcohol*, carbon monoxide, bisulphide of carbon, aniline, dinitro-benzole. (*b*) Poisons of infectious diseases: *diphtheria*, *influenza*, dysentery, *malaria*, typhoid and other acute fevers. (*c*) Disorders of metabolism: *diabetes*, *beri-beri*. (*d*) Cachectic conditions: tuberculosis, cancer. (*e*) Acute toxæmia of doubtful nature: acute infective polyneuritis.

A few cases have been described in which hæmatoporphyrinuria was a symptom. In some of these drugs of the sulphonal group had been taken, while in others the change in the urine seemed to be a result of chronic constipation.

In many cases no cause can be discovered.

The disease is characterised by the combination of flaccid paralysis and subjective and objective sensory disturbances of symmetrical distribution, mainly affecting the distal portions of the limbs. To a certain extent the symptoms vary with the nature of the poison at work. It is advisable, therefore, to give a separate description of some of the commoner forms.

Lead Neuritis

The effects of lead are confined almost entirely to motor neurons. Subjective sensory disturbances are often slight or absent, and in most instances there is no objective sensory loss.

Pathology.—The degenerative changes in the nerves are confined almost entirely to the motor fibres, and are most intense in the intramuscular twigs supplying muscles of the extensor groups. Normal and degenerated fibres are found side by side, the former becoming more numerous as the nerve is traced upwards. In cases of the Aran-Duchenne type, atrophy of the anterior horn cells has been found.

Symptoms.—In most cases of the common *antebrachial* or *wrist-drop type*, paralysis is limited to the extensor muscles of the fingers and wrists—that is, to the muscles supplied by the musculo-spiral nerve. But the supinator

longus and the extensor ossis metacarpi pollicis, also supplied by this nerve, usually escape. Inability to extend the first phalanges of the two middle fingers, owing to weakness of the common extensor, is usually the first difficulty. The special extensors of the index and little fingers, the long extensors of the thumb and the extensors of the wrist are next attacked, and the characteristic wrist-drop appears. As a rule the paralysis becomes severe about a week after it is first noticed. By this time it is usually bilateral and symmetrical, but for several days, or even for several weeks, it may be confined to one side. The affected muscles waste rapidly and the back of the forearm becomes flattened, thus rendering the intact supinator longus more prominent. In this form, loss of power always precedes atrophy, and some muscles may show weakness without any wasting. Recovery is almost always complete. Simple weakness without atrophy usually passes off in a few weeks. If the wasting is moderate and the muscles still react to faradism, recovery may be expected in a few months. When the atrophy is severe, a year or more may elapse before recovery is complete.

Occasionally the deltoid, biceps, brachialis anticus and supinator longus muscles are affected, either alone or in company with the forearm muscles —*upper arm or brachial type.* Less often paralysis occurs in the legs, the muscles supplied by the peroneal nerve, namely, the long extensors of the toes and the peronei being chiefly involved—*peroneal type.* Like the supinator longus in the arm, the tibialis anticus, although supplied by the peroneal nerve, usually escapes. This type is usually associated with paralysis of the forearm muscles, and runs the same course.

In the form of paralysis described above the features are those of a traumatic lesion to a nerve. Loss of power precedes, and may be more extensive than wasting, faradic irritability of the muscles is lost or diminished while the reaction to galvanism is retained, and recovery is usually complete. It is therefore called the degenerative form. In the second form, the paralysis has the characters of progressive muscular atrophy. Weakness and wasting come on together, faradic and galvanic irritability of the muscles are both diminished in proportion to the wasting, and the paralysis is often permanent. This is known as the primary atrophic form. It occurs especially in the small muscles of the hand—*Aran-Duchenne type*—but is sometimes irregular in its distribution and affects many muscles in all four limbs. It is often associated with the first form, but may occur alone. Wasting comes on slowly, and accompanies the loss of power, instead of succeeding it. It is much more intractable than the degenerative form, and often persists after muscles showing the first form of paralysis have recovered.

Arsenical Neuritis

Peripheral neuritis may be caused by a single large dose of arsenic, or it may result from prolonged use of the drug in the treatment of such diseases as lymphadenoma, chorea and severe anæmia. It is a rare malady, and the likelihood of its appearing under the last-named conditions is negligible. It appeared in epidemic form in the North of England in 1900 as a result of the use of sulphuric acid containing arsenic in the process of brewing beer. The toxic action of arsenic with alcohol seemed to be greater than that of either alone.

Except that the mental condition is usually normal, the description given below of alcoholic neuritis applies to this form as well. Hyperæsthesia of the skin and tenderness of the muscles are more constant and more severe in the arsenical form, and paralysis and atrophy of the muscles are often more widespread and more rapid in their progress. Hyperkeratosis of the soles and pigmentation of the skin are characteristic of arsenical poisoning. In a suspected case, the diagnosis can be confirmed by the discovery of abnormal quantities of arsenic in the urine or in the hair and skin.

Alcoholic Neuritis

In former years alcoholism was perhaps the commonest cause of severe peripheral neuritis. At present it is a rare disease. It occurs most often in women, especially in those who take small amounts of alcohol frequently. It has often been the first indication of secret drinking.

Pathology.—The changes in the nerves are those of parenchymatous neuritis. They are most intense in the small branches supplying the skin and muscles, and they diminish in severity as the larger branches are approached. They are best seen in the terminal branches of the musculospiral and anterior tibial nerves. The wasted muscles often show a reduction in the size of their fibres, and an increase of connective tissue—fibrous myositis. The spinal cord may be healthy, but in almost all cases examination by modern methods shows changes in the nerve cells and degeneration in the tract fibres derived from the posterior roots.

Symptoms.—The onset is insidious, and in most cases premonitory symptoms, such as numbness and tingling in the extremities or cramps in the muscles of the lower limbs, are present for several months before actual weakness occurs. Subjective sensory troubles are a marked feature, even in the early stages. Besides numbness and tingling, the patients complain of feelings of excessive heat or of coldness in the limbs, or of severe aching or cutting pains in the legs. Painful cramp in the calf muscles is a common symptom. It is often worst at night, and may interfere seriously with sleep. Objective examination usually reveals sensory loss, in which the various elements of sensation are affected in a manner which is almost pathognomonic.

Stated briefly, there is anæsthesia of the skin with hyperæsthesia of the deeper structures. Light touches are not appreciated at all or many are missed, the temperature sense is defective, and the prick of a pin causes no pain, whereas even moderate compression of the muscles may cause the patient to cry out. The sensory loss is greatest in the feet and hands and diminishes towards the knees and elbows. Muscular tenderness is usually greatest in the calves. The soles of the feet are also unduly tender. Hyperalgesia is often well marked before anæsthesia of the skin appears. To the disability caused by pains and spasms, weakness of the muscles is added in all but the slightest cases. The arms may suffer first, but in most cases the extensors of the toes, the dorsiflexors of the ankle, and the extensors of the fingers and wrists are attacked in progression, and double foot-drop and wrist-drop result. To overcome the foot-drop, the knees are raised high in walking. This gives to the gait the "steppage" character which is common to all forms of peripheral neuritis. In most cases the distal flexor muscles are also affected,

but to a slighter degree. In severe cases, weakness extends to the proximal muscles and even to the muscles of the trunk. The affected muscles become soft and diminish rapidly in bulk. Unless precautions are taken, contractures occur in the flexor muscles and produce deformities of the limbs, which add greatly to the difficulties of treatment.

At the onset the knee-jerks are exaggerated, but in most cases by the time the patient comes under observation all the tendon reflexes are absent. The cutaneous reflexes may be unaltered, diminished or absent. Sphincter control is retained so long as the patient is fully conscious. Slight bilateral weakness of the face is often present but severe paralysis is rare. Ptosis, nystagmus, weakness of the external ocular muscles and even Argyll Robertson pupils, have been observed.

Trophic and vasomotor disturbances in the extremities are very common. The hands and feet often perspire freely, and they may be white and cold or red and hot. In some cases œdema of the hands or lower extremities is present. In chronic cases the skin of the hands and fingers is thin, smooth and shiny, and the nails are ridged and brittle.

In almost every case of alcoholic neuritis there is some *psychical defect*. One form—Korsakoff's psychosis—is characteristic of and almost peculiar to this disease. The most prominent feature is failure of memory and loss of appreciation of time and place. A patient who has been bedridden in a hospital for nervous diseases for several weeks, when visited by the resident physician who has attended her daily, will "recognise" him at once as Dr. X., whom she has not seen since he brought her first child into the world some years ago. She is now, she says, in a lying-in hospital which she entered yesterday, and has just been confined with her second baby, who is in bed beside her. She also "recognises" strangers at her bedside, and connects them with events of long ago. She went for a walk this morning along certain streets which she names. In her travels she met several old friends with whom she had conversations, which she repeats—and so on. Everything is related in the most circumstantial manner, and if the facts were not known her tale might well be accepted as truth. A clinical clerk has been known to take a long "history" without realising that it was entirely fictitious. In most cases the mental defects are not so gross. There is merely a failure of memory, to which is added moroseness and irritability, caused by withdrawal of alcohol.

Diphtheritic Paralysis

The toxins of diphtheria are highly obnoxious to nervous tissues, and some form of paralysis occurs in a very high proportion of the cases. The intensity of the paralysis bears no relation to the severity of the local infection, for cases, in which the original disease has passed unnoticed, may be followed by serious damage to the nervous system. The nervous manifestations of diphtheria fall into three distinct groups, namely, the local, the specific and the generalised paralyses.

Local paralysis occurs in parts related anatomically by nervous connections to the site of the diphtheritic lesion. In faucial diphtheria, the local palsy appears in the palate. In extra-faucial diphtheria, *e.g.* infected sores on the limbs, the local palsy appears in the muscles supplied by the segments

of the cord to which afferent nerves from the infected focus pass. The reason for this is, that toxins elaborated by the diphtheria bacillus ascend from the primary focus to the cord or the medulla, in the perineural lymphatic channels of the afferent nerves. Having reached the central structures, they diffuse to neighbouring motor cells and, by injuring them, cause paralysis of the muscles they supply. Paralysis of the palate therefore does not occur except in faucial diphtheria.

The *specific* manifestation of diphtheria is paralysis of accommodation. Like trismus in tetanus, it is not due to a local lesion, but occurs in many cases, whatever the site of origin of the toxins. It is present in cases of both faucial and extra-faucial diphtheria, and is most probably an effect of toxins circulating in the general blood stream.

The third or *generalised* form of diphtheritic paralysis is multiple neuritis. It follows extra-faucial as well as faucial diphtheria, and is also a result of the action of toxins circulating in the blood.

Pathology.—The pathological changes in the nervous system are in complete accord with the symptoms. In cases of faucial diphtheria with palatal palsy, acute degenerative changes are found in the nuclei of the medulla. As a rule, the peripheral fibres connecting the palate with the medulla appear healthy. This is accounted for by the peripheral situation of the perineural lymphatics, along which the toxins travel to reach the central structures. The nerves are further protected by their neurilemmal sheaths. In their intramedullary course, where this protection is absent, the fibres show degeneration of their myelin sheaths.

When the primary focus is on the trunk or limbs the same degenerative changes are found in the corresponding part of the cord. In these cases medullary lesions are absent. In multiple neuritis, the chief lesion is a parenchymatous degeneration in the peripheral portion of the nerves supplying the distal parts of the limbs.

Symptoms.—As faucial diphtheria is the commonest form, the most frequent nervous symptom is *paralysis of the soft palate*. It is shown by the nasal quality of the voice and by the regurgitation of fluids through the nose. As a rule, the weakness is bilateral and equal, but in some cases it is greater on the side on which the local lesion is more severe. It makes its appearance in most instances about the end of the second week, but may come on as early as the fourth day, and as late as the sixth week. The soft palate is relaxed, and its movement on phonation is diminished. The palate may be insensitive, and its reflex is often diminished or lost. Recovery usually occurs in a few weeks. In rare instances the muscles of the pharynx and the vocal cords are paralysed. Together with palatal palsy, it is common to find weakness and tenderness of the sternomastoid muscles and of the masseters. These are also local effects.

Paralysis of accommodation appears about the same time as the palatal palsy, perhaps a few days sooner. The reaction of the pupils to accommodation as well as to light, can almost always be obtained. The trouble is subjective, and is shown by defects of near vision—for example, by inability to read small print. Hypermetropes suffer great inconvenience. In myopes it may pass unnoticed. Paralysis of any of the extrinsic ocular muscles with strabismus and diplopia may occur, and this may be either nuclear or peripheral in type.

Multiple neuritis usually comes on two or three weeks after recovery from the throat infection. Its presence is often detected when patients begin to exert themselves during convalescence. Weakness and aching pains in the legs, unsteadiness in walking, clumsiness in performing fine movements with the hands, feelings of pins and needles in the extremities—all these are common early symptoms. Weakness affects in varying degree the muscles of the neck, trunk and limbs. It is generally slight in degree, greater in the lower than in the upper extremities, and greater in the extensor muscles than in the flexors. Marked local atrophy is uncommon. In severe cases, life may be endangered by paralysis of the intercostals and of the diaphragm, but fortunately one set of muscles has usually begun to recover before the other is seriously affected. The small muscles of the hands and feet and the muscles of the calves and forearms are almost always tender on pressure. They are soft and flabby, and often show a partial reaction of degeneration.

Sensory ataxy is almost always present, and is often severe when the paralysis is trivial. It causes the patient great inconvenience, as it interferes seriously with walking and with the finer movements of the hands. Objective examination reveals sensory impairment of the "glove-and-stocking" type. On the hands and feet, the loss to light tactile stimuli is often complete, pain and temperature being less affected. As the limb is ascended, sensation gradually becomes normal. Even when the sensibility of the skin is but little diminished, the sensations of position and of passive movement in the extremities are often seriously impaired, and the sense of vibration is often lost.

Compared with the symptoms already described, loss of the tendon reflexes is a late sign. In the early stages they are exaggerated, but are lost later in every case. Their return is often long delayed, and it is common to see patients months after recovery of normal power, in whom the knee-jerks are still absent. It is common also to find them absent many months after an attack of diphtheria in patients who give no history of nervous symptoms during the attack. The skin reflexes are usually retained, and stimulation of the sole gives a normal response. The external muscles of the eyeball are sometimes paralysed. The most common defect is weakness of the internal recti, which causes a slight divergent squint, like that of myopia.

Cardiac failure is a grave but uncommon complication. It is not yet decided whether it is attributable to paralysis of the vagus, or to degeneration of the heart muscle. Vasomotor paralyses and disturbances in the nutrition of the skin, which occur so often in other forms of peripheral neuritis, are never seen in diphtheria. In those that survive the attack, complete recovery from the nervous troubles always occurs.

Diabetic Neuritis

In many patients with glycosuria, symptoms are present which point to changes in the peripheral nerves, or in the fibres of the posterior roots. In many respects they resemble tabes rather than peripheral neuritis; but as the exact pathology is still unknown, it is convenient to describe them here.

Pathology.—Degenerative changes have been found in the peripheral

nerves in some cases, in others these were healthy, whilst the intramedullary portion of the posterior roots showed degeneration, similar to that found in tabes.

Symptoms.—In some cases the only symptom is neuralgic pain in the distribution of one or more peripheral nerves. This is commonest in the lower limbs, where it simulates sciatica, and sugar is found in the urine in the absence of any other sign of diabetes.

In severe cases of diabetes the knee-jerks and ankle-jerks are diminished or lost in more than half the cases. This may accompany subjective sensory troubles in the lower limbs, or it may appear as an isolated symptom. The muscles are very often tender and the vibration sense in the feet is frequently absent. To objective examination, the sensibility of the skin is usually intact. Perforating ulcers of the feet have been observed.

Diagnosis.—The diagnosis of multiple neuritis from other diseases rarely presents any difficulty. It is made from the combination of symmetrical flaccid paralysis with sensory loss of the "glove-and-stocking" type, and tenderness of the muscles and nerves, confined to or most intense in the distal parts of the limbs. When sensory disturbances and diminished tendon reflexes are prominent symptoms and muscular weakness is slight, *tabes* may be suggested, and the resemblance is still greater when ataxia is present. Difficulty usually arises when the distinction has to be made between tabes and alcoholic neuritis, in a patient who has courted both diseases. In most instances the diagnosis can be made from the nature and distribution of the sensory changes. The lightning pains of tabes cannot be mistaken by any one who is familiar with their peculiar characters. Anæsthesia of the extremities is common to both diseases, but diminished sensibility around the nose and across the chest is peculiar to tabes and is present in almost every case. In neuritis the calf muscles and nerve trunks are tender, whereas in tabes the sensibility of these structures is usually greatly diminished. Hyperæsthesia to touch and temperature, and great exaggeration of the abdominal reflexes, also suggest tabes. The presence of Argyll Robertson pupils or of optic atrophy, though in favour of tabes, is not decisive, as both have been found in chronic alcoholism.

Treatment.—The first essential in treatment is to remove the patient from the influence of the existing cause. In alcoholic cases, rigid precautions are necessary to prevent secret access to alcohol. To attain this, treatment in an institution is almost a necessity. In most instances when the cause, whatever it may be, is removed, gradual improvement sets in and complete recovery ensues, in a time that varies with the severity of the symptoms. During this time the physician's most important duty is to prevent the occurrence of deformities and contractures. From the beginning, each joint in the affected limbs should be moved passively to its full range several times each day, and care should be taken to ensure that the attitude of the limbs during rest is a suitable one, especially that the feet are maintained at right angles to the legs by the use of appropriate apparatus. Drawing up of the heel must be prevented at all costs.

Gentle massage is soothing in the acute stage. Later, more vigorous rubbing may be given, and the patient should be encouraged to move the limbs voluntarily. Electricity is of doubtful utility. Analgesic drugs and

soothing applications may be needed at the onset. Thereafter, local treatment to the limbs is combined with measures to improve the patient's general condition.

LANDRY'S PARALYSIS

In the year 1859 Landry applied the name "acute" to a case in which acute flaccid paralysis with loss of reflexes and without sensory disturbances commenced in the periphery of the lower limbs, and rapidly spread upwards. The arms were next involved, first in the periphery, and later the trunk, respiratory muscles, neck, and lastly the cranial muscles were involved, and death occurred from respiratory failure. He made a careful microscopic examination of the spinal cord with the methods then at his disposal, and failed to detect in it any morbid changes. He subsequently described this symptom complex, which has since borne his name, from an analysis of 10 cases.

Since this time a large number of cases have been recorded which from the acute nature of the onset, and from the spreading nature of the paralysis, have been described as cases of Landry's paralysis. This name should be restricted to those cases of acute spreading paralysis, in which disorders of sensibility and sphincter trouble are absent or little marked, and in which recovery is complete if the patient survives, and in which no gross lesion is found within the nervous system after death.

It is important to bear in mind the fact that acute spreading paralysis may be produced by gross lesions of the nervous system, and it is most important in diagnosis that these conditions should be at once distinguished from Landry's paralysis. Foremost among such conditions are acute spreading myelitis and hæmorrhage into the theca. These are at once distinguished by the simultaneous development of sensory, motor and sphincter paralysis, and thecal hæmorrhage is further distinguished by the results of the lumbar puncture.

Acute poliomyelitis may also, in rare cases, give rise to a spreading paralysis, and cause much difficulty in diagnosis; but it is invariable that some permanent paralysis remains upon recovery, and, further, the lesions of poliomyelitis are both gross and characteristic.

The majority of authors who have written upon this subject have made the attempt to separate Landry's paralysis from the group of "acute toxic polyneuritis," both on pathological and on clinical grounds. Such a separation would appear to be entirely unsupported by the evidence. For in Landry's disease we are certainly dealing with an acute toxic process which has an especial physiological selective capacity for the lower motor neurons, though its action is not always quite confined to them. Exactly the same holds good for the majority of the conditions, which are grouped together as "acute toxic polyneuritis." In both these conditions all the nervous pathological changes which have been discovered are confined to these lower neurons, motor and sensory, and are often in polyneuritis confined to the lower motor neurons. The assumption that has been made, that in Landry's paralysis the toxic process is incident upon the nerve cells in the spinal cord, whereas in polyneuritis it is upon the peripheral part of the neuron—the

periphery of the nerve fibre, does not rest upon any sure foundation, and is unsupported by any clinical or pathological facts. It is probable that, in all conditions of toxic polyneuritis, the poison acts upon the neuron as a whole, and that the devitalising action of the poison is first manifest at the extremities of the neuron, both centralwards and distalwards, and both physiologically and histologically. The clinical separation of Landry's paralysis and polyneuritis is equally artificial and impossible, though much stress has been laid upon the presence of disturbances of sensibility, and the strictly peripheral distribution of the paralysis in polyneuritis. As regards sensory disturbance, this clinical feature is dependent upon the peculiar selective capacity of the poison. For example, in many conditions of polyneuritis, sensory disturbances are conspicuous by their absence throughout, as in some cases of lead neuritis and diphtherial neuritis. Further, peripheral distribution is not even the rule in polyneuritis, and forms, in which the paralysis is as much or more proximal than peripheral in distribution, are frequently seen. Further, the now generally accepted advent of so many poisons to the nervous system by means of the perineural lymphatics, which deliver the dose locally into the nervous system to be subsequently spread within the nervous system, must necessarily render the conception of peripheral distribution as an essential in polyneuritis untenable. The following description of this malady is based upon the personal observation of 10 cases with 4 autopsies which have come under our observation at the National Hospital and at St. George's Hospital.

Ætiology.—What is known of the causation of the disease in general resembles very closely that of acute polyneuritis. It affects males much more frequently than females, and occurs chiefly in adult life between the ages of 16 and 54 years. The cases which have been reported in children were probably examples of the spreading type of poliomyelitis. In many cases the patient is taken ill in the midst of good health, while in others there has been some known cause productive of a toxic state, such as exposure to heat and cold, specific infections (of which small-pox, diphtheria, enteric fever, influenza and cellulitis are the most important), or a febrile attack of obscure nature. Still more frequently it has immediately followed upon symptoms indicative of gastro-intestinal toxæmia.

Pathology.—Slight hyperæmia of the spinal cord, and especially of the grey matter, with a few punctiform hæmorrhages, is the only change noticeable upon naked-eye examination. Very definite histological changes are found upon microscopic examination in the anterior horn cells and in the cells of Clarke's column, where any degree of change may be found, from an early pericentral chromatolysis to a complete loss of the chromatin granules and concentration of nuclei. Neuronophagia seems not to occur. The most intense changes are found in those regions corresponding with the first appearance of the paralysis. The myelin sheaths of the spinal cord often show a diffuse fatty change when examined by the Marchi method. No neuroglial proliferation occurs. The blood vessels are engorged, but are free from mural changes. The peripheral nerves show some degeneration, secondary to the affection of the cells. The skeletal muscles show early fatty changes. The whole of the changes found in the nervous system seem to be of a completely recoverable nature, and this is in line with the

almost invariable clinical outcome, that if the patient survives he recovers perfectly.

The cerebro-spinal fluid is in excess, and clear. In two of the cases under our care, it presented no abnormality either as regards cell or albumin content. In other cases there is an excess of albumin, and in this respect it resembles the cerebro-spinal fluid of polyneuritis, which is usually albuminous, and sometimes so highly so as to clot spontaneously. Enlargement of the spleen and of the mesenteric glands is not uncommonly found.

In 1903 Buzzard, in a very typical case which had been under our care, isolated a micrococcus in pure culture from the blood after death, and he found this same organism in the loose tissue forming the external layer of the theca. Injection of this organism into a rabbit by the subdural method produced, after some days, a rapidly spreading paralysis, and the same organism was found in the theca of the rabbit, and isolated in pure culture from its blood. The organism was not discovered in the spinal cord nor in the arachnoid space of either the patient or of the rabbit, and in neither case were there inflammatory reactions in these tissues.

Symptoms.—The onset is in some cases abrupt, with the appearance of the characteristic spreading paralysis. Much more frequently the paralysis is preceded by certain premonitory symptoms, which may last from a few hours to days or weeks. These symptoms may consist in malaise, headache, lassitude, insomnia, anorexia, constipation, gastralgia, vomiting and diarrhœa, and there is not infrequently slight elevation of temperature. More characteristic still among the prodromal signs are subjective disturbances of sensibility. Pains in the back and limbs are common, and may be of a dull aching nature, or they may be sharp and shooting in character. Numbness, tingling, "pins and needles" and other paræsthesias may occur over any part of the body, and are most commonly complained of in the periphery of the limbs. The muscles may be locally tender during this prodromal stage.

The paralysis usually comes on quickly and smoothly; but sometimes a cessation of its advance for a time is followed by a rapid exacerbation. Such an exacerbation proved fatal in one of our cases weeks after the onset, some considerable recovery having occurred during the interval. The paralysis is usually symmetrical in the end; but at its commencement, and in slight cases, which soon recover, there may be very considerable asymmetry of distribution.

As in Landry's original case, it is not uncommon for the paralysis to commence in the periphery of the lower extremities, to ascend rapidly, and to involve the muscles in the order of their innervation from the spinal cord, the trunk becoming affected before the upper extremities, and the intercostal muscles before the diaphragm. Such a true ascending paralysis must be due to direct spread of the toxic process within the spinal cord; but it is by no means usual in Landry's paralysis. For the muscular weakness may commence in any group of muscles, as, for example, in the face, neck, upper extremities or trunk, and when so commencing the spread of the paralysis is downwards, constituting a descending type of paralysis. The spread of the paralysis seems always to be in terms of the contiguous elements of the spinal cord.

In Landry's paralysis, as in acute polyneuritis, the innervation of the respiratory muscles seems to be peculiarly resistant to the toxin, for in both

these diseases we have seen cases completely recover, in which the paralysis was universal and complete for a time, with the exception of the respiratory muscles, which retained some activity sufficiently long to outlast the height of the paralysis.

It is not uncommon to see in Landry's paralysis and in acute polyneuritis, when the paralysis is widely spread and affecting trunk and limbs severely, that the paralysis seems to be proximal in distribution and that while no voluntary movement of any trunk muscle nor of any muscle of the proximal parts of the limbs can be called forth, yet feeble movements of fingers and toes may be possible. This has been a marked feature in every case of Landry's paralysis which we have examined, either during the onset or during the recovery. In this connection it must be remembered that this appearance may be simply a matter of gravity, and the amount of weight which the feeble muscles have to lift in their contraction. Lastly, there are a few cases in which the onset of the paralysis is not local, but is general and gradually deepening.

The paralysis is of the painless, flaccid type, and is associated with a complete abolition of the deep and superficial reflexes in the affected area. It first appeals to the patient as tiredness and heaviness in the affected region when commencing in the legs, trunk or shoulders, and as a loss of the finer movements when commencing in the hands. It usually takes some hours, and occasionally some days, to become complete. Generally it advances smoothly and regularly upon the regions previously unaffected, until the respiratory muscles and the muscles of the face and neck are affected, when it is the usual result for respiratory failure to prove fatal. Sometimes, however, the advance may cease for a while, to be followed by a more rapid advance of the paralysis.

In those cases which recover the advance of the paralysis ceases, and those muscles which have been most recently affected begin to show some recovery quickly. In one case, for example, which we watched through the night, with an advancing paralysis, the intercostal muscles failed completely, swallowing became difficult, and the facial muscles showed signs of increasing weakness. Then the diaphragm failed, and the patient was left breathing feebly with the sternomastoids and scaleni. After remaining about an hour in this apparently hopeless condition, it became obvious that the diaphragm had recommenced to act, and this was followed within a few hours by the intercostals, and within 24 hours the facial and bulbar paralysis had disappeared. This patient made a complete recovery within 3 months.

When the disease does not prove fatal either from respiratory failure, pulmonary complications or sudden syncope, the paralysis ceases to spread, and the patient enters upon the stage of recovery, which presents many features of interest. The flaccid muscles show a moderate degree of wasting within 2 or 3 weeks of the onset, this wasting being much less in those cases which recover rapidly. It is a general atrophy, and is not limited to particular groups of muscles. In rare cases, though fair power is regained, yet the muscles remain conspicuously small for life; but generally the muscles recover their bulk and tone completely. The paralysed muscles retain their excitability to faradism throughout, though there may be some slight diminution of faradic excitability in proportion to the general wasting of the muscles. Contractures and deformities do not occur.

Disorders of sensibility, though usually present in some degree, are completely overshadowed in intensity by the motor paralysis, which dominates the clinical picture of the disease. The paræsthesias, which have been described with the onset, often persist, and there may be cramp-like pains. Not uncommonly the muscles are tender upon deep pressure; but there is never that severe degree of tenderness met with in some forms of peripheral neuritis as, for example, in alcoholic neuritis. There is exceptionally blunting of sensibility, most marked in the periphery; but this is never deep, and is rapidly transient.

Though from the general weakness of the trunk muscles there may be some difficulty in emptying the bladder and rectum during the first few days and even retention with overflow incontinence that may require catheterisation from the same cause, yet these last but a few days, and there is never any true paralysis of the action of these sphincters. The deep and superficial reflexes disappear early with the onset of the first signs of the paralysis in the affected regions. The psychic functions remain entirely unimpaired throughout. Occasionally vomiting occurs, and it is difficult to explain. It is a sign of bad portent, and in one case under our care, which seemed otherwise hopeful, it was conspicuous throughout, and brought about a fatal issue.

Diagnosis.—The rapidly spreading character of the paralysis in Landry's disease is so striking as to necessitate distinction only from those few maladies in which a similar rapidly spreading paralysis may occur, and these are acute spreading myelitis, intrathecal hæmorrhage, acute poliomyelitis (spreading type) and acute polyneuritis. Acute spreading myelitis is at once distinguished from Landry's paralysis by the severe sensory loss and sphincter paralysis, which in the former condition develop *pari-passu* with the motor paralysis and, further, if the myelitis does not involve the lumbo-sacral enlargement of the spinal cord, an extensor plantar reflex will be observed.

Similarly, thecal hæmorrhage is associated with severe sensory loss and sphincter disturbances. It is always an ascending paralysis, and the cauda equina and lowest regions of the spinal cord are first affected. The nature of this lesion should be at once revealed by the results of a lumbar puncture. The rare, spreading form of poliomyelitis presents more difficulty in diagnosis, especially in the acute stage. The general symptoms and the pyrexia are apt to be more severe in poliomyelitis. An onset in childhood is more suggestive of poliomyelitis than of Landry's paralysis. A fairly high polymorpho-nuclear leucocytosis in the blood, and a lymphocytosis in the cerebro-spinal fluid, are in favour of poliomyelitis. The persistence of local atrophic palsy on convalescence is absolute evidence of poliomyelitis. The distinction of Landry's paralysis from acute polyneuritis is held by the writers of this article to be entirely artificial, since they argue that Landry's disease is merely a striking type of acute polyneuritis.

Prognosis.—In about one-half of the cases the paralysis advances until the respiratory and bulbar muscles are involved, and death occurs from respiratory failure, usually on the third or fourth day, but sometimes not until 10 days or more have elapsed. In one case which came under our observation, after some degree of improvement in the paralysis had been noticeable, a rapid extension of the paralysis occurred in the sixth week, and proved fatal. So long as the paralysis is extending, and especially when

the respiratory and bulbar muscles are failing, the prognosis is very grave. The extension of the paralysis may, however, cease at any stage, and when this occurs the prognosis at once becomes favourable, even though there be considerable involvement of the respiratory and bulbar muscles. Any sign of improvement in the paralysis of the muscles last affected is of the most favourable import. The prognosis is best in those cases in which the paralysis nowhere becomes complete. When improvement has set in, it is almost invariable for the patient to make an uninterrupted and complete recovery in from a few weeks to 3 months.

Treatment.—The patient must be placed at complete rest, and the discomfort and panic which are likely to arise from the utter inability to move must be assiduously relieved by frequent changes of posture. The greatest care must be taken that the patient is adequately fed with nutritious and light food. Stimulants are usually indicated. A mercurial aperient should be administered early and the bowels regularly relieved, for in some cases obstinate constipation occurs. The bladder should be catheterised, if there is a difficulty in micturition. Both pain and pyrexia may be relieved by the administration of salicylates or aspirin.

Atropine seems to have a definite effect in checking the advance of the paralysis, especially when the respiratory muscles are weakening, and it further tends to check accumulation of secretion within the bronchi. Hexamine in 10-grain doses (0·6 gm.), 6 hourly, seems to be of some value. It may possibly act as a disinfectant to the respiratory and alimentary mucous surfaces, by which it is probable that the toxic agent gains access to the system. Oxygen may be administered where cyanosis occurs. Lumbar puncture should be performed daily, and the cerebro-spinal fluid removed freely on each occasion. When once the patient has shown signs that the malady has passed its height, and that recovery is commencing, little treatment is required except careful nursing and feeding. Gentle massage may then be employed.

MYOTONIA CONGENITA (THOMSEN'S DISEASE)

Definition.—A very rare malady, commencing in early childhood, which is hereditary and familial, and characterised by a striking slowness in the relaxation of the muscles after voluntary effort. The muscles pass into a spasm on voluntary contraction, which relaxes very slowly, resembling the contraction of the veratrinised frog's muscle, and its subsequent slow relaxation. Peculiar changes in the electrical excitability of the muscle and hypertrophy of the muscle fibres are constant.

Ætiology.—Beyond the facts that the malady is usually hereditary and familial, only a few sporadic cases occurring, and its incidence in early childhood, nothing is known of the causes. Cold, heat, fatigue and hunger conspicuously increase the symptoms.

Pathology.—The affected muscles are actually hypertrophied, and are always firmer to the feel than normal muscles, while sometimes they show a board-like hardness. The individual fibres show considerable hypertrophy, 75 per cent. of them showing, when measured, a diameter of from 60 to 145 μ against the 20 to 65 μ of normal muscle fibres. An increase of the muscle

nuclei also occurs. Dejerine and Sottas hold strongly that the disease is primary in the muscles. Gregor and Schilder deny this, on the grounds that the myogram obtained with the string galvanometer proves that its peculiarity cannot be of myogenic origin, but that the disorder is of central innervation.

Symptoms.—The presence of the disease first becomes evident from slowness, clumsiness and awkwardness of movement, with a great tendency to fall if the balance is upset. This is often most noticeable after rest, when, on attempting to move, the limbs seem glued down and move very slowly. Often the patient is able with exercise to work the stiffness off, and the myotonia lessens in the muscles which are being used; but if he is suddenly called upon to put another set of muscles into action, as, for example, by losing his balance, he is at once caught up by the myotonia and so is apt to fall. In other cases the myotonia increases or is uninfluenced by exertion. The muscles of the legs are as a rule most affected, but sometimes all the muscles of the body may be involved; while further, in a few cases the myotonic condition may be confined very locally to individual regions, as in myotonia atrophica. If the face be affected, when the patient smiles the smile will not relax for many seconds or even minutes; and when the upper limbs are affected, if the patient grips forcibly, he cannot disengage his hand for quite a while.

Passive movement does not reveal the presence of any rigidity except that following voluntary contraction. The abnormality affects the voluntary contractions and relaxations of the muscles only, and the peculiarities of these are—(1) their slowness, (2) their tonic character, and (3) the continuance of the contraction after voluntary impulses have ceased. The peculiarities of electrical excitability bear the name of the "myotonic reaction" of Erb. The contraction, either on faradic or galvanic stimulation, lasts much longer than the normal and relaxes very slowly, and this is more marked the stronger the current used; with the stabile application of galvanism, slow wave-like contractions of the muscle are seen to proceed slowly from the cathode to the anode. There is no pain, no sensory disturbances or loss, and the sphincters and reflexes are unaffected.

Diagnosis.—The only malady which can be confused with Thomsen's disease is myotonia atrophica, in which the myotonic symptoms and signs are identical. In the latter malady, the onset is at a much later age, the incidence of the spasm is upon local groups of muscles, and the characteristic weakness of the facial muscles and atrophy of the sternomastoids, etc., at once distinguish it.

Course and Prognosis.—Thomsen's disease has no tendency to shorten and destroy life. It tends to become more marked from infancy to puberty, and then less marked again as age increases. It has never been cured.

Treatment.—This is entirely unavailing, except in the way of the avoidance of those conditions, such as fatigue, cold and hunger, which are known to increase the condition. Thomsen himself, who was afflicted with the disease, was always better with free exercise.

DYSTROPHIA MYOTONICA (MYOTONIA ATROPHICA)

Definition.—A disease of familial incidence, which begins usually in the third and fourth decades of life, and which is characterised by muscular atrophy of peculiar distribution and unlike that of any other disease. This atrophy occurs, first and most in the sterno-mastoids and facial muscles, next in the muscles of forearms, and may also be found in the muscles of mastication, in the vasti, and in the dorsiflexors of the feet and peronei. Associated with this wasting, but not commensurate with it, nor necessarily occurring in the same muscles, is a peculiar difficulty in relaxing the muscles after effort, called "myotonia," which gives to this malady an especial feature which at once separates it from all other forms of muscular atrophy. Signs of bodily dyscrasia are often present, the most important of which are cataract, premature baldness, atrophy of testicles, loss of sexual power and general bodily wasting. This disease was first placed upon a firm clinical basis by Batten and Gibb, and Steinert in 1909. Curschmann in 1912 adopted the term Dystrophia Myotonica as being more correctly descriptive.

Ætiology.—This condition is probably always familial, and the heredity is homologous—that is, it tends to appear in the same child-rank, in a number of apparently unconnected families at a common distance from one and the same ancestor, and often it seems to be entirely confined to one child-rank. The descent of the latent tendency is equally through the males and females, but where there is direct heredity the males more frequently transmit. The presence of the heredo-familial disease in earlier generations is often betrayed by other signs, such as cataract, frequent celibacy, childless marriages, high infant mortality, a dying out of certain branches of the family, a steady decline, generation after generation, in the family fortunes from affluence to poverty—all of which circumstances must be regarded as evidence that these families are in the grip of a progressive degenerative disease. The malady has been observed at the age of 10 years, but usually the onset occurs between the ages of 20 and 35 years. A large number of the patients have been unusually gifted and proficient in athletics prior to the onset. Both sexes may be affected. No exciting causal factors are known.

Pathology.—No definite changes have been found in the nervous system. The muscles presenting the myotonia have repeatedly been examined and found normal. In the atrophic muscles the morbid process singles out certain fibres especially, so that thick and thin fibres are found lying together. There is increase of the muscle nuclei round thick and thin fibres alike, though some atrophic fibres may be found with no increase of nuclei. Later, the nuclei tend to pass into the muscle fibres and become arranged in conspicuous rows, both in the centre of the fibres and underneath the sarcolemma. The muscle fibres become rounded, and thereafter the sarcoplasm dwindles and disappears, the columns of nuclei alone remaining to mark the spot from which the muscle fibre has departed. Changes in the anterior and middle lobes of the pituitary body, and in the cortex of the suprarenal bodies, have been found.

Symptoms.—The onset is gradual and the course extremely slow. The first symptom to call attention may be, either the difficulty in relaxing after

muscular effort—the clinging of the hand to the tool which has been grasped, the smile that is so slow to disappear—or the weakness and wasting of the muscles. The two chief signs of the disease—the myotonia and the wasting—seem to have no connection the one with the other, either as regards coincidence in time or place. The myotonia may appear years before there is any obvious wasting, and at least one case has occurred in which the patient was under the observation of a skilled neurologist, as a case of progressive muscular atrophy, for a year before any myotonia appeared. Moreover, the muscles which show the most conspicuous myotonia are often those which are not wasted, and finally those muscles which waste greatly tend to lose any sign of myotonia which they may have had. The extent and the intensity of the muscular atrophy and of the myotonia show great variations. The atrophy may be widely spread, and many muscles may be myotonic, or the former may be severe and the myotonia slight, or both may be present in minor degree only. Lastly, there are cases in which only the atrophy or only the myotonia is present. The myotonia consists in an inability to at once relax a muscle after it has been put into voluntary contraction, and the greater the effort used in contracting the muscle, the greater the difficulty with relaxation. The patient grasps one by the hand, and is unable to disengage the hand, but pulls it away still grasping, and it may take seconds to relax. He smiles quickly to a suitable stimulus, and the face remains fixed at the height of the smile for long after the emotion has vanished. In eating, his jaw becomes fixed, he is unable to perform any alternate movements in the muscles which are affected, but at a very slow rate. When the myotonia is severe and general, he is liable to fall like a log when walking, from inability to relax muscles which have been put into contraction. The myotonia is seen most often and to a greater extent in the flexor muscles of the forearm and in those of the face, but it may be quite general. In the same patient it may be very marked at one time and absent at another. The muscular weakness and wasting usually have a most typical distribution, involving the sterno-mastoids and other muscles of the neck, the facial and masticatory muscles—giving rise to the sad "myopathic" face, the vasti of the thighs, and the dorsiflexors of the feet, and this is the usual order in which the muscles are affected. It is always in one or other of these groups that the wasting commences, but sometimes the sequence of muscles attacked is quite different. From its place of commencement the atrophy may spread to all adjacent muscles, or it may pick out individual muscles at a distance. Fibrillation does not accompany the atrophy, and the weakness present is often much greater than the wasting will account for. The electrical reactions show a reduction both to faradic and to galvanic stimuli, with a tendency to a polar change. Some modification of the "myotonic reaction" is often superadded in those muscles which are wasted, and this usually is present in the muscles which are myotonic and are not wasted. This "myotonic reaction" consists in a very long, lasting contraction when the muscles are stimulated with every form of stimulus, and if the latter be strong it may last as long as 30 seconds.

The affection of the muscles of the face and jaw entails some alteration of articulation and phonation. The voice is low, it lacks intonation, and has a definite nasal quality. Sensibility is not affected.

The rule is for the muscle-jerks to be diminished or lost, and it is very

rare for all the jerks to be present in any case. When there is atrophy of the muscles concerned with a particular tendon reflex, this loss is easily explained. But often the deep reflex is lost in dystrophia myotonica, where there is no wasting of the muscles concerned, and the cause of this is to be sought in a pathological condition of the muscles.

Apart from symptoms and signs connected with the muscles, the most important sign of the dystrophy is cataract, which occurs in more than half of the cases. This cataract is often met with in otherwise healthy brothers and sisters of those who have the muscular changes, and in otherwise healthy members of earlier generations in the afflicted families. In succeeding generations after its first appearance, the age of occurrence of this cataract shows remarkable "anticipation"—that is, commencing at first as senile cataract, it appears at an earlier and earlier age with each successive generation, until with fully developed myotonia atrophica it appears in youth. The presenile cataract of the dystrophic generation begins as a star-shaped opacity, first in the posterior and later in the anterior cortical lamellæ, sometimes with fine point-like opacities scattered through the lens. It ripens quickly to a total soft cataract, with a small central nucleus.

The genital organs remain infantile in some cases; celibacy and childless marriages are common. More often sexuality is normal until the onset of definite symptoms, after which desire and power disappear. Early baldness is the rule. A general wasting of all the tissues of the body is seen in many cases. Ultimate atrophy of the testicles is usual.

Diagnosis.—There is no difficulty in the diagnosis when the distribution of the muscular atrophy is typical and when myotonia is obvious; it simply involves a recognition of the unique characteristics of the disease. When the myotonia precedes the wasting, the age of onset will distinguish this malady from Thomsen's disease, or myotonia congenita, and the oncoming of any sign of facial weakness or muscular wasting will make the diagnosis certain. When the myotonia does not appear until long after the wasting is apparent, the diagnosis is much more difficult. One has then to rely upon the peculiar distribution of the wasting, which is by no means invariable. Many authorities, however, are of opinion that some degree of myotonia is always the first sign to appear, and that scrutinous search for this sign in every case of muscular atrophy will lead to the certain recognition of all the cases of dystrophia. The untypical cases in which myotonia and muscular atrophy are absent or little marked are very difficult to recognise. Absence of the deep reflexes, otherwise unexplainable, should suggest the possibility of the presence of this disease, as also should loss of sexual power, and cataract should positively suggest the disease. The importance of repeated examination of the patient must be insisted on, since the myotonia, which is an all-important physical sign in the diagnosis, is apt to be variable.

Course and Prognosis.—This malady usually progresses very slowly, but occasionally very extensive and incapacitating wasting of muscles and weakness may develop within a year of the first symptom. Some cases seem to remain stationary for very long periods. The tenure of life is certainly short in all cases, and does not appear to be prolonged beyond the middle of the fifth decade. The oldest patient reported in the records as still living was aged 50 years.

Treatment.—There is no treatment known to benefit this disease specifically. Attention to the general health and to the well-being of the patient in providing such occupation as his capacity will allow, while avoiding fatigue, exposure to cold, and especially long confinement to bed, are the measures which are most likely to help. Neither electrical treatment nor massage has the slightest effect in altering the course of the disease.

JAMES COLLIER.
W. J. ADIE.

TETANY

Definition.—A group of symptoms of variable completeness and due to a multitude of widely different causes, characterised by a combination of intermitting painful cramp in the muscles usually of the extremities or larynx, but which may affect any of the voluntary muscles, with hyper-excitability of the neuro-muscular apparatus and peripheral sensory apparatus. It appears to be due to a disturbance in the calcium metabolism of the body, the withdrawal of calcium leaving the neuro-muscular apparatus in a condition of hyper-excitability. It can be produced experimentally in animals by calcium deprivation and by the removal of the parathyroid glands which control calcium metabolism, and when so produced it can be removed at will by the injection of a soluble salt of calcium into the circulation. Tetany has close ætiological and symptomatic relations with epilepsy, and may be hardly distinguishable from the tonic fits of epilepsy. It may occur also in typical form in any of the myotonias.

Pathology.—The researches of MacCullum and Voegtlin have shown that tetany is the constant sequel of parathyroidectomy and of calcium deprivation. The parathyroidectomised animals show: (*a*) a marked reduction in the calcium content of the blood and nervous tissues during tetany; (*b*) an increased calcium output in the urine and fæces during tetany; (*c*) an increased output of nitrogen and of ammonia in the urine with an increased ammonia ratio; (*d*) an increased amount of ammonia in the blood with evidences of some type of acid intoxication which does not disappear on the introduction of sodium salts. The injection of a solution of a salt of calcium into the circulation of the animal promptly checks all the symptoms and restores the animal to an apparently normal condition. The parathyroid secretion in some way controls the calcium exchange in the body. It is possible that in the absence of the parathyroid secretion substances arise which can combine with the calcium, abstract it from the tissues and cause its excretion, and that the parathyroid secretion prevents the formation of these substances. The calcium salts appear to have a moderating action upon the neuro-muscular tissues, and in their absence hyper-excitability and spasm occur. The mode of action of the parathyroid glands in this connection, the strictly local distribution of the spasm in some cases and the way in which many of the clinical factors of tetany produce the disease are at present entirely unexplained. Nor is it clear upon which part of the neuro-muscular apparatus the morbid process is incident. In herbivorous animals the parathyroid glands are entirely separated anatomically from the thyroid gland, and thus allow of exact experimentation. In carnivorous animals and in man the parathyroid glands are embedded in the lateral lobes of the thyroid gland, and the symptoms of parathyroid insufficiency, of which tetany is the

most obvious, are apt to arise when the lateral thyroid lobes are diseased or removed.

It would seem that parathyroid insufficiency may be brought about by a great variety of causes. In infantile tetany Yanase has frequently found hæmorrhages into the parathyroids. In the insufficiency tetanies from thyroid extirpation and disease the pathogeny is clear and the calcium treatment restorative. In acute epidemic tetany, thyroid involvements and therefore probably parathyroid involvements are known. Tumours, tuberculosis and many other pathological conditions of the thyroid gland have been reported in association with tetany. There seems to be some connection between tetany and myotonia, in that recurring tetany may pass over into myotonia. I have seen a case of myotonia in which painful spasm of the hands exactly resembling tetany occurred frequently.

Tetany may occur in simple acute forms and in chronic recurring forms. Its many ætiological connections are well shown in the following classification after Frankl-Hochwart:

1. Infantile tetany which is usually associated with rickets or gastro-intestinal disorders, and of which laryngismus stridulus must be considered a local variety.

2. Tetany from over-exertion. A striking example of this rare condition came under my observation in a "girl guide," who though otherwise strong and healthy developed the most characteristic tetany when she had marched more than 6 miles.

3. Workman's tetany. This condition occurs epidemically as an acute recurring affection in the early spring in certain cities, notably Vienna and Heidelberg. It chiefly attacks handworkers such as shoemakers and tailors. The malady lasts from 2 to 3 weeks.

4. Gastro-intestinal tetany from pyloric stenosis, dilatation of the stomach, prolonged vomiting and diarrhœa, helminthiasis, etc. It is obvious that these conditions may profoundly modify both the calcium intake and excretion.

5. Tetany from acute infectious diseases. It has been known to occur in the course of typhoid fever, influenza, cholera, measles and scarlet fever.

6. Tetany from acute poisoning may be caused by chloroform, morphine, ergot, phosphorus, lead, and by renal and genital gland extracts.

7. Tetany of maternity may occur during pregnancy, following parturition or during lactation, especially when the latter is prolonged or the subject is weakly. (Nurse's Contracture.)

8. Parathyroid and thyroid tetany from gross disease or extirpation of these glands. It is sometimes met with in exophthalmic goitre.

9. Tetany has been rarely met with in the course of cerebral tumours, syringomyelia and other nervous diseases.

Symptoms.—In a well-defined attack of tetany four sets of symptoms are usually observable: (1) muscular spasms or cramps which may be followed by considerable weakness; (2) Trousseau's phenomenon—pressure upon the nerves or vessels of a limb or encircling the limb will at once bring on or increase the spasm; (3) Erb's symptom—hyper-excitability of the motor nerves to galvanism, the application of which often produces conspicuous fibrillation which may amount to a tetanus; and (4) Chvostek's sign—there is great mechanical hyper-excitability of the motor nerves and muscles so that

when the facial nerve is lightly tapped as it crosses the jawbone, spasm of the whole of that side of the face occurs. In some cases one or more of the last three groups of symptoms may be absent. Occasionally there is marked tenderness of the sensory nerves with great hyper-excitability to galvanism—Hoffman's sign—and there may be œdema of the extremities, cyanosis, disturbances of respiration and of temperature and trophic changes in the skin, hair and nails.

Muscular cramps.—These may affect any muscles of the body, even the ocular muscles, and it is said also the bladder; but they are much most common in the periphery of the limbs, and especially of the upper limbs. The spasm is tonic and nearly always bilateral, and is usually induced by any mechanical or emotional stimulus, and in ratio to its degree it is very painful.

The small muscles of the hand are first affected. The thumb is crossed into the palm and the fingers drawn closely together, being flexed at the metacarpo-phalangeal joint and extended at the interphalangeal joints, so producing the "accoucheur's" or "penholding" position. The cramp may be limited to these muscles, or it may extend with marked flexion of the wrist and flexion of the elbows, and adduction at the shoulders may cross the arms over the chest. In rare cases the spasm closes the hand in a fist and may carry the arms away from the body so that they are held in the air.

In the lower extremities the toes and the feet are dropped and inturned, and there is usually flexion at the knee and hip with adduction. The legs are rarely affected so much as are the upper limbs, and frequently they escape altogether.

Spasm in any set of muscles in the body may be expected in tetany; but apart from those of the limbs it is rare. Trismus, risus sardonicus, laryngospasm and emprosthotonus or opisthotonus are occasionally met with, while spasm of the bladder, rectum, diaphragm and tongue muscles has been reported. In 7 of Frankl-Hochwart's 122 cases spasm of the eye muscles, sufficient to cause diplopia, occurred.

The attack of cramp lasts for a variable time, usually from 15 minutes to 3 hours; but it may last for 10 days and may prove fatal. The spasm is usually painful, and attempts to undo the contracture increase the pain severely. The spasm may abate and recur.

Laryngospasm is one of the common forms of local tetany, and occurs most often without spasm elsewhere. It is said to be peculiar to tetany of rachitic origin, and is commonly termed "laryngismus stridulus." It is met with in rickety children between the ages of 6 months and 3 years. The attack may come on at any time in the night or day—often when the child wakes or is startled—and it may recur with great frequency. Respiration is suddenly and quietly arrested by closure of the glottis; the air can leave the chest but cannot re-enter. The child struggles for breath, the face becomes congested or cyanosed. Then the spasm quickly relaxes, and as it does so air is drawn into the empty chest over the still closely approximated vocal cords with a high-pitched, crowing sound. Convulsions may occur during the asphyxial stage, and death may result before the laryngospasm relaxes.

Trousseau's phenomenon.—This is probably a reflex phenomenon due to irritation of the peripheral sensory nerves. Pressure upon the vessels or upon the nerves of the limb or encircling the limb will produce the spasm if absent, or augment it if present, in from 60 to 80 per cent. of the cases, and stretching

the nerves as in holding the arm vertically in the air has the same effect. That these performances upon one limb will evoke the spasm in the opposite limb proves clearly that the resulting temporary local anæmia is not the cause of the phenomenon.

Erb's phenomenon.—Hyper-excitability to the galvanic current is shown in both motor, sensory and special sense nerves, and fibrillation and spasm may be induced by cathodal stimulation of the muscles by currents which are subminimal to the normal subject.

Chvostek's sign.—Chvostek first pointed out the remarkable readiness with which mechanical stimulation induces spasm in the muscles in the tetany subject, and tapping of the facial nerve close to the lobe of the ear is a convenient method of eliciting this sign. Even stroking of the face may cause the spasm. It is interesting to note that this sign also has been met with in tuberculosis, chlorosis, gastro-enteritis, myxœdema and cretinism.

Diagnosis.—In a well-marked case this presents few difficulties, the peculiar nature of the spasm, its distribution, symmetrical with the hands most affected, and the characteristic appearance of the limbs when in spasm, with the Chvostek, Trousseau and Erb signs, suffice at once to determine the diagnosis.

Laryngospasm again is so characteristic as hardly to allow of error in its recognition.

Mild chronic tetanus, though presenting a superficial resemblance in the facial and jaw spasm, is distinguished by the frequently reflex nature of the spasm in tetanus.

Hysterical spasm may closely simulate tetany, but there is usually associated sensory loss, the type of the spasm is different, and the attempts at voluntary movement and the emotional upset on passive movement are valuable in distinguishing hysteria. In tetania parathyreopriva the spasms may come on so rapidly and be so severe as to suggest epilepsy. In fact a case was recently sent into my ward at Queen Square Hospital with this diagnosis. Both lateral lobes of the thyroid gland had been removed for goitre. Consciousness was impaired at the onset of the attack, but the attack lasted many hours, and the patient was in agony from the painful cramp meanwhile.

Course and Prognosis.—In infantile tetany the course is invariably rapid to a favourable termination, a few cases fatal from laryngospasm excepted. For a few days the spasms may recur from time to time with lessening severity. The more severe and persistent cases are seen in older children, and in adults, where several attacks a day may occur for months. Here the course and prognosis are often determined by the cause and its removability. Epidemic tetany lasts but a few weeks, and that due to definite poisoning and to maternity comes to an end with the removal of the cause. There are, however, cases of adult tetany which, though benign at first, tend to become more severe with each recurring attack, and Frankl-Hochwart doubts whether these admit of cure. They tend to pass over into a grave form in which the attacks occur with greater and greater frequency and severity, and the patient dies as the direct result.

Treatment.—The treatment of tetany consists in the first place in the removal of any definite causes that may be present, such as rickets and intoxications, and in the second place by providing food rich in calcium such as eggs, milk or whey, and by administering calcium salts either orally or intra-

venously—calcium lactate and hypophosphite being suitable for the former, and calcium chloride, which has been extensively used in animal work, for the latter mode of administration. Parathyroid preparations are decidedly useful in all forms of tetany, and sometimes these seem more efficacious if thyroid extract is also given.

Transplantation of parathyroid gland has been so uniformly successful in animals that it is obviously applicable to cases of chronic tetany, and especially in tetania parathyreopriva.

Surgical interference is required in tetany from pyloric stenosis. Helminthiasis when present must be dealt with in the usual way. In laryngospasm a few grains of chloral hydrate will always avert the attacks until radical treatment is set going.

The pain caused by the cramp may be greatly alleviated by the application of cold to the affected limbs.

JAMES COLLIER.

MYASTHENIA GRAVIS

Definition.—A chronic malady of adult life characterised by—(1) a variable paralysis of muscles which is produced or rapidly increased by exertion, and which tends to disappear slowly during rest; (2) a permanent paralysis which shows no improvement with rest, and which succeeds the variable paralysis. This permanent paralysis may be very local in distribution, and may be associated with atrophy of the muscles; and (3) the affected muscles on strong faradisation soon cease to respond to faradism, but remain excitable by galvanism.

Ætiology.—The malady seems to be much more prevalent in England during the past 20 years than formerly. Rarely occurring before puberty, it commences most commonly in the third decade of life, and affects the sexes equally. Nothing is known of any causal factors either immediate or remote. The one clinical association which cannot be ignored is with exophthalmic goitre, for not only may myasthenia follow that malady, but the ophthalmoplegias which occur in Graves' disease bear no small resemblance to those of myasthenia. Senator states that a condition identical with myasthenia may occur in myeloma.

Pathology.—The only changes found within the nervous system are slight atrophy of those nerve cells which supply long paralysed muscles, and these changes are certainly not primary. In a certain number of the cases a large persistent thymus gland, showing proliferative and degenerative changes, or thymic rests showing similar changes, have been found. Small collections of round cells have been found repeatedly in the muscles and in other organs in all the cases, and they have been termed "lymphorrhages." They appear not to occur in other diseases. The limitation of the malady to the muscles, and the loss of faradic excitability with preservation of galvanic excitability, suggest a defect of the motor end organs such as is produced by the poison curare. The theory that the malady is due to the action of an endogenous toxin is difficult, because of the narrowly local affection of the muscles in some cases. For example, the eye muscles may be affected severely for 20 years, before any sign of myasthenia appears elsewhere.

Symptoms.—The first sign of myasthenia is the variable paralysis which may commence in any of the voluntary muscles. It may be unilateral at first, but soon becomes symmetrical. The paralysis appears first upon exertion and fatigue. The schoolmaster finds that towards the end of the day's work he cannot raise his arm readily to write upon the blackboard, or that his voice fails him in speaking. The housemaid finds that her broom slips in her hands, because of an ever-weakening grasp. The theatre-goer, towards the end of the performance, finds himself tilting his head farther and farther back to escape from an oncoming ptosis, or he develops diplopia. Next morning these symptoms are gone with the night's rest, to reappear with fresh exertion perhaps earlier each day, until work becomes impossible. The affected region may be narrowly confined, the eyes alone, the face, the muscles supplied by the trigeminus, or the larynx alone may be affected, or it may be the muscles of the upper extremities, or of the lower extremities, or of the back which may be solely involved. Lastly, the myasthenia may be quite universal, though never in the same degree in all the affected regions.

The incidence is greatest upon the muscles innervated from the brain stem, next upon the upper extremities and trunk, and least upon the legs. When the initial incidence of the malady is upon the eye muscles, diplopia and ptosis are the first symptoms. The paralysis is usually of the nuclear type, involving both eyes in terms of the conjugate movements; but inequality in the paralysis upon the two sides usually gives rise to decided strabismus and diplopia, and we have observed one case in which the initial paralysis was confined to one external rectus. When the permanent paralysis sets in, the axes usually become parallel, and the diplopia ceases. Until this event occurs, the great feature of myasthenic ocular paralysis is its variability, and its increase with fatigue. An ocular paralysis which is well each morning on waking, and which develops in the course of each day, is always due to myasthenia. The pupils are often unequal and sluggish in reaction, and the light reflex may be lost. Short, very quick, jerky movements of the eyes on attempted voluntary movements are often characteristic, and are quite different from the movements of nystagmus. Though ptosis is the rule, sometimes there is retraction of the lids, and both von Graefe's and Stellwag's sign may be present. Permanent nuclear ocular paralysis follows the variable paralysis in nearly every case, though it varies in degree. When the face is affected, epiphora, dysarthria and lack of facial expression with a peculiar weak "nasal smile" are conspicuous. The facies of myasthenia, with inability to close or pucker the eyes and mouth, the motionless and slightly dysarthric speech and peculiar smile are unmistakable.

Involvement of the muscles supplied by the fifth nerve causes trouble with mastication, and when the palate is affected there may be nasal speech and regurgitation of liquids. We have seen one case in which total unilateral paralysis of the larynx preceded the onset of typical symptoms by twelve months. When the tongue is affected it usually shows some wasting, especially of the linguales, and dysarthria results. Sometimes a widely spread involvement of this region causes severe dysphagia and dysarthria, and the former may be so great as to necessitate nasal feeding. The original name used for the disease, "asthenic bulbar paralysis," arose from this combination of symptoms. The permanent paralyses are rarely seen, except in the muscles supplied by the nuclei of the brain stem. The neck muscles

are usually affected when the malady extends on to the trunk, and it is a common thing to see the patients sitting at rest, either with the head supported by the hands, or resting upon the table. In the extremities the variable paralysis appears more marked at the proximal joints in most cases, and the test for myasthenia in the upper extremity is to ask the patient to extend his upper limbs level with the shoulder, when they will be seen to fall slowly down from the increasing fatigue paralysis.

Involvement of the respiratory muscles is common, and constitutes the gravest danger in the disease, since any effort, and especially an emotional outburst, may in a few seconds fatigue the respiratory muscles into a complete and fatal paralysis. Myasthenia often remains long confined to one region, and subsequently spreads rapidly. In two blacksmiths who were under our care the ocular paralysis began at the age of 18 years, and became complete within a year. These men continued their heavy work without further symptoms until the age of 42, when the myasthenia became general, and proved fatal within 3 months. Wasting of the muscles occurs only when there is marked permanent paralysis, and may be seen in the muscles of the tongue, face and in the masticatory muscles. In one fatal case under our care there was marked wasting of the intrinsic hand muscles on both sides.

The myasthenic reaction is only seen in those muscles which are showing conspicuous fatigue paralysis. If a strong interrupted faradic current is applied to such muscles, there is at first a strong contraction, but this is not maintained as in normal muscles, and it rapidly decreases until there is no response. If the stimulation is discontinued for a few minutes, and again applied, there is a further response, which tires more rapidly than the first. After exhaustion of the muscles by faradism, some volitional contraction remains. Exhaustion of the muscles does not occur from galvanic stimulation. Sensibility and sphincter control are not affected. The reflexes are normal in all but the rarest cases. Absence of knee-jerk has been met with, and the jaw-jerk is likely to fail when the trigeminal muscles are severely affected. The knee-jerk is not abolished when the quadriceps is exhausted, either by voluntary exertion or by faradisation.

Diagnosis.—This is never a matter of any difficulty if the variable paralysis, increasing with fatigue and lessening with rest, is conspicuous, for this phenomenon occurs in no other disease. When permanent paralysis only is present, the diagnosis requires care. It must be remembered that any unilateral or bilateral palsy of muscles supplied by the brain stem may be myasthenic. Here the history of a slow onset with variable paralysis and fatigue phenomena can nearly always be obtained, and the absence of the usual signs of gross lesions of the brain-stem nuclei, or progressive diseases affecting the latter, should avoid confusion. When, as sometimes happens, myasthenia begins with a unilateral ophthalmoplegia or laryngoplegia, the diagnosis may really be difficult. The possibility of such a commencement should be borne in mind, and a careful watch kept for the appearance of conclusive evidence. Other forms of nuclear ophthalmoplegia do not show a long history of variability and fatigue phenomena. Spastic and atrophic bulbar paralysis have distinctive features of their own, such as the spasticity of the former and the atrophy and fibrillation of the latter, and they do not show variability. Diphtherial bulbar paralysis and the bulbar paralysis of

tetanus have characteristic associations and signs. The bulbar paralysis of lethargic encephalitis shows little variability, and tends gradually to improve. The facial types of muscular dystrophy and myotonia atrophica show only a superficial resemblance to myasthenia in the facial appearance.

Course and Prognosis.—Myasthenia is always a very dangerous disease, as the term "gravis" implies. Some of the cases, and especially those in which the brain-stem region escapes, recover completely; but no records are as yet available to prove in what proportion of the cases this event occurs. The disease has proved fatal within a fortnight of the onset of symptoms, and, on the other hand, in our two cases here recorded, strenuous work was followed for 24 years after the development of permanent ophthalmoplegia. Improvement and relapses are very common. Frequently a patient will get rapidly worse, and become bedridden, in spite of careful treatment; to recover completely for the time being, when treatment has been abandoned as useless. Sometimes a patient with severe myasthenia will live for many years, if life be carefully protected. We have had one patient under observation in this state for 20 years, and she is not materially worse.

Sudden death is very liable to occur in any of the cases, but especially in those with bulbar paralysis and implication of the muscles of respiration. Death has been attributed to respiratory failure and asphyxia; but some of the patients die much too quickly for any such explanation. Two of our patients, seated at a table with their heads supported by their hands, and engaged in pleasant, quiet conversation, smiled, lowered their heads on to the table, and were dead without the slightest sign of distress or reaction, as if from sudden syncope.

Treatment.—The life should be so ordered as to eliminate all dangerous muscular fatigue. Beyond this there is little to do. Massage and electrical treatment are positively harmful. Tonics and hygienic measures may be of benefit. Strychnine and polyglandins do not seem to help. Mercury and iodide of potassium in moderate doses have seemed to me to be really of service in some of the cases.

FAMILIAL PERIODIC PARALYSIS

Definition.—A flaccid paralysis affecting the muscles of the trunk and of the extremities, associated with loss of the deep reflexes and diminution or loss of faradic excitability in the muscles. The paralysis is temporary in character, though it may be fatal during the attack, and it recurs at intervals. It is a rare malady, some 200 cases having been reported in the literature.

Ætiology.—It has been noted as early as the fifth year, and as late as the thirtieth year; but usually it appears about the age of puberty. Most of the cases occur in the male sex. Heredity is very marked, and the malady has been traced through five generations. Transmission may occur either through the male or through the female, and not infrequently a generation is skipped. Several members of the same family are usually affected.

Pathology.—Several cases have come to autopsy, but no lesion which could be associated with the symptoms was found. Biopsy of the muscles has given entirely negative results. From the severity of the symptoms, and

their complete recovery in very short spaces of time to complete health, the prevailing opinion as to the nature of the disease is that it is an auto-intoxication of a peculiar kind, associated with metabolic states, and induced by muscular activity, followed by a period of rest. There appears to be some evidence that the malady is associated with disturbance of gastro-intestinal and metabolic function. In Holtzapple's series of 17 patients, bulimia preceded the attacks, and if the appetite was satisfied, and more particularly with rich and heavy foods, an attack was almost certain to follow in the night. Edsall examined the contents of the stomach during an attack, and found total inacidity, and that even starch digestion was not proceeding, showing that the whole digestive process was at a standstill. In a family with three members affected, which were under our observation, the incidence of the attacks seemed to depend entirely upon absence of food. If, for example, these patients dined at eight o'clock in the evening no attack occurred, but if, as their occupation of travelling merchants often determined, they dined very early or missed their evening meal, an attack occurred with certainty. It may be said that in these patients an attack could be produced at will by withholding food for more than a certain number of hours, and causing them to sleep in the starved state, and that the severity of the attack corresponded with the length of time of starvation.

Symptoms.—The clinical picture is so striking as to be almost dramatic. The patients are, as a rule, otherwise perfectly strong and healthy. In the family reported by Holtzapple alone, was migraine associated. The patient retires to bed feeling perfectly well, and awakens in the morning without pain or malaise, but with a flaccid motor paralysis, which always involves all four extremities, and which may reach all the muscles of the body, except those of the organs of speech, deglutition and respiration, and even these are often partially involved. Severe involvement of these vital muscles during an attack has caused death, as in six of Holtzapple's family, of eleven cases. The bladder and rectal functions are retained, and it is unusual for the patient either to void urine or fæces during the attack. The paralysis is usually at its height on waking; but it may subsequently increase. After lasting for a variable time, from a few hours to a few days, it passes off, sometimes gradually, sometimes rapidly. In the family under our care it was astonishing how the patients on waking in an attack could judge invariably how long the particular attack would last. They could judge with unfailing certainty when ability would return, and were in the habit of arranging their business accordingly. Most of the patients in addition to the severe attacks of paralysis suffer from what they call "morning weakness," temporary inability to grip with the hands, and slight disability with the feet on waking. It is curious that similar morning weakness, lasting a few minutes, is not very uncommon in normal children. The paralysis in periodic paralysis is flaccid, and there is loss or marked diminution of response to faradism during the paralysis. The deep and superficial reflexes are lost in the paralysed region. Objective sensation is not affected; but there may be subjective sensations of tingling and numbness, and the muscles may be a little sore and stiff after the attack. We have noticed flushing of the surface and sweating during the attacks. There is an invariable tendency for the attacks to diminish in frequency and severity after middle life is reached.

Diagnosis.—This must be evident to any one acquainted with the

symptoms of the disease. But there are other forms of periodic paralysis which bear more than a slight resemblance to the malady under consideration. For example, Rich described five members of his own family who developed transient recurring spastic paralysis of the face as the result of fatigue and exposure to cold, and we had two members of one family at the National Hospital in whom spastic paralysis of a severe type could be produced at will by withholding food and giving exercise.

Treatment.—When there is any definite cause for the attacks, such as dietetic considerations and fatigue, the obvious necessity is to adjust these to prevent the attacks. In our series of cases, where withholding food caused the attacks, the provision of an emergency food case, should ever they be put short on their journeys, caused the attacks practically to disappear. In Holtzapple's cases, a dose of bromide over night seemed always to avert the attack; but in other cases this drug has not been efficacious. No treatment seems to alter the nature or duration of an attack, when once it has developed.

MUSCULAR DYSTROPHY; MYOPATHIC ATROPHY (THE MYOPATHIES)

Under this heading, a disease is described in which the voluntary muscles undergo primary degeneration, independent of detectable disease in other parts. To facilitate description, a number of clinical types have been distinguished according to the age at which the disease appears, to the group of muscles first attacked, to the presence or absence of pseudo-hypertrophy, or to the prominence of the hereditary factor. The chief of these are—(1) the pseudo-hypertrophic type; (2) the juvenile type of Erb; (3) the facio-scapulo-humeral type of Landouzy and Dejerine; (4) the distal type.

The first type is fairly constant, but there is in reality no sharp division between the different forms. That the others do not represent separate diseases is proved by the appearance of more than one of them in members of the same family. The disease is familial, and it is also hereditary in the sense that it may appear in some or all the members of a family through several generations.

The changes in the muscles in the myopathies are the same as those which occur when muscles degenerate from any other cause, namely, a slow and progressive atrophy of the contractile elements, with a concurrent increase of fat and fibrous tissue. In the pseudo-hypertrophic form the connective-tissue hyperplasia is excessive in some of the affected muscles and their bulk is increased. In the other forms of the disease, and in those muscles in the pseudo-hypertrophic form which become weak without any increase in size, the overgrowth of connective tissue may balance the loss of bulk due to atrophy of the contractile tissues, and the diseased muscles retain their normal size; or atrophy may proceed faster than hyperplasia, and the muscles waste from the beginning.

Pseudo-hypertrophic Paralysis

Ætiology.—The cause of the disease is unknown. In many instances no antecedent cases can be traced in the family. In others, a family history

is obtained, always on the mother's side. Isolated cases occur, but more often several children are attacked in each generation. Boys suffer more frequently than girls in a proportion of about 5 to 1. Sometimes one sex alone suffers, sometimes both. It is rare for all the children to be attacked. The males who escape beget healthy children, whilst the females, who appear to have escaped, may transmit the disease to some of their offspring.

Symptoms.—The symptoms appear in early childhood. The onset is often delayed to the fourth or fifth year, rarely until towards puberty, and very rarely until as late as the twentieth year. In cases of late onset, enlargement of the calves has usually been present for many years. Weakness appears first in the muscles of the pelvic girdle. The child, who usually looks fat and strong, begins to walk late, he falls easily, and rises again with difficulty. He does not romp as other children do. He cannot skip or jump, and he has great difficulty in mounting stairs. At first the muscles may be normal in size, but, as a rule, some show obvious enlargement before the fifth year is reached. The enlargement is most conspicuous in the calves, the buttocks and the infraspinati. The erector spinæ, the quadriceps in whole or part, the deltoid, the supraspinatus and the triceps often show considerable hypertrophy. Occasionally the masseters are enlarged. At the same time other groups of muscles atrophy. This is most severe and most frequent in the latissimus dorsi and in the lower part of the pectoralis major. Later it extends to other muscles, and ultimately to those which were at first hypertrophied. The neck and face are spared. There is no exact correlation between the size of the diseased muscles and their power, but weakness is usually greatest in those which show most atrophy. The defects are greater in the proximal muscles, and diminish distally. The hands often retain good power to the end. This distribution of paralysis gives rise to certain characteristic defects of attitude and movement.

In standing the legs are placed far apart, and the upper part of the trunk is thrown back, so that a plumb-line from the most prominent vertebra falls behind the sacrum. This attitude compensates for the forward tilting of the pelvis, resulting from weakness of the glutei, which normally raise the anterior border of the pelvis by lowering its posterior border. In the sitting posture the lordosis disappears, for now the attachments of the flexors of the hip are approximated, and these muscles no longer lower the anterior border of the pelvis. On lying down the lordosis appears again, but can be abolished by relaxing the flexors of the hip-joint, that is, by flexing the hips passively. In walking, the feet are widely separated, and to clear the ground with the advancing foot the body is inclined first to one side and then to the other. This "waddling" produces a gait like that seen in congenital dislocation of the hip. The early preponderance of weakness in the extensors of the hip and knee is betrayed by the great difficulty experienced in mounting stairs.

The manner in which the child rises from the supine to the erect position is almost pathognomonic of the disease. He first tries to sit up, but fails. He then rolls over on his belly, and raises himself first on his knees and elbows, and then on his hands and feet. Next he places his hands on his knees, and as it is impossible for him to raise the trunk actively owing to weakness of the extensors of the hip, he literally climbs up his thighs, pushing the trunk passively almost to the erect position. The remaining power in the extensors may be enough to enable him to complete the movement.

If not, he jerks the shoulders back suddenly and gains the erect posture by a writhing movement, whose details are difficult to follow. To climb the thighs successfully a certain amount of power is necessary to hold the knees slightly flexed. When this power is lost he is no longer able to rise. The arms are also used to assist the weak legs in sitting down and in getting up from a chair.

As time goes on the weakness increases, and invades all the muscles of the trunk and limbs. Some of the muscles become shortened, and distortions are produced by permanent alterations in the position of the joints. The knees and elbows become flexed, the feet take up the attitude of talipes equinus, the spine becomes curved, and the whole body is grossly deformed.

The deep reflexes and the electrical excitability of the muscles diminish gradually as the wasting increases. Sensation is unaffected. The sphincters are not involved. The mental condition shows no abnormality.

Diagnosis.—The diagnosis is usually simple if a few of the outstanding features of the disease are known. The defects of attitude and movement, especially the mode of rising from the supine position, together with the characteristic association of enlargement of the infraspinati and calves with atrophy of the latissimus dorsi, form an unmistakable combination.

Prognosis.—This is most grave. Few patients reach adult life, and most die within 10 years of the onset of the disease.

Treatment.—Drugs have no beneficial influence. Massage and passive movement are useful in the prevention of contractures, and the efficiency of the muscles may be prolonged by suitable exercises. Walking should be practised daily, until it becomes impossible. Very often this is lost owing to contractions of the calf muscles, and is regained after tenotomy.

Other Types of Myopathy

Ætiology.—The separation of the remaining types of myopathy from the pseudo-hypertrophic form is not an absolute one, as isolated cases are occasionally met with which seem to form a connecting link between the several varieties. The varieties, however, are habitually separate in occurrence, and in families in which numerous cases conforming to the types to be described hereunder have occurred throughout several generations, no cases presented the peculiar features of the pseudo-hypertrophic form. Moreover, the sex incidence as well as the period of onset is different in the two varieties, and it is possible that there is some essential pathological difference between them, and that they are separate diseases. With regard to the types of myopathy unassociated with pseudo-hypertrophy, no doubt exists as to their fundamental unity. They are merely varieties of one disease.

The influence of heredity is much more prominent than in the pseudo-hypertrophic form. Isolated cases occur, but they are rare. In most instances several members of a family are affected in the same and in succeeding generations.

The sexes suffer equally. The time of onset varies within wide limits—from infancy to old age. When the wasting begins in the face (*facio-scapulo-humeral type*) the disease frequently begins in childhood; but sometimes it begins there late in life. In the cases where it is first noticed in the muscles of the shoulder and pelvic girdle the onset is most frequent between the ages

of 15 and 35 (*Erb's juvenile type*); but here, again, it may begin in childhood or early old age, and the term juvenile is hardly applicable to it. The same variations in the age of onset are noticeable in cases where the atrophy begins in the forearms and legs (*distal type*).

The various types may be exemplified in members of the same family, and in the same family the age of onset may show extreme variation.

The cause of the disease is quite unknown.

Symptoms.—In the so-called juvenile form weakness and wasting come on simultaneously. In most cases they are first noticed in the arms; but in some families the legs suffer first. Of the arm muscles the biceps, triceps, and supinator longus are most often first affected. The lower part of the pectoralis major, the latissimus dorsi, trapezius and rhomboids are attacked in most cases. Atrophy of the serratus magnus is common; but it may escape even in severe cases. The deltoid, supraspinatus, infraspinatus and subscapularis usually escape. Atrophy of the forearm and hand muscles is rare.

In the legs, the flexors of the hip, the extensors of the knee and the glutei are most frequently affected. The muscles below the knee often escape entirely.

In the face the zygomatic muscles and the orbicularis are attacked. The face is dull and expressionless, the naso-labial fold is obliterated, the lips are habitually separated and the lower lip projects—myopathic facies. The face does not light up in conversation, in blinking the eyes are incompletely closed, and the articulation of labial consonants is defective. In smiling the mouth forms a straight line, instead of its angles being drawn upwards and outwards by the zygomatici. The power of whistling is lost. When the patient closes his eyes, or compresses his lips as forcibly as he can, they can be forced open with great ease. The buccinators are often affected, the tongue and the masticatory muscles never. The spinal muscles often atrophy, and in a few cases the abdominal muscles have been involved. The excitability of the muscles to faradic and galvanic stimulation usually diminishes in proportion to the wasting. The muscles never show fibrillary tremors. Sensibility is unaffected, and all the other functions of the nervous system are normal. Deformities are neither so common nor so severe as in the pseudo-hypertrophic form.

Diagnosis.—When a family history of atrophy is obtained, myotonia atrophica and peroneal muscular atrophy must be excluded. Myotonia atrophica is distinguished by the peculiar prolonged response of some of the muscles to voluntary, electrical and mechanical stimulation, and by the distribution of the wasting. Atrophy of the sternomastoids, which is constant and severe in myotonia atrophica, is never seen in the forms of myopathy now under consideration. In peroneal muscular atrophy the combination of atrophy in the lower limbs and small muscles of the hands, together with sensory disturbances in the lower limbs, is distinctive. In an early case, when the hand muscles are still normal and sensory changes are absent, the differentiation from myopathy may be impossible for a time.

In isolated cases myopathy is suggested by the appearance of muscular atrophy in childhood or youth. The diagnosis of myopathy is based on the distribution of the wasting in the absence of any sign of disease of the nervous system.

Prognosis.—The disease shows wide variations in its course and duration. The atrophy may remain confined to the group of muscles in which it begins, or extension may take place after an interval of several years. It rarely extends beyond the muscles mentioned above. In most cases, even in those that begin in childhood, progress is extremely slow, and as no symptom of the disease is necessarily fatal, death usually results from other maladies unconnected with the disease.

Treatment.—Owing to the variable course of the disease, it is impossible to estimate the value of any treatment that may be employed. Massage, electrical stimulation, and especially voluntary exercises designed to bring the weakened muscles into play, seem sometimes to retard the progress of the disease.

AMYOTONIA CONGENITA

Synonym.—Oppenheim's Disease.

Definition.—A malady of early childhood, usually congenital and sometimes familial, characterised by extreme flaccidity, smallness and weakness of the muscles, which are not actually paralysed, by lowering of the faradic excitability of the muscles, by loss of the tendon jerks, and by contractures in the region affected.

Ætiology.—In most cases the disease is present at the time of birth; in a few cases it has appeared during the first year of life in an apparently healthy child, and sometimes following an acute illness, such as bronchitis or diarrhœa. Usually sporadic, it has occurred in several children of the same parents.

Pathology.—The chief morbid changes are found in the muscles. In these very conspicuous pathological conditions are present, closely resembling those found in the myopathies. The three most striking conditions are—(1) the minute size of the majority of the muscle fibres, from 7 μ to 12 μ; (2) the presence of a few very large or "giant" fibres reaching 140 μ in diameter, and larger than any fibre occurring in normal muscle; (3) marked regressive changes are seen in the giant fibres. There is increase of the connective tissue between the muscle bundles and a notable determination of fat. Reduction in numbers of the ventral horn cells of the spinal cord occurs, and the ventral roots are small and poorly myelinated.

Symptoms.—The extreme flaccidity of the affected muscles is noticed from the time of birth. They are small and weak, and though there is no muscular wasting and no absolute paralysis, yet in many cases the limbs cannot be raised against the action of gravity, nor can the head be held up. The great relaxation of the muscles and ligaments allows of the most fantastic attitudes being assumed without pain. When the child gets older, he is unable to sit up, but when placed in the sitting position the spine bunches up from absence of any muscular support, and he is unable to support his weight upon the weak legs. The amyotonia is symmetrical, and affects the legs always, the trunk often, the arms not infrequently, but never the face. Notwithstanding the flaccidity, some degree of flexor contracture is usually present. The faradic excitability of the muscles is much lowered, but not lost. Sensibility and the sphincters are not affected. The superficial reflexes are normal, but the deep reflexes are invariably absent in the affected

regions. The children are usually intelligent, with good bodily development, and growth proceeds normally.

Diagnosis.—This presents no difficulty on account of the presence of the flaccidity at birth, the absence of the deep reflexes, and the tendency slowly to improve. It has to be separated from those maladies to which it bears a superficial resemblance, namely, the myopathies, rickety weakness, obstetrical, infantile and diphtherial palsies.

Course and Prognosis.—Some of the children succumb during the early and severe stages of the disease, but the tendency of the disease is to improve slowly in the course of years, and in some cases almost complete recovery with return of the knee-jerks occurs.

Treatment.—This consists in aiding the natural tendency to improve with massage, passive movements and exercises, in treating contractures with tenotomy, and in attending to the general health and nutrition.

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SECTION XX

PSYCHOLOGICAL MEDICINE

PROLEGOMENA

THE isolation of psychiatry from general medicine was long and complete. In Greek medicine the treatment of mental disorder fell to the physician, but for many centuries, throughout the Middle Ages and far into the Renaissance, the insane person was regarded as possessed or bewitched, treated with exorcism or disciplinary measures of great severity and, loaded with chains, was confined as a criminal with criminals. Little by little, these barbaric practices were mitigated, and the physician again took the place of the jailer. Still, however, there linger in popular and even in official thought such notions as the necessity for "locking up" the lunatic, "bringing him to his senses," "keeping him under restraint," and not allowing him to "escape," while the idea of the mentally disordered person as a patient requiring supervision for his cure, where such is possible, or for his permanent care where chronicity has set in, has only very slowly made headway. From the medical point of view it has in the past unfortunately been only too often the case that the physician practising amongst the insane has, from the nature of his circumstances, directed his attention too exclusively to morbid mental phenomena and has tended to ignore those which are concurrent and somatic. Hence the treatment, regardless of pulse-rate, of general nutrition and of the body weight, by almost ceaseless exercise or the treatment of acute excitement by confinement in a "cell" of very limited size loaded with a mephitic atmosphere. On the other hand, until recent years, a study of psychiatry was not included in the medical curriculum, with the result that the doctor in general practice shunned the treatment of states unknown to him, regarded early symptoms as vagaries of character or at any rate as beyond his control, and waited until the patient's conduct became so strikingly morbid that nothing was left to be done save certification and removal to an institution. Fortunately this state of affairs has passed away, and it is recognised that treatment of the mental and physical morbid states should proceed concurrently and be preceded by as thorough examination as is possible of mind and body. With this rule is associated another, namely, that treatment should be commenced at the earliest possible moment. The institution for the insane is, like the workhouse infirmary, only too often a repository for human wreckage, where are recorded the last chapters of histories of illness. The earlier have been sometimes read by the general practitioner, but only too frequently have escaped notice by competent eyes. Prophylaxis and early treatment are as important in psychiatry as in any

other branch of medicine, and the asylum and infirmary would be less full if this were generally recognised. It is to be hoped that in time to come, when cases will be brought forward for early treatment, many a morbid process will be cut short before chronicity sets in. A factor militating against early treatment is the widespread antipathy to an acknowledgment of the existence of mental disorder either by the patient himself or by his family. The causes of this antipathy need not here be discussed, but it is of no use to ignore its most obvious existence, especially while it is unfortunately nourished by legal enactments which make the treatment of this particular class of patients almost impossible, at least for persons of moderate means, without the process of certification and outside an institution. It is natural, then, that initial antipathy fostered by unwise legislation should lead too often to the suppression of evidence of illness until symptoms become so marked that steps have necessarily to be taken, that is, until a time when treatment can effect far less for good than if it had been commenced earlier. It is to be hoped that the general physician, recognising the importance of preventive and early treatment, will impress upon patients and their friends how very much may be done to prevent the development of symptoms, and that he will exercise his influence in the direction of enabling the treatment of such cases to be carried on in general hospitals. Much has been done to draw general medicine and psychiatry into closer relationship. Much, however, remains to be done; but we see no reason to doubt that in the future the numbers of the chronically insane will diminish *pari passu* with attention to the earliest symptoms and to prophylaxis.

No special section has been devoted to classification. No two authorities agree upon this matter, save upon its difficulty, and such division of the subject as is convenient will be found in the headings of sections. Some day, perhaps, ætiology or pathology will furnish us with a wholly satisfactory classification. At present æ'iological factors are often unknown, or when surmised overlap each other so confusedly as to be valueless for purposes of classification. Morbid anatomy has furnished us with an immense amount of information, especially as to changes occurring in cases of long standing. Changes occurring in acute cases are less often seen, and from those changes it would be hard, as a rule, to characterise the symptoms as they had been during life. In some cases there would appear to be no discoverable alterations, and it should always be borne in mind that change of function may precede change of structure. So far, then, morbid anatomy supplies grounds not generally regarded as sufficient for satisfactory classification. Assistance in classification might be expected from psychology. The departments of the human mind abstracted by psychology from the continuum of consciousness are for many purposes convenient. Nevertheless, to divide mental disorders into groups corresponding with such departments is impossible. Disorders of affectivity, of memory, of judgment, or of will refuse to be limited in scope by such artificial boundaries. A delusion, a morbid error of judgment, is unlikely to exist without producing elevation, depression, perversion or instability of the affections: that is, of the feelings of attraction towards or repulsion from things upon which thought is concentrated. Similarly depression or elevation of affective tone colour judgment, and our prospects, for instance, are deemed brighter or darker according to the mood of the moment. Defect of memory may alter the affective tone by

eliminating pleasing or displeasing recollections, or by introducing pseudo-reminiscences, and through it there may be such a quantitative diminution of data that judgment becomes difficult, perverted or impossible. Hallucinations lead judgment astray and affect the emotions and the will.

To classify by symptomatology is also futile. Two similar groups of symptoms occurring in two patients may be of different ætiology, run different courses and be, for various reasons, obviously episodes of two different disorders, while two widely differing groups of symptoms occurring in two patients are as obviously episodes of a disorder from which both patients are suffering.

At the present time two sets of opinion contend in the field of morbid psychology, the one holding that many of the causes of insanity, primarily at least, are to be found in interference with normal function, and the other that the causes are for the most part associated with structural alteration, the result of disease or of defective development.

From the psychological point of view the mind is regarded as consisting of groups of thoughts having more or less attraction for or repulsion from each other. Such groups have come, in the language of the school, to be called complexes. These groups are regarded as at times being in harmony and at times in conflict with each other, and it is in the existence of the latter state that disturbance of mental function may arise. In some instances the storm is abated by the invention, more or less conscious, of excuses of varying degrees of plausibility for a line of conduct set in action by a group, that is, by a process of self-deception. So thorough may such a process be that, to every one except the patient himself, the result is seen to consist in the development of delusions. In other cases, the obnoxious group is put out of the mental field; it is avoided or repressed. Avoidance may be sought in the cultivation of other fields of activity: the patient may endeavour to do what, in familiar language, takes him out of himself, and if this process be carried to a morbid length he may pursue the ceaseless, restless and irrelevant activities which characterise some forms of insanity. Avoidance may also be disclosed in the development of opposite characteristics, such, for instance, as an absurdly meticulous accuracy of expression in one who has a repressed complex associated with an untruth or an exaggerated prudery in one who has a complex associated with a love affair.

Evidence of the existence of an inharmonious complex may also be sought in phenomena known as "phantasy" and "projection." In a condition of phantasy the mental state known popularly as "day dreaming" becomes very much exaggerated: the patient takes himself in imagination so much out of his surroundings that he loses in great measure his hold on the objective world, and lives, careless of it, in a fantastic world of his own creation. In "symbolism" various poses may be adopted as expressing fulfilment of a desire which has had no chance of expression in a normal way—for instance, the affectation of the manners and customs of the great or of the beautiful by the mentally small and the physically ugly. Mannerisms and affectation are frequent in dementia præcox, associated with what appears to be considerable mental deterioration, and are indicative of hidden mental processes of which they are the sole manifestation. In "projection" self-reproach for some error of conduct may be changed to the reprobation of others, and the burden on the patient thus removed or lessened.

It will be seen that in these mental processes there is a dissociation of groups of thought which, to secure harmonious mental working, should have been in association and co-operation. Not only, however, must these groups be regarded as dissociated, but as subsequently in a measure isolated, so that the effects produced may be regarded as an absence of certain factors necessary for proper mental activity. Or if, in fact, the groups do influence mental activity the influence is indirect, exerted at the wrong point and at the wrong time and issues eventually in perversion of conduct.

The claims of what may be called the Structural School are nevertheless insistent. Classification is made to depend on anatomical defects and alterations, some of which are gauged by micrometric measurements and the order of the development of the laminæ. There is a class in which neuronic development is imperfect, and which includes various grades of idiocy and feeblemindedness, epileptic, moral and delusional insanities and hysteria. A second class includes cases known as senile, climacteric, adult or adolescent dementia in which there occurs neuronic degeneration, the change in structure being due to insufficient durability. A third class consists of cases in which the neurons have become subject to the influence of toxic agents, the result depending in part on the power of resistance of the nervous structures, which varies with different individuals. A fourth class is associated with gross cerebral lesions and with the deprivation of some special sense.

Such, in briefest outline, are the positions maintained by the two schools. Except as advanced by extremists they are not mutually exclusive, and the work of the future will probably render them co-ordinated and consolidated.

CONFUSIONAL INSANITY; INSANITIES OF TOXIC AND INFECTIVE ORIGIN; EXHAUSTION PSYCHOSES

Definition.—Mental confusion is a condition in which those notions persons ordinarily have of their relations with time and space and of their own personalities become less clear, perhaps to such a degree that the patients, though conscious, no longer recognise their surroundings or realise their own identity. Associated with this inhibition of the action of high psychic centres, there may be a removal of restraint upon lower and more automatic ones, so that agitation, excitement and hallucinations take the place of orderly conduct, equable affective tone, and true perceptions.

Ætiology.—Intoxication from one source or another is the cause of mental confusion. Such intoxication may be acute, as in the case of the infective diseases, for instance, influenza, septicæmia, pneumonia, or enteric; or chronic, as in some forms of gastric, intestinal, cardiac, renal or other organic diseases of prolonged duration. It is possibly premature to assert that exhaustion, whether due to physical strain, such as trauma occurring in war, railway or other accidents, surgical operations, excessive venery, pregnancy, parturition and lactation, privation and starvation, or to emotional stresses, such as continual worry, shock and mental overwork, is a source of intoxication; but evidence at least seems to suggest the existence of "fatigue bodies" as the result of such conditions, and as exercising an influence in the production of symptoms of exhaustion. Until the matter is elucidated, it may be

provisionally held that exhaustion is synonymous with intoxication. If it be not so, then we must add exhaustion to intoxication as a cause of mental confusion. There is no doubt the milder forms of confusion are indistinguishable from the more severe forms of nerve exhaustion, and the latter, running an unfavourable course, may become the former. The two states may, indeed, be regarded as essentially identical, and only as artificially separated by the fact that the one has, in the past, for the most part been treated in asylums, and the other elsewhere.

Heredity looms less large in confusional insanity than in some other forms. There is a strong probability that those of psychopathic or neuropathic inheritance are more apt to fall victims when attacked by some occasional cause, than those of good family history; but in confusional insanity the occasional exciting cause is the prominent factor, and often succeeds in breaking down the resistance of those of unimpeachable inheritance.

Symptoms.—Exaggerated weariness is the most prominent initial symptom. Mental and bodily activities excite no pleasure, and the patient finds it hard work to bring himself to the performance of the ordinary duties of life. The distraction of travel or of pleasure, unfortunately too often advised in these cases, instead of serving the purpose only leads to further lassitude and inertia. Headache, insomnia, irritability, depression and loss of flesh are prominent and constant symptoms. In the case of the acute infective processes the gradual onset, usual in cases of other causation, is compressed into a much smaller amount of time. The feeling of weariness as the result of a few days' illness is then extreme, and of such a degree that the patient may find it almost impossible to raise his hand an inch from the bed. But whether the cause operates with violence over a short space of time, or subtly does its work over an extended period, the march of the symptoms is much the same. The patient has difficulty in concentrating his attention, and as a consequence his memory for immediately past events becomes poor. He displays some degree of confusion and hesitancy as to where he is, what is going on around him, and as to his own identity. He loses his appreciation of time. His power of judgment becomes less, and delusions develop. These are, however, very fleeting, are soon forgotten and replaced by others, and have nothing of the definite systematisation and fixedness of such as occur in delusional insanity. In many cases the character of the emotions also changes, and the patient is not at all or but little affected by what normally would give him pleasure or pain, or, on the other hand, is extremely depressed and miserable, or unduly elated. In extreme cases there may be a suspension of all psychic functions, so that the patient is in a state of stupor. More often a superficially very opposite state of affairs obtains. The highest mental functions being inhibited, there is an exuberance of the lower and more automatic, so that talking or incoherent chattering, restlessness and impulsiveness, issuing in attempts at assault or suicide, take the place of a peaceful stupor. Hallucinations are frequent. The character of the reactions will depend at any given moment upon the nature of the imaginary circumstances amidst which the patient finds himself. He may sometimes appear happy, contented and pleased with his lot, while at other times, and more commonly, he is agitated, anxious, suspicious, frightened and perhaps angry and violent.

Symptoms of bodily illness accompany the mental symptoms. If the

insanity occur with or shortly after some infective process, the special somatic alterations of that process will be observed; otherwise the symptoms may be as follows. General nutrition is not satisfactory, and the patient loses weight even before the onset of the mental symptoms. The blood shows the changes of anæmia of the chlorotic type. The appetite is generally very poor and the ingestion of food resented. The tongue is furred, and the breath offensive. The bowels are constipated, and the stools are often particularly foul. Digestion is frequently impaired, and complaint is made of acid eructations, heartburn and flatulence. The pulse is small, easily compressible and occasionally irregular, its rate is apt to vary within wide limits, but is usually more rapid than normal. The extremities are often cold and cyanosed. Alterations in the urine have been noted in some cases. If renal disease exist, albumin will probably be present in larger quantity, and has been detected even where the kidneys have not been suspected. During an attack, the amount of urine has been found to be diminished as well as the contained solids, notably the phosphates and chlorides, while towards the close of the illness its quantity as well as its solid contents again rises. Indican has been found in some cases. Abnormal signs indicating involvement of the nervous system are not very common; but inequality of the pupils and sluggishness in movement have been observed. The tendon reflexes are very variable; but on the whole more often exaggerated than diminished. In the case of trauma symptoms commence at various times after the accident. If the trauma or shock be sufficiently severe, they may be induced at once, or appear after an incubation period of about a fortnight, or if the trauma has set in motion certain continuing causes, such as suppuration or the expectation of litigation, only after months. When symptoms come on gradually, there is at first some alteration of character with depression, irritability, loss of self-control, blunting of the intelligence and failure in will power. Later the symptoms of confusion as described above develop.

Course.—When due to severe and rapid intoxication, as, for instance, an acute infective disease, symptoms speedily develop, are likely to be severe and to clear up comparatively soon in the course of a few days or weeks: when, on the other hand, as a result of chronic intoxication lasting over many months or years, the symptoms come on insidiously, they last perhaps for many months or years, and pass off very slowly.

Diagnosis.—Certain aspects of confusional insanity have suggested its identity with mania; but the two are in fact by no means similar. In mania, perception of environment is far more rapid than normal, and but little of what is happening escapes the patient. The procession of ideas through his mind is so rapid it is difficult for the observer to keep pace with it, or to follow how any one idea is connected with what preceded or follows it. The memory of the maniac is vastly improved, and he reproduces that which, in his usual state, he has utterly forgotten. His orientation in time and space is perfect. Indeed, far from the mental processes appearing blunted, they are quickened, and are chiefly remarkable in being too rapid to be useful. It may also be noted that the events of his illness are remembered by the patient who has been maniacal; but they pass from the memory of one who has been confused, as does a dream.

Prognosis.—In cases due to trauma, whether psychic or somatic, or to the

shock induced by explosions, the course of symptoms is so varying as rarely to make any definite prognosis at all justifiable. Some such cases get better with astonishing speed, while in others their chronic character is equally a matter of wonderment. Indeed so perverse is the course of nervous and mental symptoms due to emotional shock, or to physical trauma, that both as to its character and duration it is difficult to apply any rules. The somatic symptoms generally improve before the mental. The appetite becomes better, the bowels less constipated, sleep improves, and weight is increased. If unfortunately these improvements be not accompanied, or shortly followed by mental betterment, chronicity may be expected. In the majority of cases patients get quite well. In a few, where the intoxication has been extreme, death occurs from exhaustion.

Acute Confusional Insanity

Synonym.—Acute Delirious Mania.

Ætiology.—It may be the accompaniment of some well-recognised infection, as influenza, or enteric, or occur apparently independently.

Pathology.—As might be expected, the changes found in acute delirious mania are more marked than those found in the less severe forms of confusional insanity. The alterations are indicative of meningo-encephalitis. The meninges and brain are hyperæmic, the cortex is œdematous, and the veins and lymphatics engorged. Small extravasations of blood, both in meninges and cortex, are visible to the naked eye, while under the microscope extravasations of small round cells are seen about the vessels. The cortical cells are deformed and swollen, their nuclei eccentric, and perhaps extruded, and the protoplasm shows chromatolysis. Their processes may be broken, and exhibit a varicose appearance. In cases of less severity the naked eye appearances are, as a rule, absent, though degenerative changes may be seen in the cells microscopically. In some cases no change has been discovered.

Symptoms.—The symptoms of severe forms of acute confusional insanity are those already described, but of so serious a character that the syndrome has in times past received a special name. They sometimes, though uncommonly, actually precede the bodily symptoms of the infection, but more often appear when the fever is highest, and the other bodily symptoms at their worst, or when fever has subsided, and the symptoms have disappeared. Sleeplessness becomes complete, the temperature high, and the respiration and pulse-rate much increased. With these bodily symptoms there are associated extreme restlessness, intense apprehensiveness, complete disorientation, hallucinations, usually of a most terrifying character, and very impulsive reactions of conduct. The symptoms and signs of a profound general intoxication develop, the tongue becomes dry and cracked, sordes collect, tremor and subsultus tendinum make their appearance, and the patient dies comatose. When mental symptoms appear on the abatement of the fever, and the other physical symptoms, they indicate the exhaustion from which the patient is suffering. He may be depressed, vacant and vague as to his surroundings, or psychic operations may appear entirely suspended, and the patient may become stuporose, or his appearance may suggest the idea of one having an unpleasant dream.

Treatment.—It is at present impossible to deal radically with the poisons considered to be the cause of this disorder, and efforts can only be directed towards eliminating them and mitigating their effects. The patient should, as far as possible, have perfect rest—both mental and physical. He should be kept in bed, preferably in the open air, and failing this in a thoroughly well-ventilated room. Not only should his activities be reduced to a minimum, but his perceptive apparatus should be stimulated as little as possible by the removal, as far as may be, of sights, sounds and other sources of sensation. He should see only his physician and nurses, and conversation with them should be limited to essential topics.

It is sometimes very difficult to persuade patients to stay in bed, but a good nurse will often succeed in most unpromising cases. If it be found impossible, the patient should be carefully watched and guarded from doing himself any harm. If a sufficiency of attendants cannot be provided, the patient has, perforce, to be placed in a strait-waistcoat, or in a strong or padded room. Resort should only be made to mechanical restraint when human force is not available, or is not skilled and efficient. Very few, indeed, are the properly treated cases in which mechanical restraint can be deemed necessary. In rare instances restraint is asked for by patients themselves, to prevent them from the commission of involuntary impulsive acts harmful to others, or to themselves.

In the acutely delirious cases it may be desirable to give the patient a general anæsthetic for the purpose of feeding and administering drugs through a tube. The opportunity may also be taken to wash him and change his clothes.

The condition of the bowels should receive careful consideration. Patients are often known to be constipated; but there are many with a reputation for regularity, who are only found to be constipated when the character and quantity of the fæces has been examined. That the bowels should be regularly and effectively evacuated is of the utmost importance, and this must be secured by drugs or enemata. Food should be given in ample quantity, and should be as nutritious and as easily assimilable as possible. Patients have great difficulty with the ingestion of food, and here, again, it is necessary not to be content with an assurance that food is being taken, but to inquire precisely as to its nature, frequency and quantity.

Where there is agitation, restlessness and insomnia the question of the administration of sedatives and hypnotics arises. Such drugs should always be tried, though it is not possible beforehand to be confident that success will follow their use. The sedatives and hypnotics may be used in turn, in varying doses, administered at different times, and it will be seldom found but that some drug, given in a particular dose, at some particular time, does yield a good result. Too often their usefulness is denied, because they have been given in doses too large or too small, and at the wrong time. Treatment should be carried on along the same lines for months, or at any rate until the patient's physical condition has considerably improved, and he has returned to his normal weight, or surpassed it. It should then be very cautiously relaxed, and the patient allowed very gradually to do more, but not to overtax his strength. When the patient has at length lost all symptoms, and is in good physical health, he should go for a change before returning to work.

ALCOHOLISM

Alcohol is taken in excessive quantities for a variety of reasons, among the commonest being social convention, its effect in producing a general sense of well-being and, in most of its forms, its pleasant flavour. A family history of alcoholism, of epilepsy and of mental and nervous disease is quite frequent in those addicted to excess, but it must be remembered that home influences and education, where the parents suffer in any of these ways, are unlikely to be very satisfactory, or to result in the production of persons properly informed or with a sufficiency of self-control. The bad example of parents is very easily followed by children, and a boy or girl may be brought up in what may be called an atmosphere of alcoholism without realising that very excessive amounts are being consumed by those around or that such excess tends to physical and mental decay. If allowance be made for these circumstances there are yet families whose members are peculiarly susceptible to the temptations of alcohol: in successive generations certain members take to drink, or in the same generation brother after brother succumbs. Family histories are not easy to obtain. In the wealthier and more educated classes unfortunate histories are suppressed; in the less wealthy and educated the history of forbears soon passes into oblivion.

Certain persons, as a consequence of their mental attitude, whether their dispositions be mainly inherited or cultivated, seem unable to grasp the bearing of the course upon which they have entered. Advice, admonition and even demonstration of the bad effects of alcohol upon them are entirely wasted; they lack any sense of appreciation or, which from a therapeutic point of view is as hopeless, they deliberately thrust consideration of the subject out of mind. Such persons belong to a class the members of which disclose lack of judgment in very numerous ways. It is not that they drink from imperious need, as do some alcoholics, but their range of mental outlook is singularly limited.

The circumstances of an individual are of great importance. Many seek in wine relief from mental worry, from weariness of mind and body and from pain. That alcohol has effects in the relief of these states is a matter of such wide general experience that they can only be denied by the fanatic, but the danger zone is reached when it becomes regarded as a panacea and when, therefore, it is taken in excess. The question of what is meant by excess is at once raised. An amount of exercise, food or sleep which is not only adequate but necessary for one individual may be wholly inadequate or excessive for another, and the same is true of alcohol. Some persons, particularly females, cannot stand the smallest quantity, while others take large amounts for many years without being the worse when judged by any available method. The state of the particular individual under inspection can alone present the data from which the physician must endeavour to elucidate the problem as to the amount of alcohol, if any, which is safe.

Alcoholism is sometimes a symptom of such grave mental disorders as general paralysis of the insane, mania, epilepsy and senile degeneration. Perhaps never before in his life given to excess, the patient suffering from commencing general paralysis, mania or senility, to the surprise of those who have known him well, takes to the immoderate use of alcohol; or a

patient, suffering from some variety of epilepsy, and as a rule of quite sober habits, from time to time has bouts of furious drinking.

Symptoms.—A single overdose of alcohol may produce acute symptoms, the amount constituting an overdose and the severity and character of the symptoms varying very largely. Repeated doses may in time produce symptoms called chronic, because they are of prolonged duration. Here again the frequency and amount of the doses and the character of the reaction of the tissues vary very much. Acute and chronic symptoms often occur together, the former being superimposed upon the latter and being as a rule due to the ingestion of a large amount, in addition to the habitual overdose, but they are sometimes the result of the sudden stoppage of the accustomed amount.

Most persons have, when sober, some degree of self-restraint, and the diminution of this restraint is one of the earliest symptoms of the influence of alcohol. Quite a considerable number of persons become talkative, witty and even instructive who ordinarily, because shy, prudent or otherwise restrained, are silent, dull and uncommunicative. Diminution of restraint is not, however, always thus advantageous, but passes on, as the amount of alcohol taken increases, to looseness of conversation and conduct. Regard for conventional decency is lost, and the patient may commit silly, disagreeable, outrageous, or even criminal acts. Psychic weakness thus indicated may extend later to more automatic functions, so that speech becomes thick and unintelligible, and the gait and other movements awkward or impossible, and eventually sleep or coma supervenes. In rare instances, paralysis extends to the vital bulbar centres and the patient dies. In certain cases symptoms take special forms. Excitement may be intense with much noisiness and violence, convulsions may occur, or the patient may develop delusions of persecution or of grandeur, or he may become depressed and even suicidal. As a rule the symptoms rapidly clear up, at any rate if their cause be withdrawn.

Acute Alcoholic Delirium

Synonym.—Delirium Tremens.

The symptoms of acute alcoholic delirium are usually superadded to those of chronic alcoholism. They may occur when alcohol is suddenly withdrawn from a patient who has become habituated to large quantities. Emotional stress, trauma or illness is sometimes the occasion of their appearance.

The first symptom to attract notice is sleeplessness. The patient looks haggard and worn and his hands and tongue are very tremulous. His tongue is furred and his bowels constipated. The pulse-rate is increa He is apprehensive in mind and restless in body. In the course of a day or two, during which he becomes more depressed and excessively irritable, visual, auditory and other hallucinations develop. These are of a most unpleasant character. The patient sees vermin, reptiles, wild beasts or human enemies, armed with all sorts of weapons, approaching to attack him, and he may also hear them hissing, roaring or uttering threats. There is a considerable degree of confusion in the patient's mind, and he loses knowledge of his surroundings, of himself and of time. Mixed in mind and terrified in feeling,

the patient's conduct is impulsive and violent. He shrieks with horror at the sights before him, or at the contact of the reptiles or other noisome beasts, and may seek to avoid them by flight or by jumping out of the window, or, on the other hand, he may attack them with anything handy which can be used as a weapon of offence. The aspect of the patient is that of extreme anxiety or terror. The face is congested and the eyes bright and bloodshot. The temperature may be a little raised. The pulse-rate is rapid.

Course.—In some cases the patient, worn out by want of sleep, restlessness and agitation, lapses into a state of profound asthenia, becomes comatose and dies, while in others the confusion, the delusions and the hallucinations become less pronounced and continue indefinitely as chronic confusional insanity. In a majority of cases in a few days the physical condition improves, the tongue cleans, sleep returns, the pulse-rate diminishes, appetite improves and the tremor becomes less marked, while the mental state gradually improves. Hallucinations become less terrifying and slowly disappear, and the patient again begins to realise his surroundings.

Treatment.—The first requisite of treatment is adequate care of the patient. If the conduct be impulsive and violent the patient must necessarily be restrained, and this is best effected by a sufficiency of tactful, kind and powerful attendants. If attendants of a proper sort and in sufficient number cannot be provided, it may be necessary to use a strait-waistcoat or other mechanical appliance. Recourse should only be had to physical restraint when absolutely necessary. Every effort should be first made by kindly persuasion to comfort and reassure him. Bed is the best place for the patient, and he is there better under control than if up and wandering about. He is almost certain to have had too little food, and he should be persistently fed with milk and other easily digested foods. If the patient has been drinking up to the time of the commencement of the symptoms, the amount of alcohol he has been taking should, so far as possible, be ascertained. This amount may be reduced by one-fifth each day until on the sixth day no alcohol is taken. The reduction of a fifth a day must only be taken as a rough guide, and may be greater or less according to the strength of the patient, his tolerance for alcohol, and his reaction to treatment. If the patient has not been drinking within two or three days from the commencement of symptoms, or has been vomiting his drink almost as soon as it has been swallowed, symptoms may be mitigated by the administration on the first day of treatment of half the amount of alcohol to which he has been accustomed. Thereafter a reduction of a few ounces is made each day until none is given. Such a gradual withdrawal or tapering is not always practised, and some prefer to stop alcohol abruptly as soon as the patient comes under treatment. If digestion is defective and there is vomiting, the stomach may with advantage be washed out with hot water and bicarbonate of soda, two drachms of the latter to the pint of water. When the health is fairly good, a large dose of calomel may be given, and in any case the bowels should be kept well open. Sedatives and hypnotics should be given, potassium bromide being particularly valuable before the acute symptoms have arisen and when they are subsiding. They are not always a success, but should at any rate be tried until found to be useless.

Dipsomania

Definition.—The term dipsomania is employed with much looseness, but it is as well conventionally to restrict it to a thoroughly defined syndrome. It signifies an imperious tendency towards an act or a line of conduct which is scarcely, if at all, influenced by judgment, and consists in the ingestion of alcohol.

Symptoms.—Between times the patient may be entirely abstemious or perfectly well able to keep himself within bounds, but on the occurrence of the impulsion he becomes in this respect an automaton and obeys the tendency to act without power of resistance. The impulsion to drink is often preceded by a few days of alteration of disposition, evidenced by irritability and depression, during which it gradually develops and gathers strength, and at last overwhelming the judgment a drinking bout is commenced.

Treatment.—If prodromal symptoms are known to occur, advantage should be taken of them as a warning, and endeavours should be made to control the movements of the patient. Sedatives may also be administered. Suggestion is often of great help in cases of this description and should be employed during the healthy intervals as well as in the prodromal stage.

Mania a Potu

Another form of excitement induced by alcohol is known as Mania a potu. Persons in whom it occurs are usually of a neurotic diathesis and their family histories often disclose instances of insanity, epilepsy and nervous disease. The attack is often induced by a very small amount of alcohol, acting on one of quite abstemious habits. Immediately alcohol is taken, in amount perhaps only a glass of wine, the patient becomes acutely excited, noisy or violent or both. The attack lasts from some hours to a few weeks, when the symptoms abate and the patient becomes again quite normal.

Treatment.—Treatment is obviously of a preventive character, and alcohol should be absolutely forbidden. When symptoms of excitement occur they must be treated as if of any other causation. Having in consideration the short time during which attacks usually last, certification should be avoided in all cases where proper provision can be made for nursing the patient outside a licensed institution.

Chronic Alcoholism: Dementia

Having now reviewed the groups of acute symptoms associated with the occasional excessive consumption of alcohol, there remain to be considered the mental effects of its frequent consumption in excessive quantity over long periods of time. Some of the mental effects of chronic alcoholism are so striking that they have led to grouping of cases in which they occur in several categories, but underlying that and common to all forms is the gradual decline of mental level known as alcoholic dementia.

Pathology.—In cases of long-standing alcoholism the meninges are found

to be thickened and adherent to a cortex more or less atrophied. The arteries are degenerated, and there may be appearances of recent or old hæmorrhages of varying size. In acute cases there may be general congestion and serous or bloody effusions. In many cases the anatomical appearances are normal.

Symptoms.—The appearance of the symptoms is very gradual. Dementia may reveal itself in the course of a few, or many, years after excess has become established, and in some persons after the consumption of a daily dose apparently quite inadequate to produce any bad effect in the majority. Subtle alterations in character are first to attract attention. The patient becomes less nice in personal habits, less discriminating in the choice of associates and less punctual in the performance of social or business duties. His attention is found to be hard to hold and he tends to ramble in conversation. Judgment becomes of poorer quality, less well founded and either unduly hesitating or hasty. Volition displays weakness, in obstinacy or in irresolution. Gradually such defects become more pronounced and the patient is found to be untrustworthy either socially or in business. Appointments are neglected for no pretext or for such as are manifestly absurd. Silly quarrels are fastened upon good friends, and even more absurd partialities are shown for those that are bad. Conduct becomes objectionable, obscene or even criminal. Loss of memory is very marked. At first it is due to the inability of the patient to fix his ideas by an adequate effort of attention; later, to a loss of the power of reproducing past memories; and lastly, to a loss of the power of conservation. The mental state may be reduced to a very low level, where nervous reactions are purely automatic and only a flicker of intelligence can be roused by the notion of the desired drink. With mental deterioration are associated those numerous somatic symptoms indicative of degeneration of various tissues.

Hallucinations of the special senses, but particularly of hearing and of sight, may occur at any stage of mental deterioration. So notable and long lasting may be the hallucinations that the condition has received the name of *chronic alcoholic hallucinosis*. The patient may see animals, often reptiles, but they have not the terrifying effect of those seen in delirium tremens. He may also hear voices which often call him names, or threaten him. Delusions are also not uncommon and are more or less fixed and systematised, but never to the extent met with in delusional insanity. They are of many varieties, but those of jealousy, suspicion, persecution and grandeur are the commonest. To this condition the term *alcoholic paranoia* has been applied.

Cases at times very closely resemble general paralysis of the insane. The delusions may be exactly those of the extravagant magnificence met with in that disease and there may in addition be several of its abnormal physical signs. The movements for the production of speech may be weak, tremulous, unduly prolonged and badly co-ordinated so that the indistinct, hesitating and slurring utterance of the general paralytic is produced. The pupils may be sluggish in reaction and unequal in size and the tendon reflexes may be lost or increased or unequal. There is, as a rule, much tremor. Such cases are included under the term *alcoholic pseudo-paresis*.

Diagnosis.—In the cases of pseudo-general paralysis just described it may only be possible to make a diagnosis by examining the cerebro-spinal

fluid. In general paralysis this will give a positive Wassermann's reaction and a leucocytosis. In alcoholism, unless complicated by syphilis, which unfortunately it often is, Wassermann's reaction will be negative and there will be no leucocytosis.

Korsakoff's Polyneuritic Psychosis

Ætiology.—In this disorder mental symptoms are associated with multiple neuritis. The condition is not only the result of alcohol but is also met with as the consequence of other intoxications, of infections and of exhaustion. The special symptoms come on rapidly during the course of chronic alcoholism.

Symptoms.—At first these consist of anxiety, agitation, restlessness and hallucinations. These become less marked in about a week, but there is considerable confusion and forgetfulness. The patient fabricates stories, pseudo-reminiscences, which he relates and in which he thoroughly believes. The symptoms and signs of multiple neuritis, such as pain and tenderness along the course of the nerves, loss of muscular power, abolition of tendon reflexes, paræsthesiæ and anæsthesiæ, also develop. There is, as a rule, considerable emaciation. The action of the heart is feeble and irregular.

Course.—Such symptoms may last for several months and then pass away gradually, though complete recovery is rare when alcohol is the cause.

Prognosis.—If the patient be young, of good disposition and of normal bodily health and can be persuaded to stop the use of alcohol, the prognosis as to symptoms of both mind and body is good. Often, however, the patient is of such enfeebled judgment and will that his disposition is not favourable to his co-operation in his cure.

Treatment.—The fundamental treatment of alcoholism lies in endeavouring to stop the patient from taking the poison. Where this is not possible, attempts should be made to persuade him to enter an institution. The treatment carried on within special institutions varies very much, and various modes are vaunted by various practitioners. A great point has been gained when a patient has consented to enter an institution, and if he leave it without having taken alcohol for some time, in better general health and with strengthened judgment and will, the object of treatment has been achieved. There are, doubtless, those who would do well to remain in institutions altogether, for they are persons whom nothing will restrain from drinking save the physical impossibility of getting alcohol. To deal with such persons outside an institution is, from the physician's point of view, idle ; advice and all forms of psycho-therapy may be administered, but without the goodwill of the patient himself are useless. In some cases treatment by suggestion, whether in an institution or not, is of great value. In all cases efforts should be made in every way to raise the general standard of health as far as possible.

DRUG HABITS

Morphinomania

The habitual consumption of opium either by the mouth or by smoking results in symptoms almost precisely the same as those caused by the habitual

hypodermic injection of morphine. In the East the opium eater or smoker asserts the drug is sedative or restorative, and he consumes it for this reason rather than for the pleasure of the preliminary excitement. In countries inhabited by a white population the usual method of administration is hypodermic and the preparation is morphine.

Ætiology.—The power of morphine to afford immediate relief from pain and discomfort, mental or physical, constitutes at once its value in the hands of the physician and its danger in the hands of the patient. The neurotic, degenerate and ill-balanced are particularly prone to bad habits of all descriptions and to the drug habit in particular. Curiosity sometimes tempts persons to try the vaunted delights of opium and morphine, but perhaps more usually some trifling and temporary disorder suggests the use of the drug, and the patient, unable from weakness of judgment or will to abandon it when its use is over, continues to take it as a matter of habit. To some few persons the drug has been given in the first instance by a medical practitioner for the relief of the symptoms of such chronic maladies as rheumatism, asthma, dysentery, dysmenorrhœa, migraine or tabes dorsalis. In the case of chronic disorders of a painful character, the physician should ever remember the possible consequences of the prescription of opium and its derivatives, and should only in the last instance have recourse to them. The professions and occupations which have special means of access to drugs, and some knowledge of their actions, such as those of medicine, pharmacy and nursing, provide a particularly large number of morphinomaniacs.

Symptoms.—At first, and for a period of time which may be months or years, the effects of the drug are only such as are pleasant to the patient, and consist in feelings of exuberant mental and physical well-being and power. In some persons there is also generated a dreamy state into which many varieties of delightful hallucinations enter. Such states are succeeded by feelings of lassitude and depression, the more intense as time passes. Before long the pleasing effects become shorter and the subsequent depression deeper and of longer duration, and to relieve this another and stronger dose has to be taken. With the establishment of the habit, and the concomitant chronic intoxication, mental and physical symptoms develop. The patient gradually loses all sense of moral values, but at the same time, while under the influence of the drug, may be amusing, clever and capable of working well. He is ingenious in excusing his own faults, and in saddling others with blame. The occasional failings of the neurotic temperament are converted into permanent symptoms, and the patient becomes untruthful, untidy, unpunctual, dirty and dishonest. The faculties of attention, memory, judgment and will deteriorate. Insomnia becomes marked. Physically, the patient becomes thin, sallow and prematurely old in appearance. The heart's action becomes feeble and sometimes intermittent. Perspiration is usually scanty, but is sometimes excessive. The body temperature falls below the normal. The mouth is dry and the gums shrink. Dyspepsia, vomiting, diarrhœa and constipation are common. Myosis is usual. The reflexes are diminished, and there is sometimes hyperæsthesia and sometimes anæsthesia of the extremities. Albuminuria develops in certain cases. The functions of the sexual organs cease. Abscesses from the use of contaminated needles are not uncommon, and may be the starting-point of septicæmia. The daily quantity used may vary from 3 to 40 grains. With

gradually increasing doses, the amount discharged by the bowel and kidneys diminishes until none is excreted at all. It would appear probable that the tissues acquire a power of destruction of the drug.

As time goes on a chronic state of mild confusional insanity becomes established, with delusions and hallucinations, while the general mental level becomes slowly lowered. The concurrent physical deterioration eventuates in a state of cachexia, and death usually results from heart failure, septicæmia or tuberculosis.

Diagnosis.—When the patient or his friends furnish a correct history a diagnosis is easy. When, however, no history is given or is deliberately falsified, as is often the case, a diagnosis is of extreme difficulty. An account of changes in character, temper and general condition occurring at short intervals of time, with periods of well-being associated with contraction of the pupils, is suggestive, and the diagnosis may be regarded as certain if the marks of the needle are also present. A definite diagnosis may also be established by isolating the patient for twenty-four hours, and at the same time preventing access to the drug.

Prognosis.—A morphinomaniac persisting in his habit and in no way controlled by external forces is on the high road to death, his rate of progress depending on the vigour of his constitution, the amount of the drug consumed and his financial circumstances. One initially feeble in physique and badly circumstanced will probably die in a few years, whereas one of good constitution and living in comfortable surroundings may last for many years. In the case of those who voluntarily or forcibly come under treatment, and are permanently weaned from the drug, the prospect of health and life is almost as good as if they had never had the habit. Unhappily, in the majority of cases, even though treatment has succeeded in breaking the habit, and raising the patient's health to a high level, relapse sooner or later occurs, and the custom becomes rapidly re-established.

Treatment.—Unless the patient consents to reside in a special house of treatment, to obey the instructions of the physician and submit to a régime for a period of several months, treatment is practically of no value. It is essential that it should be impossible for the patient to obtain the drug, and in consequence the choice of trustworthy attendants is of the greatest importance. On admission, the patient should take a bath, his clothes should be removed and with his other belongings carefully searched. A watch should be kept on everything sent to him from the outside world, and it is as well to explain at the outset that all letters and parcels will be examined.

The treatment of morphinomania consists essentially in the withdrawal of the drug. Abrupt withdrawal is dangerous and may result in collapse or death, while the attendant suffering is intense. The method of withdrawal most usually adopted is gradually to diminish the amount taken, the rate of diminution depending upon the general condition of the patient and the amount of morphine he has been accustomed to consume. The process of suppression may last a fortnight. On the first day, the dose given is diminished by one-fourteenth of the patient's maximum dose, and on each succeeding day the dose is further diminished by the same amount. In this way at the end of the fortnight no morphine will be given. The patient should be kept in bed while the withdrawal is taking place, and for at least one week after the drug has been suppressed. His mental depression and anxiety

and physical distress may be largely controlled and alleviated by the administration of such sedatives as the bromides, grs. x–xx, 6tis; hyoscine hydrobromide, gr. $\frac{1}{200}$–$\frac{1}{100}$, once or twice a day hypodermically or by the mouth; amylene hydrate, ℥xxx–℥iss, or paraldehyde, ʒss–ʒij. The doses of these drugs will in all probability have to be large to produce the desired effect, and a careful watch must be kept upon the action of the heart to prevent its undue depression. Heart failure must be met with the usual remedies. Food of good quality and in large quantity should be given. As dyspeptic symptoms are common, the details of diet may have to be carefully laid down. The bowels should be freely opened with suitable aperients or enemata, to eliminate the accumulated drug. As the symptoms attending abstinence abate, the patient may be very gradually returned to a normal course of life, and every means should be taken to improve the appetite, increase the body weight and diminish anæmia. A course of suggestion under hypnosis, to fortify the patient's resolution to avoid the drug in the future, should be instituted.

The Cocaine Habit

This habit is generally consequent upon the medicinal use of the drug, and has been known to begin with its employment in the cure of the morphinomaniac. It may be taken by hypodermic injection or in the form of snuff or lozenges, and the daily dose has been known to reach as much as 40 grains.

Symptoms.—The symptoms are like those of the morphine habit, and a dose is followed by similar feelings of well-being and self-satisfaction. The pleasant effects last a shorter time than those of morphine, and are succeeded by physical prostration and mental depression. Sometimes the symptoms are like those of acute intoxication by alcohol. After a varying time, the patient commences to suffer from weakness, loss of appetite, nausea and other dyspeptic symptoms, tremulousness, paræsthesiæ, hallucinations and delusions. Hallucinations are often connected with the skin, and the patient feels that he is infested with insects or small crawling animals. The delusions are frequently of persecution and conduce to dangerous reactions of conduct. Confusional states, agitation and heart failure result from chronic cocaine intoxication. The habit is even more degrading, both physically and mentally, and more difficult to break than the morphine habit.

Treatment is the same as for Morphinomania.

The Veronal Habit

Veronal taken habitually in large doses and at frequent intervals, uncontrolled by medical supervision, is apt to eventuate in dyspepsia, cardiac weakness, pulmonary congestion, cutaneous rashes, polyuria or suppression of urine, hæmaturia and albuminuria. Its effect on the mind is to produce a state of obfuscation which may amount to confusion, with disorientation, general mental debility, depression, transitory and varying delusions and hallucinations. Treatment consists in gradual withdrawal, during which the heart must be most carefully watched. Other hypnotics may have to be given during withdrawal, and their administration should be kept most strictly in the hands of the medical attendant.

The Chloral Habit

Symptoms.—The symptoms of this habit have their chief incidence upon the cardio-vascular and gastro-intestinal systems. The powers of the mind gradually deteriorate, but more marked mental symptoms rarely occur.

The **Treatment** is as for Morphinomania.

The Ether Habit

The desire for this drug does not equal in intensity that for morphine or cocaine. The symptoms and treatment are similar to those of alcoholic intoxication.

MENTAL SYMPTOMS OF PELLAGRA

Symptoms.—Mental symptoms are of a confusional character, and would appear to indicate intoxication or exhaustion. The onset is slow, and insomnia is the first symptom which attracts notice. The patient gradually loses his memory, gets muddled in mind, more and more disorientated, and eventually so befogged as to become stuporose. Hallucinations and delusions may develop and, according to their character, may result in reactions of excitement or depression. The attacks of mental symptoms tend to pass off with treatment by rest, nourishment, and sleep; but the patient often relapses when he returns to his usual surroundings, work and food.

Course.—The course is slow. The mental level tends to become lower with each exacerbation of symptoms, and eventually dementia is established.

Treatment.—It is desirable that the patient should be removed from the locality in which he has become infected. Hexamine, mercury and arsenic may be administered, the last in the form of liquor arsenicalis, atoxyl or salvarsan. General hygienic measures are important. Deficiency in vitamin and protein intake has been suggested as the cause of pellagra, and particular attention should be paid to the adequacy of these substances in the diet.

INTRACRANIAL TUMOURS, GRANULOMATA AND ANEURYSM

The mental symptoms are those of confusion, somnolence and stupor. There may also be hallucinations of the various senses and delusions of rather vague character. Mental symptoms are more likely to occur when the neoplasm is situated in or near the frontal lobes of the cerebrum.

If there is any suspicion that the tumour is a syphilitic granuloma, anti-syphilitic measures should be taken. In other cases, the question of operation may be mooted. Operation may be undertaken only for the relief of pressure and consequent pain and blindness, or it may be radical in the hope of removal. If mental symptoms are present the lesser operation is the preferable.

SYPHILIS AND MENTAL DISORDER

In the secondary stages of syphilis there may be, as in any acute infective state, symptoms, more or less severe, of confusional insanity. Acute delirium, of varying duration, with hallucinations, agitation and restlessness may occur,

or melancholic anxiety and perhaps stupor. In syphilitic cachexia there may also occur, as in states of exhaustion, whether due to acute or chronic illness or to overwork and worry, the symptoms of confusional insanity. General paralysis of the insane is now universally admitted to be of syphilitic origin. Idiocy and juvenile general paralysis are the mental diseases associated with congenital syphilis. Patients with tabes dorsalis sometimes present mental symptoms. Some such are probably cases of general paralysis, while others are cases of confusional insanity and due to exhaustion.

Besides these mental disorders due to the virus of syphilis there are others not due to it, but based upon ideas about syphilis. Some persons have an abnormal fear of catching the disorder, perhaps by some extraordinary mode of chance contagion, while others, having had it, have abnormally acute fears as to its consequences. Such persons are often psychasthenic, ill-balanced or degenerate, and their fears on the subject of syphilis may be combined with or may alternate with abnormal fears on other subjects.

MENTAL SEQUELÆ OF ENCEPHALITIS LETHARGICA

The mental sequelæ of encephalitis lethargica are very varied. Some consist merely in the patient's mental level being a little lower than before the attack. Beyond this comparatively trivial alteration are many gradations of severity right down to such defect as amounts to imbecility. In addition to defect there may be more definite symptoms reminiscent of other mental syndromes. Mental symptoms may occur during the original attack (see p. 148) and be indefinitely continued when it has subsided; or they may appear after a period of days, months or even years of seeming good health. The most common of the symptoms is apathy, associated with disinclination for any activity. The apathy may be accompanied by drowsiness and prolonged periods of sleep. In some cases uncontrollable sleep during the day alternates with complete wakefulness at night. Automatism occasionally develops.

The patient's disposition may become altered, and there may be such a diminution of the affections as strongly to suggest dementia præcox. Or the patient may be irritable and anxious and develop various phobias. Among the most striking and pitiable symptoms are extraordinary perversions of character, the patient becoming untrustworthy, uncontrolled and depraved. A few cases pass into a state of euphoria and even exaltation. Maniacal and melancholic symptoms may occur. In other cases symptoms suggest an exhaustion neurosis or psychosis. Attention and memory, for both recent and remote events, become enfeebled. Confusion, hallucinations, delusions and violent conduct may follow.

Where there is feeble-mindedness the defect may be of an all-round character, but may have a special tendency to be irregular in its incidence upon intelligence.

The prognosis as to the mental sequelæ of encephalitis lethargica is grave, but some cases ameliorate and some few get quite well.

MENTAL DISORDERS ASSOCIATED WITH EPILEPSY

Ætiology.—A history of fits, major or minor, is not always to be found in the family or personal histories of epileptic insanity. It is scarcely, how-

ever, to be doubted that the episodic mental disorders ascribed to epilepsy are due to the same exciting cause as are fits, whether major, minor or visceral. On this part of the subject therefore the chapter on Epilepsy should be perused.

Symptoms.—The symptoms of epilepsy, so far as they are mental, may be divided into two groups: one comprising episodic attacks, analogous to somatic fits, which pass under the term "psychic equivalents," and another which may be characteristic of the entire mental life of the epileptic individual. It is to this latter group that reference will first be made.

The symptoms here to be described do not occur in all cases. Many who suffer from epilepsy present no mental symptoms at any time in their lives, are of normal attainments and indeed sometimes of exceptional ability. On the other hand, varying degrees of mental defect are very common. The patient may be but very slightly below the average level, or an idiot incapable of the most rudimentary education, or at some degree between these states. Whatever the intellectual level (provided it be sufficiently high to admit of manifestations of character), egoism, self-importance and idleness are likely to be much in evidence. At a low level of intelligence this may not be of much importance, since the patient is likely to be always under control, but at higher levels, when he is considered to be capable of living an ordinary life in society, such qualities may prove injurious both to himself and to others. In a yet more pronounced variety these features of the epileptic's mental make-up result in alcoholism and crime or form the basis of various sorts of insanity. Such symptoms may persist throughout a patient's life without a declension of mentality; but, on the other hand, it often happens that a patient starting at a low level descends to those yet lower, or starting at a normal or high level gradually descends until almost all sign of intellectual life is extinguished. This process may be observed both when the patient has suffered from somatic symptoms, or from psychic symptoms alone or from the two sorts conjoined. The symptoms are of most gradual approach, and the mental enfeeblement is at first disclosed by a deterioration of the higher functions and diminished restraint over the lower. Patients become yet more selfish and sly and less amenable to healthy suggestions. They become gluttonous, and may be guilty of various sorts of sexual crime. Such mental accomplishments as may have been acquired are lost, and the tendency is towards a state of complete dementia in which nothing is left of the higher faculties, and existence is one in which vital functions continue to be automatically performed but all signs of mental activity are absent.

Episodic mental symptoms may be associated with, or occur independently of, the somatic symptoms. Those occurring in association with fits may precede, be concurrent with, or follow them. The aura of a fit may sometimes be mental. Hallucinations of special senses are not infrequent and may be of definite sights, sounds, smells or tastes, or, most commonly, of quite vague and ill-defined sensations of either the special senses or of the so-called common sensibility of the body in general or of some special part of it. Another mental change sometimes to be noticed is some degree of alteration in the patient's character. Excitement, depression, obfuscation, obstinacy, or a fear of impending calamity may be the recognised heralds of an attack and as such may be of importance. The mental symptoms occur-

ring during an attack can scarcely be marked, seeing that the patient is unconscious in a vast majority of cases. Nevertheless, some patients affirm they have preserved some degree of awareness of their surroundings, accompanied by a feeling of overwhelming horror. It is quite likely patients miscalculate the time of the occurrence of such symptoms, and that they, in fact, experienced them just as consciousness was being lost or regained. However this may be, there is no evidence that such feelings eventuate in any sort of conduct during the convulsive stage of the attack. After an attack is over, a state of mental confusion is very common. In some patients the confusion only amounts to a muddled feeling, while in others the disorientation is so complete, that persons and things are not recognised, and the patient may even appear to be living amidst illusory or hallucinatory sights and sounds. In some cases the reactions resulting from this state of affairs may be very violent or, on the other hand, orderly and quiet, but absurd and wholly unconnected with the normal course of the patient's life.

Alternating with somatic fits there occur in some persons groups of mental symptoms, called psychic equivalents, which are regarded as of similar causation. In other persons similar groups of symptoms occur without any sort of bodily seizure and are regarded as due to epilepsy, because they resemble the group of mental symptoms met with in those who have, or in the past have had, somatic attacks. Symptoms, whether alternating or isolated, come on with great rapidity. The patient rapidly becomes confused and disorientated in time and space, and the void thus left may be filled with hallucinations of all sorts, some vague and some quite clear and well defined. The capacity for healthy judgment is diminished, and under the influence of the hallucinations perversions of judgment, or delusions, develop. Such delusions may be of a depressed, hypochondriacal, grandiose or persecutory character. The conduct of one whose mental capacity is diminished and who is suffering from hallucinations and delusions, necessarily differs from the normal, and in the case of the epileptic is often extremely violent. So suddenly are acts of violence committed and of so extreme a nature that such patients are among the most dangerous of insane persons. Epileptic mental symptoms develop with great rapidity, last but a short time, varying from a few hours to a few days, and quickly pass off. With the attack there may be tremors of the tongue, face and hands, some disorder of speech and an unsteady gait. When an attack has passed off the memory of events which have occurred during it is extremely hazy, or oftener there is none at all. In a few cases of epilepsy a condition of automatism occurs, the patient suddenly commencing a line of conduct different from that habitual to him, following it for a time, and then suddenly resuming his usual life, wholly unaware of what he has been doing. This period of alienation of the patient from his habitual self may last for a few hours only or may be prolonged for months, and during it the patient may perform acts which are absurd, improper or criminal.

Treatment.—The hygienic, dietetic and drug treatment of the mental symptoms of epilepsy is similar to that for the somatic forms of the disorder. When the mental symptoms are those of extreme excitement care at an asylum is almost inevitable, but it must be remembered that such patients often rapidly recover and may be well again by the time they reach the asylum door. Further, bearing in mind the impulsive violence of the symptoms,

ample provision should be made to prevent the patient from attempting to do any harm.

MELANCHOLIA

Definition.—Melancholia is the term applied to an abnormal mental state whose outstanding feature is the misery of the patient, shown by his facial expression, speech, attitude and movements.

Ætiology.—A family history of mental disorder is not uncommon. In the individual, melancholia is often preceded by disappointment, overwork, worry and some variety of bodily ill-health. Its incidence is chiefly upon the retiring, sensitive and conscientious. Affection denied expression, owing to loss of its object or to lack of opportunity, may in some persons turn itself in upon itself and, identifying itself with the external agent of its disappointment, take the blame and inflict punishment. Hence ideas of disease, ruin and damnation. Many of the symptoms suggest chronic intoxication, the poison perhaps being elaborated in the gastro-intestinal tract. It most commonly occurs in the fourth, fifth and sixth decades. Symptoms often appear at the menopause in women and in the fifth and sixth decades in men, and have suggested the term "involution psychosis."

Pathology.—Alteration in the cells of the cortex has been described by some, and the appearances of slight meningo-encephalitis by others. These morbid changes are not, however, constant. In cases lasting many years, wasting and other degenerative changes in the brain are often found.

Symptoms.—There are four marked clinical types of melancholia: (1) simple melancholia; (2) melancholia with delusions; (3) melancholia with agitation; (4) melancholia with stupor.

Simple Melancholia

Before the illness has shown definite mental symptoms it may have been noticed that the patient's appetite has been very poor, his tongue furred and his breath foul. His weight may have diminished, and he may have complained of dyspepsia and constipation. With these symptoms there may be a feeling of diminished power for work, of attention and will, with vague præcordial and epigastric distress and apprehensiveness. Later, this develops into fearfulness as to the correctness of his own conduct, the state of his health, the condition of his monetary fortune and his social status, or the welfare of relations and friends. He experiences profound and unwarranted sadness about some particular thing or about things in general, and he cannot detach his mind from this line of thought. He often complains he does not see things as he did before, and they seem strange and different. Perhaps his viscera betray their presence by unpleasant sensations: his brain feels turned to lead or his heart as if it were stopping or his intestines abnormally mobile. He cannot think as he did: he does not feel appreciative of friends or affectionate towards relations, his interest in them is diminished or lost. His features are drawn and his expression one of misery. In some cases, the inner ends of the eyebrows are lowered and approximated while the outer are raised. The attitude is one of general flexion, the head bowed, the arms held to the sides and the elbows, wrists

and knees flexed. He adopts a crouching position, like a dog about to be whipped, suggesting an attempt to occupy the smallest possible space. Patients creep, as it were, away from others and into themselves to avoid the shafts of mental and physical misery. Speech is monotonous in tone and matter, the patient reiterating sentences expressing his fears. Such symptoms denote some defect in that faculty of receiving and co-ordinating impressions, internal and external, which in usual circumstances conveys to us the feeling that all is well with our bodies and is known as Kœnæsthesia.

So absorbed may the patient become in his misery that any activity becomes impossible. He does not get up, dress, eat, go to stool or to bed unless assisted or even compelled. Refusal of food is a very troublesome symptom and a very common one. It may be due merely to want of appetite or to some delusion, for instance that the food is poisoned, or he may think he is so impecunious that he cannot afford to pay for what he takes, or he may hold he is unworthy to have food, or he may wish to kill himself by starvation. A suicidal tendency is very common and for purposes of treatment should be held to be present in every case of melancholia. Some patients though wishful to kill themselves cannot, from want of power of will, make the necessary effort; or if it be made, it is half-hearted and not carried to a conclusion. On the other hand, some ponder the details of a more or less elaborate scheme and watch for an opportunity to carry it into effect. Other patients act on the impulse of the moment, not having previously paid much attention to the matter. Self-mutilation is sometimes inflicted. Patients have been known to gouge out their eyes or amputate the genital organs, perhaps as punishment for sins of which they accuse themselves and perhaps from impulse. Homicide is uncommon, but it occasionally happens that, for example, the father of a family kills his wife and children to save them from the effects of some disaster he believes to be impending.

Physical symptoms are numerous. The tongue is generally thickly coated and often dry. The breath is foul. Flatulence is common and constipation the almost invariable rule. Not infrequently the complexion has a slightly icteric tinge, which presumably gave its name to the disease. The gastric juice has been found to be hypertoxic.

The pulse is often slow. It is apt to be very variable in the same patient, sometimes being normal in rate, sometimes too rapid and sometimes too slow. Blood-pressure also varies: it is often higher than might be expected. The extremities are frequently cold and clammy; occasionally purple and œdematous. The blood shows changes of a chlorotic type. The respiration rate is slow and the range of the respiratory excursion diminished. The urine contains a smaller amount of solid matter than normal, and has been found to be hypertoxic. In the female, the catamenia are often suppressed, or at least are very scanty and irregular in time. The sensitiveness of the skin appears to be diminished, and definite areas of anæsthesia and analgesia of so-called functional distribution have been described. The great difficulty of determining degrees of cutaneous sensibility in mental patients has to be borne in mind, and results sometimes vary from day to day. Reflexes are usually sluggish. Muscular force seems to be diminished and a faint tremor may often be observed. The temperature is frequently subnormal. The skin and hair are dry and the latter also brittle.

Melancholia with Delusions

On such clinical phenomena as these may be superimposed delusions. The illness commences, as does simple melancholia, with weariness, irritability, insomnia and vague general uneasiness. These symptoms are followed by fears of some impending evil, disgust at the world or at self, and by sentiments of unworthiness and remorse. The patient carefully examines his past life and not infrequently fastens upon some moral lapse or even upon some absurd peccadillo of childhood as the sin for which he is forsaken by God, is damned, has had his soul destroyed, or for which he is about to be imprisoned, tortured and executed. In other cases, the delusions are of financial ruin and loss of social position. Kœnæsthesia may be so diminished that the patient feels as if some part of his body were lost or converted into some lifeless material, or indeed that he is wholly dead. He may suffer from kœnæsthetic paræsthesiæ and believe his body is occupied by some animal or devil, or he is turning into an animal. When the delusions become fixed and systematised, as they sometimes do, the disorder resembles delusional insanity. In this state delusions of a most depressing character may coexist with an affective state of comparative cheerfulness, and the patient talks placidly and even with gusto of his miserable condition.

Melancholia with Agitation

In certain cases of melancholia the reactions of intense grief and of despair are a most marked characteristic. The patient is quite obviously most anxious and agitated. His face expresses terror. There is a monotonous reiteration of gestures of despair and anguish. He groans, exclaims, complains, wrings his hands, twists his fingers and perhaps tears his clothes, plucks out his hair or even rolls on the floor in the extremity of his mental pain. The pulse is usually accelerated.

Melancholia with Stupor

A very different picture is presented in melancholia with stupor. In this variety there seems to be so entire an absorption in misery that the patient is prevented from movement and paralysed with sorrow or terror. Words seem to make no impression upon him and he appears lost to the world. The face is fixed in an expression of pain and the body generally is inert and immobile. Limbs may be moved by a bystander and tend to remain in the position imposed upon them. The patient does nothing to help himself and is often quite incontinent. The pulse is slow and the extremities cold. Anæsthesia and analgesia are usually present, or at any rate no expression of feeling can be excited by the application of a painful or other stimulus. In the midst of this stuporose inaction there are occasional impulsive outbreaks, as though for a moment the inertia were overcome by an imperative call to action.

Course.—The course of melancholia runs from a few weeks to a year or eighteen months and in some cases to several years. Oscillations in severity in chronic melancholia are not uncommon, and among female patients exacerbations coincide with the catamenial periods, or if these be suppressed with

the times when they would have occurred. Melancholia with agitation is of more rapid onset than the other varieties and shows a greater tendency to chronicity. Melancholia with stupor presents a slower march of symptoms at the onset and is generally of longer duration. More especially in this form, but occasionally also in the others, there occurs a progressive mental enfeeblement and the patient is sooner or later reduced to dementia. Death may occur from starvation, auto-mutilation or suicide, but this is unusual when the patient is under care, and the majority of such cases occur among those whose disorder has passed unnoticed or has been misinterpreted.

Prognosis.—Most cases of melancholia end in recovery, but the prognosis is distinctly less good when the patient is over fifty.

Treatment.—The primary rule in the treatment of the depressed is to take measures to keep them alive. Firstly, they must be constantly and assiduously watched to prevent suicide. The various modes of self-inflicted death by precipitation from heights, cutting instruments of all descriptions, drowning, strangulation, poisoning, suffocation or starvation have to be carefully anticipated and averted. Secondly, the patients must be fed. A depressed patient never takes a sufficiency of food if left to himself, and one of the most exacting duties of a nurse consists in persuading the patient to eat. In most cases, where time permits, this may be done by moral persuasion. If this fail it may be necessary to spoon the food into the patient's mouth, but in cases where the patient will not open his mouth or swallow his food even when placed there, tube-feeding becomes necessary. A large tube passed through the mouth necessitates the use of a gag, which on introduction is apt to chip or to dislocate the teeth if, as may be necessary, force be required. It has the advantage of transmitting coarser food more easily than does the nasal tube, and is less apt to get choked. A well-lubricated nasal tube of smaller calibre passed through the nose is the more usual method. It occasionally finds its way into the larynx, and care should be taken this is not the case before food is passed down it. If the tube be in the larynx the patient coughs and chokes; it should then be partially withdrawn and repassed. The food should consist of milk, 4 pints during the day, and with it as a vehicle, well-beaten eggs, malt extract, somatose, Benger's food, sugar, cream and such other foodstuffs of good nutritive value as will pass the tube. Drugs may be given at the same time. Constipation has to be overcome by aperients or by enemata. Hypnotics may be given for sleeplessness, and careful observations should be instituted to discover the dose and time of administration most suitable for the particular patient. Opium is sometimes of value, and is especially so in melancholia with agitation. The initial dose should be 5 minims of the tinct. opii given every six hours. This is increased by 2 minims until 20 minims are given four times a day. The dosage is then gradually diminished, according to the character of the symptoms, and ultimately stopped. It is desirable that the patient should not know he is taking drugs, as this knowledge may induce delusions of poisoning or lead to endless and pointless controversy with physician and nurses as to their supposed effects. Patients should be confined to bed, preferably in the open air, until they have made very substantial physical progress as indicated by the weight, the pulse-rate, the temperature and the character of the facial expression and complexion. They should then only gradually be promoted to a sofa

and to a little gentle exercise, the amount being regulated by the effect on the mental and physical symptoms. Warm baths are sometimes soothing and promote sleep. It is to be carefully borne in mind that on recovery patients usually remember the details of their illness and of the conduct of those by whom they have been tended. The patient should be removed from the influences of home surroundings and of relations and friends, as they are almost always bad. Whether certification is to be advised or not should depend for the most part on the financial resources of the patient and his friends, and the possibility of providing suitable accommodation and a sufficiency of skilled attendants.

MANIA

Definition.—Mania is the term applied to a mental condition in which there is intense excitement, emotional instability and motor activity.

Ætiology.—A family history of mental or nervous disorder is frequent. The affection is chiefly one of early adult and early middle age. Infections, intoxications, emotional stress, worry and overwork have been regarded as causes. It is, however, likely such cases have in fact been rather of the nature of acute confusional insanity and will pass in the future into that category.

Mania tends to recur in the same individual; the abnormal influences which immediately precede an attack are not known.

Pathology.—In most cases of acute mania which come to autopsy nothing abnormal has been found. In some a slight general hyperæmia has been described and in others such degenerative changes as chromatolysis and fatty and pigmentary deposits in the cortical cells. In old cases of chronic mania thickening of the meninges and shrinking and sclerosis of the convolutions may be found.

Symptoms.—Before the symptoms of mental disorder make their appearance the patient may for some days suffer from lassitude, insomnia, headache, irritability, loss of appetite and constipation, or, on the other hand, maniacal symptoms may arise with great rapidity without warning. In the first case the subjective symptoms give place after a few days to feelings of exhilaration and well-being. The patient becomes talkative and abnormally active both at business and at pleasure. Ideas seem to arise and pass through his mind with extraordinary celerity. The attention is easily attracted and with difficulty held. The memory is enhanced and various present circumstances recall things long forgotten. Ideas are not curbed and directed by the will and that particular form of it called the attention, but follow the line of the automatic associations. It is difficult to understand the connection between the ideas expressed by the patient in speech, and this leads to an impression of complete incoherence. If, however, the ideas be analysed it will be found that there is some relationship between them, not, it is true, such as is regarded as important in health, but connections formed by the similarity of the sound of words, chance recollections of the patient and the influence of ordinarily unconsidered and trifling events going on at the moment. The emotions are very unstable and unrestrained. The patient may be gay, affable and friendly even with those whom in health he would repel. With members of the other sex he is likely rapidly to become amorous.

If his friendliness and love be excessive, so too is his dislike and hatred. With but slight or no provocation he will become abusive, threatening and violent. The emotions are also liable to sudden alteration, and changes from effusive friendliness to extreme anger and the reverse are very striking and characteristic. Egoism and vanity are pronounced. The patient feels himself capable of anything and propounds schemes and inventions of every description and on the most extravagant scale. Restlessness is extreme and the patient is perpetually up and doing. He appears to lose all sense of fatigue and his muscular power seems increased, though sooner or later he will look tired, drawn and haggard. He is incessantly talking and laughing or perhaps singing and shouting. His actions are impulsive and without suicidal intent, though he may bring about his death by some impulsive act. He may throw things about and be destructive of property and dangerous to those around. The patient's dress is usually disordered and in the case of women the disregard of appearance and even of decency is striking. The eyes are bright, the hair often on end, and the expression of the features perpetually altering.

Hallucinations are of rare occurrence and delusions are fleeting and without any systematisation.

The pulse and respiration rates are increased, the former ranging between 90 and 120. In a few cases the temperature is slightly elevated. The appetite, if the patient find time amid his many activities to think of food, is voracious. Constipation is the rule, genital excitement quite common. Among women the menstrual flux is diminished or absent. The secretion of sweat and saliva is increased. Weight is lost, the loss often occurring before the appearance of mental symptoms. Sleep is probably absent or at best very inadequate.

Course.—The course is very variable and ranges from a few days to a year or two, in most cases ending in recovery. Exacerbations and remissions are usual. The symptoms may by degrees abate or terminate as rapidly as they began; or the remissions may gradually become shorter and less severe.

When a mania is about to become chronic the physical state improves, the weight increases, sleep is restored and in women the regularity of menstruation becomes established. There is, in addition, abatement of the mental symptoms, although some degree of confusion may occur, perhaps as evidence of oncoming dementia. In some chronic cases the evanescent delusions of the acute stage tend to become fixed and rather more systematised. The course of subacute mania is similar to that of the acute form but shorter.

Prognosis.—The chances of recovery are best in the first six months, and gradually diminish up to about 2 years; after that amount of time recovery is unlikely.

A variety of mania commonly described is the subacute form or hypomania. The symptoms are similar to those of acute mania but less marked. Imagination is very active. Business, social, scientific or political projects are rapidly developed, much talked of and occur in swift succession. The schemes are of a sweeping character, of large scope and often clever, though generally vitiated by some absurd impracticability which escapes the notice of the patient. His conversation has often a certain brilliance, in part due to the unusual activity of his imagination, in part to the exuberance of his repro-

ductive memory, whereby all sorts of matters long forgotten surge into consciousness, and in part to the absence of that restraint which normally checks the expression of a large proportion of a conversationalist's ideas. Egotism is accentuated. Sensuality is increased and the patient often drinks to excess.

Treatment.—The patient should be isolated, by preference away from home, relations and friends. Efficient means must be taken to prevent him harming himself or others, or making himself a nuisance or ridiculous in public. Bed is the best place for him, and a good nurse will often persuade a patient who at first resolutely declines to go there at all to stay in bed. The bed should, if possible, be in the open air, or at least the room should be thoroughly ventilated, as vitiated air leads to an increase of the patient's excitement. There is usually no difficulty in getting the patient to take food. It should, however, be minced, as bolting the food is common. Prolonged warm baths are sedative. Hypnotic and sedative drugs should be tried one after the other in varying doses, and at different times, till some one is found to produce the desired effect. In certain cases drugs fail altogether. The patient's bowels must receive careful attention and an initial dose of calomel is often desirable.

The patient should be kept in bed until the symptoms of excitement have subsided; 3 months or more are not too much. The time he is at first allowed up should be very short and only gradually increased. An accelerated pulse-rate is a marked indication the patient has been up too long. The resumption of other activities should be gradual and a return to home and the ordinary duties of life only allowed after several months have elapsed since the mental symptoms disappeared.

MANIACAL-DEPRESSIVE INSANITY; CYCLOTHYMIA

There are patients who time after time have attacks of mania or of melancholia, that is, who suffer from periodic insanity. There are others who periodically suffer from mania followed by melancholia or vice versa. In some cases the mania is followed immediately and without break by the melancholia, and in others there is a time of complete health between the two. To those cases where there is no interval between them, and the melancholia is again followed forthwith by mania and this by melancholia in indefinite succession, the term circular insanity has been applied.

So intimate has seemed to some the bond between melancholia and mania that they have denied that the one exists without the other and have asserted that the one is either always followed by the other, with or without interval, or the symptoms of the two are invariably mingled. Both phases are held to be disorders of the affections and to be characterised by defect of some of the higher functions, of those of will, attention and judgment and by the predominance over these of lower level automatic associations.

There are probably but few cases of mania in which, notwithstanding the general feeling of mental and physical exhilaration experienced by the patient, he has not moments of depression indicated by his expression of face or by something he says or does. The occurrence of these evidences of depression has been taken to support the hypothesis of the identity of mania with maniacal-depressive insanity. Moments of exhilaration during melancholia are very rare, while the excitement of depression takes the form of

agitation and suggests a stage of misery even more acute than that of passive suffering.

Ætiology.—A history of heredity of the same disorder or of other mental or nervous affections is common. Maniacal-depressive insanity commences as a rule between 20 and 30 years of age and is rather more frequent in the female than in the male sex. It has been suggested that attacks begin as the consequence of the summation of toxæmic states in a manner analogous to the process which not improbably exists in epilepsy. Other investigators have found reason to suppose maniacal and melancholic attacks to be caused by inadequate nitrogenous excretion. Various other occasional circumstances, such as worry or other emotional stress or states of physical ill-health, have been suggested as having causative relations with the attacks.

Pathology.—No anatomical alterations have constantly been found. Degenerative cortical cellular changes have been described.

Symptoms.—The symptoms of the melancholic phase of maniacal-depressive insanity are those described under Melancholia and the symptoms of the maniacal phase those under Mania.

Course.—When one set of symptoms passes into the other the transition is usually a very gradual one; the symptoms of the mania or melancholia gradually diminish and the symptoms of the next phase gradually develop. Between the phases there may be a normal interval of very varying length; on the other hand, in a few cases, the transition is abrupt. The attacks may last for days or for years, but as a rule extend over a few months. The intervening periods are also very variable and range from days to years. After each attack it may be noticed in many cases that the mental level of the patient is inferior to what it was; on the other hand, no alteration may be apparent. Some cases become chronic in one or other phase. Beginning in early adult age, attacks may recur throughout life; on the other hand, they may cease and the patient remain free from them.

Treatment.—The individual of insane inheritance should be carefully directed to live a particularly hygienic life and so far as possible to avoid the numerous physical and mental stresses which are likely to result in a lowered health standard. The patient who has had an attack should be even more careful, and his weight, general nutrition, appetite, the condition of his bowels and of his sleep should all receive attention. The treatment of the attacks is similar to that set forth in the sections on Mania and Melancholia.

STUPOR

A condition in which for periods varying from days to months there is an absence of the usual signs that the mind is at work. The patient is irresponsive, expressionless, unoccupied and mute, and in some cases so inert that he lies for an indefinite time in any position in which he has been put. Stupor occurs in association with the toxic and exhaustion confusional psychoses, manic-depressive insanity, dementia præcox, epilepsy, general paralysis of the insane, and acute alcoholic and lead poisoning.

CHRONIC HALLUCINATORY PSYCHOSIS

In some persons hallucinations, generally of hearing, but occasionally also of sight and cutaneous sensation, occur as the essential or only symptoms, and last for many years. In time a patient may become so exhausted by being harassed by the hallucinations, or confused by the trains of thought consequent upon them, that secondary symptoms may develop.

MENTAL DISORDERS ASSOCIATED WITH DISEASE OF THE THYROID AND OTHER GLANDS

Myxœdema

Symptoms.—The somatic symptoms are elsewhere described. Mentally, the chief symptom is the torpidity of the mental processes. Perceptions, thoughts, feelings and the reactions to these in conduct, all seem prolonged, and this suggests a degree of hebetude out of proportion to the actual loss of power. In many cases there is, however, some clouding of the faculties and apathy. In a few cases there may be present the symptoms of confusional insanity with agitation, hallucinations and fleeting delusions. If left to itself, myxœdema terminates in advanced mental enfeeblement and somatic cachexia.

Treatment.—Treatment by the administration of a preparation of thyroid gland should be used as in cases of myxœdema without marked mental symptoms. It is as well to begin with small doses and gradually increase them, the guide being the pulse-rate, which should be a little in advance of the normal.

Exophthalmic Goitre

Symptoms.—Emotional instability is the marked mental characteristic. The patient has an appearance of terror, anger, or both, and is, in fact, irritable, worrying and anxious. Sleep is often bad. Hysteriform functional symptoms may occur from time to time. In some instances mental symptoms of confusional insanity with a variety of hallucinations and fleeting delusions, mania or melancholia, especially of the anxious type, may be encountered. Such symptoms last but a few days or weeks and rarely become chronic. There are cases in which, in the absence of physical signs, such as enlargement of the thyroid and exophthalmos, the cardio-vascular and nervous symptoms of Graves' disease are present. We are not yet in a position to affirm that the syndrome is essentially the same as that of exophthalmic goitre, and it is premature to assign it either to the group of the sympathoses or to hyperthyroidism.

Treatment.—Careful attention to general nutrition is of great importance, and both on account of cardiac and nervous symptoms exertion should be limited. Patients are almost always anæmic and emaciated, and with the rectification of these symptoms by a good dietary, containing plenty of milk,

malt and cod-liver oil, tonics and rest and fresh air, considerable improvement may result. The serum and milk of dethyroidised goats is perhaps occasionally of service. Surgical operations with excision of part of the thyroid or tying of its arteries are sometimes useful. Carefully regulated doses of X-rays applied over the gland are often followed by excellent results. Symptoms often occur in those who are anxious, and an investigation of the mental state, with an attempt to abolish or diminish the causes contributing to anxiety, may be cautiously attempted.

Pituitary Gland

Besides the somatic symptoms of acromegaly, gigantism and alteration in sugar excretion associated with changes in various parts of this gland, mental symptoms of confusion and melancholia, with or without delusions, have been observed.

Suprarenal and Genital Glands

As well as the symptoms of Addison's disease, there may be mental symptoms of torpor, abulia, inertia and depression. Absence of the testicles in the male or impairment of their functions at the beginning of life results in certain well-known characteristics physical and mental. It is probable the same sort of change occurs in the female, but in her case the difficulty lies in knowing when the defect really exists. The eunuch does not exhibit positive feminine traits of character, but fails in complete masculine development. The same seems to be the case in the female. Human beings without sexual glands, whether they be called male or female, are, as far as generalisation may be permitted, of similar character. Changes of bodily and mental characteristics after castration in adult life are less marked, but such as they are tend to take place in a similar direction. The effect of genital glands on nervous and mental states may, perhaps, be seen in the evidence advanced by some of the effect of testicular and ovarian substances in the treatment of various functional disorders. It at least seems not improbable that such effects are seen in their biological aspect at puberty and at the climacteric.

DISORDERS ASSOCIATED WITH THE SEXUAL LIFE; EPOCHAL INSANITY

Epochal insanity, as here described, has reference to mental disorders whose incidence is specially noticeable at certain times of life, the time of puberty, menstruation or at the climacteric. The symptoms of such insanities are for the most part fundamentally those of syndromes elsewhere described, such, for instance, as confusional insanity, mania or delusional insanity.

Puberty

Definition.—Puberty or the time of most noticeable development of sexuality, in its primary and secondary characteristics of elementary somatic appetite and mental alteration, extends over a period of some years, roughly

between 12 and 20 years of age. In some persons the process appears to begin earlier and in some later. In some the evolution is so slow as to be scarcely noticeable, and in others it is rapid. In some the accretion of fresh feelings and ideas scarcely alters the general character of the individual, in others it transforms it into something quite different from what it was before.

Ætiology.—A history of mental and nervous ill-health is frequent in the families of those showing mental symptoms at puberty. Accident, infective disorders, overwork, too great physical exertion and masturbation have all been suggested as possible causes, and certainly it may be that any one of these acting upon a weakly disposition may prove to be a stress too great for the nervous system to bear. It is possible that in this, as in other disorders, the internal secretions may be too small or too great in quantity or improper in quality or may fail harmoniously to co-operate with internal secretions of other glands. Psychic maldevelopment is obvious in many cases and in others can be discovered on investigation; it may often be traced to its source in faulty home environment or to some ill-balanced method of education.

Symptoms.—In some persons, the usual mental changes are exaggerated to a degree suggesting morbidity, while in others, positive mental symptoms make their appearance. With a mere exaggeration, there may be an affective tone of sadness with apprehensions as to the burden of the future, shyness, avoidance of society or moroseness. Feelings indicated by such expressions as "Nobody understands me" or "If only I could get away" are frequent. Reticence, dissimulation and untruthfulness may become noticeable, and may be described as defensive reactions tending to repel uncongenial intrusions upon the individual's domain of his own personality. Between these states and more definitely morbid mental syndromes may be noted "borderland" phenomena, such as neurastheniform symptoms, not infrequently associated with masturbation; hypochondriacal fears especially related to the genital organs; obsessions of scrupulosity in religious and sexual matters; delinquencies of conduct, such as cruelty to animals or to weaker human beings, theft, running away from home or school, or sexual misconduct and functional nervous disorders of the hysterical form. Among more definite mental syndromes may be mentioned alternating restlessness and passivity, amounting in some cases to stupor, stereotyped actions, verbigeration or the long-continued reiteration of words and phrases, cataleptic attitudes and negativism, suggesting very strongly hebephrenic or catatonic forms of dementia præcox; obfuscation, confusion, erotism and religiosity with terrifying visual hallucinations of animals, ghosts and devils and impulsive reactions, suggesting confusional insanity; hysterical insanity; mania and melancholia or combinations thereof.

Treatment.—The preventive treatment of these states is most important and is seldom employed. Parents themselves unconsciously react defensively and are apt to thrust any evidence of neuropathic taint in the family into the background, or at any rate to ignore it. Such parents are apt to present characteristics which scarcely fit them to be successful educators of neurotic children. Where possible, education should be carried on under medical supervision or by those who know something of the particular difficulties of these cases. General hygiene, including the prescription of proper amounts of sleep, rest, exercise, mental work and food, should receive careful atten-

tion and the effect of mental and physical exertion be assiduously watched. A sympathetic insight into the child's mind is of importance, and he should be encouraged to carry his difficulties, often of a sexual character, to the proper quarter for explanation and advice. In some instances change of scene and companionship are most useful. Where actual disorder occurs, attention to general health and cessation of mental work are imperative. In many cases a period of rest in bed is indicated. Attention to the amount and character of the food and to the action of the bowels is always important. Symptoms must be treated according to their character. Analytic investigation of the patient's mental make-up may be of immense help.

Menstruation

Ætiology.—Symptoms are more likely to occur in those predisposed by heredity or by the possession of a nervous diathesis than in others. What precisely may be the process by which the nervous system is affected by menstruation is unknown, but here, as elsewhere, auto-intoxication has been suggested. It has been supposed that by the flux a toxin is eliminated; and if the eliminating process be in some way imperfect, the retention of the poison may produce symptoms. In support of this hypothesis it has been found the toxicity of the serum of the blood is increased just before the commencement of the catamenial period. An upset of endocrine balance should be remembered as a possible cause.

Symptoms.—Some alteration of mental characteristics may be observed in a certain number of women at the times of the menstrual flux. There may be merely a slight degree of heightened sensitiveness, irritability, capriciousness or apathy; or quite a marked alteration of affective tone with depression or, on the other hand, with excitement, restlessness and loquacity. When still more pronounced, functional nervous disorders of an hysterical type may occur with some degree of confusion, impulsiveness or obsessions with strong tendencies to alcoholism, sexual satisfaction, theft or suicide. So severe, in rare instances, may the symptoms become, that the attack may properly be called one of confusional insanity. Hallucinations may arise, while genital excitement may be intense. In some cases, instead of the usual agitated and restless reactions of the confusional state, there may be stupor. Symptoms, whether pronounced or not, commence as the time for the appearance of the flux draws near, and last for an indefinite time during the flow or after it has ceased; in some instances, with its appearance the symptoms abate. If there has been any confusion, the patient has subsequently a very indefinite notion of what occurred. Even in cases of amenorrhœa nervous or mental symptoms may obtrude themselves at the periods when the flux should have appeared. It should be remembered in any mental disorder, especially if acute, that symptoms are usually more pronounced during the catamenia and for a few days before and after the flow, or if there be amenorrhœa, at the times when the catamenia should have begun.

Treatment.—The only known way to combat these evils lies in endeavours to raise the general health standard. Constipation is exceedingly common, and is also the most usual local cause of menstrual disturbance. Measures against it may be adopted even in the presence of a denial of its existence, for it is astonishing how many women are found to be constipated who allege

a regular action of the bowels. The question of food is also important, and it is again surprising how many women maintain that their absurdly small intake is sufficient. Rest at about the time the period is expected is of great importance, and small doses of bromide, for instance gr. v, three or four times a day, are most useful. Some have found ovarian substance of value. Remembering that even the severest symptoms are usually only of a few days' duration, arrangements may be made for the treatment of the patient at home.

Menopause

Mental symptoms, sometimes of a severe character, may be associated with the menopause. This process of involution, indicating the termination of the individual's biological function of child-bearing, appears, in the predisposed, to be even more of a strain than the process of evolution associated with puberty. It may perhaps be supposed that the stress is now upon an organism less able to bear up against it. Certainly, in many instances, the excessive loss of blood must in itself be a cause sufficiently exhausting to produce nervous and mental symptoms. Auto-intoxication has in this case also been advanced as an explanation of the condition.

Symptoms.—Symptoms are as a rule those associated with exhaustion. Headache, backache, feelings of weariness induced by but a slight amount of exertion or even by none at all, depression and irritability, are almost the natural accompaniments of the menopause. Hypochondria, jealousy, various unreasonable apprehensions, obsessions, devotional excess, erotism and even obscenity of conduct have all been noted. Melancholia and confusional insanity may be quite definitely present, while delusional insanity with hallucinations of genital sensations suggesting assault, rape and pregnancy may commence at this time.

Course.—The course of the symptoms, if slight, or if those of confusional insanity, is of some months' duration and terminates in cure. If the symptoms be those of melancholia, the course is likely to be longer and may become chronic, while if they be those of delusional insanity, chronicity may almost certainly be expected.

Treatment.—Treatment should be directed towards the prevention of excessive hæmorrhage and the mitigation of the exhaustion which may ensue upon it. Plenty of good food, rest and sleep are of great importance. Removal from home surroundings is generally desirable.

DISORDERS ASSOCIATED WITH CHILD-BEARING

Mental disorders may occur during pregnancy, at or shortly after parturition, and during lactation.

Disorders of Pregnancy

Ætiology.—A family history of nervous and mental disorders, of alcoholism or of epilepsy, is frequent. In some instances the mothers of patients have suffered in a precisely similar way. In the personal history of the patient albuminuria, alcoholism or other intoxication, emotional shock, worry and overwork may appear as possible causes. The incidence

is greater upon primiparæ, upon the unmarried and upon women over 30 than upon others. Some women seem to have an inexplicable idiosyncrasy for mental breakdown in connection with child-bearing. In one class of case, there seems no predisposition by heredity or otherwise and the cause would appear to lie in the pregnancy itself or in some condition such as emotional stress, overwork or a toxic or infective state occurring during it. In another class of case, predisposition is marked, intoxication, infection or circumstances of an exhausting nature are absent or not plainly present, and the affection may be regarded as one occurring in a predisposed person and excited by the pregnancy.

Symptoms.—That pregnancy is a time of nervous instability is well known, and many women while in this state exhibit irritability, impulsivity, religious or sexual excitability, or absurd and extravagant tastes and desires entirely foreign to them at other times. More pronounced mental symptoms are, however, present in some cases. Where there seems to be no predisposition the symptoms are those of confusional insanity. Sleeplessness generally precedes the more acute symptoms, which consist of restlessness, agitation, anxiety, loss of bearings in space and time, and hallucinations, sometimes pleasing and sometimes terrifying. Conduct may be violent or sexually licentious, or both. Such symptoms vary in intensity and length of duration and sometimes get better before or at parturition. Where predisposition is marked, the symptoms may be those of mania, melancholia or a mixture of both. The melancholia is usually of the simple type, but may occasionally be of the delusional kind with delusions of ruin, of unworthiness, sinfulness, jealousy or love. These symptoms have a march which seems independent of the pregnancy, and which lasts beyond it.

Treatment.—Treatment of cases due to exhaustion, infection or intoxication consists in elimination or neutralisation of the cause and in regulation of sleep, rest, food and the bowels. The treatment of cases not apparently due to such causes can only be symptomatic. The problem as to the desirability of artificially terminating the pregnancy may have to be faced, and its solution must depend upon the physical state of the patient and the extent to which the pregnancy may be regarded as an essential and continuing cause of the mental disorder.

Mental Disorders of Parturition and the Puerperium

Symptoms.—The symptoms of excitement occurring immediately before or during parturition as a rule pass away when the child is born. More rarely they persist for some weeks. A more common variety of puerperal insanity commences in the second week after parturition. The temperature rises, the skin becomes dry and hot, the pulse rapid, the bowels constipated, the tongue furred, the lips dry and the eyes bright. The patient complains of headache and of feeling ill. The lochia may become foul, with local manifestations of infection. The urine often contains albumin, while the amount of urea is diminished. Agitation, anxiety and restlessness soon appear, and are associated with varying degrees of confusion, amounting even in some cases to acute delirium. Hallucinations are often present. The symptoms of cases in which there is no local infection and in which exhaustion from loss of blood or from the general strain of parturition appears

to be the exciting cause are precisely the same, save that fever and other such signs of infection are not present.

Course.—The above symptoms may last a few weeks, or even months, and then gradually pass off or leave the patient stuporose for a further period. Occasionally death occurs from the severity of the toxæmia or from exhaustion, and at times the symptoms become chronic and in a few cases suggest dementia præcox of the catatonic type.

Treatment.—In the cases of initial excitement labour should be expedited under chloroform and sedative measures adopted. In cases due to toxæmia the essential treatment is that of the toxic focus, and to place the patient in the best possible position to resist the action of the toxins. In cases due to exhaustion, measures should be taken such as those suggested in the treatment of the exhaustion psychoses.

Insanity of Lactation

Symptoms of mental disorder occurring during the period of suckling are almost always due to exhaustion, when feeding has been carried on too long or because the patient was not fit to undertake the work in the first instance or owing to lack of sufficient nourishment. The symptoms are those of confusion, either with or without hallucinations. The patient may show an aversion for her child, and precautions should be taken against both infanticide and suicide. The physical state is one of asthenia and there is probably much loss of weight.

Course.—The course is rather more prolonged than in puerperal insanity and proportionately rather fewer cases get better.

DEMENTIA PRÆCOX; ADOLESCENT INSANITY; SCHIZOPHRENIA; FOLIE DISCORDANTE

Definition.—A mental disorder commencing in a large majority of cases during juvenility and early adult life; sometimes running a regularly progressive course and sometimes irregularly with exacerbations and remissions; whose most salient symptoms are a diminution of the emotions and will, and which, as a rule, terminates in general mental enfeeblement.

Ætiology.—The symptoms of dementia præcox most usually first make their appearance between 15 and 30 years of age. They may, however, appear much earlier, about the beginning of the second dentition; or much later, at the time of the menopause. The adjective præcox must not, therefore, be taken to imply that the disorder is one only occurring at a period of life when dementia might be regarded as precocious in its appearance. It affects both sexes equally.

A family history of dementia præcox or of other sorts of mental and nervous diseases is common. In some instances the disorder affects several members of the same generation. If dementia præcox be likened to such an affection as, for instance, Friedreich's disease, it might be regarded as a developmental failure; for this view anatomical evidence has been brought

forward. But whether or not there is an initial weakness or mal-arrangement of the neurons, occasional events, such as infections, auto-intoxications, emotional shocks, excesses in intellectual work, masturbation and venery have in many cases immediately preceded the first appearance of the symptoms of the disease. The internal secretions of testicles or ovaries, regarded as defective or excessive in amount or abnormal in quality, have been suspected to have an influence in its production; and, on the other hand, regardless of somatic influences or structural peculiarities, the guilt has been laid at the door of emotionally toned groups of ideas, named complexes, mostly, if not entirely, of sexual origin, forced out of consciousness by a process of repression, and in this abnormal situation exercising an influence sometimes productive of symptoms of psychasthenia, sometimes of hysteria and sometimes of dementia præcox. The trend of thought of patients suffering from dementia præcox seems to be of a particularly introspective character. A process similar to day-dreaming goes on, but is carried to excess along abnormal lines. By a diminished interest in the environment and by the development in its place of a world of phantasy, refuge would appear to be instinctively sought from the conflicts and failures of actual life.

Pathology.—Macroscopically pachymeningitis, congestion and exudation have been described. Often there are no abnormal naked-eye appearances. Degenerative changes in the cortical cells, as swelling, dislocation and atrophy of the nuclei, chromatolysis, fatty and pigmentary degeneration of the cell-bodies are usual, especially in the case of the cells of the deeper layers. Quantitatively the cells are reduced. The cell processes forming the association fibres exhibit degenerative changes: the neuroglia is increased. These appearances are occasionally associated with vascular alterations, and may then possibly be regarded as secondary to an inflammatory or toxic process; but, on the other hand, the vascular system may be quite normal, and the appearances may then suggest a primary neuronic degeneration. Similar lesions of the cerebellum and spinal cord have been described. The testicles show an increase of interstitial tissue, shrinking of the tubules and diminution of the spermatogenic cells. Analogous changes are found in the ovaries.

Basal metabolism has been found to be reduced by about a quarter in half the cases of dementia præcox examined from this point of view.

Symptoms.—The childhood of patients is often, from a medical point of view, quite uneventful. On the other hand, there may have been unusual brilliance and precocity, either general or of some particular faculty, or the child may have been reserved or shown some special characteristic, as excessive or defective emotionalism.

Symptoms as a rule develop very insidiously, and are very likely to be attributed to laziness and want of goodwill rather than to disease. The patient's power of attention seems to fail, intellectual effort becomes difficult, there is a lack of interest in things formerly entertaining, and this is especially noticeable in a diminishing display of affection or a hostile note in his attitude towards members of his family. Variations of humour of inadequate causation are frequent, the patient being inordinately angry or pleased about trifles; sometimes he is absurdly obstinate and sometimes absurdly docile. Purposeless laughter or crying, the continuous reiteration of certain words or phrases, grimacing, mannerisms and extravagant behaviour suggesting

a desire to attract attention or to be humorous; leaving home and wandering from place to place for no reason or for some very silly one; the expression of ideas of grandiosity, persecution or religious extravagance, or assaults on others or attempts at suicide on absurd grounds, are all symptoms which may definitely draw attention to the patient's mental condition. In other cases the disease may have a far more rapid onset with neurastheniform or hysterical symptoms, or with those of mania, melancholia or confusion. In any case, with the disordered conduct and with the expression of morbid notions, there will probably be found the somatic symptoms of anorexia, constipation, loss of weight, anæmia, headache, insomnia and occasionally elevation of temperature.

Hysteriform and epileptiform convulsions are not uncommon in the early stages. In some cases apoplectiform seizures with subsequent aphasia and hemiplegia occur. The palsies are, as a rule, transient and in this respect resemble those of general paralysis of the insane. In a few rare cases, such seizures have been the first symptoms of the disease.

Physical signs are often, but not invariably present. General sensibility and that of the special senses often appear diminished, though it always remains doubtful whether patients do not in fact feel quite acutely, though psychic inhibition prevents them from showing that they feel. The mechanical excitability of the muscles and nerves is sometimes increased. The tendon reflexes are usually increased and the cutaneous diminished. In catatonia, and occasionally in other forms, muscular rigidity is present. The pupils are usually dilated and sometimes display a transient irregularity and deformity of contour: they are not infrequently sluggish in their reaction to various degrees of light and to other nervous and mental influences. The paradoxical reflex to light may be present. Cyanosis and coldness of the extremities are common. Œdema of the dorsa of the hands and feet and of the cheeks is sometimes found. Over the œdematous areas there may be superficial erosions. Dermographism has occasionally been observed. The pulse-rate is variable, sometimes low, sometimes high and sometimes alternately high and low. The blood presents the appearances of a chlorotic type of anæmia so far as the red corpuscles are concerned. In the acute stages there is a moderate leucocytosis, the increase being chiefly in the polymorphonuclear and the large mononuclear corpuscles. With an approach to recovery the blood count tends to approximate to the normal. In stuporose states a lymphocytosis and an increase of eosinophil cells occur. In females the menstrual flux is suppressed or at any rate irregular. The menopause occurs early. The quantity of urine is slightly diminished. The excretion of chlorides is increased, of phosphates remains normal and of urea is diminished. Albumin is sometimes found. The excretion of methylene-blue is retarded.

Hebephrenia

Definition.—Etymologically the term means the insanity of youth and is expressive of nothing else than adolescent insanity. There are, however, varieties of dementia præcox, and hebephrenia is conventionally used as the name of one of them.

Symptoms.—Symptoms commence in the majority of cases during juven-

ility or early adult life and in a small number of cases in childhood and middle age. The onset may be by scarcely perceptible stages, the patient slowly becoming idle, obstinate and indifferent and displaying symptoms of general ill-health and failure in nutrition. On the other hand, the earlier symptoms may simulate those of hysteria. As the disorder progresses, symptoms of confusion develop and the patient's ideas of his relationship with time and space become muddled. He may by word or action express delusions alike absurd, puerile, vague, transitory and not systematised. These may concern his body which he believes to be changed in some way; or his personality has become altered; or they may be persuasions that he is guilty of some crime, persecuted, or is wealthy and of importance, or may turn upon religious or sexual matters. Masturbation is commonly practised with great frequency and, if possible, unrestrained intercourse with the other sex is obtained. Hallucinations are frequent. The result of the delusions, the hallucinations and the confusion may be seen in restlessness and agitation. With such symptoms there may also occur grimaces, attitudinisation, mannerisms, the frequent performance of some apparently purposeless movement or series of movements, the constant repetition of words and sentences, senseless laughter, impulsive violence and emotional emptiness which in general characterise dementia præcox and which in part differentiate hebephrenia from confusional insanity occurring in young persons. The suggestibility, stereotypy and negativism which will be dealt with under catatonia may also be present in hebephrenia. Symptoms such as these may last for years or may in some cases remit or intermit. As time goes on the patient appears to get more and more demented, loses touch with the outside world and lives the mere passive life of the vegetable rather than the more active one of the animal. The degree of dementia as estimated by loss of memory and power of ideation is difficult to estimate, since from time to time the patient may show signs of an intelligence whose existence would otherwise scarcely be suspected. The mental faculties passing under the names of affectivity, appetency and will do not, however, after the earliest stages give evidence, even occasionally, of their existence. It is because of this peculiar and partial incidence upon the mental functions that the terms "folie discordante" and "schizophrenia" have been suggested as appellations alternative to dementia præcox. Some authorities describe a "simple" form of dementia præcox and mean thereby a condition in which there is a slow decline of capacity, commencing at the time of juvenility, and not marked by the more striking symptoms of mental disorder described under the above heading of hebephrenia.

Catatonia

Symptoms.—This variety of dementia præcox may commence in the same ways as hebephrenia, or occasionally with stupor or one or more of the symptoms now to be described or, more frequently, with such symptoms conjoined with those described as peculiarly characteristic of hebephrenia.

One of the most striking of these symptoms is negativism. In this there is what appears to be a pig-headed opposition to actions suggested to the patient for performance. He declines to get up from or to go to bed; to dress or to undress; to eat or indeed to do anything unless he is compelled by

superior force. This resistive attitude extends in some cases to an opposition to the patient's own needs—for instance, he will not go to stool, or pass water, even though such actions would appear imperative. As a further extension of this attitude the patient will sometimes not only decline to carry out what is required of him but proceeds to do the exact opposite. As an explanation it has been suggested that negativism is a defensive measure on the part of the patient to hinder the operation of an external influence upon his own personality. The next most pronounced symptom is suggestibility. This may or may not be curiously mixed with negativism, though superficially the two states are very different. In it there is a tendency to accept and to act upon any suggestion coming from without. Patients are slavishly obedient. The limbs are as pliable as wax and preserve any attitude imposed upon them. Movements seen, or noises heard by patients, suggest imitation and they will adopt the poses or movements of those about them (echopraxia) or repeat words and sentences (echolalia). It may, however, be noted that it is only the suggestion to perform more or less futile or indifferent actions which is accepted. Suggestions to carry on useful lines of conduct are ignored. Stereotypy is another common symptom, and patients will take up some attitude, or repeat some movement, word or sentence perhaps for hours together.

In bed a catatonia patient may lie tightly curled up or on the flat of the back with limbs rigidly extended and the head uncomfortably raised from the pillow. When up, the patient remains in some one attitude, kneeling or standing on one leg, or on tiptoe, or he sits on a chair in an odd or uncomfortable-looking attitude with his arms in some favourite position, perhaps of contortion, and his face set in an expression of fatuous pleasure or depression or contempt. If the patient walk it will probably be up and down a short length of ground or round a small circle and perhaps with an odd mannerism of gait. He may walk on his toes, or on his heels, or effect progress by a series of hops, by alternate long and short steps or by a step something like that of a polka. If asked to shake hands, he will do it with a sort of diffidence, without an answering pressure, the elbow being kept to the side and the hand and fingers extended. If the patient says anything at all, he will probably repeat words and sentences which seem to have no reference whatever to the actualities of his situation (verbigeration). He may invent neologisms, or words composed of the senseless juxtaposition of the syllables of words really in use. At times the patient is quite mute for months or years. The handwriting is often strange and affected. Flourishes and hieroglyphics are frequent. Words and sentences are repeated and underlined. In a few rare cases the letters are so formed that the writing can only be read in a mirror. The written matter is often surprisingly good, and does not indicate such a degree of mental deterioration as might be expected from the patient's general conduct. If asked for an explanation of their oddities patients often cannot account for them or state they are compelled to perform them. Emotional indifference or apathy, absence of feeling for relations and friends, for propriety and decency, diminution of spontaneous and voluntary attention, and absence of will coexist in the early stages, and often for years, with a high degree of intelligence and with intact memory. After some considerable time, perhaps amounting to many years, the appearance of dementia is more established and the capacity for intel-

lectual effort and memory of reproduction seem seriously diminished or indeed abolished.

Course.—The course of catatonia is a long one. Patients may continue in the same state for years. At times symptoms abate and the patient seems to wake up. His memory of conservation and his intelligence may be found during a remission not to have been impaired. There are in catatonia occasional phases of agitation and with them an increase of grimaces, absurd actions and verbigeration. Occasionally there may be impulsive destructiveness or violence.

Paranoid Form

This form commences at the same time of life as the other two or perhaps a little later.

Symptoms.—The onset is rapid, and the delusions which are a marked feature and give this variety its name, at once attract attention. They may be hypochondriacal, perhaps with ideas of bodily change into some foreign substance, or into some animal, of persecution, sinfulness, financial ruin or grandeur. They are generally accompanied by hallucinations of the various special senses. The delusions are more fixed than those met with in hebephrenia and tend to systematisation, but they are not so fixed or so systematised as those of chronic delusional insanity. At first, the delusions and hallucinations produce agitation, depression, exhilaration or a trance-like state and, according to the dominating idea of the moment, the patient will probably conduct himself with arrogance, shrinking timidity, or with suggestive coyness or as if in ecstasy, but emotional activity soon passes and leaves behind indifference. At this stage, or earlier, such evidences of automatism as stereotypy, verbigeration, grimacing and mannerism will appear. Dementia ensues after a very varying period.

Course.—Dementia præcox may begin with symptoms of one type and during its course those of another may develop. The advance in the severity of symptoms may be very gradual, without remission or marked exacerbation, or it may be rapid. In some cases, notable exacerbations are frequent and are followed by remissions, in each of which the patient is found to occupy a lower intellectual level than before. Whether gradually or after many exacerbations, the patient eventually arrives at a condition of apparently profound dementia, in which, however, there may appear from time to time evidences of a degree of memory and intelligence which suggest that the dementia is more apparent than real. Often after the subsidence of the more acute symptoms, the patient is found capable of some useful though humble employment. In other cases, the abatement of the severity of the symptoms is very great, and indeed total disappearance of symptoms is not unknown. The term "dementia" in the title of the affection must therefore not be taken to mean that dementia is a necessary part of the disorder, or that the appearance of dementia always corresponds to real mental extinction.

Treatment.—Where a child is known to be predisposed by heredity and his character or mental equipment is abnormal in some way, particular care should be taken over his education. Overwork, physical or mental, emotional excitement and the infections should be assiduously avoided, and the education of character such as to prevent the development of self-absorption,

vanity and introspection and to promote self-control and unselfishness. On the appearance of pronounced symptoms, or earlier if possible, the patient should be put to bed and every effort made to improve the general health. The amount of food taken, the action of the bowels, the weight, and the length and quality of sleep are all most important matters to which attention should be paid. Food should be ample and of high nutritive value. Rest, diathermy and strychnine appear to raise the rate of basal metabolism. It is well, however, to be cautious in the administration of strychnine if the patient is at all excited. Purgatives or aperients should at first be regularly given and until there is no doubt that the constipation, which almost invariably exists, has been relieved. No reliance should be placed on the patient's reports as to the bowels, and the dejecta should be inspected. If the sleep be poor, hypnotics should be given, not with unthinking routine, but they and the dosage should be varied, and by experiment the minimum necessary dose which best suits the patient discovered. So far as possible, the patient should spend his time in the open air, his couch or bed being arranged in a garden, on a veranda or near an open window. Attempts at suicide, though infrequent, should be prevented by constant watching and the removal of everything the patient might use as a weapon against himself. If his bed be near a window on any but the ground floor, arrangements must be made to hinder him from throwing himself from it, and for this purpose light wire netting may be used. The length of time the patient is kept in bed should depend on the progress made, but at least no harm will be done if he stay there for months. If improvement be obtained, convalescence should be prolonged and the patient only gradually permitted to increase his activities. At this stage, occupation therapy may be commenced, and consists in getting the patient to learn some handicraft—for instance, sewing, knitting, basket-work, rug-making, modelling, gardening, or carpentry. In this way the emptiness of life, so marked a feature in the institution career of chronic patients, may be mitigated. In contrasting the condition of patients suffering from dementia præcox upon whom constant individual attention cannot be bestowed with that of those who are more fortunate and have had the advantage of the guardianship of a good and wise nurse to themselves, it is difficult to avoid the conclusion that skilled individual attention has an enormous therapeutic influence. Patients so circumstanced can often, by the psycho-therapeutic influence of a healthy mind properly applied, be restored to at least a considerable degree of mental health and can be kept at that level. Unfortunately, few can afford such attention, while on the other hand a sufficiency of the qualities of patience, charity, knowledge and skill required in the nurse is rarely present in any one individual. The pity of a diagnosis of dementia præcox lies in the therapeutic hopelessness at once engendered thereby. Nevertheless, experience teaches that treatment on the lines above suggested does much to stay progress towards that mental degradation which too frequently is regarded with fatalistic resignation.

The treatment of patients by the induction of malaria has been attempted, and in some cases temporary improvement has followed. The results, however, have been less encouraging than similar treatment in cases of general paralysis of the insane.

When dementia has apparently definitely set in, the somatic functions should

still be watched and regulated and attempts should be made to make use of such mental activity as may still be left.

Paraphrenia.—Of late years the term *paraphrenia* has been introduced to indicate a mental disorder having resemblances, on the one hand, to paranoid dementia præcox and, on the other, to paranoia. During the early stages of paraphrenia it is impossible to distinguish between it and paranoia, but later on exaltation of self with delusions of grandeur are more markedly a feature of paranoia than of paraphrenia. The paranoic patient is, however, less aggravated and influenced by delusions of persecution than is the paraphreniac; is somewhat more reasonable and controlled in his dealings with those he holds to be his persecutors and enemies; and tends rather to halt at a certain stage in the development of his disorder than to pass, as does the paraphreniac, through increasingly extraordinary delusions and hallucinations to dementia. The paraphreniac, in contrast to the patient suffering from paranoid dementia præcox, does not show the emotional vacuity which is so marked a feature in the latter.

The distinction in practice between paranoia, paraphrenia and paranoid dementia præcox is often of extreme tenuity; nor do descriptions found in literature present anything like clear pictures of decidedly separate morbid entities. It is perhaps for this reason that the conception of paraphrenia has met with less acceptance in this country than abroad.

DELUSIONAL INSANITY

Delusional insanity or paranoia is an affection in which delusions, generally of very gradual growth, persist for long periods, usually until death or the patient's mental extinction in dementia.

Ætiology.—In many cases, but by no means in all, there is a family history of mental or nervous disorder. The age at which symptoms manifest themselves for the first time is, as a rule, early middle life. Usually they appear quite insidiously, but occasionally seem to date from some bodily or mental stress. Some find the cause of paranoia in reaction against inadmissible phantasies, the resulting self-accusation being diverted from the self and fastened upon others. Marked delusions occur in some cases of senility, but are not so fixed nor are they systematised in the same way.

Pathology.—In cases of long standing in which dementia has occurred the brain shows degenerative changes. In many cases nothing of a morbid character has been found.

Symptoms.—The basic mental characteristics of the patient, shared with many persons who do not become more pronouncedly morbid, are touchiness, a tendency to see in the words and conduct of others endeavours to slight him, suspicion, reserve and no small degree of vanity. Persons exhibiting these peculiarities are commonly enough met with in the ordinary business of life, and a certain few of them are recognised as eccentric, without being regarded as insane. In those about to suffer from delusions, these characteristics slowly become more marked. Whether as a result of illness or worry, or of those disappointments which are so common in early middle life and which blunt the edge of earlier hopes, or quite independently of any obvious cause, the patient develops vague feelings of something being amiss.

In seeking for an explanation, he may decide the feelings are due to some disorder of his alimentary or genital or other system, and a hypochondriacal turn may thus be given to his mental twist; or, on the other hand, he may be suspicious that his relations with society, or with some group of society, or with some particular individual, have become warped through the agency of some one who owes him a grudge or has a mischievous and inexplicable desire to do him an injury. The patient becomes at once both more introspective and watchful of the behaviour of those with whom he comes in contact. He analyses what they do and say, and sees in trivial acts and words a meaning having reference to himself. People, he supposes, point at him or look at him with contempt, or smile as he passes or whisper to each other about him. To avoid these annoyances, the patient may frequently change his residence, or leave home and wander from place to place, seclude himself or complain to the police. At this stage the vague feeling of being worried and annoyed by some one or other, who may be no more closely defined than as "one" or as "they," becomes a more definite delusion of persecution by some body of persons, as, for example, "the secret police" or the Jesuits, or some one person upon whom the patient fastens as the author of his wrongs. Patients' explanations of these fancies are often very ingenious, and such skill do they sometimes display that the detection of flaws in their arguments is most difficult. Not infrequently they induce others to regard them as real martyrs. In most cases, hallucinations of hearing, taste, smell and general sensibility now develop, hallucinations of sight being extremely rare. The patient hears the voices of his enemies insulting him, the sound of their voices being conveyed to him in extraordinary ways, perhaps, for example, by wireless telephones. He may allege persons climb up to his windows at night, or hide themselves in the ceiling, for the sole purpose of worrying him with their insulting or obscene remarks. Some patients stuff their ears with cotton-wool to avoid hearing such voices. At times patients complain their minds are read and their most intimate thoughts are repeated aloud or that they are compelled to say words and sentences, usually obscene, put into their mouths against their will. Such a symptom goes by the name of a "psycho-motor" hallucination. Hallucinations of smell and taste are employed by the patient to demonstrate that his food is poisoned or an endeavour being made to kill him with noxious fumes. Hallucinations of general sensibility suggest to the patient he is being electrified or acted upon by some mysterious agency. Hallucinations in connection with the genital organs are frequent, and patients complain they are sexually assaulted or their organs are tampered with, perhaps with a view to rendering them impotent. They frequently invent words which they think descriptive of their state or of what they think is being done to them, and which consist of a curious medley of syllables derived from scientific terms. For instance, a patient may allege that he is being "tortified" or "telepathrayed." Having decided who are their enemies and the modes by which they are persecuted, patients proceed to defend themselves, sometimes by flight and concealment and sometimes by the radical method of homicidal assault. This class of patient is the most dangerous of all. He has perhaps effectually concealed his disorder or at the least has avoided certification, has waited his opportunity and has cleverly elaborated the proposed attack. They are not as a rule suicidal, though some have been

known to kill themselves to avoid persecution, and some others with a view to putting their persecutors in the wrong. At a later stage the patient's ideas as to his personality become changed in a grandiose direction. He opines his position in the social order has immensely improved, and he puts forward pretensions he is a king, or his wealth is enormous, or he has gathered up all power and wealth into his hands and is a god. Some explain this transition as a sequence of the ideas of persecution, the patient imagining that one so much persecuted and thought about as himself must necessarily be some one of very considerable importance. As time goes on the hallucinations appear to become less well defined. The patient may continue to talk of his wrongs and the tortures which are inflicted upon him, but he appears to do this as a habit and to take them as a matter of course.

Course.—It remains a moot point whether or not delusional insanity always terminates in dementia. In many cases, intelligence of a high order remains for many years, and in its possession the patient dies of some physical disorder. In others, there arises a slowly progressive deterioration, and this is perhaps more likely to occur in those cases in which symptoms appear earlier than is usual and in which systematisation is not much elaborated. In any case the course of the affection is very prolonged. Very few cases of recovery are on record, and as a rule it lasts as long as the patient lives. Remissions and exacerbations are frequent, the latter often being provoked by some accidental illness or some real cause of worry and anxiety outside the delusional system.

The above description is an outline of the most common form of delusional insanity. In some cases the delusional system centres round the patient's own body and the fancied disorders of its various systems. He may allege he has cancer, tubercle, syphilis or some obscure affection which cannot be diagnosed. Whatever the disease, the patient becomes absorbed in its supposed symptoms and can talk and apparently think of nothing else. Doctors, charlatans, and various "cures" are tried one after the other, but the patient remains convinced that no one understands his complaint and no one can do him any good.

In other cases, religion forms the basis of the disorder. The patient may announce himself as a prophet or the founder of a new religion, and may regard his hallucinations as evidence of divine revelation. The litigious paranoiac brings suit after suit in the courts against those who he supposes have aggrieved him: no decision of any sort ever satisfies him. The political paranoiac has firm belief in some nostrum he is convinced will set right the wrongs of some section of society. Delusions in the field of love are apt to be a most serious annoyance to the object of the patient's affection. The patient by letter-writing, presents and personal attention becomes such a pestiferous nuisance that the assistance of the police has to be invoked. In other cases, the patient erroneously believes himself or herself to be the object of some unfortunate person's love, and may seek police protection from an anticipated abduction by some one who may even be ignorant of his or her existence. Delusions of jealousy may be the most marked symptom in some cases, the object of suspicion being liable, if he bestow a casual glance on any other woman than the patient, and even if he happens to sit next to one in a church or theatre, to torrents of abuse.

Treatment.—The child of suspicious and touchy character requires

especially careful educational handling. Judicious training in the society of those of his own age and a little older, healthy competition by which he will find his level in work and play, and lessons which will teach him to unbosom himself and not to nurse his grievances, real or supposed, will all assist to form a point of view little favourable to the growth of delusions. On the other hand, it must be remembered, many a child of sensitive disposition retires into himself when exposed to the not too kind society of his school-fellows, and from that retirement may never emerge unless taken in hand by an adult who understands him. It is in such a defensive position the soil is prepared for seeds which may afterwards develop into delusions.

In the early stages of the disorder something may be done by analysis and tactful influence to neutralise the morbid bent of the patient's character, but when the delusional system has become established little avails to overthrow it. So long as the patient's behaviour is not a nuisance to society and harmful to himself, certification is not indicated, but on the smallest sign that the patient feels resentfully towards any person or body of persons whom he regards as hostile to him, it is as well to certify, seeing that the step between such resentment and retaliation is but a short one. In this, as in all mental disorders, careful attention to the physical health is of importance.

IDIOCY; IMBECILITY; FEEBLE-MINDEDNESS; MORAL IMBECILITY; DEGENERACY

Definitions.—The following definitions of idiocy, imbecility, feeble-mindedness and moral imbecility are derived from the Mental Deficiency Act, 1913. They were made for the purposes of the Act, and are convenient and as correct as any hitherto alternatively proposed.

Idiots are persons so defective in mind from birth or from an early age as to be unable to guard themselves against common physical dangers.

In imbeciles, the mental defect, existing from birth or from an early age, does not amount to idiocy, but renders them incapable of managing themselves or their affairs, or of being taught to do so.

Feeble-minded persons are those whose mental defect has existed from birth or from an early age, but does not amount to imbecility, yet is so pronounced as to require care, supervision and control for their own protection or that of others, or, in the case of children, are those who appear to be permanently incapable of receiving proper benefit from instruction in ordinary schools.

Moral imbeciles are those who from an early age display some permanent mental defect, coupled with strong vicious or criminal propensities, and on whom punishment has had little or no deterrent effect.

The Mental Deficiency Act, 1927, more closely defines "mental defectiveness" as a condition of arrested or incomplete development of mind existing before the age of eighteen years, whether arising from inherent causes, or induced by disease or injury.

The classification of the first three states obviously merely consists in a useful grading of mental capacity, persons presenting a total or an almost

total absence of intelligence being called idiots; those with rudimentary intelligence, imbeciles, and those with yet a larger amount of intelligence, feeble-minded.

Ætiology.—The causes of mental defect may be conveniently divided into those operating before, at the time of, and after birth.

A family history of mental or nervous disease and especially of epilepsy is very common Consanguinity of the parents has been supposed to be a cause, and it might be as well, with a view to the elucidation of the supposition, that a study of the products of incestuous unions should be systematically undertaken.

Alcohol and other intoxicating agents, operating in either parent or in both, before or at the time of conception; infections, especially syphilis, in either parent at the time of conception or in the mother during gestation; and emotional shock, worry, accident, physical disease or alcoholism of the mother while pregnant, are all alleged causes. The Wassermann reaction is so frequently found to be positive in the mentally defective, that it seems probable syphilis plays an even more important part than has hitherto been suspected.

At the time of birth, prolonged labour, and other anomalies of parturition, and the use of forceps appear in some cases to have had a disastrous effect upon the cerebral cortex of the child.

After the birth of the child, infections or accidents associated with convulsions, meningitis and encephalitis seem to arrest a development which until then had proceeded normally. The hydrocephalic variety occurs as the result of imperfect circulation of the cerebro-spinal fluid, whereby it is collected and dammed up in the ventricles of the brain or upon its surface within the meninges, and by its pressure interferes with proper development. This imperfection of circulation is due to closure of the foramina between the various spaces containing the fluid, in some cases brought about by inflammation and in others by congenital defect. In the case of endemic cretinism climate, soil, character of the water supply, bad hygienic surroundings, heredity and consanguinity have been assigned as causes. There is no doubt, since the improvement of sanitary conditions in some of the districts in which cretinism has been endemic, that the incidence of the disease has been less. In sporadic cases, alcoholism, syphilis, tuberculosis in the parents and infections of the mother during pregnancy are alleged causes. It has been conjectured that in some cases a thyroiditis has occurred during an infection and this has resulted in subsequent atrophy of the gland.

In the Mongolian type of idiocy, syphilis and tuberculosis in the parents, and emotional shocks, frights, worries and ill-health occurring to the pregnant mother have been presumed as causes. This type appears accidentally in a family in whom there is no history of nervous or mental disorder. The affected children are often among the younger members of large families, the mothers being somewhat advanced in life. Hence uterine exhaustion has been proposed as a cause.

Pathology.—The shape of the skull varies. It may be acrocephalic, platycephalic, plagiocephalic, scaphocephalic, macrocephalic or microcephalic, the last form being the commonest. In some cases the sutures ossify prematurely, and in others either later than normal, or never. Except in hydrocephalus and in a few rare instances in which the brain is larger and heavier

than normal (*hypertrophic sclerosis*), its size and weight are diminished. The hemispheres are sometimes unequal in size, one being atrophied. In a few cases, an important part of the brain, as, for example, the corpus callosum or the central masses of grey matter, is absent. There may be hydrocephalus or porencephalus, that is, a cystic degeneration of the cortex, or scattered nodules of sclerotic tissue, of the size of filberts; or certain of the gyri may be small or absent and the sulci between them wide and deep. The grey matter may be unduly hard or unduly soft, and there may be signs of a past meningitis or encephalitis. Histologically, the nervous tissue cells are reduced in quantity and degenerate in quality, while the fibrous tissue elements are increased.

In amaurotic family idiocy the anatomical changes are those of a primary degeneration of the cell bodies of the cortex, the most completely affected parts being the interfibrillar protoplasm.

In cretinism, ossification of the sutures of the skull is late and the bone is thicker than normal. The dura mater also may be thickened and more than usually adherent. The volume and weight of the brain are diminished and the cortex, corpora striata, cerebellum and medulla but ill-developed. In many endemic cases the thyroid is enlarged, with a superabundance of connective tissue, or cystic degeneration may be present. In other endemic cases and, as a rule, in those that are sporadic, the thyroid is atrophied and its glandular elements replaced by fibrous tissue, with a general proliferation of fine subcutaneous connective tissue: the walls of the blood vessels are thickened.

In the Mongolian type the cerebral cortex is quantitatively diminished and its structure is less complex than normal. The cortical cells are less thickly set. The sulci are not so numerous. The cerebellum, medulla and cord are likewise diminished in size.

Symptoms.—The most profoundly affected idiots are mindless. Their special senses, when present—for they are often defective or absent—convey impulses which are not transformed into perceptions: in other words, there is no mind to refer sensations to external objects. No judgments, even of the most elementary sort, are formed. There is no liking, disliking, memory or desire. The instincts of the brute are absent. Patients such as these are incapable of sitting up or walking, and taking food resolves itself into a reflex act which occurs when a foreign body stimulates the mucous membrane of the tongue and pharynx. They are completely incontinent; often congenitally deformed, rickety or suffering from hemiplegia, diplegia or paraplegia. Rumination, athetoid movements and meaningless noises form their only modes of activity. The face is expressionless or foolish-looking, the lips not properly opposed and saliva dribbles from the mouth. Strabismus, cleft palate, hare-lip and anomalies of trunk, limbs and genitals are frequent. Such patients do not develop and die early. In rather less extreme cases, patients after a time recognise their attendants and dislike to be absent from them. They may, perhaps, be taught to control the bladder and the rectum and to feed themselves. They may have preferences as to their food, and even be able to say a few words or sentences. Beyond these few likes and activities, there is no evidence of mental function. In some patients, sexual instincts are early developed, and they will masturbate, display their genital organs in public, and run after members of the opposite sex quite shamelessly. The temper is often easily roused and conduct may

be violent. Many are epileptic. In a few cases, amidst a desert of mental sterility, some one faculty, as for music, or arithmetic, or memory, is found to be abnormally well developed.

The addition of various faculties and improvement in their quality may result in the higher grades of imbecility and feeble-mindedness and it is unnecessary here to describe these in detail. Some imbeciles have sufficient faculties to enable them to be converted by education into harmless and happy members of institutions for their like, or even of their own families, while the feeble-minded may be taught some simple occupation and so may become not wholly economically useless to the community.

Intelligence tests have been devised for the purpose of comparing the mental state of defective children with a standard of attainment ascertained by experience to be approximately correct for the normal child. Essentially the tests consist in attempts to measure the powers of perception of the defective child, his capacity to assimilate the rudiments of scholastic education, to perform actions more or less complicated, to solve very simple problems and to develop elementary abstract ideas. Sets of questions and problems are arranged in order of increasing difficulty, the most easy being those which should be answerable by the normal child of three or four. If the child cannot answer the set of questions proper to his age, but can only deal with those proper for a younger child, he is set down as being of a mental age by so much less than his real age. His development is at any rate regarded as delayed.

Mongol Type

In this type the palpebral aperture is narrow and almond-shaped and its long axis is directed downwards and inwards, while at its internal corner the epicanthic fold of skin concealing the caruncle is evident. The nose is snub with the root flattened out, the malar eminences are advanced and the skin over them red. The oral aperture is small, but the lips large. The tongue is large and rugose and tends to protrude. The upper parts of the ears overhang the lower. The head is small and round and the sutures often remain patent. The arch of the palate is high and narrow, with a median groove. The teeth are usually carious and may be placed abnormally. The signs of rickets are often present. The abdomen is pendulous and protuberant. The hands and feet are short, broad and thick, the fingers taper and the little finger is often radially deflected. Ligaments around joints are slack. The genitals and mammæ are small. Congenital cardiac lesions are common. The degree of mental deficiency is profound, though the patients tend to show a little more affection than do other types, and are less irritable. Development is very slow and death usually occurs early, often from tuberculosis.

Cretin Type

The arrest of development occurring in this type is probably due, for the most part, to thyroid insufficiency. This gland is occasionally enlarged, but in most cases atrophied. The mental condition varies and there is more or less idiocy, imbecility or feeble-mindedness. The head is generally large, especially in the occipital region. The face is podgy in appearance, the root of the nose being flattened, the eyelids puffy and obscuring the eyes, the lips thick and open and dribbling is common. The tongue is large and the teeth

carious and ill-placed. The neck is short and stubby, and the supra-clavicular fossæ are filled in or converted into protuberances. The abdomen is large. The legs are curved as in rickets, and the hands and feet large and splayed. The skin and hair are dry and harsh, and the latter is scanty. Everywhere there is an œdematous appearance, the feeling imparted to the finger on pressure suggesting, however, elasticity rather than the dough-like yielding resistance of œdema. The extremities are purple in colour and cold to the touch. The genitals are small. The respiration and pulse rates are slow.

For the treatment of Cretinism, see p. 469.

Amaurotic Family Idiocy (see p. 1478).

Epiloia

Under this term are included cases in which feeble-mindedness and epileptic fits occur in association with adenoma sebaceum, fibrous nodules of the skin, nodular sclerosis of the brain, and renal tumours.

Microcephalic Type

The small size of the head is the outstanding feature. The face is like that of a monkey, and the ears are large and protrude laterally.

Hydrocephalic Type

The head is large and may be gigantic, the face remaining about the normal size. Patients may be of very good and indeed of normal mental development, but, in most instances, are defective. As a rule, some elementary moral and social notions are present, but the will-power of patients is feeble and they are often absurdly vain. They are not long-lived.

Mental defect is frequently associated with the hemiplegia, diplegia and paraplegia of infancy. Its grade varies widely and depends on the amount of damage the cortex cerebri has sustained.

Treatment.—Treatment consists in patient and systematic endeavour to make the most of such mental power as may be present. Patients are roughly divided into the educable and the ineducable, but it is undesirable to class them until some educative effort has been made by properly qualified persons. Even the seemingly most unpromising cases may in some instances have elementary notions of the control of the sphincters instilled into them. Others can be brought into some sort of rudimentary relation with the external world by laboriously teaching them such physical qualities as weight, roughness and smoothness, hardness and softness, colour and shape. They may be taught to learn the feel of the ground by their feet, of the upright position and of motion. Some may be made eventually to stand upright and even to walk. Similarly the hands may be educated so that the patient may feed himself, dress and undress, wash, use such simple tools as a broom or scrubbing brush or, in the higher grades, exercise some handiwork such as laundry work, basket- or shoe-making. It is seldom in the home circle that skill and time can be found for the conduct of such education, and patients have far better chances in special schools or institutions. The somatic health requires careful attention, and mental progress will largely be proportionate to the physical standard that can be attained.

Moral Imbecility

Symptoms.—Among the insane, improper and criminal conduct is frequent. It may be due to impulsiveness; that is, as it is customary to explain the matter, to the operation of automatic centres acting independently of, and indeed perhaps in opposition to, the highest centres subserving judgment and will. In the automatism of epilepsy we have the most striking examples of the achievement of complicated actions, even over considerable periods of time, in the seeming absence of the patient's usual personality. In such a state crime of a complicated sort may be committed. In psychasthenia and other disorders, obsessive or imperative ideas which force themselves into the field of the attention and usurp it, may issue in action, perhaps of a criminal character. The systematised delusions which occur most pronouncedly in chronic delusional insanity and to a less extent in confusional insanity and dementia præcox, may, for example, prompt the patient to rid himself of his supposed enemies by homicide. The delusion of the melancholic that his family is hopelessly ruined, may lead him to murder its members to save them from the miseries of destitution and starvation. A sexual pervert may commit crimes in satisfaction of his abnormal tastes. An imbecile or feeble-minded person may commit an act, say, of incendiarism, without having sufficient sense to appreciate its consequences, or the person in a state of acute confusional insanity may perpetrate a crime because he is at the time too muddle-headed to know what he is doing or why he is doing it.

The moral imbecile knows what he is doing and the consequences of his acts, and he does not suffer from impulsiveness, obsessions, perversions or delusions. His moral sense is lacking and he has no appreciation of right and wrong. The condition dates from infancy and becomes more obvious as the looked-for results of education fail to appear. As a child an extraordinary indifference to the feelings of others is noticeable. This is not only due to the self-absorption, thoughtlessness and ignorance which in the case of the ordinary child make him neglectful of others, but, in addition, must be attributed to a defect of feeling, displayed not only to strangers, but even to the nearest members of the patient's own family. He is disobedient to those in authority, untruthful, jealous, bad-tempered and cruel in his dealings with other children or with animals. Later, when educational efforts are made, he will probably be found to be idle, though quite possibly equal to the average, or surpassing it in intellectual capacity. Later still, gambling, thieving, drinking and sexual licence become added to the catalogue of the patient's vices. Every patient does not necessarily exhibit the entirety of such moral imbecility. In some, the moral lacunæ are confined to one or two virtues, such, for instance, as sobriety and honesty. Some spend their lives amidst general approbation until it is discovered they cannot keep their hands from picking and stealing, at any rate in shops; while others become affluent on business transactions involving widespread ruin and misery, to the effects of which they are utterly indifferent.

The deterrent effects of punishment are scarcely operative, and its pains only serve to sharpen the wits of the patient to enable him to escape it in the future. Educational measures are almost equally useless. If the delinquencies be not such as are illegal, or in the event of their being criminous

if the patient has been sufficiently astute to escape the consequences, he will at any rate almost certainly be the terror and scourge of his family.

Treatment.—The treatment of such persons consists in their removal to surroundings where their activities are restrained and the consequences of their actions are reduced to a minimum of bad effect. Psychotherapy by analysis or re-education should be attempted.

The Degenerate, Unbalanced and Eccentric: Akatastasia

Ætiology.—Persons coming under these headings may be regarded as displaying some evidence of the failure of the vital force, transmitted to them by their forbears, to produce an average quality, either somatic or mental. The symptoms are not found to be impartially distributed among all the members of a family; their incidence is frequently concentrated upon certain individuals. Why this should be so, if the initial defect lies only in the quality of the transmitted material or force, it is difficult to determine and it may well be the subtle influences of a defective environment have something to do with the production or accentuation of symptoms. Careful examination of early life often discloses a history of most unsatisfactory home conditions during infancy and childhood; while analysis may show that mental evolution has proceeded along abnormal lines.

Symptoms.—Patients are frequently particularly intelligent, and occasionally brilliant, but there is a lack of balance between the various faculties, one of which is probably not efficiently kept in order by the others. Imagination may be untrammelled and without judgment, or in other and more rare instances judgment proceeds with leaden feet unassisted by a suspicion of imagination. Memory may be exceptionally good, but owing to want of judgment may merely introduce unutilisable additions to the data of present problems. Capacity in childhood is often precocious and particular faculties, such, for instance, as for arithmetic and music, are remarkably developed, but their fruitful application is thwarted by want of attention, caprice or obstinacy. At the time of puberty, vague and often absurd aspirations after distinction, affectedness, religiosity and sexuality are common features. Grown up, such patients, if not wholly idle, frequently occupy themselves in a dilettante fashion with the Arts—poetry, literature, painting and sculpture. Rarely producing anything of value, they tend to affect extremes of fashion; are anti this, that or the other; doubt and deny, on quite inadequate grounds, current beliefs and modes of thought; see short ways to the improvement of every one and every thing; are Utopians, and, above all, set a high value on themselves. Their defects lie in want of breadth of view, of a sense of due proportion and, frequently, of common morality; while such details of business as paying bills, punctuality and keeping of engagements are almost beneath their contempt. The result of these defects, which unfortunately outweighs the value of the product of the patients' cleverness or manipulative skill, renders them of small use in the professions, or in looking after the affairs of others or even their own. Affectivity is often small in quantity and poor in quality; with much display of emotion there is but little depth of affection or sympathy. Periods of feverish activity alternate with periods of complete idleness. Affectations in hairdressing, clothes, jewellery, in ways of talking and walking; eccentricities

shown in excessive love for flowers, animals, furniture or dress; extravagance or miserliness; preferences for the absurd in love, religion and the Arts; gambling and drunkenness, may all be symptoms of degeneration. Hypochondriasis, cynicism, misanthropy and ill-placed or ill-guided philanthropy are still more pronounced and noticeable symptoms. Sexual perversion, inversion and other such anomalies are not uncommon.

Patients may exhibit some or many of the above-mentioned symptoms, without possessing that specious show of cleverness and brilliance which often induces the world at large to mistake the degenerate for a genius. They are mentally slow, their instruction is laborious, and at school they are behind the standard usually attained by those of their own age, though they may display that eminence in one faculty which is not infrequent even among the imbecile. Eccentricities, affectations and mannerisms may be marked, while judgment and will-power are weak. From such a mental make-up it is obvious the symptoms of more marked disorder may easily emerge, and in fact the approximation to dementia præcox and paranoia is sometimes very close. Indeed, in some cases the patient commencing as a degenerate passes eventually into the category of dementia præcox. The degenerate is an incomplete example of dementia præcox, while conversely dementia præcox is a term of the process of degeneration. Degenerates are also prone to confusional insanity, mania and melancholia. The last is likely to be of the delusional variety with ideas of culpability, hypochondriasis and persecution. Patients commence by misinterpreting the words and behaviour of those about them, seeing in them references to themselves; or they read meanings into newspapers and advertisements which, they allege, imply they are being insulted or attacked, or are great personages, or are being communicated with by some one in love with them. They may develop some social or political scheme and support a thesis in its favour with extraordinary persistence and energy. Political assassins, who think that by the removal of some prominent person the system of government of their countries will be altered and perfected, often come of this class. Or having, perhaps, had some small difference over business affairs or having suffered some slight reprimand at the hands of an official superior, the degenerate exaggerates the injury and elaborates wholly disproportionate efforts to get himself set right.

Similarly, some losing cases at law will not be content with the decision, but repeatedly appeal to higher courts and spend all their time, energy and substance in the useless prosecution of an idle cause. Eventually, they impeach the integrity of their own advisers and of the judges before whom they have appeared, and perhaps proceed to secure what they regard as justice by assault and homicide. Sometimes the degenerate will be given to the invention of articles which are of no use to any one, and will allege that the failure of his absurdities is due to the jealousy or fraud of others. The religious degenerate may invent ecclesiastical systems, or improve upon older religions by blending with them his own crude notions. Some degenerates exhibit the acutest jealousy and see in every act of the unfortunate victim a proof of his infidelity towards themselves, while others seeing the tokens of love towards them in the behaviour of a selected individual harass him, perhaps for years, with evidences of their own affection.

Impulsiveness is common: it is irresistible, and the patient is fully conscious of what he is doing when it issues in action. The impulse may

be for taking certain poisons, for instance, alcohol and morphine, or theft, murder, suicide, incendiarism or sexual crimes.

The following is a brief catalogue of some of the more important physical abnormalities known as the stigmata of degeneration. So far as general conformation is concerned gigantism, infantilism, feminine appearances in the male and masculine in the female are noteworthy. The head may be too large or too small; asymmetrical, flat-topped or pointed at the vertex; too round, too oval, too narrow or too broad. The face may be asymmetrical. The orbital cavities may be too near to each other or too far apart. The palpebral aperture may show odd shapes, be too round or too oval or too large or too small. There may be anomalies in colour and structure of the eye itself. The ears may be abnormally set upon the head and their shape peculiar. The nose similarly may be too large or too small, bifid or imperforate. The mouth may be too large or too small, with hare-lip or cleft palate. The palate may be unduly arched or pointed. The teeth may appear late and the first dentition may persist. Teeth of either dentition may decay early and be badly set or too few or too many. The tongue may be large, small or bifid. The jaws may be too large or too small. The shape of the trunk may be anomalous. The spine may show various deformities and may be bifid. Anomalies of situation and in the development of the thoracic and abdominal viscera and hernial protrusions may be found. Large, small and coalesced fingers and toes may occur, and whole limbs may be unequal in size to their fellows. The genitals may be unduly large or small. Testicles may be undescended or absent. Epispadias, hypospadias, hermaphroditism, atresia of the vulva, large or small labia or clitoris may be present. Albinism, vitiligo, anomalies in the thickness and colour of the skin and the set and colour of the hair may exist.

INSANITIES OF INVOLUTION

Under this title will be included the mental disorders associated with senility, premature senility, arterio-sclerosis, cerebral hæmorrhage and thrombosis.

Senility

The mental symptoms of senility are analogous to the physical in that they betray enfeeblement of faculty.

Ætiology.—The physical alterations and the functional disabilities of senility are due to wearing out of the tissues, the process being accelerated by the vast variety of intoxications brought to bear upon the body throughout life. Alcohol, lead, tobacco, syphilis and other infective disorders, gout, constipation or gastro-intestinal intoxication without constipation, may separately or in combination play a part. It is at present doubtful if physical or mental overwork and worry directly exhaust the tissues or whether they imply a katabolic process during which toxins are formed.

Pathology.—Macroscopically, thickening of the meninges, dilatation of the cavities of the brain and atrophy of both cerebrum and cerebellum are to be found. The vessels may be manifestly degenerate, and small hæmorrhages

and patches of sclerosis may be seen. Microscopically, atrophy and disappearance of the cortical cells, diminution of the number of the fibres and proliferation of the neuroglia are noticeable.

Symptoms.—The mental symptoms of senility are of two kinds, those arising from loss of power and those due to the perversion of such faculties as remain. It is possible that this last results from the activities of centres not the highest which in the presence of the decay of the latter are unrestrained. Weakening of power is distributed generally, though in some cases there seems to be a special incidence upon some one faculty. The power of perception diminishes and observation becomes less acute. Attention is concentrated and held with difficulty, so that the power of fixing recent events in memory becomes poor. The affections, of which the sentiments of love, hatred, hope and fear are examples, become enfeebled, and losses of friends, fortune and health produce an effect which often seems surprisingly small. Besides weakening of the power of fixation in memory, there is also diminution of that of conservation. The loss of memory of events progresses, as it were, into the past. Events of comparatively a short time since are forgotten, while the memory of events long past is preserved. In the end, the writing on the tablets of the memory is wholly erased and nothing at all is remembered. Judgment becomes hesitating and uncertain. Appetency fades and the desires of the senile are but of small range. The power of the will is reduced and decision becomes difficult. Manners are often disregarded and even the sense of ordinary decency may be obliterated.

All forms of mental symptoms may occur on this basis of decay, such as mania or melancholia, perhaps with delusions of unworthiness, ruin, or perhaps of the anxious type, occurring in isolated or intermittent attacks or alternating. There may be confusional insanity with or without hallucinations, auditory hallucinations being particularly frequent among the deaf, and associated with temporary delusions of hypochondriasis, grandeur, jealousy and erotism. In this state the patient may make attempts at indecent assault or at rape, or other forms of violence, or at suicide. The delusions may sometimes be fixed and systematised and the resemblance to delusional insanity very great. In certain cases patients become childish and renew infantile tastes, as, for instance, that for playing with toys and dolls.

Superadded to the dementia, *presbyophrenia* or *involutional schizophrenia* may occur. In this case there is confusion, amnesia, loquacity and fabulation, the whole frequently tinged with euphoria. It may occur as a result of even slight infections or auto-intoxications, and passing away leave the patient at a lower level of mental power than he occupied before.

A syndrome, resembling Korsakoff's polyneuritic psychosis, combining general peripheral neuritis with loss of memory, pseudo-reminiscence and preservation of a large measure of judgment and decency of conduct, is sometimes seen.

In the absence of any particular disorder, the uncomplicated physical symptoms of senility are weakness, liability to fatigue on but a small amount of exertion, giddiness and either insomnia or undue sleepiness. The patient gradually gets thinner and loses appetite.

Course.—Senility may come on very gradually over a long period of years or its changes may follow upon each other with almost startling

rapidity. Death eventually comes from cardiac, cerebral or respiratory complications or from intercurrent disease.

Treatment.—The treatment consists in adapting the activities of the patient to his powers, which, it must be remembered, are constantly lessening. Food, work and recreation have to become simpler in character. It is useless to goad the tired body to do things for which it is no longer able. If mental symptoms of a pronounced character arise, it is better and kinder to keep the patient at home in all cases where proper provision can be made for looking after him. It is particularly necessary to exercise close supervision in those cases in which the patient is likely to indulge in erotic conduct or to attempt assaults or suicide. The exercise of undue influence by attendants, friends and relations in order that they may become beneficiaries under the patient's will should, so far as possible, be guarded against, and the medical man may properly warn those concerned of the increased suggestibility and diminished will-power of the patient.

Arterial Disease

Arterial disease plays a large and perhaps preponderating part in the production of the symptoms enumerated under the head of Senility, but, as is well known, it may commence at a period of life which in length of years cannot be called one of senility.

Symptoms.—The symptoms of arterial disease, so far as the nervous system is concerned, may come on very insidiously, quite rapidly or even suddenly. Loss of energy, fatigue following upon slight exertion, diminution of the power of attention, headache and giddiness are very common early symptoms. Some change in character such as irritability, lessening of business faculty and instability of the emotions may have been noticed. Sleep at night is poor, while during the day the patient may scarcely be able to keep awake. With intellectual enfeeblement, there may also be such symptoms as absurd euphoria, indifference to those interests which have hitherto been most cherished, confusion, stupor, anxiety, agitation, hallucinations and delusions. The physical signs of senility with vascular sclerosis, myocardial degeneration and renal sclerosis are also frequently present, as well as such effects of vascular degeneration as pareses, aphasia and paralysis, sometimes transitory and sometimes permanent.

Cerebral Vascular Lesions

The symptoms produced by hæmorrhage and thrombosis of cerebral vessels are in most cases symptoms of involution in so far as they are the results of degeneration of vessels. Thrombosis, embolism and hæmorrhage may in a few cases be the result of trauma, septic or other infection or anæmia, and here involution cannot play any part. Such cases are, however, for convenience included here since the symptoms are similar to those obtaining in hæmorrhage and thrombosis due to vascular degeneration.

Symptoms.—Before the occurrence of the stroke, changes in character and affectivity may have been noticed, together with enfeeblement of memory and impairment of the sense of morality and decency. Inattention, fussiness

and apprehensiveness may have become accentuated. Such symptoms are those of arterial degeneration and, perhaps having previously escaped comment, are only brought to light when the patient's history is being elicited after the stroke has occurred. The initial mental symptoms following the stroke are those of confusion, accentuated and complicated by failure to recognise and classify sensations carried by intact sense organs (agnosia), and inability to execute acts even though the motor apparatus, from the upper motor neurons downwards, is intact (apraxia). A normal relationship with the outside world may never be regained, and confusion of varying degree may persist for the rest of the patient's life. There may, in addition, be states of excitement and depression, with delusions of grandeur, ruin, persecution or concerning religion or love. Hallucinations of all sorts, but especially of hearing and sight, may occur. The patient is likely to be impulsive, and his conduct in general may, in obscenity or in other ways, be different from what was usual with him in health.

Treatment.—The treatment of the symptoms of vascular degeneration is essentially the same when of the nervous as of any other system. The impulsive, absurd and improper behaviour which is the symptom of the mental disorder, requires attentive watching, and if this can be secured at home there is no reason why the patient should be removed elsewhere.

PSYCHASTHENIA

Symptoms at one time frequently included in the comprehensive syndrome which has gone by the name of neurasthenia have been separated from it and have come to be regarded as constituting a clinical entity which has received the name of psychasthenia. It has lately been sought to divide psychasthenia in its turn into an obsessional state and an anxiety state, but both for convenience of description and because this division is not everywhere accepted, the term psychasthenia has been here preserved. The chief points that appear to remove the symptoms which are termed psychasthenic from the syndrome known as neurasthenia are: (1) that there is an absence of such obvious exciting causes as circumstances that exhaust, or toxæmia; (2) that the symptoms are not amenable to treatment appropriate for nerve exhaustion, though they may be temporarily ameliorated thereby; (3) that good somatic health often exists alongside psychic symptoms, though the latter may be accentuated during somatic ill-health; and (4) that there is much more frequently a history of mental and nervous disorders in forbears. The terms neurosis, psycho-neurosis and psychosis have been avoided in this section inasmuch as they convey different notions to different persons and, indeed, are used with varying meaning by many individual authorities.

Ætiology.—Many patients suffering from psychasthenia are derived from families of bad nervous and mental history, but not all the members of such families are necessarily affected. Whether the inherited defect or the home atmosphere made by neurotic parents, in which the patients' earliest years are passed, is the more inimical to balanced growth, remains a moot point, but it is at least noteworthy that psychasthenic patients frequently proceed from homes which for some reason have not been happy in that

one or other parent has been a constant source of irritation or resentment; or the child has been imbued with ridiculous fears—for instance, of the dark or of catching cold; or the parents have bickered or quarrelled; or parents or other attendants have suppressed too ruthlessly infantile longings or affections, or have teased or bullied; or, on the other hand, have encouraged unhealthy sentimentalism; or because something really catastrophic has occurred—for instance, a fire, an accident, an assault, or the death of some one much loved; or, lastly, because the child has never been taught a due amount of consideration for others, unselfishness and self-control—in short, has been spoilt.

The trend of more recent psychological work has been vastly to extend the meaning of education and to include in it not only formal education but also all the influences of example, speech and environment dating from earliest infancy. The acquisitions of mental life are not all represented in consciousness; many associated with emotional tone and with action have by repetition become automatic; and others, owing to their incompatibility with notions later developed, have become repressed and in the normal individual do not so obtrude themselves that conscious thought and conduct are affected. In abnormal individuals, however, these latent or repressed acquisitions tend to affect conscious thought and conduct and so to produce symptoms.

The unstable character with which many, if not all, psychasthenic patients appear to be endowed from an early age may be upset by circumstances often of a very trifling character; small disappointments or disagreements, social or professional slights and trivial somatic disorders or fatigue may produce unpleasant psychic effects of quite extraordinary character, intensity and duration.

Symptoms.—Psychasthenia comprises obsessions, impulses, imperative ideas, doubts, scruples, infirmity of will or abulia, morbid fear or phobia associated with particular circumstances, and states of generalised panic, fear and anxiety. Differentiation between obsessions, impulses and imperative ideas is practically difficult. Imperative ideas are such as insistently intrude themselves into consciousness without reference to the trend of thought proper to the patient in the circumstances in which he finds himself; for instance, an idea may insistently crop up in a patient's mind that he should break with his stick the electric light bulbs in a building in which he may find himself. He does not wish for any conscious purpose whatsoever to break the bulbs, the idea is in no way consciously associated with the purpose for which he is in the building and he is aware that the breaking of the bulbs will afford him no satisfaction, nevertheless he cannot put aside the idea. Imperative ideas may be, as might be supposed, of infinite variety.

An obsession may be defined, though it is not always, as an imperative idea which issues in action; for instance, the patient may not only feel himself compelled to think of breaking the bulbs, but may feel himself compelled to take action and actually to break them. As imperative ideas are varied, so also are obsessions, and may consist in some triviality, such as touching certain objects, or in such grave actions as taking others' goods, or in assaults, even of a homicidal character.

A morbid impulse may be defined as an action without previous conscious ideation or with ideation of extremely short duration; for instance, the

patient smashes the bulbs directly the idea comes into his mind or, indeed, without the idea being formulated in consciousness.

Of the nature of negative obsessions are the symptoms of morbid doubts, scruples and infirmity of will. In such states thought and action are hesitating, since to every idea proposing a line of thought or of action there is at once opposed an idea of negation; for instance, the matter to be decided is whether the patient shall go out-of-doors or stay in, and whether the occasion be trivial or important, an argumentative process commences and proceeds in the patient's mind until very possibly the opportunity for going out is lost. Scruples similarly arise when either trifling or momentous issues are involved.

Imperative ideas, obsessions, impulses, doubts, scruples and weakness of will are almost always accompanied by an affective or emotional tone of unpleasantness, the emotions frequently being concerned with objects normally of indifference or of no value to the individual. Such may consist of mere annoyance at the unwished-for cropping up of foolish, unseasonable and useless thoughts; or apprehension that the condition is one which will pass into insanity; or disgust at the possession of an uncontrolled, puerile and feeble character; or, lastly, a state of fear, insecurity and anxiety which is seemingly wholly unaccountable and which cannot in reason be based on the realities of the situation in which the patient finds himself. Many of these fears have received names, the commoner being *Agoraphobia*, the fear of open spaces; *Claustrophobia*, the fear of being shut in—for instance, in a railway carriage or in a church; *Nosophobia*, the fear of catching disease; and *Erythrophobia*, the fear of blushing. In some persons morbid panic and anxiety are not consciously associated with any particular set of circumstances in which the patient may find himself and may occur either as a continued state of fearful apprehension or in paroxysms.

Symptoms of uncontrollable apprehension and anxiety, whether they take the form of unaccountable fears of the present and the future, or are particularly associated with such disordered functions of the cardio-vascular, respiratory, gastro-intestinal or other systems, as rapid or intermittent heart-beat, dyspnœa, indigestion, epigastric discomfort or "neuralgia," or nocturnal terror, have been grouped under the head of *anxiety neuroses*. Attention has been particularly focused upon these symptoms by Freud's theory that they result from some deviation from "normal sexual life," and by the large crop produced by the Great War.

To differentiate these various symptoms from somewhat similar ones occurring in other abnormal mental states, it should be remembered that there is no marked disorder of perception or of judgment, of memory, of the sense of relationship to time and space or of the sense of personal identity. The patient recognises the morbid character of his affection and the absurdity of his doubts, questionings and foolish conduct. In certain cases, however, in which the imperative ideas are of a harassing and worrying character, or in which the obsessional or impulsive acts are wearying, it may eventually happen that upon the psychasthenic state are engrafted the symptoms of exhaustion or confusional insanity or of melancholia.

The course of the symptoms of the psychasthenic state is extraordinarily variable. Some persons present such symptoms throughout life, the symptoms varying in intensity with somatic health and with mental equanimity, and

perhaps scarcely at all interfering with the course of business or pleasure. Both the patient and his friends learn to bear with his mild eccentricities and, indeed, successfully to ignore them. Others suffer from occasional attacks which appear to be entirely episodic, which leave the patient apparently perfectly well between them and which eventually cease to recur Others again, from the severity of their symptoms, or, as indicated above, from their complication with other mental disorders, break down completely and remain invalids for long periods or for the rest of their lives. No psychasthenic should be considered as finally rid of his affection until his death, and this, indeed, no matter what the nature of the methods of treatment to which he has submitted.

Treatment.—The education of the child derived from families the members of which suffer from nervous or mental affections should be particularly carefully conducted from the earliest infancy. Affection for parents, nurses and others in the child's immediate neighbourhood should be duly balanced, and the affection shown to him should be displayed rather in a cultivated care for his present needs and his future development than in the coddling and caressing which not infrequently alternate with impatience, petulant scolding, shaking and slapping. The ideal of home life which has for long been the aim of almost all the most civilised human communities has perhaps in part consciously or unconsciously been formed by experience of the unhappy effects upon children of early life in which the relations between parents and others has not been harmonious. It is at any rate noteworthy that many nervous and mental patients come from families in which there has been a very decided want of harmony. It is not possible here to do more than to emphasise the importance of a well-thought-out system of education in the case of predisposed individuals and to point out the disastrous effects of a haphazard upbringing by those who themselves are sufferers. In an established case of psychasthenia it is as well to inquire into the circumstances of the education, especially the early education, of the patient; and by education is here meant not that only which is formal and scholastic but also that which lays the foundations of primitive likes and dislikes and the ideas which are associated with these affections. This inquiry may be conducted not only by the ordinary method of minutely questioning the patient but by examination of his free-associations, time-reactions and dreams. The mental enlightenment which ensues upon such an inquiry may of itself suffice to ameliorate symptoms or at any rate to afford the physician an opportunity of effecting some readjustment of the patient's ideas and affections by a process of re-education.

On the somatic side the condition of the alimentary, cardio-vascular, respiratory and renal systems should be examined and any defect remedied as far as possible. Watch should always be kept on the patient's weight and upon the amount and character of his sleep. Both should be a little in excess of the strictly sufficient. If sleep is not good, hypnotics, strictly under medical supervisison, may be employed, but should be varied in character and amount. The physician must never forget that from the ranks of the psychasthenic are derived those who in taking drugs pass beyond therapeutic limits and continue their use for the pleasurable effects. Small doses of the bromides—about grs. v, t.d.s.—are often useful in allaying the acuity of anxiety and restlessness.

PSYCHOTHERAPY

Included in psychotherapy are the endeavours made by the healthy mind to influence therapeutically the unhealthy mind and through it such somatic symptoms as may reasonably be attributed to its faulty operations. The therapeutic action of material things, for instance, drugs and climate, upon the mind is not usually comprehended in the notion of psychotherapy; it may be entitled the physicotherapy of mental disorder, and will not be further alluded to in this chapter.

It is axiomatic that before the commencement of the procedures of psychotherapy a thorough examination of the body should be made, and that such derangements as may have been discovered and are amenable to physicotherapy should be treated, or at least that they should be treated concurrently with the psychotherapeutic measures. It is in cases of purely psychic origin that psychotherapy is at its best, though it is not without its uses where somatic symptoms are associated with those that are mental. If it is of supreme importance that a thorough physical examination should be made before treatment is commenced; so is it equally important that a thorough psychic examination should also be effected. Whereas, however, an adequate physical examination may be made in a few hours, a psychic examination is not unlikely to occupy a quite unlimited amount of time.

In the case of such mental affections as mania, melancholia, dementia præcox and paranoia, of which the ætiology is obscure and in which it may be supposed that there are psychic causative factors, an analysis of the mental state is very desirable, but because of the divertibility, the inaccessibility or delusions of the patient, is extraordinarily difficult save in very mild cases or during remissions.

In hysteria, psychasthenia and in certain cases of epilepsy in which the patient preserves an insight into his mental state, realises that he is in a morbid condition and desires relief, analysis is less difficult and at least can be attempted. The procedures of analysis are designed to explore those regions of the patient's mental field which are not present to his consciousness and some of which can only be discovered by special methods. Here, as it is alleged, lie concealed the sources of those processes which eventually result in symptoms.

The development of the mind in the first place takes place along the channels which seem to be laid down as guides for vital energy, that is, through the instincts, but very early in life the activities of the instincts impinge upon obstacles, some natural, some due to the laws and conventions of society and some to the character of the first human beings with whom the individual has to deal, and thus progress is retarded or thwarted or turned aside or wholly stayed. Later in life habits or automatisms, good or bad, may be opposed in many ways and by influences of very varied sorts: by the desire of sensual gratification or by a revolt from the consequences of such gratification; by the desire and struggle for worldly wealth and position or by the realisation of their essential vanity; by want of faith in high ideals or by a belief in the possibility of their realisation. All these oppositions involve an idea of mental conflict and the expression in thought of the one tendency and the repression of the other. With the repression of the idea

of an action out of consciousness goes also the repression of the affective tone associated with the idea, that is, of its pleasure- or pain-giving qualities. These are often likened to a quantum of energy which must pass in some direction or other or must remain stored up. If the affect cannot pass in the direction of the action equivalent to the repressed idea it may pass in abnormal directions and emerge as symptoms such as phobias or other unreasonable dislikes or likings. Analysis seeks these repressed ideas in order that their affects may be rightly orientated.

Further, normal psychic development passes from the primordial intensely egoistic stage, through affection for those who are near and useful in the gratification of early physical wants to an elevation which varies enormously among different persons. Some never get beyond the first stage and appear not even to care for those who minister to their comforts, others pass to the stage where affection is entirely of the order of cupboard love, and all stages of subsequent elevation may be daily observed up to the point where man transcends himself, and his ego is lost in some great ideal. At some early stage in this path progress may be checked and a morbid fixation of an affect may occur. In this case also analysis seeks the repressed ideas in order that the affect may resume its progress.

It would not be possible here to set forth in detail the procedure of analysis, and a very brief description must suffice. Dreams are examined with care, as they are regarded as a direct expression of unconscious mental processes, and the ideas presented in them are submitted to the processes of free- and time-association. In free-association the patient tells of every thought that comes into his head while the experiment is being held, regardless of its character. In the time-association test the patient is given a word and is directed to say the first word that comes into his head after he has heard it. Prolongation of the reaction interval and peculiarities in replies made are noted and compared. By these methods much of the psychic development of the patient is reconstructed and made objective, while imprisoned affects are freed.

The method of psychotherapy known as re-education would appear to involve a belief that the patient's education has been faulty, that his symptoms are due to this and are capable of being remedied by a fresh process of education. The first two of these assumptions can only be sustained if a prolonged examination of the patient's mental life is first undertaken, and can then only be held as true of the conscious part of his mentality, unless indeed the special methods of analysis are undertaken in addition. Re-education is probably in practice directed less to the enlightenment of the patient's pure cognitions, if any such exist, than to the orientation of his affections or emotions. Whatever our theories as to the fixation or abnormal deviation of affects, there can be very little doubt that neuropathic or psychopathic patients display a degree of self-interest and self-centredness which is astounding, even in this world of egoists, and for the most part the efforts of the re-educationalist are directed to getting the patient out of himself and introducing him to the possibility of other interests. Strictly speaking, conventional exhortations which are so common in medical practice may be regarded as instances of re-education. To enlighten a patient by explaining to him that pain occurring in the lower part of the left side of the thorax is due to indigestion and not to cardiac disease is often of considerable therapeutic value, and it is surprising to notice the intensity of the relief which

frequently ensues upon the bald statement that a disease is functional and not organic. The term Re-education has been further extended to the training in active movement of a limb paralysed from either organic or functional causes, or to the training of control of members of the body which are the subject of abnormal movements, as for instance in habit spasm, or to training in the relaxation of muscles habitually maintained by some patients in a state of functional hypertonus.

Like re-education, Persuasion involves a belief that the patient's views of his disorder and its effects upon him are faulty and that the correction of these will eventuate in a relief of his symptoms. The term Persuasion possibly indicates that the patient's mental condition is due to conscious and intellectual processes and that ratiocinative effort on the part of the physician will correct them if in error. It is, however, probably seldom that persuasion used therapeutically amounts to more than authoritative affirmations made in virtue of the physician's specialised knowledge. Fully to explain his pathological state to a patient would obviously involve in him a considerable amount of such technical knowledge as he does not as a rule possess, and in so far as this knowledge is wanting so far is the argument of the physician removed from the realm of reason. In practice, persuasion, like re-education, resolves itself into an endeavour to secure a fresh orientation of the patient's affections or emotions by inducing him to forget or at least to minimise his symptoms, to think and to act with resolution and courage, and to devote a large part of his thoughts and activities to the interests of others.

Unlike re-education and persuasion, which are avowedly addressed to that part of the patient's mind which is conscious or which can readily be brought into consciousness, a third method of psychotherapy, which usually passes under the name of Suggestion, seeks to influence the tendencies to imitate, to believe, to do what he is told, which are so universal among men, but whose existence in himself is rarely acknowledged or recognised by the average individual. These tendencies, even if not instinctive, are among the very earliest acquisitions of mental life, and one or other at least of them will be found in every one, though they are not in every one capable of exploitation for therapeutic purposes. There is no system of therapy, whether it be confessedly miraculous or mysterious, or mental or physical, which does not to a greater or less extent seek to make use of such authoritative powers as it can muster and by virtue of these to impose itself upon those patients who may seek its help. Successful therapy founded upon pure cognitions, although the dream of the man of physical science, is to-day unknown, and the healer who acquires the confidence of his patient, who induces the patient to do what he is bid and who is emphatic as to the merits of his mode of treatment, will often do more good than the scientist who endeavours to carry his patient with him along a path of pure heuristic ratiocination. The method of suggestion has to some extent been an attempt to legitimatise the frank appeal of the charlatan to the gullibility and gregarious imitativeness of the individual, and its successes have largely been due to the ordered and restrained use of such an appeal. But whereas the charlatan indiscriminately makes use of his unflattering generalisations and applies his method to all without any previous inquiry as to its suitability to individual cases, the psychiater endeavours by mental analysis to discover

in his patient those habits and lines of automatic working which, if they are of value, he can set to work or strengthen by his suggestions or which, if they are nocuous, he can seek to impede or to obstruct. In education, re-education and persuasion it is sought to generate in an individual ideas and new lines of thought which may be of use to him; in suggestion it is sought to arouse, to stimulate and to render preponderant already existing, but latent, trends of thought. In practice the genesis of new ideas or excitation of such as already exist is often confused, for who, indeed, save possibly after a most profound, extensive and long-continued analysis can ascertain precisely when an idea first entered into a patient's mind? But so far as suggestion is practised as such, so far should its particular objects, as above set forth, be borne in mind.

Hypnotism, or the induction of a state resembling somnambulism, often, but not always, renders a patient more suggestible and is therefore used as an adjuvant to suggestion. In some persons, the state may be induced on the word of command or on command associated with some such physical act as looking intently at a small glittering object, or listening to a monotonous sound, or feeling repeated stroking or passes about the face and head. When the state has been induced desirable suggestions are made. A distinction should be made between the hypnotic state and one of mere drowsiness into which complacent patients will often pass as an act of polite acquiescence in the injunctions of the physician.

Merely to catalogue the affections in which hypnotism and suggestion have claimed successes would not be profitable, and it must suffice to set forth that affections of purely psychic origin are those that are most amenable. It should be remembered that such may include sensory disturbances, such as headaches or widely distributed neuralgic pain; motor disturbances, such as paralysis, spasm or abnormal movement; or disorders of various systems, for instance, indigestion, breathlessness or palpitation. The patient, however, must have some insight into his own morbid state and an honest intention of submitting himself to treatment. Disorders of physical origin frequently have secondary symptoms grafted upon them, and these also may sometimes be ameliorated.

Auto-suggestion may here be referred to since it has its uses in medical practice and looms largely in certain forms of extra-medical therapy. Auto-suggestion usually means that the patient has been recommended to suggest to himself that he is getting better of his ills, or that he has no ills, or indeed that there are no such things as ills to have. From any point of view, save that of a spurious "science," it is plainly essential that, before telling a patient that he is getting better, or that he has nothing the matter with him, the medical practitioner should make himself as sure as he possibly can be that the event will not falsify his forecast. In this matter, the charlatan, from the very limitations of his knowledge, has a distinct advantage over the man of science and does, indeed, with his more emphatic assurance, induce a hopeful expectancy of health. The medical practitioner, when he has by examination satisfied himself, if he can, that not even an obscure auto-intoxication, or profound endocrine disharmony, or elaborately symbolised mental complex, is at the root of the patient's disorder, may with profit counsel the patient to turn his thoughts from notions of disease, to break himself of the habit of thinking he is unwell and to create the habit of thinking

he is well. Auto-suggestion as expounded by its more scientific professors does not seek to influence health through the will but through processes regarded as taking place in the "sub-conscious," or the "unconscious." Hence the exhortation mechanically to repeat sentences asserting an expectation of improvement in health, day by day, for a prescribed number of times.

Such are the main outlines of the more important methods of psychotherapy. There are others of miraculous, mysterious or metaphysical origin which can scarcely be considered as within the scope of the present work, but perhaps it may not be wholly out of place to allude to the enormous succour that religion may bring to any form of therapy, even the most physical.

CERTIFICATION

When for various reasons it has been decided to certify a patient suffering from mental symptoms, the course most usually followed is to obtain two medical certificates, one of which is, where possible, under the hand of the patient's usual medical adviser. For reasons which will be obvious, the persons described in the following list are not competent to sign. The petitioner, whose functions we shall presently consider, the superintendent, proprietor or medical attendant of the asylum, hospital or house to which it is proposed the patient shall go; any person interested in the payment made for the patient; the husband or wife, father or father-in-law, mother or mother-in-law, daughter or daughter-in-law, son or son-in-law, brother or brother-in-law, sister or sister-in-law, the partner or the assistant of any of the foregoing persons. It is further provided that the medical practitioners signing the certificates must not be in partnership, nor one of them the assistant of the other; nor must they be related to one another as father, father-in-law, mother, mother-in-law, son, son-in-law, daughter, daughter-in-law, brother, brother-in-law, sister or sister-in-law. It is simpler to fill in the printed formula, which can be procured of a law stationer, than to write the certificate in full. The blank certificates set forth in detail the information required by the Board of Control, and the directions should be carefully followed. It should also be particularly borne in mind that the facts, as observed, which indicate insanity are to be set forth. The inference of the practitioner from the facts or his diagnosis are, for the purposes of the certificate, of no value or interest. For example, to write that a patient has general paralysis is valueless, for one suffering from general paralysis has not necessarily mental symptoms. To write that a patient says he is Emperor of the World is to report a fact indicative of insanity, and is of importance, while it is, on the other hand, of no value for the purposes of certification, whether such a delusion is a symptom of general paralysis or of paranoia or of some other form of mental disorder. If the detailed directions printed on the form be not scrupulously followed, the certificate will be returned for correction by the Board of Control. The medical practitioners signing the certificates must gather the evidence for their certificates in interviews with the patient apart from each other. Certificates must be signed and completed within seven clear days from the date of the interviews.

The person who carries through the business of certification is called

the petitioner, and should be the nearest available next-of-kin to the patient. If a relation be not available a friend or man of business may act. The petitioner has to fill two forms, one the petition and the second the statement. The petition is a request to a judicial authority to order the reception of the patient in an asylum, in a licensed house or in the house of some one undertaking the care of a single patient. The statement consists of a description of the patient's civil state, religion, previous history and of a few other particulars of like nature. The petitioner must have seen the patient within fourteen days of the presentation of the petition, and the petition must be presented not more than seven clear days after the date of the medical examination. The Judicial Authority in England may be a Stipendiary Magistrate, a County Court Judge or a Justice appointed for the purpose. On the presentation of the petition and the medical certificates, the Judicial Authority makes an order for the reception of the patient in the institution or house chosen for him. The Judicial Authority does not necessarily see the patient, but may do so. On medical grounds it is usually undesirable that such an interview should take place, for the intervention of one who does not know how to talk to or deal with a person of unsound mind frequently leads to the latter's detriment. When the order has been signed the legal requirements for the reception of the patient are fulfilled. The patient must be received within seven clear days of the date of the order, or the whole process is annulled and has to be undertaken *de novo*.

If the patient's condition be such that it is deemed desirable that a more expeditious process than that described above should be adopted, an urgency order may be made. The order is in these circumstances made by the nearest available next-of-kin, or by a friend, and is supported by only one medical certificate. The relative or friend making the order must have seen the patient within two days of the order, and the latter must be received within two days of the date of the medical examination. Upon such an order a patient may be detained within an asylum, or house, for seven days from the date of the order, but within that period all the papers required by the normal method of petition and certification must be completed.

In dealing with pauper patients, it is best for the relations or friends to obtain the services of the relieving officer of the district where the patient is domiciled. This officer may act by means of Summary Reception Orders as follows.

When any constable, relieving officer or overseer has knowledge that any person, whether or not a pauper, wandering at large, is a lunatic, it is his duty to take such person before a Justice. Or a Justice may upon information order a constable, relieving officer or overseer to bring an alleged lunatic before him. The Justice then calls upon a medical practitioner to examine and, if necessary, certify, and orders the reception of the lunatic in an institution.

It is the duty of a constable, relieving officer or overseer if satisfied it is for the public safety, or for the welfare of an alleged lunatic, to remove such lunatic to the workhouse of the Union. The Master of the workhouse may detain the alleged lunatic for not more than three days, and before the expiration of that time proceedings as already described must be taken by the constable, relieving officer or overseer.

When the Medical Officer of a Union has knowledge that a pauper resident within his district is a lunatic, it is his duty to give notice to the relieving officer or overseer, who, in his turn, informs a Justice, who orders the relieving

officer or overseer to bring the lunatic before him. It is further the duty of a constable, relieving officer or overseer, if it come to his knowledge that a person, not a pauper, and not wandering at large, is not under proper care and control or is being neglected, to give information under oath to a Justice. The Justice thereupon authorises two medical practitioners to examine the patient, and if necessary to certify. When the person is certified, the Justice makes an order that he shall be placed under care.

If a Justice be satisfied, in any case where a summary reception order might be made, that it is expedient a lunatic should forthwith be placed under care, he may make an order for the lunatic to be taken to a workhouse, but an order so made does not authorise detention for more than fourteen days.

When the question of the sanity of persons of property is raised an Inquisition in Lunacy may be held before a Master in Lunacy or a Judge of the High Court and a Jury. The sanity of the patient and his fitness to look after himself and his property are determined by this tribunal. If he be found unfit to look after himself, a Committee of his person is appointed, and if he be found incapable of looking after his property, a Committee is appointed to attend to it. This method is an expensive one.

A patient may also be certified by order of the Board of Control. In such a case, two or more members of the Board visit the alleged lunatic, not being in an institution or workhouse, and, if they think fit, call in a medical practitioner to examine the patient. If the practitioner certifies, the members of the Board may order the patient to be received in an institution.

It is to be understood in all cases that the medical practitioner who signs a certificate is in very much the same position as a witness who gives evidence in a court of law. The Authority which, according to its discretion, acts or does not act upon the evidence before it, is a Judicial Authority.

TESTAMENTARY CAPACITY

The power to make a will must obviously depend upon the possession of certain mental faculties. From the legal point of view, an individual must have a "disposing mind." His memory must be sufficiently good to enable him to understand the nature and extent of his property, and to remember those who by relationship or otherwise may be considered to have claims upon him. He must also be of sufficient intelligence to understand what a will is, and to appreciate the effect of what he is doing when he makes one. He should be capable of weighing the claims of various persons, and the reasons for the exclusion of some from, and the inclusion of others in, his will. He should not suffer from delusions which may affect his judgment in this respect. The testator should also have a "disposing will," that is, he should be capable of exercising a free and independent choice, unswayed by the suggestions, recommendations or persuasions of interested persons.

ERIC DANVERS MACNAMARA.

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