लाल बहादुर शास्त्री राष्ट्रीय प्रशासन अकादमी
L.B.S. National Academy of Administration
मसूरी
MUSSOORIE
पुस्तकालय
LIBRARY
110727
अवाप्ति संख्या
Accession No. ~~11908~~
वर्ग संख्या
Class No. 617
पुस्तक संख्या
Book No. Pye 15th ed

PYE'S

SURGICAL HANDICRAFT

A MANUAL OF SURGICAL MANIPULATIONS, MINOR SURGERY, AND OTHER MATTERS CONNECTED WITH THE WORK OF SURGICAL DRESSERS, HOUSE SURGEONS, AND PRACTITIONERS

EDITED BY

HAMILTON BAILEY, F.R.C.S.Eng.

Surgeon, Royal Northern Hospital, London; Surgeon and Urologist, County Hospital, Chatham; Surgeon, Consolation Hospital, Lambeth; Senior Surgeon, St. Vincent's Clinic and Italian Hospital; Consulting Surgeon, Metropolitan Ear, Nose, and Throat Hospital, Potters Bar Hospital, and Essex County Council; Formerly External Examiner in Surgery, University of Bristol

FIFTEENTH EDITION, FULLY REVISED
WITH 789 ILLUSTRATIONS

Vel de minimis curat chirurgicus

BRISTOL: JOHN WRIGHT & SONS LTD.
LONDON: SIMPKIN MARSHALL (1941) LTD.

1947

First Edition, September, 1884
Second Edition, October, 1885 — WALTER PYE
Third Edition, July, 1891

Fourth Edition, December, 1899 — BERTRAM M H ROGERS

Fifth Edition, June, 1909
Sixth Edition, October, 1912
Seventh Edition, May, 1916 — W H CLAYTON-GREENE
Eighth Edition, January, 1919
Reprinted, January, 1924
Ninth Edition, December, 1924 — *Editors*

Tenth Edition, January, 1931 — H W CARSON

Eleventh Edition, December, 1938
Twelfth Edition, July, 1940
Thirteenth Edition, September, 1942
Reprinted, July, 1943 — HAMILTON BAILEY
Fourteenth Edition, September, 1944
Reprinted, June, 1945
Fifteenth Edition, February, 1947

SPANISH EDITION in preparation

PRINTED IN GREAT BRITAIN BY JOHN WRIGHT AND SONS LTD., BRISTOL, ENGLAND

PREFACE TO THE FIFTEENTH EDITION

SINCE Lister's day *Pye's Surgical Handicraft* has served succeeding generations of house surgeons and practitioners. If the present generation are to regard their 'Pye' with the same confidence, nay, even affection, as did their predecessors, the pages of the fifteenth edition must be replete with topical requirements.

To-day a large and highly technical field has to be presented in a manner which will harmonize with current practice. With the help of the contributors, and the co-operation of the publishers, I have endeavoured to embrace this field, which, without such assistance, seemed bereft of a horizon.

In the more leisured days of the carriage and pair the reader had time to peruse comparatively long descriptive matter illuminated only here and there by a woodcut. To save the reader of this fifteenth edition time in building up his own conception of the written word, I have striven to present technical procedures pictorially. This has necessitated a very large number of additional illustrations and the replacement of many others, but the space allocated to the text has thus become relatively unburdened and has been left with some measure of freedom to convey rationale. To improve and perfect our technique is an admirable goal, but the true surgical craftsman must always have reasons for the measures he employs. Such reasons, based on physiology, pathology, anatomy, and kindred sciences, have been stressed throughout the book.

I acknowledge with gratitude the help afforded me by the careful proof-reading of Mr. John Boyes, and Drs. D. N. Baron, J. S. F. Hutchison, A. Jolleys, A. J. Marsden, and H. M. Rayner.

86, *Brook Street, W.*1. HAMILTON BAILEY.

LIST OF CONTRIBUTORS

HAMILTON BAILEY, F.R.C.S.Eng., Surgeon, Royal Northern Hospital, London; Surgeon and Urologist, County Hospital, Chatham; Senior Surgeon, St. Vincent's Clinic and the Italian Hospital; Consulting Surgeon, Metropolitan Ear, Nose, and Throat Hospital, Potters Bar Hospital, and Essex County Council; Formerly External Examiner in Surgery, University of Bristol.

The Arrest of Hæmorrhage—1. Resuscitation (jointly)—7. Hollow-needle Technique in Injection Therapy (jointly)—29. Saline and Other Infusions—40. Blood Transfusions and Plasma Infusion (jointly)—54. Transnasal Gastric, Duodenal, and Intestinal Intubation: Technique and Uses—133. Newer Methods of Dressing Wounds: Factors in Wound Healing—175. The Management of Head Injuries—181. The Management of Thyroid Cases—192. The Management of Gastric Cases—210. The Management of Gall-bladder and Pancreatic Cases—216. The Management of Lower Abdominal Cases—220. The Management of Renal Cases—235. Catheters and Catheterization—243. The Management of Bladder and Prostatic Cases—251. The Management of Some Complications after Abdominal Operations—270. Bandages and Bandaging (jointly)—286. Bandages and Bandaging: Adhesive Plaster Technique (jointly)—295. Some General Principles in Minor Operations—308. Minor Operations on the Male Genital Organs—316. The Treatment of Abscesses—351. The Treatment of Carbuncles and Bed-sores (jointly)—357. The Treatment of Infections of the Hand—363. Lumbar Puncture and Allied Procedures (jointly)—394.

STELLA M. BECKETT, S.R.N., S.C.M., R.F.N., Theatre Sister, St. David's Wing, Royal Northern Hospital, London

Bandages and Bandaging (jointly)—286.

C. ALLAN BIRCH, M.D., F.R.C.P., D.C.H., D.P.H., Physician, Chase Farm Hospital, Enfield

The Administration of Sera (jointly)—63. Sulphonamide Therapy—276. Lumbar Puncture and Allied Procedures (jointly)—394.

DENIS BROWNE, F.R.C.S.Eng., Surgeon to the Hospital for Sick Children, Great Ormond Street, London.

The Management of Hare-lip and Cleft-palate Cases—189. Operations upon the Tonsils—401.

JOHN BRUCE, M.B., F.R.C.S.Edin., Lecturer on Clinical Surgery, University of Edinburgh, Pediatric Surgeon, Leith Hospital; Assistant Surgeon, Edinburgh Royal Infirmary.

Resuscitation (jointly)—7. Preparation for Operation—87.

E. G. B. CALVERT, M.D.Belfast, F.R.C.P.Lond., D.P.H., Physician, Royal Northern Hospital; Physician, National Temperance Hospital; Consulting Physician, Samaritan Free Hospital for Women; Consulting Physician, Victoria Hospital, Kingston-on-Thames.

Examination of the Urine—68. Renal Function Tests—226.

E. NOBLE CHAMBERLAIN, M.D., M.Sc.Liverp., F.R.C.P.Lond., Lecturer in Medicine, University of Liverpool; Physician, Royal Liverpool United Hospital, Royal Southern Hospital; Visiting Physician, Smithdown Road Hospital, Liverpool.

Diabetes and Operations—95.

HENRY COHEN, M.D.Liverp., F.R.C.P.Lond., F.F.R., Professor of Medicine, University of Liverpool; Physician, Royal Infirmary, Liverpool.

Post-operative Hypnotics and Sedatives—114.

J A. EAST, B.Sc., M.B.Lond., F.R.C.S.Eng., Surgeon, County Hospital, Chatham.

Blood Transfusions and Plasma Infusion (jointly)—54. The Treatment of Carbuncles and Bed-sores (jointly)—357. The Relationship of the House Surgeon to his Chiefs, his Patients, and the Nursing Staff (jointly)—629.

ELLIOTT EMANUEL, B.A., B.M., B.Ch.Oxon, D.C.H., Capt., R A M C., Late Resident Medical Officer, Royal Manchester Children's Hospital.

Technical Procedures for Infants and Children—in various chapters.

GEORGE G. EXNER, M.R.C.S., L.R.C.P.Lond., D.M.D.Berlin, L.D.S., R.C S.Eng., Consulting Surgeon, Eastman Dental Clinic; Dental Surgeon, Miller General Hospital, Greenwich.

The Teeth—449.

A. G. TIMBRELL FISHER, *M.C.*, M B., Ch B., F.R C.S.Eng., F.I.C.S., Orthopædic Surgeon to the Order of St. John Clinic; and to the Arthritic Unit, St Stephen's Hospital (L C C.).

Treatment of Bruises and Sprains—472. Treatment by Manipulation—476.

FREDERICK PATRICK FITZGERALD, M A., M.B., B Ch.Dublin, F R C.S.I., Assistant Orthopædic Surgeon, Royal Northern Hospital (Temp.); Orthopædic Consultant, L C.C.

Minor Operations and other Procedures which concern the Feet—343. Plaster-of-Paris Technique—486. The Treatment of Tuberculous Joints—578.

WILLIAM BASHALL GABRIEL, M.S.Lond., F.R.C.S.Eng., Surgeon, Royal Northern Hospital; Surgeon, St. Mark's Hospital for Diseases of the Rectum

The Management of Rectal Cases—258. Minor Ano-rectal Operations—324.

H E GRIFFITHS, *C B E.*, M S.Lond., F R C.S.Eng., Surgeon, Albert Dock Hospital, Consulting Surgeon, Wimbledon Hospital and Hertford County Hospital

Assessment of Incapacity—625.

B. JOAN HARAM, M R C S Eng., L R C P Lond., Pathologist, Elizabeth Garrett Anderson Hospital, London

The House Surgeon and the Pathological Department—163.

FRANK DUDLEY HART, M.D.Edin., M R.C.P.Lond., Major, R A M C., Late Medical Registrar, Westminster Hospital.

Post-operative Pulmonary Complications—117. The House Surgeon and the Radiological Department (II)—158. Medical 'Operations'—379.

A E. HODGSON, M.D.Edin., D P.H.Camb., Medical Superintendent, City Hospitals, Fazakerley, Liverpool, Lecturer in Infectious Diseases in the University of Liverpool.

The Administration of Sera (jointly)—63.

J. LEIGHTON HOPKINS, L.M.S.S.A., D.A., Anæsthetist to the Metropolitan Hospital, Hounslow Hospital, East Ham Memorial Hospital, Italian Hospital, and the Miller General Hospital, Greenwich

Pre-operative Medication and Basal Narcosis—97. General Anæsthesia—596. Intravenous Anæsthesia—607.

I ILLINGWORTH-LAW, M A Cantab., M.R.C.S., L.R.C.P Lond., Surgical Registrar and Penicillin Officer, Royal Northern Hospital, London.

Penicillin Therapy—282.

A. E W. McLACHLAN, M.B., D.P.H.Edin., F.R.S.E., Lecturer in Venereal Diseases, Bristol University, Consultant in Venereal Diseases, City and County of Bristol.

The Treatment of Gonorrhœa—461. The Treatment of Syphilis and Chancroid—468.

HENRY HERBERT MacWILLIAM, M.B., B.Ch.Belfast, D.P.H.Liverp., Medical Superintendent, Walton Hospital, Liverpool.

Hospital Administration—631.

CECIL P MALLEY, M B , B Ch Dublin; F.R.C.S Eng., Surgeon, Metropolitan Ear, Nose and Throat Hospital; Aural Surgeon, St. Mary's Hospital for Women and Children, Plaistow.

The Larynx—413.

HUGH LESLIE MARRIOTT, M.D., F.R.C.P Lond., Physician to Out-patients, Middlesex Hospital, Physician, St. Saviour's Hospital.

The Treatment of Acute Poisoning—611.

NORMAN MURDOCH MATHESON, M.B , Ch B., M.R.C P Lond., F.R C.S Eng., F.A.C.S., Surgeon, Staines County Hospital.

Assisting at Operations—100. Repair of Operative Incisions—108. The House Surgeon and the Radiological Department (1)—147.

D N MATTHEWS, *O.B.E.*, M A , M.D., M Ch Cantab, F.R C.S.Eng., Assistant Surgeon, University College Hospital; Civilian Specialist in Plastic Surgery to the R A F , late Surgical Specialist, R A F V.R ; late Surgical Officer-in-Charge, R A F Plastic Unit, late Surgical Chief Assistant, Westminster Hospital.

The Treatment of Burns—15.

ALLAN H MORLEY, M.B , B S.Lond , M.R.C S , L.R C P., Joint Medical Officer, Mill Hill School.

Vaccination—391.

DAME ELLEN MUSSON, *D.B E*, R.R.C , LL D , S R N , formerly Chairman of the General Nursing Council for England and Wales

The Relationship of the House Surgeon to his Chiefs, his Patients, and the Nursing Staff (jointly)—629.

DONALD C NORRIS, M.D Lond , F.R.C S Eng , Barrister-at-Law, the Inner Temple , Chief Medical Officer, Metropolitan Water Board, London , Medical Officer, Bank of England

Medico-legal Reports—621.

J B OLDHAM, *V.D* , M.B., Ch.B Liverp., F.R C.S.Eng , Surgeon, Royal Liverpool United Hospital, Lecturer in Surgery, University of Liverpool; Consultant in Surgery to the Admiralty

The Treatment of Varicose Veins and Ulcers—371.

SISTER PAULINE, *C.B E.*, S R N., S C.M., C.S.M.M G., M.S.R., Theatre Sister, St Vincent's Clinic, London.

Hollow-needle Technique in Injection Therapy (jointly)—29. Bandages and Bandaging : Adhesive Plaster Technique (jointly)—295.

EVELYN C. PEARCE, S R N., R.F.N., M.M.G., T.M.G , C.S.M.M.G., formerly Senior Nursing Tutor, The Middlesex Hospital; Member of the General Nursing Council for England and Wales.

The Administration of Enemata—143.

WILLIAM BENTLEY PURCHASE, *M.C.*, M.A., M.B.Cantab., M.R.C.S., L.R.C.P. D.P.H., Barrister-at-Law, the Inner Temple; H.M. Coroner, Northern District, London.

Certification of Death and Reporting to the Coroner—638.

JOCELYN M. W. REED, C.S.M.M.G., T.M.G., In charge of Physiotherapy Department, E.M.S. Hospital, Harefield, Middlesex.

Post-operative Breathing and Other Exercises—128.

T. HOLMES SELLORS, M.A., D.M., M.Ch.Oxon., F.R.C.S.Eng., Surgeon, London Chest Hospital and Queen Mary's Hospital for the East End; Consulting Thoracic Surgeon, London County Council, etc.

The Management of Surgical Thoracic Cases—196.

SYDNEY A. SMITH, *C.B.E.*, M.D., F.R.C.P.Edin., Regius Professor of Forensic Medicine, University of Edinburgh.

Death Certification in Scotland—640.

R. SCOTT STEVENSON, M.D., F.R.C.S.Edin., Surgeon, Metropolitan Ear, Nose, and Throat Hospital; Consulting Ear, Nose, and Throat Surgeon, Hayes Hospital, Middlesex, Heatherwood Hospital, Ascot, and London County Council Tuberculosis Hospitals and Sanatoria.

The Ear—419.

W. H. TUCK, F.I.B.S.T., Works Manager, The Royal National Orthopædic Hospital, London.

The Ordering of Surgical Appliances and Splints—586.

MICHAEL VLASTO, M.B., B.S.Lond., F.R.C.S.Eng., Surgeon to Ear, Nose, and Throat Department, West London Hospital; Consulting Aural Surgeon to Queen's Hospital for Children.

The Nose and Accessory Sinuses—406.

SIR REGINALD WATSON-JONES, B.Sc., M.Ch.Orth., F.R.C.S.Eng., Orthopædic Surgeon to H.M. the King; Consultant in Orthopædic Surgery to the Royal Air Force; Director of Orthopædic and Accident Service, the London Hospital, Surgeon to the Robert Jones and Agnes Hunt Orthopædic Hospital; Honorary Director of Rehabilitation to the Miners' Welfare Commission.

Emergency Treatment of Fractures—503. Treatment of Wounds and Compound Fractures—509. General Principles in the Treatment of Fractures—514. Complications of Fractures—521. Fractures and Dislocations of the Upper Limb—525. Fractures and Dislocations of the Bones of the Face, Spine, and Pelvis—549. Fractures and Dislocations of the Lower Limb—556.

NORMAN WHITE, M.A., M.D.Cantab., F.R.C.S.Eng., F.R.C.O.G., Obstetric Surgeon, University College Hospital; Gynæcological Surgeon, Royal Northern Hospital.

Gynæcological Procedures and Minor Operations (jointly)—332.

J. E. M. WIGLEY, M.B.Melbourne, F.R.C.P.Lond., Physician for Diseases of the Skin, Charing Cross Hospital; Physician, St. John's Hospital for Diseases of the Skin, London; Consultant Dermatologist, London County Council.

The Skin—455.

FREDERICK ARNOLD WILLIAMSON-NOBLE, B.A., M.B.Cantab., F.R.C.S.Eng. (with Ophthalmology), Ophthalmic Surgeon, St. Mary's Hospital, National Hospital for Paralysis and Epilepsy, and Central London Ophthalmic Hospital.

The Eye—428.

STANLEY W. WRIGHT, M.B., B.S.Lond., M.R.C.O.G., Senior Obstetric Surgeon, County Hospital, Chatham.

The Management of Gynæcological Cases—265. Gynæcological Procedures and Minor Operations (jointly)—332.

CONTENTS

CHAPTER		PAGE
I.	The Arrest of Hæmorrhage	1
II.	Resuscitation	7
III.	The Treatment of Burns	15
IV.	Hollow-needle Technique in Injection Therapy	29
V	Saline and Other Infusions	40
VI.	Blood Transfusions and Plasma Infusion	54
VII	The Administration of Sera	63
VIII	Examination of the Urine	68
IX	Preparation for Operation	87
X	Diabetes and Operations	95
XI.	Pre-operative Medication and Basal Narcosis	97
XII	Assisting at Operations	100
XIII	Repair of Operative Incisions	108
XIV.	Post-operative Hypnotics and Sedatives	114
XV	Post-operative Pulmonary Complications	117
XVI	Post-operative Breathing and Other Exercises	128
XVII	Transnasal Gastric, Duodenal, and Intestinal Intubation Technique and Uses	133
XVIII.	The Administration of Enemata	143
XIX	The House Surgeon and the Radiological Department (I)	147
XX	The House Surgeon and the Radiological Department (II)	158
XXI	The House Surgeon and the Pathological Department	163
XXII.	Newer Methods of Dressing Wounds Factors in Wound Healing	175
XXIII.	The Management of Head Injuries	181
XXIV.	The Management of Hare-lip and Cleft Palate Cases	189
XXV	The Management of Thyroid Cases	192
XXVI	The Management of Surgical Thoracic Cases	196
XXVII	The Management of Gastric Cases	210
XXVIII	The Management of Gall-bladder and Pancreatic Cases	216
XXIX.	The Management of Lower Abdominal Cases	220
XXX.	Renal Function Tests	226
XXXI.	The Management of Renal Cases	235
XXXII	Catheters and Catheterization	243
XXXIII.	The Management of Bladder and Prostatic Cases	251
XXXIV.	The Management of Rectal Cases	258
XXXV.	The Management of Gynæcological Cases	265
XXXVI	The Management of some Complications after Abdominal Operations	270
XXXVII	Sulphonamide Therapy	276
XXXVIII.	Penicillin Therapy	282
XXXIX.	Bandages and Bandaging	286
XL.	Bandages and Bandaging: Adhesive Plaster Technique	295
XLI.	Some General Principles in Minor Operations	308

CHAPTER		PAGE
XLII.	Minor Operations on the Male Genital Organs	316
XLIII.	Minor Ano-rectal Operations	324
XLIV.	Gynæcological Procedures and Minor Operations	332
XLV.	Minor Operations and other Procedures which concern the Feet	343
XLVI.	The Treatment of Abscesses	351
XLVII.	The Treatment of Carbuncles and Bed-sores	357
XLVIII.	The Treatment of Infections of the Hand	363
XLIX.	The Treatment of Varicose Veins and Ulcers	371
L.	Medical 'Operations'	379
LI.	Vaccination	391
LII.	Lumbar Puncture and Allied Procedures	394
LIII.	Operations upon the Tonsils	401
LIV.	The Nose and Accessory Sinuses	406
LV.	The Larynx	413
LVI.	The Ear	419
LVII.	The Eye	428
LVIII.	The Teeth	449
LIX.	The Skin	455
LX.	The Treatment of Gonorrhœa	461
LXI.	The Treatment of Syphilis and Chancroid	468
LXII.	The Treatment of Bruises and Sprains	472
LXIII.	Treatment by Manipulation	476
LXIV.	Plaster-of-Paris Technique	486
LXV.	Emergency Treatment of Fractures	503
LXVI.	Treatment of Wounds and Compound Fractures	509
LXVII.	General Principles in the Treatment of Fractures	514
LXVIII.	Complications of Fractures	521
LXIX.	Fractures and Dislocations of the Upper Limb	526
LXX.	Fractures and Dislocations of the Bones of the Face, Spine, and Pelvis	549
LXXI.	Fractures and Dislocations of the Lower Limb	556
LXXII.	The Treatment of Tuberculous Joints	578
LXXIII.	The Ordering of Surgical Appliances and Splints	586
LXXIV.	General Anæsthesia	596
LXXV.	Intravenous Anæsthesia	607
LXXVI.	The Treatment of Acute Poisoning	611
LXXVII.	Medico-legal Reports	621
LXXVIII.	Assessment of Incapacity	625
LXXIX.	The Relationship of the House Surgeon to his Chiefs, his Patients, and the Nursing Staff	629
LXXX.	Hospital Administration	631
LXXXI.	Certification of Death and Reporting to the Coroner	638
LXXXII.	Death Certification in Scotland	640
	Index	642

INTRODUCTION

By HAMILTON BAILEY

SIXTY years have passed since the initial publication of Pye's *Surgical Handicraft*; it was one of the first medical books to be published by Messrs. John Wright & Sons Ltd.

When we reflect that only eight books out of every thousand that are published live for twenty years, and that the life of a book on an ever-advancing subject like surgery is very much shorter than the average, it is clear that Mr. Pye put into the hands of the profession a work of exceptional merit.



WALTER PYE
1853–1892

While still a final-year medical student at St. Bartholomew's Hospital, Walter Pye wrote a series of articles on the development of the kidneys, which attracted much attention, revealing his originality and literary ability. After he qualified in 1876 and had spent a year in resident appointments at his own hospital, he was elected Lecturer on Physiology at St. Mary's Hospital Medical School. It was not long before a vacancy occurred on the surgical staff of St. Mary's Hospital, and although only 24 years of age, Pye was elected. Among other appointments which followed was that of assistant in the Museum

of the Royal College of Surgeons, and in the course of these duties Pye had to revise the catalogue of surgical instruments. For this task he enlisted the aid of the senior cutler of the firm of Messrs. Weiss & Sons. There can be little doubt that the combined duties of demonstrating practical surgery at St. Mary's Hospital and working with a practical instrument maker at the Royal College of Surgeons inspired *Surgical Handicraft*. While preparing the third edition, Pye contracted influenza, it is said that the additional strain entailed by bringing the book up to date under adverse conditions led to his breakdown. He went to Cairo to seek health, but on his return it was only too evident that he was suffering from progressive organic nervous disease, from which he died on Sept. 2, 1892, at the age of 39.

When I assumed the editorship in 1938 I set about my task in a way of which I believe Mr. Pye would have approved; I inquired from House Surgeons and Practitioners what they wanted to find in a book of this character. I have continued this policy, but so vast is the horizon of surgery to-day compared with that of sixty years ago that without the specialized help of the contributors it would have been impossible for me to have continued to provide what Mr. Pye provided—a practical handbook suited to the needs of the reader.

SURGICAL HANDICRAFT

CHAPTER I

THE ARREST OF HÆMORRHAGE

By HAMILTON BAILEY

"Bis dat qui cito dat"—"He gives twice who gives it quickly".

I. BY DIGITAL COMPRESSION

BECAUSE of the fatigue which it produces, digital compression cannot be continued for more than ten minutes or a quarter of an hour. Long before that time, however, help may have arrived, or an improvised tourniquet may have been applied.

The position of the hand and finger to be employed will vary, but as a rule the thumb had better be used to make the pressure, and be reinforced if necessary by that of the other hand. The limb must always be raised.



Fig. 1.—The control of hæmorrhage from the lip by compressing the coronary arteries.

Arteries of the Head and Neck.—In cases of injury to the scalp, the underlying skull affords an admirable resisting surface for compression.

Bleeding from the lip forms an exception to the rule of making digital compression against bone, for the coronary arteries are best compressed between the index fingers and thumbs (*Fig.* 1).

Bleeding from the Tongue.—When hæmorrhage occurs from the posterior part of the tongue Heath's method should be employed. A finger is passed as far back as possible and the tongue is hooked forward on to the mandible.

Common Carotid Artery.—The thumb should be placed over the artery at the level of the transverse process of the sixth cervical vertebra, which is about

1½ inches above the sternoclavicular articulation; pressure should then be made *inwards* and backwards. In this way the artery is forced away from the jugular vein and vagus nerve, and is compressed against the sixth transverse process (Chassaignac's tubercle) (*Fig.* 2).

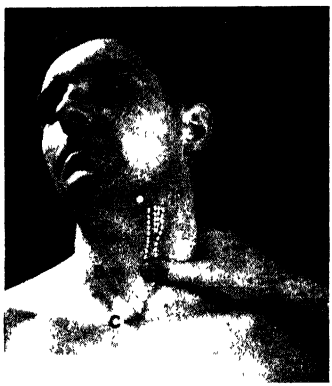


Fig. 2.—Compression of the common carotid artery over Chassaignac's tubercle. A, Pomum Adami; B, Cricoid; C, Manubrium

Subclavian Artery.—The only part of the subclavian artery which can be compressed is the third; this is sometimes difficult and sometimes easy to perform.

The bone against which it is to be pressed is the upper surface of the first rib, immediately outside the tubercle for the insertion of the scalenus anticus. In children or thin people, pressure behind the clavicle downwards and *backwards* (*Fig.* 3), at the inner margin of the subclavian triangle, will control the circulation, no matter what the position of the limb and neck may be; but in even moderately fat people it will be necessary to depress the clavicle and shoulder to bring the artery near enough to the surface.

Various devices, such as the handle of a door key, properly padded, have been devised to effect the necessary compression in obese and muscular individuals.

Axillary Artery.—The lower half of the second part, and the third part, are tolerably superficial, and can be compressed in the axilla if the arm is raised. The pressure is made against the humerus in the same manner as in the brachial (*see below*), and the vessel can be localized quite easily as it crosses to the outer side of the axillary space.

Brachial Artery.—By reason of the number of accidents to which the upper limb is liable, this artery requires compression more frequently than all the others put together.

As the brachial artery is practically subcutaneous in its whole length, it can be compressed readily against the humerus. The inner edge of the biceps, which overlaps it in the middle third, is the guiding line for the vessel (*Fig.* 4).



Fig. 3.—Compression of the third part of the subclavian artery.

Femoral Artery.—The compression of this artery as it lies over the pelvic brim is required frequently. In this situation the circulation may be completely controlled by making pressure directly backwards, i.e., at right angles to the surface, midway between the pubic symphysis and anterior superior iliac spine (*Fig.* 5).

As far as possible pressure on the vein should be avoided; the inguinal

glands, too, as they lie parallel with Poupart's ligament, must be avoided, and if they are enlarged this is sometimes difficult.

The line of the *superficial femoral artery* is one taken from the point above mentioned, between the symphysis and anterior superior iliac spine, and the adductor tubercle of the femur. When the knee is slightly flexed, and the thigh rotated outwards, firm pressure all along this line will generally succeed in stopping the current of blood ; but as the artery gets deeper in its course, more and more force is required. The artery cannot be pressed directly against the bone.

Abdominal Aorta.—In some cases the digital compression of this artery is not so extremely difficult as is often supposed. It can generally be effected in children, and in adults if they are thin, with lax abdominal walls and a bold anterior vertebral curve, and especially in women who are sparely nourished and have borne children.

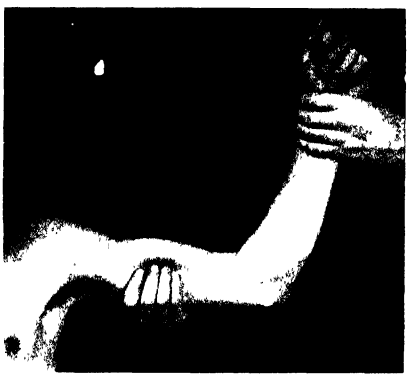


Fig 4.—Compression of the brachial artery.



Fig 5.—Compression of the common femoral artery.

The spot where this compression should be made is a point three-quarters of an inch above a line drawn across the abdomen from one iliac spine to the other (the level of the aortic division into the two common iliacs), and a little to the left of the middle line. The exact position of the artery should be ascertained before pressure is made, for frequently it is in the middle, or may even deviate somewhat to the right.

The digital compression is best and most readily made by the middle finger and forefinger of one hand, beneath which a small pad of lint should be placed, reinforced by the pressure of the fingers of the other hand.

II. BY TOURNIQUETS

Tourniquets are employed : (1) to arrest hæmorrhage ; or (2) to ensure a bloodless field during certain operative procedures on limbs. There is not a better demonstration of the old adage " it does more harm than good " than a badly applied tourniquet.

A tourniquet must never be left unreleased for more than twenty minutes. If by the end of this time compression is still necessary, the tourniquet should be loosened sufficiently to allow some blood to escape, when it is tightened once again. In this way gangrene may be averted.

The application of a tourniquet consists of two manœuvres :—

1. Elevation of the limb. This allows the venous blood to drain away by gravity, and at the same time produces a reflex constriction of the arterioles. This latter effect occurs after a period of elevation of about two minutes. Lord Lister demonstrated

this by the sudden blanching of a limb which occurs when it has been held up for that length of time.

2. The application of the constricting agent. Of the many patterns of tourniquets available only a few can be described.

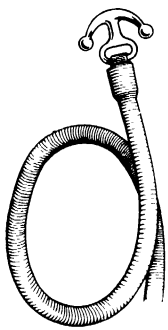


Fig. 6.—Samway's tourniquet

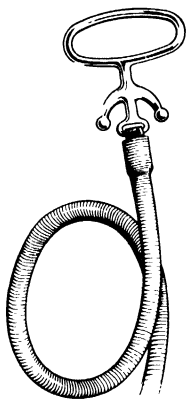


Fig. 7.—Callander's modification of Samway's tourniquet.

Samway's Tourniquet.—This consists of a length of stout rubber tubing with an anchor-shaped metal clip attached to one end (*Fig.* 6). Callander's modification (*Fig.* 7) enhances the ease of application.

The limb is elevated by an assistant, and at the end of two minutes the tourniquet is applied. The skin is protected by several layers of towelling or lint. The most important turn is the first; every endeavour should be made to make it as tight as possible. The anchor is held against the limb with one hand, while the rubber tubing is passed behind the limb and then stretched to its utmost by the other hand (*Fig.* 8). In order to get a good purchase, a fairly short length of the tubing is stretched in this way.

Keeping the tube stretched, it is applied to the limb, and when the turn is completed it is gripped by the thumb and index finger of the hand holding



Fig. 8.—The application of Samway's tourniquet. The first turn.



Fig. 9.—The application of Samway's tourniquet. Locking the tubing in the anchor.

the anchor. Another two or three turns are similarly obtained, and the free end held by passing it, still stretched, behind the flukes and over the shaft of the anchor (*Fig.* 9). Care should be taken to see that the skin is not pinched between the loops. This is a useful tourniquet for the thigh, but it should not be employed for the upper limb—the integrity of nerves, especially the radial (musculospiral), is endangered.

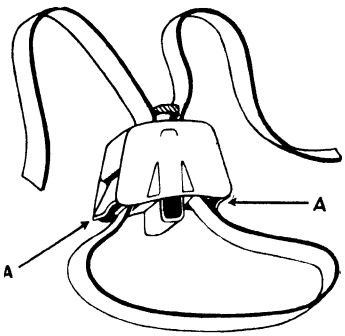


Fig 10.—The L. P. L. tourniquet.

The Pneumatic Tourniquet.—Several patterns are available. The cuff of a sphygmomanometer is a pneumatic tourniquet. A pressure of 200 mm. Hg will usually ensure avascularity of the arm without damaging nerves or muscles.

The L. P. L. Tourniquet (*Fig.* 10).—The L. P. L. tourniquet is so easy to apply and release that it is possible for the tourniquet to be applied by the patient himself (e.g., a wounded airman). By pulling on one end of the stout rubber band the tourniquet tightens automatically. The rounded metal bar should lie over the main artery and when the screw is turned considerable direct pressure is exerted on this underlying vessel. The release of the tourniquet is effected by approximating the finger grips (A).



Fig. 11.—Esmarch's bandage applied

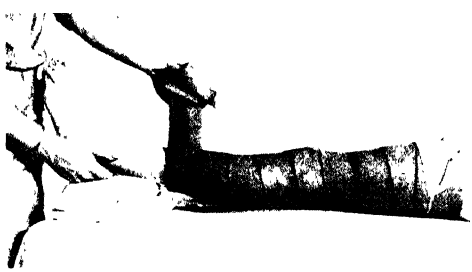


Fig. 12.—Beginning below, the bandage is removed. The major portion of the bandage is unwound.

Esmarch's Bandage is made of strong, flat rubber, 3 in. wide by 6 yd. long, with two tapes at one end.

The limb is elevated, and after an interval the rubber bandage is wound around the limb from below upwards. Each turn of the bandage is fully stretched before being applied to the limb, and each turn should just meet edge to edge, or barely overlap, the preceding one. When the middle of the thigh or arm is reached, several turns are made directly over each other, and the tapes tied. If there is still a considerable quantity of the roll left, it is tucked under the last two or three turns (*Fig.* 11), instead of unrolling it, so as to act as a pad and apply direct pressure on the femoral or brachial artery.

Beginning below, the bandage is now unwound (*Fig.* 12) as far as necessary to expose the field of operation. There is no danger of the upper part becoming loose if the tourniquet is correctly applied. If the turns are made to overlap, difficulty will be encountered in unwinding the bandage.

CHAPTER II

RESUSCITATION

By HAMILTON BAILEY and JOHN BRUCE

"Lateat scintillula forsan"—"a small spark may perhaps lie hid". This is the motto of the Royal Humane Society, the pioneers of resuscitation of the apparently drowned.

ARTIFICIAL RESPIRATION

THE common mistake of the novice is to perform artificial respiration too quickly. Slow forcible movements are the best; twelve times per minute is the rate for an adult, and somewhat faster for a child. More rapid speeds do the patient no good and only tire the operator. How long to persevere will depend upon circumstances. In general, it may be stated that if it is considered that artificial respiration is worth while attempting, it should not be abandoned until at least twenty minutes have elapsed. Success has attended efforts sustained over much longer periods. For instance, recovery has been recorded in a case of electric shock after eight hours' artificial respiration.

The best method of performing artificial respiration has not been determined. The following selection from a large number of methods should meet most requirements.

The Direct Method was employed by **Elisha.**—"And he put his mouth upon his mouth". It is still valuable, especially in infants and children and in cases of fractured ribs where pressure on the thorax is contra-indicated. A handkerchief is placed over the mouth or nose and the operator blows through it gently. In children, it is better to blow through the mouth, so as to avoid possible obstruction by adenoid tissue. When inflating the lungs through the mouth the nose should be pinched and the chin held forwards. When inflating through the nose, the mouth must be kept closed. The breath easily enters and inflates the lungs, and it is expelled preferably with the help of gentle pressure on the chest or abdomen. The process is repeated every five seconds. In the operating theatre the mask of a gas inhaler is generally at hand, and this makes an admirable funnel through which to blow (*Fig.* 13).



Fig. 13.—The direct method of performing artificial respiration, using a mask of an anæsthetic apparatus.

Silvester's Method (*Fig.* 14) is the method most easily applied in the operating theatre.

Shafer's Method is the standard method of resuscitating the apparently drowned. Place the patient face downwards on the ground, preferably with a part of a folded coat under the lower chest. Do not lose time in attempting to remove his clothing. Begin artificial respiration as follows:—

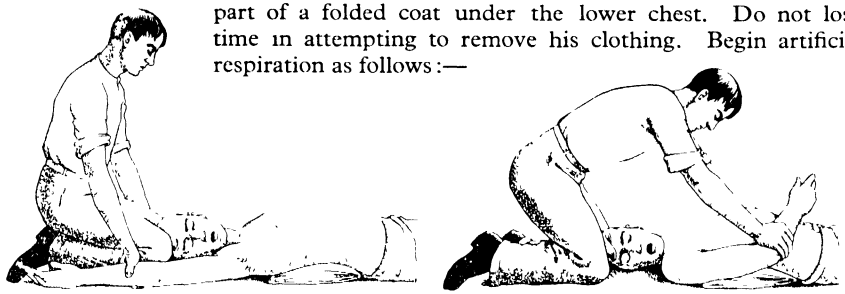


Fig. 14.—Silvester's method of artificial respiration

1. Place yourself, in a kneeling position, athwart the patient's body, facing his head.

2. Place your hands flat over the lowest ribs (*Fig.* 15), and gradually throw the weight of your body forward on to them, so as to produce firm pressure —which must not be violent— upon the patient's chest. Count one, two, three, slowly.

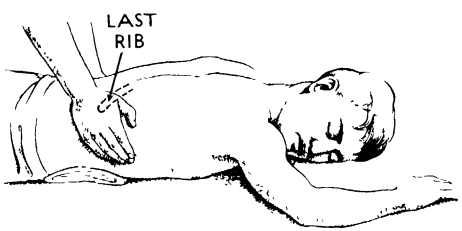


Fig. 15.—Shafer's method of artificial respiration

3. Swing back suddenly, thereby releasing the pressure Count one, two, slowly. The sudden release of pressure causes air to enter the lungs

4. Repeat, as necessary, these two manœuvres.

Resuscitation by Rocking (Eve's Method). — If a healthy person is strapped upon a stretcher and rocking carried out fifteen times per minute through 50 , the respiratory excursions induced by the rocking are so effective that the individual does not require to breathe himself As far as respiration is concerned, rocking can maintain life indefinitely, provided there is a clear airway. In cases of drowning the patient should be placed face downwards ; in other instances he can be placed on his back.

There are various types of rocking stretchers (*Fig.* 16) on the market, and numerous suggestions have been put forward for making a suitable trestle to accommodate a standard stretcher. If a patient is secured by straps to a modern operating table, resuscitation by rocking can be carried out.

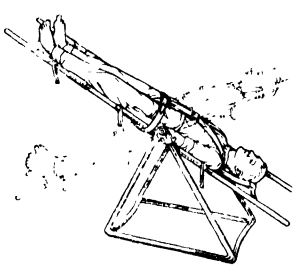


Fig. 16.—Riley's rocking stretcher.

Long-continued Artificial Respiration.—In respiratory failure from anterior poliomyelitis, artificial ventilation of the lungs may have to be continued for many months, and a mechanical device has to be employed to ensure this. The best known of these mechanical respirators is the Drinker, in which the patient's body is placed

in a cabinet, with his head projecting at one end. The chest is dilated by reducing the pressure within the chamber, and expiration is effected by the actual elastic recoil of the lungs. Forced expirations may be induced by raising the pressure, and so actively compressing the chest.

TREATMENT OF COLLAPSE

POSTURE

Simple postural treatment is easy to apply as a first-aid measure. Howat has pointed out that elevation of the limbs is a method of postural treatment splendidly applicable to first aid. The first-aider stands astride the head of the supine patient, and raises the lower limbs to the vertical (*Fig.* 17). By pulling on the legs, the pelvis can even be raised off the surface. Such elevation of the limbs not only renders them bloodless, but induces a reflex vasoconstriction of the



Fig. 17.—Invoking the aid of gravity in the first-aid treatment of the shock-hæmorrhage syndrome

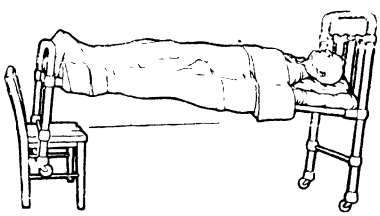


Fig. 18.—An effective method of blocking a bed.

limb vessels. In some cases the effect is enhanced if the arms are similarly elevated by a second worker.

The head should be lowered, or the foot of the bed raised, in collapse due to hæmorrhage, traumatic and surgical shock, anæsthesia, and electric shock. It is often surprising how great an improvement can be effected by this means alone, or in combination with the adequate provision of warmth. In the absence of suitable blocks, the bedrail can be placed upon a chair (*Fig.* 18).

APPLICATION OF HEAT

In all forms of collapse, and particularly so in external hæmorrhage, this is a most important supplementary measure.

Warmth may be applied in the form of suitably protected hot-water bottles, electric blankets, or "shock" cages fitted with electric bulbs.

In severe cases of shock, the type of shock cradle used should be an all-metal one, which reflects and retains the heat. Cages of wire netting are less effective in emergency. It is true that cold increases shock, but it must be realized that overheating is more harmful than the corresponding degree of underheating. Unless the cage is thermostatically controlled, it is safer to rely on blankets and hot-water bottles. The aim should be to warm the patient to about 99° F. and no more, and to maintain this temperature.

Infusion and Transfusion.—Saline infusions (Chapter V), blood transfusion, and particularly plasma transfusion (Chapter VI) are of the greatest value as resuscitative measures.

Oxygen Therapy (Chapter XXVI) also plays a great part.

Oxygen–Carbon-dioxide Therapy.—In most forms of collapse and respiratory failure or asphyxia, the respiratory centre is in need of stimulation. For this purpose, CO_2 is added to the oxygen administered. A useful mixture is 7 per cent CO_2 in 50 per cent oxygen. The increased activity of the lung hastens the return of normal respiration, and in addition, by preventing or diminishing the blockage of alveoli, tends to prevent secondary pneumonia. Oxygen–carbon-dioxide administration is particularly useful in poisoning by carbon monoxide and the lung-irritant gases, and in electric shock.

RESTORATIVE DRUGS

No drug yet discovered has been universally acclaimed as the perfect analeptic. Many have been, or are, in vogue, and some are useful in certain forms of collapse. The house surgeon should be familiar with the indications for, and the limitations of, these.

Strychnine, camphor, ether, and caffeine—the stand-bys of a former decade—are practically without value, and find no place in modern resuscitation. They have been largely supplanted by coramine, cardiazol, and picrotoxin. Cardiazol and coramine, despite their names, have no direct action upon the heart. They are cerebral stimulants, and tend to restore consciousness and improve respiratory and circulatory function by their effect on the medulla. Cardiazol has the more rapid action, and is probably the better. Both are antidotal to higher levels of avertin and ether narcosis.

Methedrine (Burroughs, Wellcome & Co.).—The effective dose is from 15 to 30 mg. intramuscularly or 10 to 20 mg. intravenously plus a maintenance dose of 10 to 20 mg. intramuscularly. Dodd has found this drug efficacious in cases of impending post-operative shock. When the blood-pressure begins to fall during an operation, in a large percentage of cases methedrine given as above restores the blood-pressure to normal limits.

Cardiazol (Leptazolum B.P.) is given by mouth or by injection; in cases of great urgency the intravenous route may be employed, 3 to 4 c.c. of a 10 per cent solution being administered. Further injections can be given after an interval of one to two hours, but larger doses (5 to 8 c.c.) often produce epileptiform convulsions.

Coramine (Nikethamidum B.P.) is very widely used. The usual dose is one ampoule (containing 1·7 c.c.). It should be understood that coramine is quite useless for raising the blood-pressure, e.g., in collapse during spinal anæsthesia. In barbiturate poisoning 5 to 10 c.c. intravenously is often beneficial.

Picrotoxin is similar to cardiazol in its action. It is, however, almost specific for barbiturate poisoning (e.g., pentothal). The usual dose is 0·5 to 2 mg., but from 3 to 10 mg. may be given in divided doses. It has been found that 1 mg. is antidotal to 30 to 40 mg. of pentothal, and this may be given intravenously, in 1–1000 solution.

Cortin Preparations.—Cortin is the hormone of the adrenal cortex. Desoxycorticosterone acetate (D.O.C.A.) is the synthetic preparation. Both are promising restorative drugs, especially in shock associated with burns, but their high cost and the limited amounts available make their extended use uncertain. Five mg. of D.O.C.A. is equivalent to 10 c.c. of cortin. This is the usual dose and it may be repeated.

IMPENDING DEATH UNDER ANÆSTHESIA

There must be few of those entering the portals of medicine who at some time or another will not come suddenly face to face with this, which ranks, after severe arterial hæmorrhage, as the most urgent of all emergencies.

Patients who stop breathing and give rise to anxiety whilst under general anæsthesia may be divided into two main classes: (1) blue asphyxia (primarily respiratory); (2) white asphyxia (primarily cardiac).

Blue asphyxia seldom need give rise to serious concern. The anæsthetist having cleared the airway, pulled the tongue forward, and administered oxygen, artificial respiration usually brings about a restitution. In stubborn cases stretching the anal sphincter is a useful adjunct.

White asphyxia calls for a calm, organized massed effort by the whole theatre staff. In order to deal with the situation as efficiently as possible, it is necessary to have some preconceived plans upon which efforts to resuscitate the patient may be based.

GENERAL MANAGEMENT (WITH SPECIAL REFERENCE TO BLUE ASPHYXIA)

In all cases it is assumed that the anæsthetist has cleared the airway, pulled the tongue forward, and is administering oxygen.

Artificial Respiration.—On receiving a request from the anæsthetist for artificial respiration, the most usual practice is for the operator to exert rhythmical pressure on the lower thorax. Useful as this method is, I do not believe it should be carried on for more than a minute. If after this period respiration has not recommenced, the field of operation, if near the thorax, should be covered with a sterile towel securely clipped by towel forceps to prevent its becoming deranged. Silvester's artificial respiration is then carried out slowly, systematically, and symmetrically, usually by the surgeon's assistant, who summons an unoccupied helper.

WHITE ASPHYXIA

The Time Factor.—It is probable that certain cases are prematurely abandoned as hopeless, owing to anxiety masking our estimation of time. Minutes under these circumstances hang fire, if the clock is not watched.

Is the Heart Beating?—If the operation in progress permits access to a large artery, it is the surgeon who should obtain this information. When the integument is intact, it is the anæsthetist who must settle this point by the means he thinks best. In our view the carotid pulse is the best indicator. When the surgeon is unable to supply this information, so difficult and time-consuming is this all-important question that in white asphyxia the correct procedure is to assume the worst, and to proceed with resuscitative measures according to a plan which provides for confirming the necessity of heroic measures by the best means available.

Distribution and Duties of Personnel.—With but three to three-and-a-half minutes at our disposal, each must know his or her duty; provided they know exactly what to do, even semi-skilled and unskilled members of the theatre team can perform most useful parts.

Time-keeper: A student, a junior nurse, or a porter should be detailed to cry loudly each passing minute from the time the anæsthetist sounds the warning note of danger.

Provider of hot packs: If, in addition to a time-keeper, there is a junior nurse available, her duty should be to get a bowl of really hot water and some packs, and be prepared to place the packs, wrung out in hot water, on the precordium at frequent intervals while the artificial respiration is in progress. This worker is not essential. She should go about her duties without asking questions or distracting the attention of the theatre sister. Her services should be at the disposal of the surgeon's assistant if he should require them.

The surgeon's assistant is dismissed immediately by the surgeon, and relegated to the sole task of performing artificial respiration under the direction of the

anæsthetist. He carries out Silvester's procedure—if necessary, single-handed —but summons the most suitable helper available.

The theatre sister comes forward and takes on the duties of the surgeon's assistant. Her essential objective is to have in readiness the simplest requirements for a midline upper laparotomy.

The anæsthetist takes sole charge of the respiratory apparatus. His first, and at all times his most important, duty is to be perfectly satisfied that there is a clear airway. His other essential parts can be played without moving his position from the patient's head. They are: (*a*) settling the question "Is the heart beating?" if required to do so; and (*b*) injecting adrenaline into the heart.

A bottle of adrenaline should be at hand in the operating theatre. This bottle is changed every two months, in order to make quite certain that the drug is in an active form. The bottle of adrenaline, together with a sterile syringe and a 3½-in. long needle which fits that syringe, should be kept in a sealed sterile jar on the anæsthetist's table. At the appropriate time (*see later*) the syringe is loaded with 1 c.c. of adrenaline and its needle is thrust into the fourth interspace at the upper rim of the fifth rib close to the sternal border. The needle should be directed backwards and slightly medially.

A (REVISED) PLAN OF ACTION

Artificial respiration must be started at once, and continued throughout the endeavour. Intratracheal insufflation of oxygen and CO_2 is the ideal form of artificial respiration. Silvester's method is efficient if the airway is kept clear.

First Minute.—

Anæsthetist.—Clears airway; tilts the table, even slightly, so as to lower the head; breaks a capsule of amyl nitrite under the patient's nostrils.*

Surgeon.—Appoints a time-keeper; dismisses his assistant; with the help of the theatre sister attends to his operation so that it can be abandoned temporarily; if possible, palpates directly a large artery.



Fig 19.—Standard method of performing cardiac massage

Second Minute.—

Anæsthetist.—Administers oxygen; passes an intratracheal tube if circumstances permit and he is particularly skilled in this manœuvre.

Surgeon.—Supervises the sterilization of the skin of the upper abdomen and lower thorax while he scrubs up or changes his gloves, as necessary.

Theatre Sister.—Prepares the skin of the upper abdomen and lower thorax.

Third Minute.—

Anæsthetist.—If asked to do so, palpates carotid artery; when free from duties of second minute, opens the cardiac emergency jar and places it within reach of the theatre sister.

Surgeon.—If the information received is that the heart is not beating, makes an incision in the middle line through the linea alba large enough to insert the hand; starts cardiac massage from below the diaphragm, at first with a quick,

* This valuable suggestion was made by W. B. Primrose; the object of administering this drug is to distinguish between cardiac depression and cardiac arrest.

forcible movement for half a minute ; the base of the left hand over the lower thorax aids in the manœuvre ; if there is no response after thirty seconds, changes the movement to a slower rate of about eighty per minute. (*Fig.* 19.)

Theatre Sister. — Fills the syringe with 1 c.c. of adrenaline and fixes the needle firmly to the barrel.

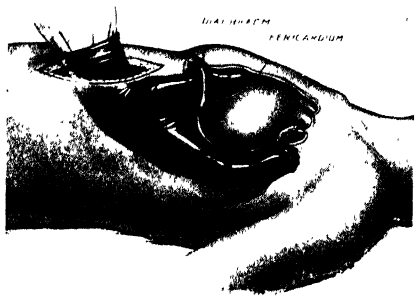


Fig 20 —Nicholson's method of performing cardiac massage

Fourth Minute.—

Surgeon. — Removes his left hand from the thoracic wall while the adrenaline is injected into the heart by the anæsthetist ; directly afterwards, with renewed hope, continues the massage as in the first instance, i.e., quickly.

Four-and-a-half Minutes.—

Surgeon.—Makes a button-hole incision behind the xyphisternum between the attachments of the two sides of the diaphragm. The thumb of the right hand is thrust through the opening and the heart is compressed between the thumb within the pericardium and the fingers beneath the diaphragm* (*Fig.* 20). This seldom fails to give at least a temporary response.

It is quite sufficient to close the upper midline incision with strong, interrupted through-and-through sutures traversing all layers.

COLLAPSE UNDER INTRAVENOUS ANÆSTHESIA

Provided the anæsthetic (pentothal or sodium evipan) is injected slowly and a good airway is maintained, complications and untoward reactions are uncommon. In collapse under intravenous anæsthesia 1 mg. of picrotoxin is antidotal to 30 to 40 mg. of pentothal. It is given intravenously in 1–1000 solution. When this drug is not available lumbar puncture has proved successful. In a case occurring in the practice of Mr. Max Pemberton, after oxygen and artificial respiration had proved unavailing, lumbar puncture resulted in the escape of cerebrospinal fluid under considerable pressure, and almost immediate improvement in the patient's condition.

COLLAPSE UNDER SPINAL ANÆSTHESIA

There are two danger periods in spinal anæsthesia. The first is almost directly after the injection, and the second is about twenty minutes later. The main danger lies in a fall of blood-pressure, which can be shown by the sphygmomanometer. The ordinary measure to be taken is that of raising the blood-pressure by the injection of a pressor substance. Excellent pressor substances are methedrine (*see* p. 10) and s-methylisothiourea (British Drug Houses Ltd.), 2 c.c. intravenously.

'Heavy' solutions, i.e., solutions of spinal anæsthetics containing glucose, are now rarely employed, and the following instructions are only applicable to the 'light', i.e., isotonic, preparations, which include stovaine in saline, nupercaine, and neocaine.

*This is Nicholson's method of performing cardiac massage, and Nicholson recommends it as the standard procedure, i.e., to be used from the commencement.

Soon after the intrathecal injection has been made, the operating table is tilted slightly by the head in order to counteract the fall of blood-pressure. If the pulse becomes poor, the table should be tilted still further, and this measure, combined with a cardiac stimulant, usually brings about some improvement. If it does not do so quickly, intravenous saline should be ordered. In the meantime the administration of oxygen and carbon dioxide is indicated, particularly if respirations are shallow and irregular.

We have found that after a period of considerable alarm, the adoption of the above measures is usually effective. With posture some improvement occurs, and by the time half a pint of saline has gravitated into a vein the period of anxiety has passed. Before the patient is allowed to be transported to his bed, the table should be raised gradually to the horizontal position.

ETHER CONVULSIONS

Carbon dioxide and oxygen should be administered at once, and the sooner an intravenous injection of sodium evipan or pentothal can be given, the better. In practically every case after the injection of 3 to 5 c.c. of one of these drugs, the convulsions are controlled. If necessary, the intravenous injection can be repeated. Oxygen and CO_2 should be continued for some time after the convulsions have ceased, and an injection of lobeline to stimulate the respiratory centre appears to be useful.

NOVOCAIN POISONING

It is extremely rare for a sudden catastrophe to occur as the result of a local anæsthetic: indeed this is the great advantage of local anæsthesia. However, one of us (H. B.) has seen four examples of poisoning by novocain, which is the least toxic of all the local anæsthetics. It is possible, even when only a 1 per cent solution has been employed, if some of the fluid gets into a vein, for the following symptoms of novocain poisoning to occur: The patient loses consciousness, and suddenly the whole body becomes convulsed in a terrifying fit. The jactitations are such that the limbs bang against the table.

The danger lies in the failure of the respiratory centre, which breaks down before that of the cardiovascular centre. CO_2 and oxygen should therefore be administered without delay, and continued for a considerable time. In one case sodium evipan was administered. The result was as dramatic as in cases of ether convulsions. The convulsion ceased forthwith. With a view to diluting the circulating poison, the administration of continuous intravenous saline seems rational.

CHAPTER III

THE TREATMENT OF BURNS

By D. N. MATTHEWS

DEATHS from burning are, with very few exceptions, due to shock or infection. Both are amenable to treatment promptly and adequately carried out. It is, therefore, of the utmost importance to assess the seriousness of a burn at once and to be able to deduce from this assessment the correct treatment, both local and general. The patient's life may depend on the decision; the degree of functional and cosmetic recovery certainly does.

HOW TO ASSESS THE SERIOUSNESS OF A BURN

Each of the following criteria must be considered; any one may denote a serious burn :—

Extent.—Burns of more than 2 per cent of the total surface area of the skin are serious. However superficial they appear at first, they are practically certain to contain areas of deeper burning which are only revealed later.

Berkov has tabulated the percentage areas of the various parts of the body as : head, 6 per cent, trunk, 38 per cent (front 18 per cent, back 20 per cent); both lower limbs, 38 per cent (both thighs 18 per cent, legs 14 per cent, feet 6 per cent); both upper limbs 18 per cent (both arms and forearms 12 per cent, hands 6 per cent).

Site.—All burns involving moveable parts of functional importance are serious. These parts are the hands, feet, face, joint flexures, and external genitalia. Crippling deformities follow if they are inadequately or incorrectly treated.

Appearance.—An erythema, or a series of unbroken blisters, denotes a superficial burn. Broken blisters and cracked, scorched, leathery, or dead white skin denote a deep burn Superficial burns have surviving epithelial cells left on the burned surface from which regeneration can take place (partial epithelial loss). Deep burns have no epithelial elements left; all are destroyed, including the epithelial cells in the dermis surrounding hair follicles and sebaceous glands (total epithelial loss). These burns heal slowly and with much scarring; they are much more serious than superficial burns.

The modern clinico-histological classification recognizes three degrees of burning. A *first-degree* burn causes an erythema and involves only the superficial layers of the epidermis. A *second-degree* burn causes blistering. The blisters are usually unruptured. The deeper layers of the epidermis are involved, but sufficient epithelial cells survive in the stratum germinativum, hair follicles, and sebaceous glands to heal the burn in two to three weeks. A *third-degree* burn causes broken blisters and cracked, scorched, or dead white skin; there is complete destruction of all epithelial elements in the epidermis and the dermis. The burn heals by the formation of scar tissue.

Although the appearance of the burned surface provides a guide to the depth of a burn in most instances, it is not always reliable in the first few hours, since the appearance sometimes changes later. For instance, blisters may

appear in an area of erythema. Moreover, it will be readily understood that the burn may be of third degree in one area and of second degree in another. The early differentiation of a deep second-degree from a third-degree burn is particularly difficult. Whenever there is doubt it is advisable to assume the burn is a third-degree one. If islands of epithelial cells are found when the sloughs separate one knows that a mistake was made and the burn is less destructive than was at first feared. It is better to make this mistake than to underestimate the depth.

Infection.—All infected burns are serious. If the area is covered with road dirt, brick dust, or similar foreign material, there is no doubt that infection is present. But burned clothes and scorched skin are usually sterilized by the heat. It is important to realize this and not to undress the patient or cover the area with anything except sterile dressings or absolutely clean handkerchiefs. The immediate application of the first available cover or medicament is a common first-aid mistake and very often causes infection of a sterile burn. All burns with broken blisters must be regarded as potentially infected and treated as such.

Length of time Exposed to Burning Agent.—This has an important bearing on the depth of burns caused by flame, steam, petrol flame, and hot objects. Momentary contact with these agents causes superficial second-degree burns; household domestic burns such as arise from lighted matches, a hot oven or the steam from a kettle, provide common instances of such lesions. Longer contact, as occurs in warfare, produces third-degree, or at best, deep second-degree burns. Examples are the flame of a burning aircraft or tank, the steam of a ship's boiler as it bursts, and the hot wreckage of a car, under which the victim is trapped. The temperature of gun-flash from cordite or bomb-flash from high explosive is so high that it produces full-thickness third-degree burns, even when contact with the skin is but momentary.

Associated Injuries.—When the patient sustains a fracture or a gunshot wound in addition to a burn, as is common in warfare, the burn is of much greater significance than in uncomplicated cases. It is serious no matter how trivial it appears, since it adds to the severity and persistence of shock.

Condition of the Patient.—If the burn causes a constitutional upset (shock) it is a serious burn, no matter how trivial it may look.

Shock is denoted by pallor, thirst, sweating, rapid pulse, fall in temperature, lowered and/or falling systolic blood-pressure, reduced pulse pressure, hæmoconcentration, and diminished urinary output.

SERIOUS BURNS

Aims of Treatment.—

Save life.
Maintain and restore function.
Restore appearance.

Attained by.—

1. Immediate transfer to hospital.
2. Energetic and adequate treatment of shock.
3. Prevention or rapid control of infection.
4. Encouragement of active movements as soon as possible.
5. Correct splinting when at rest.
6. Early resurfacing of burned areas with skin-grafts.

FIRST-AID TREATMENT

This is simple. It consists of the immediate injection of morphine (half a grain of morphine should be given to an adult and proportionately less to a child); the application of a sterile or clean cover to the burned area; the administration of fluids by mouth; the first-aid treatment of associated injuries; and the rapid transference of the patient to hospital. It is important to get the patient to hospital before the onset of shock, and before infection of the burned tissues has had time to become established.

GENERAL TREATMENT

Shock.—This is lethal in severe burns unless promptly and adequately treated. It appears between six and twelve hours after burning. It is important to perform all necessary local treatment of the burns and to take steps to prevent the onset of shock before this time. If shock is already present *no local treatment should be undertaken* until it has been successfully treated. Measures which are both preventive and curative are the hypodermic injection of morphine and the maintenance of normal body heat. Measures which are curative are the administration of fluid, oxygen, and adrenal cortical extract.

Morphine.—This is well tolerated in large doses in severe burns, and is life saving. It is scarcely possible to overdose a severely burned patient, child or adult, with morphine. After an initial first-aid dose of $\frac{1}{2}$ gr., $\frac{1}{4}$-gr. doses can be repeated without risk in an adult as frequently as necessary to keep the patient out of pain. Children require doses proportional to their age.

Warmth.—A heat cradle or tent is needed to restore and maintain normal body heat after severe burning. The burned part should not be heated where this is avoidable since it increases pain and, possibly, œdema. Overheating must be avoided.

Fluids.—Thirst quenching with sweetened drinks is helpful in replacing fluid lost from the circulation into the tissues. It should be encouraged so long as it does not cause nausea or vomiting. As the sole means of fluid replacement it is, however, inadequate, and too slow. The intravenous administration of plasma is always needed to cure established shock. Whole blood is not advisable in uncomplicated burn shock. The amount of plasma given is governed by the systolic blood-pressure and the hæmoconcentration. The hæmoglobin percentage rises to 120–140 in severe burns, and the systolic blood-pressure falls. The hæmoglobin must be estimated every half-hour during the infusion, which is continued until the figure approaches normality. The infusion is then stopped, but is restarted if further concentration occurs. Six or eight pints are often needed in a severe case. The first two pints are given as a rapid (just countable) drip and the remainder at the usual rate of forty drops per minute. A falling systolic blood-pressure is a less accurate guide than hæmoconcentration since it does not occur until shock is well established. A rising systolic blood-pressure must be maintained until the normal level is reached and held. After this the infusion is discontinued. A subsequent fall demands further infusion.

It is important not to give an excessive quantity of plasma. The immediate effect of overdosage is to strain the myocardium and cause œdema of the lungs. The late effect is to exaggerate the secondary anæmia, which always occurs with severe burns about ten days after recovery from shock.

Oxygen.—The anoxæmia which results from the slow rate of circulation of the concentrated blood is dangerous. It taxes the heart muscle and interferes with tissue respiration throughout the body. It must be prevented by the continuous administration of oxygen in high concentration. This is best effected with the B.L.B. mask which can deliver up to 10 litres of oxygen per minute. Sufficient must be given to abolish the cyanotic tinge from the lips. In severe facial burns it may be impossible to fit the mask over the nose. An intranasal catheter must then be used instead; this is, however, much less effective.

Adrenal Cortical Extract.—This is of unproved value and is expensive. In very severe cases it may be tried as an adjuvant to the other more important measures. A suitable preparation is eucortone; 2 c.c. are given intramuscularly every hour until shock has disappeared.

Nursing.—Remembering the severe pain which results from a trivial finger burn from a cigarette, it is not difficult to understand the inestimable value of skilled nursing in extensive cases. The patients are helpless and everything has to be done for them. If the hands are burned the patient must be fed, and if the face is burned fluids alone can be taken. These must be given through a straw or a rubber tube from a drinking cup. The patient will probably want to smoke. He must be given a long cigarette holder to keep the cigarette away from the dressings. The cigarette must be lighted for him and the holder put between the teeth. These are examples of the innumerable tasks which fall to the nurse's lot. The patient's morale is also in large measure dependent on the nurse. Cheerfulness and reassurance are vital. A severely burned patient who loses heart does not recover. The patient is very often worried about the fate of friends or relatives involved in the same accident, about business affairs and household duties, and about the necessary family arrangements to meet the emergency circumstances caused by his admission to hospital. The nurse receives these confidences and she must get them attended to by the proper person. Their solution has considerable bearing on the patient's general condition.

Urine.—Each specimen of urine must be measured and the total quantity passed in twenty-four hours charted as a graph. A rising urinary output is a sure indication of progress in combating shock. A falling output is of serious significance. Severely burned patients often pass red blood-cells and albumin in small amounts during the first few days; this is not serious, but should not persist after the general condition has improved. Blood and epithelial casts must be looked for regularly if sulphonamides are being applied locally or taken by mouth. Their appearance is an indication to suspend treatment until the urine is normal.

Diet.—The total diet for an adult should have a value of 2500 calories.

Fluids.—The patient must be encouraged to drink. Glucose should be added to orangeade or lemonade, a jug of which must be constantly by the bedside. Alcohol in moderate amounts is helpful; the patient's fancy is best, although red wine seems peculiarly beneficial when healing is slow or secondary anæmia persistent. Those accustomed to spirits must be given them in small quantities as soon as shock is overcome.

Proteins.—A high-protein diet is indicated since protein is lost in great quantities from the burned surfaces and in the urine. Meat, fish, and cheese should therefore be plentiful.

Vitamins.—A high content of vitamins in the diet is known to favour cellular and epithelial regeneration. The diet must include plenty of fresh vegetables.

In addition, vitamin B should be supplemented by giving marmite, vitamin C supplemented by six 25-mg. tablets of ascorbic acid daily, and vitamins A and D supplemented by 10 min. of halibut oil daily.

Sedatives.—Morphine ensures sleep in the early stages when it is being liberally administered to combat shock. Afterwards it is better not to give it regularly, but only if sleep has been lost on the previous night or if there has been a recurrence of pain. Medinal (gr. 10) is reliable and satisfactory until unaided sleep returns. If memory of the accident, or worry from any other cause, is troublesome, a bromide mixture, or luminal (gr. ½) night and morning, is beneficial. It should be given until mental stability returns. Peaceful sleep every night is of paramount importance to a burned patient and sedatives should never be withheld if needed to ensure this.

Anæmia.—Patients are always anæmic about ten days after a severe burn. The cause of the anæmia, which is hæmolytic, is unknown. It greatly retards the separation of dead tissue and the regeneration and growth of living epithelial cells. It is serious if the hæmoglobin falls below 70 per cent. It is treated by frequent small blood transfusions. Ideally the first should be of packed cells. After this 300 c.c. of whole blood are given twice weekly for two or three weeks. An iron tonic and intramuscular injections of concentrated liver extract are useful adjuncts, but inadequate alone.

Toxæmia.—

Acute Toxæmia.—This occurs on the fourth day after burning and is characterized by pyrexia, vomiting, and jaundice. It rarely, if ever, occurs unless tannic acid has been applied to the burned surfaces. So noticeable is this, that several workers have recently suggested that the toxæmia is due to the action of absorbed tannates on the liver. This is not yet proved beyond doubt, but gross liver necrosis is known to occur. Since the pathology is not fully understood the condition can only be treated symptomatically. A high fluid intake and the liberal administration of glucose are recommended as the best means of helping the liver to detoxicate itself. Rectal and intravenous feeding are needed when vomiting is persistent. The injection of 1 c.c. of coramine every two hours is advised as a cardiac stimulant. The condition is usually fatal.

Toxic Cachexia.—The substitution of open for closed therapy for extensive burns in this country during the war has been followed by the appearance of a chronic cachectic state about ten days after burning. It lasts some two weeks and is probably due to anæmia and hypoproteinæmia resulting from infection of the burned surfaces and loss of nitrogen in large quantities in the urine. It is characterized by general malaise, a raised pulse and temperature, and a leucocytosis. Treatment consists of giving repeated small blood transfusions and controlling the infection by locally applied chemotherapeutic drugs.

LOCAL TREATMENT

Available Methods.—(1) Open therapy; (2) Closed therapy; (3) Plaster-of-Paris.

1. *Open therapy* means the application of medicaments or dressings to the burned surface as often as is necessary to clean it and hasten epithelialization. The possibility of infection is accepted, but its control by local chemotherapeutic drugs is relied on.

2. *Closed therapy* means the application of a coagulant to the burned surface. This combines with the tissues (tannic acid) or coagulates on the surface

(the coagulant dyes) to form a semi-rigid eschar. Movement and local chemotherapy are sacrificed in an attempt to maintain sterility.

Selection of the Appropriate Method.—Common sense must always be allowed to dictate the most suitable method for the particular patient. It is a mistake to be bound by rule-of-thumb methods or to adhere too rigidly to listed directions. To make the correct decision, however, the doctor needs to be conversant with the principal advantages and disadvantages of each method. These may be summarized as follows :—

Table I.—ADVANTAGES OF THE VARIOUS METHODS OF TREATING BURNS

OPEN THERAPY	CLOSED THERAPY	PLASTER-OF-PARIS
1. Active movements of the burned part are possible throughout treatment	1 Pain is prevented or immediately relieved by the application of the coagulant	1 The absolute rest relieves pain and brings about great improvement in the general condition of an exhausted patient
2 Local chemotherapy can be used to limit infection	2 Cross- or auto-infection of a clean burn is prevented	2 The chances of cross- and auto-infection in an open ward are diminished
3 Separation of dead tissue can be expedited by repeated mechanical cleansing.	3 Nursing is easier and treatment less time-consuming once the coagulant has been applied	3 An associated fracture can be immobilized at the same time as the burn is treated
4 Skin-grafts can be applied at the earliest possible moment that is, as soon as the granulations are bacteriologically ready to receive them	4 Loss of fluid from the burned surface is prevented	

Table II.—DISADVANTAGES OF THE VARIOUS METHODS

OPEN THERAPY	CLOSED THERAPY	PLASTER-OF-PARIS
1. The pain caused by changing dressings in the early stages	1 The prolonged immobilization of parts of functional importance by the coagulant.	1 The prolonged immobilization of parts of functional importance
2 The danger of cross- and auto-infection which cannot be excluded no matter how rigid the aseptic technique. (The ability nowadays to control infection with chemotherapy offsets this disadvantage considerably.)	2 The serious consequences of imprisoning sepsis	2 The impossibility of using local chemotherapy
3 The time taken in performing the repeated dressings needed in extensive cases This necessitates a large staff of skilled nursing and medical personnel.	3. The impossibility of applying a skin-graft until the coagulum has separated This may take several weeks During this time fibrosis continues unchecked. This imperils the subsequent recovery of function and appearance. It also makes the final cosmetic repair more difficult.	
4 The need for a hospital with adequate facilities to maintain the very high standard of aseptic technique which is essential	4. The impossibility of cleansing and applying the coagulum to large numbers of patients quickly unless considerable reserves of staff are kept in readiness This is a serious disadvantage in wartime, when large numbers are often admitted in a short space of time. [It is of less moment when applying coagulant dyes than true coagulants (*see Table III*).]	

From the above tables it is evident that the distribution and extent of the burn, the presence or absence of infection, the presence of associated injuries, and the surgical and nursing facilities provide the data on which the decision is

made. From them, moreover, it is possible to list a few clear-cut indications for, and contra-indications to, each of the three methods. But such a list must only be regarded as a guide. The particular problems of each case must be considered and the counsel of the list reviewed in this critical light before it is accepted.

Table III—PRINCIPAL INDICATIONS FOR, AND CONTRA-INDICATIONS TO, THE USE OF EACH OF THE THREE METHODS

OPEN THERAPY	CLOSED THERAPY	PLASTER-OF-PARIS
1 Use for severe burns of the areas of functional importance These are the face, hands, feet, joint flexures, and external genitalia	1. Use for clean extensive body burns unaccompanied by burns of the limbs This particularly applies to old people and children who are very intolerant of pain	**A As a Splint.—** 1 In conjunction with open therapy (as an alternative to a metal splint) to maintain the hands and feet in the correct position of rest in the intervals between treatments
2 Use for all infected burns	2 Use the coagulant dyes when medical and nursing attention cannot be obtained for several days, as may occur on board ship	2. In conjunction with open therapy to relieve pain caused by muscle spasm and œdema
Do not use open therapy for clean extensive body burns unaccompanied by burns of the limbs	3 Use for minor domestic burns	3 In conjunction with open therapy when the joints of the hands or feet have been opened by the burn The splint must be maintained until the joint surfaces are covered with granulation tissue
Do not use open therapy for minor domestic burns	Do not use on burns of parts of functional importance, or on infected burns unless circumstances are such that medical and nursing attention is unobtainable for several days Under these conditions advise the layman to use the coagulant dyes for all serious cases, the problem is primarily one of saving life and the fate of the burned surface must be subordinate to this. The dyes serve this dual purpose under emergency conditions better than any other form of therapy.	**B. As a Cast.—** 1. In the presence of a limb burned and fractured (The combination of skeletal traction and open therapy is dangerous when the burn is close to the site of insertion of the pin because the bone may become infected)
Do not persist with open therapy when pain or the fear of pain is causing exhaustion; apply a plaster-of Paris cast instead.		2 When pain, or the fear of pain from open therapy, has caused a failure of morale. A plaster cast is life saving for such cases if applied soon enough.
		3 For comfort on long distance travel with a burned limb.
		Do not use plaster-of-Paris if conditions indicate open or closed therapy.

TECHNIQUE: OPEN THERAPY

Initial Cleansing.—The general condition must be the first consideration. Initial cleansing should not be performed in the presence of threatened or established shock; this is very unlikely to occur until at least six hours after burning. The rapid transport of a seriously burned patient to hospital is, therefore, a matter of great urgency. If this period of comparative safety is allowed to pass, no local treatment may be possible for several days. Even when cleansing within the first six hours, it is advisable to start an infusion of plasma beforehand; this forestalls shock and reduces the chances of its development to a minimum. An anæsthetic is not essential; intravenous morphine (gr. $\frac{1}{6}$) is usually adequate. But an anæsthetic is advisable for extensive cases because it excludes pain and allows the doctor to work more quickly. Intravenous

sodium pentothal is ideal. The length of time taken by the operation makes the administration of gas and oxygen difficult, besides which facial burns preclude the use of a face mask.

Cleansing must be thorough and gentle. Dead skin and ruptured vesicles are cut away. Intact blisters are left; they preserve the sterility of the tissues beneath them. A 1 per cent aqueous solution of C.T.A.B. (cetyl-trimethyl-ammonium-bromide) is a very satisfactory cleansing agent; it is marketed as Cetavlon (I.C.I.). Soap solution is also satisfactory. The cleansing agent is applied with cotton-wool swabs held in sterile forceps. The operator is masked and wears sterile gloves. Full aseptic theatre technique is observed. The whole area is systematically cleansed. No time must be wasted as prolonged anæsthesia is harmful.

Initial Dressing.—This dressing will have to remain untouched for several days if shock develops. It should always be applied with this possibility in mind. The dressing consists, from within outwards, of a sulphanilamide cream, tulle gras, layers of gauze, cotton-wool, and crêpe bandages.

The tulle gras is first cut roughly to the shape of the burned area. A gauze pad thirty layers thick is then similarly cut. The tulle gras is placed on the gauze. A thick layer of sulphanilamide cream (3 per cent in a water-soluble lanette wax base) is then spread on the tulle gras with a sterile spatula and the whole applied face downwards to the burn. If this cream is not available a light frost of sulphanilamide powder is dusted directly on to the burn instead. The cream is preferable since the sulphanilamide is absorbed more slowly; this ensures a local concentration of even intensity and greater duration The gauze is then covered with a thick pad of wool and bound firmly with crêpe bandages. These act as pressure dressings and help to resist the outpouring of fluid into the tissues (œdema). If the hand, forearm, foot, or leg is burned, a light metal or plaster-of-Paris splint is incorporated beneath the bandage. The splint holds the limb in the correct position of rest and serves as an attachment for a sling with which to elevate the part.

Splints.—For the upper limb a gutter splint is needed. It must extend from beyond the tips of the fingers to the upper end of the forearm. It must hold the wrist in dorsiflexion and the metacarpophalangeal and interphalangeal joints in semiflexion. This is the basic position of rest. For the lower limb a back splint is needed, extending from beyond the toes to the level of the tibial tuberosity. It must keep the ankle at a right angle.

Elevation.—The resistance of pressure dressings to œdema is assisted by elevation of the part. The arm splint is slung from an overhead beam or a blood-transfusion stand; it is maintained in this position so long as œdema persists. This may be several days. After transient cramp in the first few hours this position is painless and is readily accepted by the patient because of the increased comfort. The lower limb is similarly elevated by attachment to a Balkan beam or by banking up with pillows. The beam is preferable, since it allows the patient to move without fear of the limb slipping.

Subsequent Dressings.—No change of dressing must ever be made so long as shock is present. The frequency with which the dressings can be changed depends on the patient's general condition. The necessity for changing them depends on the degree of infection of the part; the less the infection, the less frequent the changes. The patient's reaction to the dressing procedure determines whether all the burned area or only part is dressed on any one day. As time

passes it becomes less painful, when both the amount done and the frequency of the changes can be increased if necessary.

Full aseptic technique is used. The operator is masked and wears sterile gloves. The dressings are removed with sterile forceps. When stuck they are soaked off either by playing a gentle stream of sterile saline on to the gauze or by immersing the limb in saline. A swab is taken for bacteriological culture each time. All exudate is gently washed away with saline-soaked gauze and separating sloughs are cut away with scissors. The burn is then treated with the appropriate chemotherapeutic agent and re-covered as at the original dressing.

Chemotherapy may be modified to combat particular infections. Sulphathiazole is added for pathogenic staphylococci and penicillin powder if a sulphonamide-resistant strain of streptococci or staphylococci is encountered. Penicillin is best added to the standard sulphanilamide cream in concentration of 100 units per gramme. If this cream cannot be prepared, penicillin powder may be sprinkled directly on the wound, but this is sometimes painful and is wasteful except when carefully applied. Sulphacetamide, applied conveniently as albucid cream, seems to be of more value against the *B. pyocyaneus* than any other chemotherapeutic agent. The *B. proteus* and *B. coli* are unaffected by chemotherapy.

The Saline Bath.—Total immersion of the patient in a bath of normal saline is on occasions beneficial. At special burn centres, baths are equipped with an automatic apparatus which delivers a continuous flow of normal saline heated to any predetermined temperature. The excess goes to waste through the overflow. The bath provides a painless method of removing dressings and loose exudate, and encourages the patient to move. These are important points. Total immersion is, however, not devoid of risk in the early stages, being followed sometimes by a profound constitutional reaction. It is wise to try the immersion of one limb first in extensive burns.

Skin-grafts.—These should be applied as soon as the granulations are free from virulent infection. The granulations must be flattened pre-operatively by tight bandaging to secure the best possible surface. A sheet of Thiersch graft is cut with a razor. It is then cut into $\frac{3}{8}$-in. squares. Each square is placed on the granulations $\frac{1}{8}$ in. from its fellows. This allows the free egress of discharge between the grafts and so minimizes the damage it can do. Pieces $\frac{3}{8}$ in. square spaced $\frac{1}{8}$ in. apart cover an area twice the size of the graft cut. The spaces are bridged with epithelium of reasonable durability in ten days.



Fig. 21. — The knee enclosed in a Bunyan-Stannard envelope. Note the method of fixation with watertight seals above and below.



Fig. 22. — The hand and forearm enclosed in a Bunyan-Stannard envelope. The side-holes for irrigation are shown.

The Bunyan-Stannard Envelope.—These envelopes are made of silk impregnated with synthetic resin to make them watertight. They are designed to fit loosely over burned limbs. An adhesive seal is attached to the open end to fix the envelope to the skin above the burn (*Fig.* 21). This seal is watertight.

Two or three openings are left at intervals along one seam to allow irrigation of the enclosed part (*Fig.* 22). Small clamps are supplied with which to close these openings at other times.

Application is simple. All that is necessary is to slip the envelope over the burned limb and stick the adhesive seal to the unburned skin above. Irrigation should be carried out at least once a day. Three times a day is ideal. Bunyan recommends irrigation with a 1 per cent solution of sodium hypochlorite electrolytically prepared; Milton (1 per cent) and normal saline are both satisfactory. It is recommended that the envelope should be filled with oxygen. This increases comfort by partially removing the envelope from contact with the limb, and may possibly be beneficial to damaged cells in the burned area.

The envelopes constitute a specialized method of applying open therapy. They are of use in hospitals which have not the equipment or trained personnel to carry out the standard technique. They are also useful as first-aid measures in warfare during the patient's transit to a burn centre. They are not as satisfactory as the standard open therapy technique when conditions are suitable for it. The objections to their routine use are difficulty in washing away epithelial debris and sloughs which collect inside them, inability to apply interdigital dressings, difficulty in splinting the part accurately in the position of rest, occasional leakage, and the sense of restriction of which a number of patients complain.

TECHNIQUE: CLOSED THERAPY

Chemical Agents Used.—

True Coagulants: tannic acid, tannic-acid jelly.

Coagulant Dyes (Escharotics): triple dye, gentian-violet jelly.

True coagulants are only used when the sterility of the burned surface is beyond question. They combine with and precipitate cellular protein to form a true coagulum. The coagulant dyes should be used when closed therapy is demanded, but where the sterility of the wound is open to doubt; such circumstances often occur in extensive burns in elderly or young subjects and in burns inflicted far from medical and nursing aid (e.g., on board ship). The coagulant dyes do not combine with cellular protein, but dry to form a protective crust on the burned surface. They are innocuous to living tissue and have a bacteriostatic action. They form a less rigid eschar than true coagulants; the eschar is less impervious to infection, but at the same time less resistant to the escape of infection from beneath it. When in doubt about the sterility of a burn always choose a coagulant dye rather than a true coagulant.

Initial Cleansing.—This should always be performed within six hours of burning if a true coagulant is to be applied; after this sterility cannot be guaranteed. The cleansing must be meticulous. An anæsthetic is necessary. Except for the fact that all blisters are cut away, the procedure is the same as for open therapy (*see* p. 21). Ideally, cleansing should be equally thorough before the application of a coagulant dye, but on occasion greater laxity is permissible. Indeed, when medical and nursing care are not available cleansing may have to be foregone altogether. In these circumstances the immediate application of a coagulant dye is preferable to attempted cleansing by untrained personnel who have no knowledge of aseptic technique. Greater laxity is also permissible with coagulant dyes with regard to the lapse of time between burning and treatment.

Application.—

True Coagulants.—A 10 per cent solution of tannic acid is painted on to the cleansed surface of the burn with a cotton-wool swab. It is allowed to dry for a

quarter of an hour : an electric hair drier fitted with an air-filter hastens drying. A second coating is then added. The two coatings give a firm coagulum. After drying for five minutes the patient is returned to bed. No further application is needed. The bedclothes must be held away from the coagulum for twenty-four hours.

When coagulating circumferential burns of the trunk, the back is coagulated first. It is covered with layers of gauze on which a thick layer of tannic-acid jelly has been spread. The gauze is covered with wool. The patient is then turned on to his back to allow the chest and abdomen to be attended to. These can be treated in the same way, or by the application of a coagulum according to the surgeon's preference. The gauze-impregnated jelly and dressings are more suitable than a coagulum for the back since they are more comfortable to lie on, more resistant to infection and to the pressure caused by the patient's weight, and less resistant to the escape of exudate if infection should occur.

Coagulant Dyes.—Triple dye is the best escharotic for routine use. It is quick drying, provides a pliable eschar, and has a wide range of antibacterial activity. It is made up of equal parts of gentian violet (1 per cent), brilliant green (1 per cent), and euflavine (1 per cent) ; all are in aqueous solution. Weaker solutions take a long time to dry. The dye is applied to the burned surface with a cotton-wool swab. After allowing a quarter of an hour for it to dry, a second coat is added and the patient returned to bed. A third and sometimes a fourth coat are added at intervals of two hours. A heat cradle expedites drying.

Gentian-violet jelly is applied on gauze in the same way as tannic-acid jelly (*see above*). It is used instead of triple dye to cover the back in those circumferential burns of the trunk for which coagulant dyes are indicated. It is also the safest form in which closed therapy can be applied by unskilled personnel. Put up in sterile tubes the jelly needs the minimum of first-aid knowledge for its successful and safe use.

Care of the Coagulum.—Cracks may appear at the edges or on the surface. They are dangerous because they provide a pathway along which infection may be introduced. They must be sealed at once by the application of gentian-violet jelly on a single layer of gauze. This provides a satisfactory seal without covering the crack so densely that infection is imprisoned if it has gained entrance. Imprisoned sepsis is indicated by pain, constitutional reaction, redness and swelling of the tissues surrounding the coagulum, and by a leucocytosis. It demands immediate exploratory incision of the coagulum and wide removal to allow drainage if pus is found.

TECHNIQUE : PLASTER-OF-PARIS CAST

Application.—The burned area is first covered with tulle gras and then with several layers of dressing gauze. The whole limb is then wrapped in a generous pack of cotton-wool. The plaster cast is applied over this. These dressings give room for the limb to swell without endangering the circulation as tissue œdema develops. Neither the tulle gras nor the gauze must be wound round the limb as one continuous piece, since either might act as a tourniquet in the event of gross œdema ; pieces about 6 in. square are suitable.

Indications for Removal.—The cast is changed once a fortnight under anæsthesia and the burned surface cleaned before the re-application of the new plaster. It is removed at once if the circulation becomes embarrassed, if hæmorrhage occurs, if pain is persistent at any one place, if discharge softens the

plaster, or if pyrexia persists or recurs. Pyrexia for twenty-four hours after a change of plaster is of no consequence ; it nearly always occurs.

LATE TREATMENT OF SEVERE BURNS

Physiotherapy.—Deep burns heal with poor quality epithelium. It is often hyperkeratotic and sometimes amounts to little more than scar tissue. Less severe burns and those which have had skin-grafts applied to the granulations in the early days present a healed surface more like normal skin. But all go through a phase of induration and inelasticity after healing before they soften. During this phase great care must be taken not to resume the dependent position too quickly or to maintain it too long at a time. Otherwise blistering, subcuticular hæmorrhage, and ulceration occur. A firm crêpe bandage must be worn until full movement of the limb in its natural position is restored. These precautions are specially necessary for the lower limb. During this period the new epithelium benefits from the gentle inunction of olive oil daily ; this scarcely amounts to massage because it is done so gently. Wax baths are also beneficial.

Rehabilitation.—As the quality of the epithelium improves, purposeful co-ordinated movements must be encouraged. Occupational therapy is invaluable. By engaging the patient in useful work, functional recovery and morale are greatly benefited. The work must be carefully selected and controlled so as to exercise the defective muscles and joints. Excessive fatigue indicates overwork and is harmful to the damaged tissues. Massage and sympathetic encouragement from a trained masseur are also of great value at this stage.

Radiotherapy.—Keloid must be treated at once with comparatively large doses of X rays. The response is much better in the early florid stages than in the late chronic state. X rays are essential before excising and grafting keloidal areas and the best results are obtained if the dosage is heavy. Grafts to replace keloid without preliminary X rays may be followed by a recurrence of keloid. The X-ray treatment must be carried out by a radiotherapeutist who is expert in treating keloid ; it requires considerable experience to judge the dosage correctly. Overdosage is disastrous ; it results in an irradiation burn. This is usually deep and is particularly difficult to graft because of the ischæmia of the underlying tissues.

Plastic Repair.—The final cosmetic repair is most pleasing if it is delayed until the burned areas have softened completely. It should be postponed as long after healing as the patient can be persuaded to wait. Eighteen months from the time of burning is ideal. But if the delay is seen to be causing deterioration of the patient's morale a start will have to be made earlier. A thick (three-quarter thickness) free skin-graft cut with the Padgett dermatome gives the best result in most instances.

MINOR BURNS

Most of the burns which come within this category are caused by domestic accidents such as occur in the kitchen, and they are frequently treated at home without medical assistance. No burn more than 1 sq. in. in extent and no burn in which the overlying blister has ruptured should be regarded as ' minor '.

Most minor burns cause only an erythema ; this is treated with calamine lotion. Those in which blistering occurs are best treated by the layman with gentian-violet jelly. The blisters are cut away with scissors sterilized by boiling for five minutes. The jelly is squeezed from the tube directly on to the raw

surface. Care must be taken not to touch this surface with the end of the tube or even with gauze or wool, since the intact blister will have preserved its sterility. The jelly is allowed to dry, after which the coagulum is covered with a bandage to protect it. The patient must be told to seek medical advice at once if the area becomes painful, swollen, or red.

TREATMENT OF SPECIAL BURNS

Burns of the Eyes.—The globe is rarely burned. It is almost always saved by reflex contraction of the lids. If it is burned, paroline drops must at once be instilled and the pupil dilated with atropine (1 per cent). The eye is then irrigated at frequent intervals with boracic lotion (60 min. to the pint) until the acute conjunctivitis has subsided. Cocaine drops (4 per cent) may be needed to overcome pain. A contact glass should be fitted as soon as it can be tolerated to prevent the formation of symblepharon. The adhesion of corneal ulcers to the burned palpebral conjunctiva is otherwise unavoidable. The glass must be worn until the palpebral conjunctiva has healed.

Inhalation Burns.—These are caused by flame entering the mouth and throat. A true flame burn of the lungs is very rare and always fatal; the patient dies of pulmonary œdema and œdema of the glottis. But the inhalation of smoke is not uncommon when the mouth is burned. The patient is always collapsed and a continuous supply of oxygen is needed. The mouth and throat are treated by repeated swabbing of the burned areas with glycerin and borax to remove the sticky fibrinous exudate which collects. An orthoform spray is used to relieve pain. If laryngeal obstruction is threatened the throat is sprayed with adrenaline; tracheotomy may occasionally be needed. Œdema of the soft tissues of the neck is common and severe; it is best treated by the application of ice packs.

Phosphorus Burns.—Phosphorus continues to burn the tissues until removed; it is unwise to rely on chemical antidotes. The burn must at once be covered with a wet dressing to prevent it bursting into flame, and the dressings must be kept moist until all traces of phosphorus have been removed. On arrival at hospital the burn is irrigated with bicarbonate of soda and all obvious pieces of phosphorus removed. The wound is then inspected in the dark; a phosphorescent glow is seen if any small pieces remain. The wound is then flooded with a 1 per cent solution of copper sulphate. This coats remaining particles with a dark deposit of copper phosphide (*Fig.* 23). These are systematically picked off or if



Fig. 23.—Phosphorus burns, showing copper phosphide deposited on particles of phosphorus by the application of a 1 per cent solution of copper sulphate.

this is impossible the ingrained area is excised. After this moist dressings are maintained for forty-eight hours before routine open therapy is instigated.

ELECTRICAL BURNS

These occur at the points of entrance and exit of the current. Occasionally they also occur in the flexures of the knees and elbows if these are bent at the time of the accident; this is due to sparking as the result of a 'short circuit'. They are usually of great depth and are very slow to heal. The area of tissue affected, however, is localized in extent and is easily distinguished from the normal skin round it. An electrical burn is not surrounded by an area of more superficial damage like a flame burn. For these reasons it is better suited than any other to the immediate excision of the burned tissue and its replacement with a skin-graft; excision half a centimetre from the margin of the dead white necrotic area is adequate. Care must be taken not to damage vital structures in the depth of the wound if these have escaped injury, but there need be no hesitation in removing all necrotic tissue. The application of ligatures to vessels encountered by so doing prevents the possibility of a secondary hæmorrhage later; this is a complication to which electrical burns are otherwise especially liable as the sloughs separate. If for any reason an electrical burn cannot be treated in this way it should be treated by open therapy using the same technique as for other full-thickness third-degree burns.

Electrical burns often cause very severe surgical shock, the patient being ashen and only semiconscious, perspiring profusely, and having an imperceptible pulse. The small size of the burned areas and the noteworthy freedom from pain which is a feature of electrical burns must not deceive the doctor. The shock may prove fatal unless energetically and adequately treated at once. This must take precedence over any form of local treatment of the burns.

CHAPTER IV

HOLLOW-NEEDLE TECHNIQUE IN INJECTION THERAPY

By HAMILTON BAILEY and SISTER PAULINE

THERE is little doubt that reputations have been made—and lost—by the hollow needle. In this instance there is no excuse for inadequate apparatus on the score of expense. As in every walk of life, skilled technicians not only provide themselves with the necessary equipment, but are vigilant in maintaining it in perfect order.

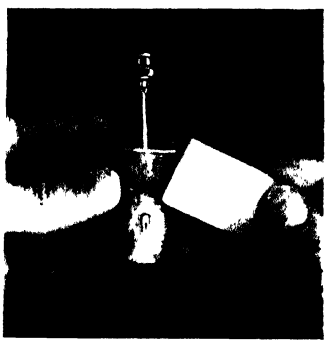


Fig. 24.—By thrusting the needle through a cork in the manner shown, it can be sharpened and the length of its bevel altered to suit circumstances.

Desirable Accessories.—

An Arkansas Stone.—Hollow needles must be sharp. If they are to be used repeatedly a cork and an Arkansas stone for sharpening them should be at hand (*Fig.* 24).

Fig. 25.—A useful file for opening ampoules. (½ *scale.*)

A File.—The files provided with ampoules are flimsy, and quite unsuited to making the necessary deep score on the neck of a thick glass ampoule. The file shown in *Fig.* 25 can be purchased at any bargain stores for 3d. It will save time, and many a cut finger from broken glass.

An Ampoule Cannula.—The familiar picture of a struggle to fill the syringe by way of a hollow needle vanishes if one is provided with a special cannula (*Fig.* 26).



Fig. 26.—An ampoule cannula.

Small Duck-bill Forceps.—Unless one is provided with a pair of forceps of special design (*Fig.* 27), it is difficult to remove syringes from the sterilizer.

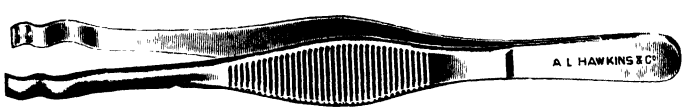


Fig. 27.—Forceps for removing syringes from the sterilizer.

An Adaptor.—Syringes of foreign make often do not fit the standard needles issued in this country. An adaptor (*Fig.* 28) is a handy little fitting to possess.

A glass 'window' attachment (*Fig.* 29) is useful when intravenous injections are to be made.



Fig. 28.—An adaptor.



Fig. 29.—Window fitting for observing drawn blood.

Ordering Needles.—The type of hollow needle suitable for intradermal, intramuscular, and intravenous use is indicated in the appropriate sections of this book.

Hollow needles are made in steel, rustless steel, and platino-iridium. The rustless steel variety is best for general purposes. Hypodermic needles, beautifully put up in metal boxes, are so inexpensive that some practitioners, rather than trouble to sharpen them, use hypodermic needles but once, in which case the rustless variety is unnecessary. A platino-iridium needle, although comparatively expensive, has the advantage that it can be sterilized by holding it in a flame until it is red-hot.

Sterilization of Syringes and Needles.—So-called sterilization by solutions of carbolic acid and other antiseptics, along with spirit, is inadequate. It is true that many are satisfied with such measures, for it is only occasionally that the doleful consequences of imperfect sterilization come to light. One of us has seen a member of the medical profession with an angry cellulitis of the thigh following a self-administered hypodermic injection. Let those who consider that exhortations for unimpeachable sterilization of hollow-needle equipment belong to the class-room rather than to the domain of everyday practice reflect that in 1939 C. H. Harney was able to collect 86 cases of gas gangrene following subcutaneous and intramuscular injections, 76 of which terminated fatally. That in 1942 V. D. Allison recorded 12 cases of severe streptococcal cellulitis among 70 nurses inoculated with TAF prophylactic. We know of a case where meningitis followed spinal anæsthesia; the infection was traced to the syringe, although boiled, having been employed to aspirate an empyema. W. and M. Smith reported a series of cases of low-grade meningitis following spinal anæsthesia, the cause of which was shown by circumstantial evidence to be due to contaminated water in which the lumbar puncture needle and syringe were placed before use. The high incidence of jaundice among American troops inoculated with yellow fever vaccine was traced to an icterogenic agent transmitted by the use of communal and imperfectly sterilized syringes. Other epidemics of jaundice occurring in patients attending venereal clinics, diabetic clinics, and arthritic clinics (where gold injections and vaccines are employed). have now been admitted to be due to the same cause. J. W. Bigger et al, exhort the practitioner to have two sets of syringes and needles—one for the injection of therapeutic products into healthy tissues, and the other reserved solely for the withdrawal of pathological fluids; his advice is even more applicable to those engaged in hospital practice.

The only really safe method of sterilizing syringes and needles is by boiling them, preferably in 1 per cent phenol solution.

In 1945 it was realized that the question of sterilization of hollow-needle equipment needed official investigation, and some of the recommendations of the Medical Research Council on this subject are as follows:—

1. The syringe of choice is an all-glass syringe.

2. After a syringe has been used to aspirate blood or pus, it should be rinsed out immediately with *cold* 2 per cent lysol solution to facilitate removal of sticky protein.

3. Anyone with acute or recent respiratory infection must wear a mask during manipulations of the syringe.

4. Sterile syringes should not be dished up in open bowls. Water or saline solution, if needed to rinse the syringe or needle, should be sterilized and stocked in small containers, the whole content of which should be emptied into the bowl.

5. Sterilization of syringes by sucking up boiling oil is not safe.

6. The standard method of sterilizing hollow-needle equipment, including syringes, should be as follows: After five minutes boiling in a closed container, e.g., a saucepan with a lid, the water is drained off; the syringe is then left in the container until required or after assembly, preferably with forceps, is placed in a dry, covered, sterile bowl.

The Care of Syringes and Needles after Use.—Directly after use the syringe and needle should be washed through with cold 2 per cent lysol solution and then the various parts dismantled. If this precaution were observed more carefully there would be far fewer 'stuck' syringes and blocked needles. To ensure perfect smoothness in action of an all-glass syringe, the plunger should be slightly coated with sterile paraffin and washed through with hot—not boiling—water.

The point of a stainless steel hollow needle is more liable to become blunted by its point becoming turned than is one made of carbon steel. Each can be sharpened on an Arkansas stone. Hollow needles should be lubricated with oil or vaseline, and the stylet replaced, before putting them away.

The 'Stuck' Syringe.—When the piston of a syringe becomes impacted a good expedient is to place the syringe upright in a vessel containing glycerol deep enough to cover the barrel completely. Each day the glycerol is warmed, after which an attempt is made to move the piston. With perseverance this method is nearly always successful, but it often takes many days.

An alternative method is to steep the syringe in peroxide of hydrogen (10-vol.) until it becomes freed. The peroxide method is indicated particularly when the piston has become glued with coagulated blood or serum.

Nelson Bell affirms that if a stuck syringe is boiled sufficiently long it will always become unstuck. He states that he has found that as much as seventy-two hours' continuous boiling may be necessary.

Storage of Sterilized Syringes and Needles.—Provided the syringe and needle have been boiled, there is no objection to storing them in spirit. The following is a good solution for the purpose.

℞	Lysol	m. 20
	Ether	m. 120
	Industrial spirit	ad pt. 1

Metal does not rust or corrode in this solution.

H. S. Gaskell has found the following method very efficient in his country practice: After sterilization, syringes are stored in a perpendicular-sided white-enamelled photographic dish 10 in. 8 in. 2 in. The dish is filled with the following solution:—

Borax . .	1·5 g.
Formalin . .	2·5 c.c.
Phenol . .	0·4 c.c.
Aq. Dest. . .	ad 1000 c.c.

The dish is kept covered with a similar vessel. Before using the syringe the needle is affixed, and any of the solution is squirted out. A wide-mouthed stoppered bottle containing boiled glycerinated water is kept alongside the storage tank, and prior to filling the syringe with the substance to be injected, the glycerinated water is drawn up and expelled. The syringe is ready for use.

The Prevention of Breakages.—By far the largest number of breakages occur during sterilization.

Golden Rules in Prevention of Breakages.—

1. *Do not sterilize syringes with other instruments.*
2. *Do not sterilize syringes with the plunger inserted.*
3. *Do not plunge syringes into boiling water.*
4. *Do not assemble syringes until they are cool.*

A Record syringe is taken apart and, together with its needle, is wrapped in gauze. The gauze packet is placed in cold water, brought to the boil, and boiled for at least fifteen minutes.

An all-glass syringe, being manufactured from heat-resisting glass, can, if it is dismantled, be put into hot water and cooled in cold water without fear of cracking. The parts of the syringe should rest on cotton-wool placed on the sterilizing tray.

Making up a Dose of Hypodermic Medication from a Hypodermic Tablet.—A teaspoon and some boiling water are the requisites. The spoon is held in the boiling water for a moment. The teaspoon containing some of the water is laid down. A little more than half a syringeful of the water is sucked

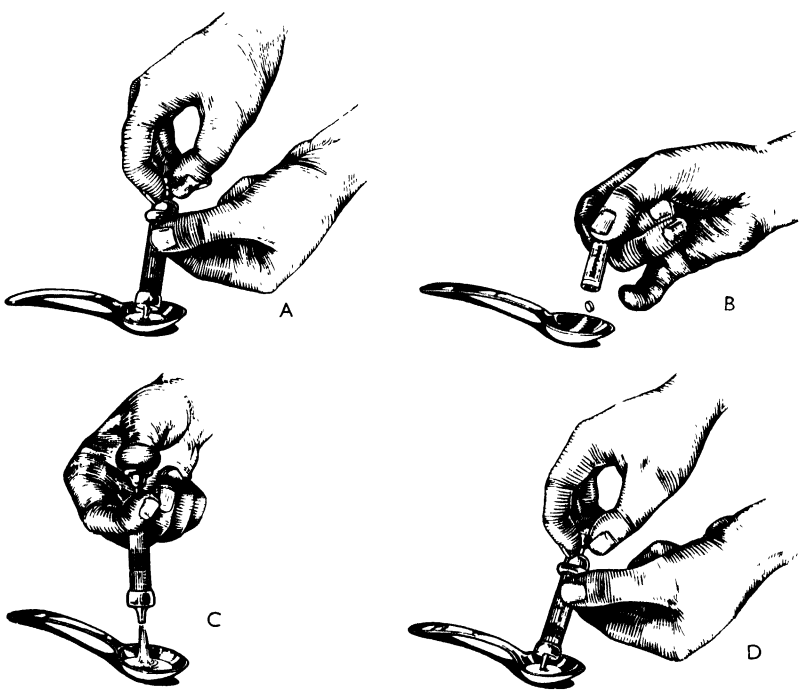


Fig. 30.—Making up a dose of hypodermic medication from a tablet.

up from the spoon (*Fig.* 30, A). The spoon is emptied and the hypodermic tablet cast into the spoon from the container (*Fig.* 30, B). The water in the syringe is squirted into the spoon containing the tablet (*Fig.* 30, C). When it has dissolved, the solution is drawn up into the syringe (*Fig.* 30, D). The needle is now affixed to the syringe for the first time in the procedure.

Technique of the Rubber-capped Stock Bottle.—Vaccine bottles and bottles of local anæsthetic are a worry to the practitioner; an improved model is one in which the rubber cap is surmounted by a bakelite screw cap containing within a pad soaked in antiseptic. Alternatively, the rubber cap should be wiped over with iodine solution before being punctured.

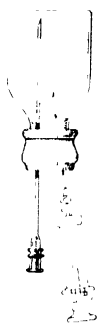


Fig. 31.—Method of facilitating withdrawal of the contents of a rubber-capped stock bottle

Particularly oily solutions, e.g., proctocaine, are difficult to withdraw. To provide an air inlet by means of a long, hollow needle while an assistant holds the bottle upside down (*Fig.* 31) facilitates withdrawal of the contents of the bottle.

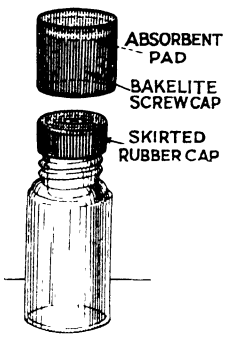


Fig. 32.—Berry's bottle

Storing 'ready to inject' Solutions.—By far the safest and most satisfactory method is to employ Berry's bottle* (*Fig.* 32). The bakelite screw cap contains an absorbent pad which can be impregnated with an antiseptic; thus the rubber cap is constantly kept free from contamination. The antiseptic recommended by the Medical Research Council is a 10 per cent solution of chloroxylenol B.P.

TECHNIQUE OF HYPODERMIC INJECTIONS

In order to avoid the frequent and annoying happening depicted in *Fig.* 33, the needle must be fixed to the syringe firmly. In order to get a good fit the needle should not be pushed on but be put on with a quarter turn. The same instruction applies when detaching the needle. This quarter-turn technique makes all the difference, and in spite of what the reader may think, it is not generally known.

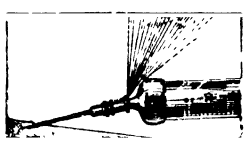


Fig. 33

The needle must be fine, sharp, and have a long bevel. Spirit causes pain; if the syringe has been stored in spirit, it should be rinsed in sterile water or ether drawn up into the syringe. The last trace of ether is expelled by aspirating the air. Some practitioners find that to sterilize the skin with methylated ether instead of spirit is to impart slight local anæsthesia.

Hair follicles must be avoided. A hairless area is chosen for the injection. Far better than pinching up the skin is to stretch it (*Fig.* 34). The needle is thrust into the subcutis. The content of the syringe is delivered and the needle withdrawn. Pressure is applied with a swab and the area massaged for a moment.

* Made by Messrs. Britton Malcolm & Co., Southwark Bridge Road, London, S.E.

INTRADERMAL INJECTIONS*

Intradermal injections are used for the Schick test and also for those of Dick and Mantoux. The technique is important, since, if imperfectly performed, the results

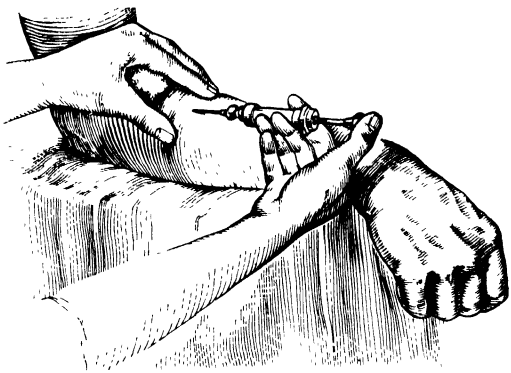


Fig. 34.—When making a hypodermic injection stretching the skin is far better than pinching it up.

of these tests are fallacious. A very short needle with a short bevel (*Fig.* 35) is employed. With the left hand encircling the forearm, the index finger and thumb stretch the skin tightly between them. The needle is inserted into the dermis with the bevel facing the operator, the penetration being almost parallel with the surface, and at right angles to the line of stretch. The injection must be performed slowly and be made into the skin itself. If the procedure is carried out correctly a white wheal (nettle-sting) is raised above the skin level. During the injection some resistance must be felt; if none is met and the injection is easy, then the skin has been wholly pierced and the test is invalid.



Fig. 35.—An intradermal needle. (*Actual size.*)

INTRAMUSCULAR INJECTIONS

A needle for intramuscular injection should have a long bevel, be of S.W.G.† 22, and 2 in. long (*Fig.* 36). When making an intramuscular injection the

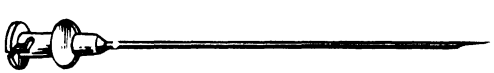


Fig. 36.—An intramuscular needle. (*Actual size.*)

skin should be stretched as for a hypodermic injection, and the needle plunged in almost at right angles to the surface (*Fig.* 37).

Necessary as it is at all times to be provided with sound needles, to employ an old and corroded needle for an intramuscular injection is frankly negligent; a fracture between the hub and the shaft is the usual accident. Especially if viscid fluids are to be injected, the lockhead type of syringe is most desirable;

* Written by A. E. Hodgson.

† S.W.G. = standard wire gauge.

indeed, in the case of oily substances, unless the circumstances are extenuating, one should always employ a syringe conforming to this type, of which Labat's syringe (*Fig.* 38) is the best.

When injecting a fluid which is liable to cause irritation in the subcutaneous tissues, a good method is to have a bubble of air in the

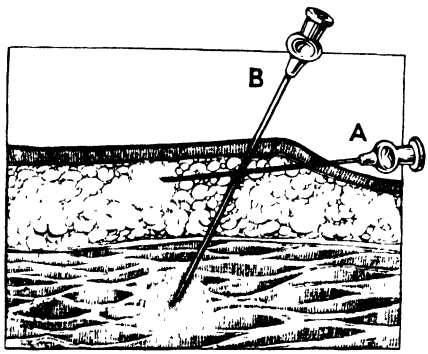


Fig. 37.—Subcutaneous and intramuscular injections, showing the angles of the needle

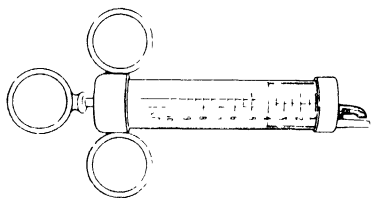


Fig. 38.—The lockhead type of syringe (Labat's pattern)

syringe. After injecting the solution into the muscle, the bubble of air is injected, which ensures that the needle is empty while it is being withdrawn. The following are the preferable sites for the injection :—

Sites for Intramuscular Injections.—

Contra-indication.—For many years the gluteal region was considered the site of choice for intramuscular injections. Old beliefs die hard, and not only is this site still being employed, but, according to Sidney Boyd, the gluteal region is still advocated at some medical schools. Among several disadvantages, the danger of inadvertently injecting the sciatic nerve is the most in evidence. On Professor Grey Turner's authority we recommend that this site be abandoned entirely.

Site of Election.—The vastus externus is a very large muscle ; it is protected by the fascia lata and is not traversed by any important vessel or nerve. The muscular mass is large enough to accommodate 500 c.c. at a single injection, in an average adult. By mapping out three zones on the outer side of both thighs (*Fig.* 39), six areas free from any dangerous structures are available for injection and changes can be rung many times without using the same site consecutively. No fewer than 50 intramuscular injections of sulphanilamide were given to the same patient in this way, without causing more than trifling discomfort (Sidney Boyd).



Fig 39
into three areas for the purpose of intramuscular injections

The ambulatory patient should brace the limb and bear his weight on the side which is to receive the injection.

The Deltoid.—This is an admirable site when the amount of fluid to be injected is comparatively small.

The Pectoralis Major.—There is no objection to this site, which may prove a useful one on occasions. With the patient's arm raised to a right angle the pectoralis major is grasped between the finger and thumb. The needle is thrust into the muscle through skin overlying the anterior fold of the axilla. That the centre of the muscle is penetrated is easily determined by the grasping finger and thumb. Up to 20 c.c. is well tolerated in this muscle, and absorption is rapid.

INTRAVENOUS INJECTIONS

Intravenous injections play a large part in modern practice. Excretory pyelography, intravenous anæsthesia, intravenous infusion, blood transfusion, and the treatment of syphilis and varicose veins are examples where it is most desirable to be an adept in inserting a hollow needle into a vein. The needle should have a short bevel, but otherwise there is no need to vary it from the ordinary large hypodermic variety. To employ a syringe with an eccentric nozzle (*Fig.* 40) is an advantage.

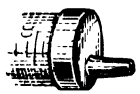


Fig 40.—A syringe with an eccentric nozzle simplifies intravenous injection.

To become efficient at venipuncture requires practice. Bungling is only too frequent; let alone the pain, waste of time, and annoyance caused thereby, the crop of medico-legal cases which have sprung up around intravenous medication should stimulate the house surgeon to lose no time in mastering the technique.

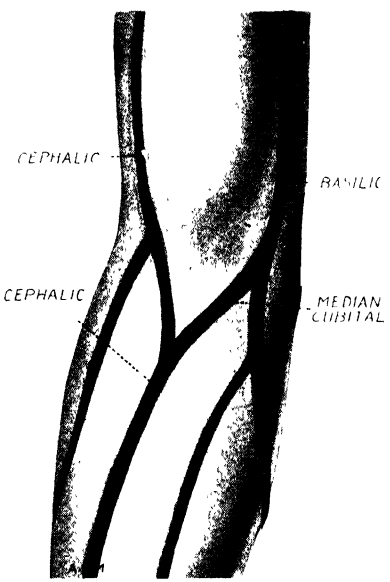


Fig. 41.—The veins of the forearm.

Especially when the solution to be injected is known to be irritating if extravasated outside the vein wall and/or the veins are likely to be 'difficult', Edwards's vein seeker, which will be described presently, is valuable, even to an expert.

It is a mistake to choose the most prominent vein, one easily palpable but well obscured and supported by subcutaneous fat will be found less mobile and thus more readily entered. The large prominent veins of the aged are notoriously difficult to enter.

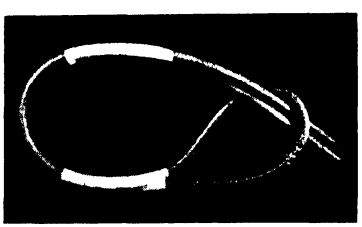


Fig. 42.—A self-releasing vein tourniquet.

A vein in front of the elbow is usually chosen, but should the veins be reasonably prominent, a radicle in the upper third of the forearm (*Fig.* 41) is often entered more easily. A very important point is to have the elbow-joint fully

extended—even hyperextended—and a folded towel behind the elbow achieves this purpose. Those who are inexperienced are advised to have the arm resting on a rigid, padded splint. The self-releasing vein tourniquet shown in *Fig.* 42 is ideal for general use.

The skin is prepared by using a fat solvent (ether), followed by spirit. The needle must be sharp; blunt needles frequently tear the vein. As a rule the skin is pierced separately. The vein is immobilized by support from the tip of the index finger, and by stretching the overlying skin with the thumb (*Fig.* 43).

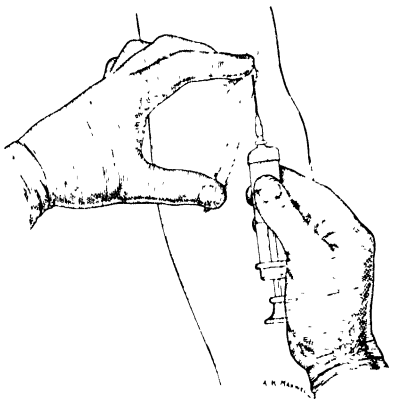


Fig. 43.—Method of stretching the skin and steadying the vein while performing venipuncture

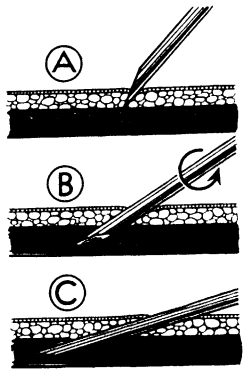


Fig. 44.—Stages of venipuncture

The vein is entered in the side opposite to the supporting index finger. Once the vein wall has been pierced the bevel of the needle is rotated so that it looks downward (*Fig.* 44). Blood should enter the needle spontaneously if the venous pressure is within normal limits. It is for this purpose that the window fitting (*see Fig.* 29) is useful. Before the injection is made the tourniquet must be released.

Edwards's Vein Seeker (*Fig.* 45) is most useful, especially when veins are collapsed or otherwise difficult to locate. The vein seeker is filled with sodium

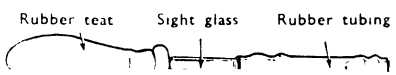


Fig. 45.—Edwards's vein seeker.

citrate solution. It is 4 in. long, and this allows the butt end of the needle to be held between the thumb and forefinger while the teat is compressed by the 4th and 5th digits against the hypothenar eminence. The teat, now compressed, is empty, but the rest of the instrument is still filled with citrate solution. The point of the needle is inserted under the skin where the vein is suspected and the pressure on the teat released. The teat remains collapsed until a vein is entered, when the negative pressure within the teat draws blood into the instrument. When blood appears in the glass tube the whole instrument is fixed in position by two strips of adhesive plaster. By sterilizing

the rubber tubing between the needle and the sight glass with spirit, the necessary injection can be made into the rubber tubing (*Fig.* 46) and thence into the venous system. The great advantage of this apparatus is that it allows repeated intravenous injections to be made without repeated puncture.

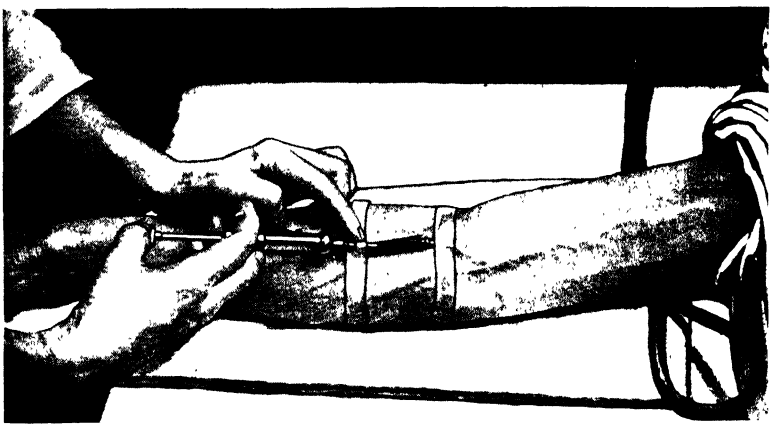


Fig. 46.—Edwards's vein seeker in use

As can be seen from *Fig.* 45, there is no difficulty in making Edwards's vein seeker from materials readily accessible in any laboratory. An alternative vein seeker, also most easily constructed, is Taylor's. It is made as follows :

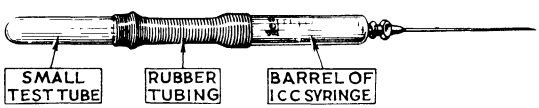


Fig. 47.—Taylor's vein seeker

(1) The barrel of a 1 c.c. syringe, preferably of glass ; (2) a short piece of soft rubber tubing of suitable size to fit over the barrel ; (3) a small serological test-tube about the same size as the barrel (*Fig.* 47).

VENIPUNCTURE IN AN INFANT

By Elliott Emanuel

The external jugular vein is a satisfactory site in infants and young children. A seated nurse holds the child facing away from her with its head lower than its body. The external jugular vein is seen easily in this position. It fills with blood when the head is lowered and during crying. The needle, pointing towards the thorax, is introduced where the vein crosses the sternomastoid (*Fig.* 48).

The anterior fontanelle, which is normally patent until fifteen months of age, is sometimes the only practicable site for a venipuncture. A small area centred over the fontanelle is shaved. The baby, wrapped in a blanket with his arms by his side, is placed on his back. The nurse grips both sides of the head

with her hands and steadies the body with her elbows. The operator can either sit facing the fontanelle or stand at the side of the infant. The shaved area of skin is sterilized. With the left hand the margins of the fontanelle, which is the shape of a lozenge, are palpated. A serum needle, size 0 to 11, is introduced $\frac{1}{4}$ in. anterior to the posterior corner of the fontanelle, strictly in the middle line and pointing towards the occipital protuberance (*Fig.* 49). Two definite layers have to be penetrated: first, the skin and aponeurosis; and, second, the outer wall of the venous sinus. When the blood has been obtained the infant's head is elevated while the puncture is sealed with collodion.



Fig. 48.—Venipuncture in an infant. The external jugular vein is a good site if the child is held in this position.



Fig. 49.—Puncture of the superior longitudinal venous sinus.

Occasionally a mixture of blood and cerebrospinal fluid is aspirated, which indicates that the needle has been pushed in too far and has penetrated the opposite wall of the sinus. When the cerebrospinal fluid and the blood concentrations of a substance, e.g., urea, are roughly equal no correction is needed for this error. On the other hand, when they are widely different, e.g., protein, a correction must be made for the blood dilution, and a hæmoglobin percentage of an oxalated specimen of capillary blood must be compared with that of the blood diluted with cerebrospinal fluid.

One c.c. of capillary blood can often be obtained from a prick in an infant's heel.

We are greatly indebted to Mr. L. van Lier, of Vann Bros. Ltd., for considerable help with the practical points connected with the care and sterilization of syringes and needles detailed in this chapter.

CHAPTER V

SALINE AND OTHER INFUSIONS

By HAMILTON BAILEY

CONTINUOUS INTRAVENOUS INFUSION (VENOCLYSIS)

TIME and again to my certain knowledge intravenous infusion, particularly continuous saline infusion, has proved a veritable breath of life, yet I have met several pathologists who, from their experience in the post-mortem room, are equally convinced that it has been an agent of death; the patient was literally drowned, they say. So it comes about that unless the house surgeon is prepared to undertake intravenous fluid therapy with the intelligence of anyone with a reasonable physiological training, it would be far better for him to restrict his activities to the more fool-proof rectal and intramuscular routes. To rig up a continuous drip, and then go off for the week-end without turning over the case, in person, at the patient's bedside, to a conscientious colleague, is little short of criminal.

Unless a balance sheet is made up every twenty-four hours we have no check upon the patient's requirements. I am definitely of the opinion that without a balance sheet intravenous fluid therapy should never be continued for more than twenty-four hours. There is absolutely no difficulty in making up a balance sheet (*Fig.* 50), and in order to save trouble and time spent in clerical

CONTINUOUS INTRAVENOUS SALINE BALANCE SHEET

Patient's Name

24 hours ending . . . 19	INTAKE	OUTPUT	
INTRAVENOUSLY:—		URINE { S.G. . a.m. / S.G. p.m. } .	pts
*@ drops per min.	pts.	Vomitus	pts
*@ ,, ,,	pts.	Normally 1½ pints { Fæces	pts
@ ,, ,,	pts.	Sweating & Lungs — say	pts.
BY MOUTH			
Total		Total	
GLUCOSE:— 5% Solution (allow 30 grammes for each pint)	120 Calories		

*50 drops per minute = 6 pints in 24 hours
*30 ,, ,, ,, = 3 ,, ,,

Fig. 50.—Balance sheet. Pads of 50 can be obtained from the Genito-Urinary Manufacturing Co. Ltd.

work, pads of fifty can be obtained at the modest price of 6d. each. In spite of this labour-saving process, I find it necessary to be ever-vigilant in seeing that the correct making-up of the balance sheet is carried out.

Preparation of the Solution.—Obviously a solution which is introduced directly into the circulation must be absolutely sterile; but this is not enough—it must also be free from dead bacteria and other extraneous matter, such as fur from the sterilizer. Boiled tap-water does not fulfil these requirements, and if it is used reactions are bound to occur. Triply distilled water not more than a week old must be employed in all cases.

It is, of course, equally important to have the sodium chloride sterile and pure. Tablets sold in tubes for the preparation of normal saline are not prepared with a view to intravenous therapy. Sterile ampoules for making the solution are obtainable.

Saline or Saline and Glucose?—Normal saline solution alone meets most requirements. When glucose is employed we are introducing a substance into the circulation which requires catabolism, and if glucose is to be used there should be adequate reasons for its introduction; the patient must be in need of glucose, as one who has been starved, and only sufficient glucose for his immediate needs must be introduced by the intravenous route. As regards insulin, if there is no reason to think that there is a deficiency of this hormone, there is no reason to give more.

Apparatus.—Special needles and cannulæ for intravenous infusion are available. The cannulæ shown in *Fig.* 51* will be found to be satisfactory. Every portion of the apparatus (*see Fig.* 59) must be freshly boiled and washed through with sterile water or saline before the reservoir is filled. New rubber tubing should be boiled, stretched, and washed through to remove the chemicals, and boiled again before the apparatus is assembled. An interceptor (*Fig.* 52) is an integral part of the armamentarium; it should be freed of contained water from the sterilizer before the reservoir is filled. The whole apparatus must be seen to be in working order and the filled reservoir suspended suitably before any attempt is made to prepare the patient for the reception of the saline.

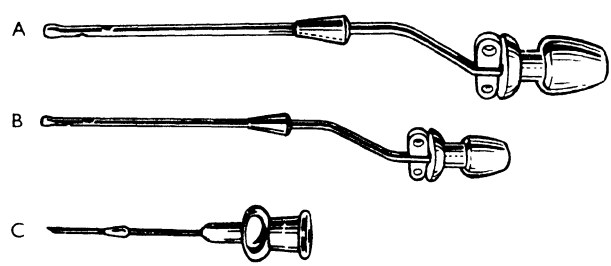


Fig. 51.—A, Hamilton Bailey's cannula, B, Child's size (A and B are gold plated, to prevent corrosion), C, Infant's cannula



Fig. 52.—An interceptor for continuous intravenous saline.

Technique.—

Choice of the Vein.—In general it is best not to use a large vein; one just a little larger than the cannula or needle is most suitable.

* A and B, made by Genito-Urinary Mfg. Co. Ltd.; C, made by Vann Bros. Ltd.

The lower limb can be splinted securely; consequently, in patients who are restless or may become so, the leg as the site for infusion is desirable. It is also obvious that it is less irksome for the patient to have a long-continued infusion

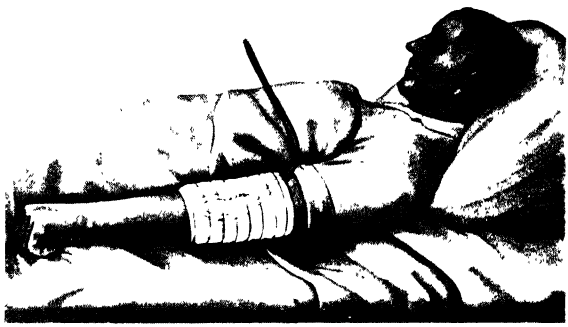


Fig. 53.—Sutton's method of keeping a hollow needle within a vein by means of a few turns of plaster-of-Paris bandage (inset). Note that the hand is pronated

into the lower limb. What is not so obvious, unless thought is given to the subject, is that in elderly patients who have been confined to bed for some weeks, it is possible, nay probable, that some thrombosis has occurred in this part of the venous system, and in this type of patient the introduction of fluid into a vein of the leg may dislodge the clot and cause pulmonary embolism. The tedium of immobilization of an arm is, to a large extent, neutralized by placing the limb in a comfortable pronated posture (*see Fig.* 53).



Fig. 54.—The internal saphenous vein is exposed just above and in front of the internal malleolus. It lies rather deeply and is accompanied by the internal saphenous nerve.

A Hollow Needle, as opposed to a Cannula, is to be Used.—A vein at the fold of the elbow or, better still (if there is one reasonably prominent), a vein of the upper third of the forearm is selected. Unless the operator is an adept at venipuncture, and even if he considers that he is, but he had not had time to ensure that his hollow needle has been honed recently (*see* p. 29), I strongly advise the following as a routine procedure:



Fig. 55.—The external jugular vein, as it crosses the sternomastoid, can be exposed easily.

Inject a drop of local anæsthetic into the superficial layer of the skin over the vein. Make a tiny nick with a scalpel and then wait about half a minute for the œdema occasioned by the local anæsthetic to abate. Insert the needle through the puncture in accordance with the instructions on page 59.

Being satisfied that the needle is unquestionably within the vein and that the fluid is running freely, the needle must be fixed in position. After trying many

devices I have found that there is no better method of keeping the needle undisturbed than that described by Sutton. All that is required is one 3-in. plaster-of-Paris bandage (*Fig.* 53). Note particularly the backward curl of the tubing under the plaster bandage; with this provision, even if there is an inadvertent pull on the tubing, the needle will not be disturbed.

Inserting a Cannula.—In many emergency conditions veins are collapsed. Consequently, it is necessary to expose the vessel. When a suitable vein of the forearm cannot be felt or it is desirable to employ a lower rather than an upper limb for the infusion, an incision is made over the commencement of the internal saphenous vein (*Fig.* 54). One never fails to find this vessel just anterior to the internal malleolus. In exceptional circumstances the external jugular vein (*Fig.* 55) offers an admirable, but little used, site for fluid therapy. Full aseptic ritual must be observed, both in the preparation of the patient's skin and the operator's hands; it cannot be stressed too often how vital it is for everything to be aseptic in this procedure. A tourniquet, preferably of the type depicted in *Fig.* 42, p. 36, is applied. If the patient is conscious, a little local anæsthetic is injected into the sterilized skin over the vein. A short transverse incision is made through the skin. The beak of a small hæmostat is introduced into the wound and its jaws opened widely (*Fig.* 56). This manœuvre is repeated until the vein has been cleared from the subcutaneous tissues. This is an absolutely satisfactory procedure; there is no fear of tearing even a delicate vein. The entire circumference of the vein must be freed over a distance of about 1 cm. before passing two ligatures beneath it. The distal one is tied. Traction on the proximal ligature will prevent blood escaping when the vein is opened. The vein wall is picked up in dissecting forceps and with fine-pointed scissors a triangular flap is raised.

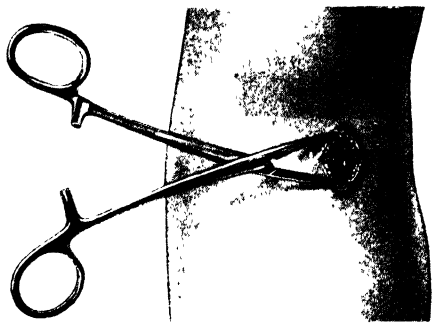


Fig. 56.—A rapid and efficient method of displaying a subcutaneous vein through a small transverse skin incision

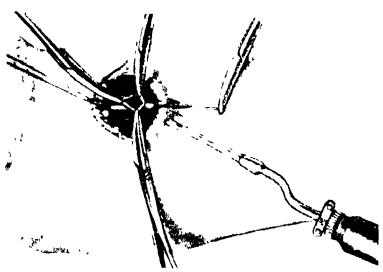


Fig. 57.—A vein exposed at the fold of the elbow ready for the insertion of the cannula.

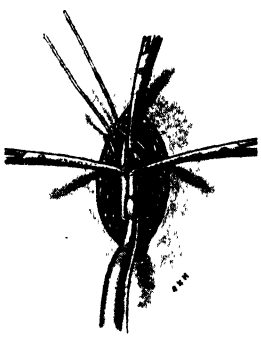


Fig. 58.—A good method of inserting a cannula into a small vein. (*After J. L. Keeley.*)

The tourniquet is now loosened. The apex of the flap is grasped in a hæmostat or by dissecting forceps (*Fig.* 57). When the cannula is within the lumen the proximal ligature encircling the vein is tied in a half knot.

In the case of a small vein it is a good practice to place the hæmostats as shown in *Fig.* 58, but this method is not recommended unless really fine (Mosquito) forceps are available.

For the subsequent smooth running it is recommended to flood the wound and moisten the cannula with citrate solution immediately before inserting the cannula into the vein. Once the cannula is satisfactorily in position the wound is closed about the cannula, which is fixed to the skin by means of fine stitches passed through the slots.

Keeping the Limb at Rest.—

The arm.—Either a Carr's splint or plaster slab well padded with Gamgee tissue, with a turn around the wrist, is eminently satisfactory.

The leg.—A posterior splint with a footpiece is serviceable (*Fig.* 59). Alternatively, a Thomas's knee splint can be used. The latter has the advantage of ensuring immobilization of the limb when the patient is restless.

The Temperature of the Fluid.—In spite of the many ingenious devices which have been put forward for keeping the fluid warm, the simplest appears to be the best—namely, the patient's leg or arm into which the saline solution is flowing is kept warm with a hot-water bottle or an electric heating pad. In addition to simplicity, this leaves the reservoir and the delivery tube in full view.

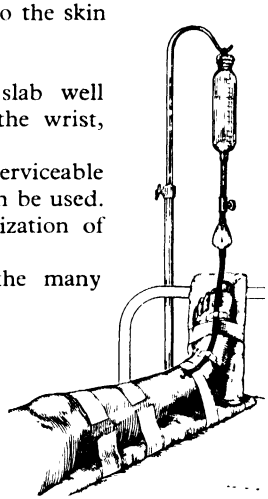


Fig. 59.—Apparatus in use. In very ill patients who are restless or may become so, the limb can be placed in a Thomas's splint with advantage

The Rate of Flow.—The average rate of flow for an adult in need of fluid should be 50 drops per minute, that is, a quarter of a pint per hour, or six pints in the twenty-four hours. In urgent cases, for the first hour the rate of flow is often accelerated to 100 drops per minute to see how the patient responds. If the blood-pressure is increased satisfactorily, we are encouraged to proceed with the measure. When in doubt as to how much fluid the patient should receive, the flow should be cut down to 30 drops a minute—that is, approximately three and three-quarter pints in the twenty-four hours, a dose which at any rate is unlikely to harm him.

The Administration.—The actual administration is largely in the hands of the nursing staff. It is of paramount importance to be sure that the nurse appreciates the simple, yet vital, responsibilities connected with the care of the apparatus and the maintenance of strict asepsis.

The nursing instructions are simple, and can be carried out by a conscientious State-registered nurse, providing that she receives special instructions if she has not been trained in the method.

Nursing Instructions.—

1. Every utensil used in the transfer of the saline to the reservoir must be absolutely sterile.

2. To prevent the entry of bacteria from the air, the top of the reservoir must be covered with sterile gauze.

INTRAVENOUS INFUSION
(Rules for the House Surgeon)

1 Never give fluid intravenously to patients with —

a Unhealthy lungs (bronchitis, pneumonia, phthisis, etc.).

b. A defective heart (myocarditis, valvular disease, etc.)

c Poor kidney function (nephritis, hydronephrosis, etc.).

d. Jaundice from any cause, unless you are authorized to do so by your chief.

2. In cases falling into the above categories employ the intramuscular route or a transnasal, intragastric drip. Make more use of the latter in suitable cases.

3 If the flow stops, do not dismantle any part of the apparatus without due thought of the possibility of air embolism. Rather remove the needle or the cannula, and if necessary, re-insert it into another vein.

4 Never continue an intravenous or an intramedullary infusion for more than 24 hours without the sanction of your chief, the surgical registrar, or the resident medical officer

5 Personally check the fluid intake and output figures at the end of 24 hours Make up or check the balance sheet yourself, bearing in mind the following —

DAILY LOSS OF WATER OF AN AVERAGE-SIZED MAN
(J H Tillisch)

	c c		fl oz
Skin (at average temperature and humidity)	450	—	15
Expired air (at average temperature and humidity)	300		10
Urine	1,500		50
Fæces	150		5
Total	2,400		80

6 When the infusion has been continued for more than 48 hours examine the bases of the lungs daily, and record your findings in the notes

7 Be watchful for the development of acute pulmonary œdema If this condition develops —

a Stop the infusion

b. Supervise the gentle alteration of the patient from Fowler's position to Trendelenburg's position.

c Give 0·5 mg digoxin intravenously

d Personally conduct postural drainage (*Fig.* 60) and show the sister or staff nurse what is required

e Having emptied the lungs (in pulmonary œdema watery sputum is expectorated) as far as possible, prop the patient up in a comfortable sitting position and give oxygen by one of the modern masks, or failing that by nasal catheters

f. Order coramine, 2 c c. four-hourly.

g. Repeat the digoxin and the postural drainage, as considered necessary, at about two- to four-hourly intervals.

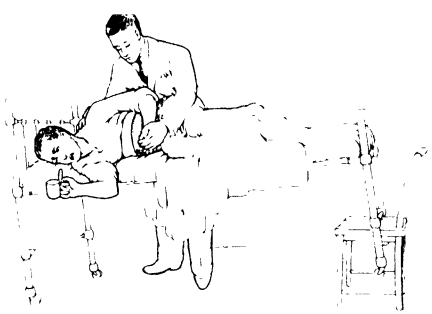


Fig 60.—Postural Drainage

h. If the patient's condition is improving and the urinary output is unsatisfactory, consider the advisability of injecting mersalyl (2 c.c. intravenously) or a suitable dose of one of the other mercurial diuretics. Do not do this without the advice of the most senior member of the medical (as opposed to the surgical) staff available, and if there is any doubt, withhold the drug.

3. The reservoir must always be kept more than half full of saline.

4. Veins are easily obstructed. There should be no bandage over the line of the vein.

5. The rate of flow should be timed and recorded at frequent intervals.

6. If the flow stops: (*a*) Do not pinch the tubing; (*b*) See if the tubing is kinked; (*c*) If the flow is not restarted by some simple adjustment of the limb or the tubing, report immediately.

7. Watch for and at once report: (*a*) Rigors; (*b*) Redness along the vein; (*c*) Œdema of the feet, face, or arms; and (*d*) Any sign of respiratory distress.

8. Measure the amount of urine the patient has passed. If the output is less than the intake report the matter. Also report if the specific gravity becomes low.

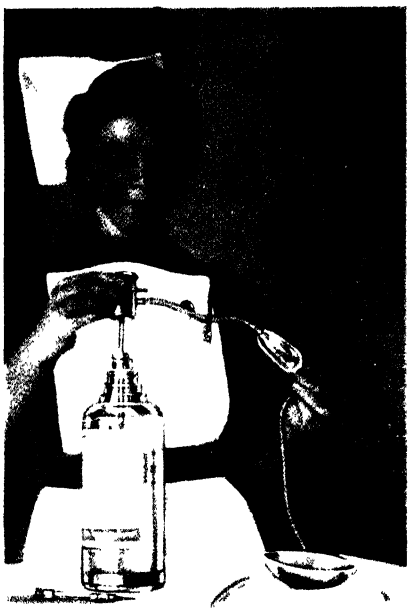


Fig. 61 — The metal cap is removed and the "Vena-dispenser" screwed in.



Fig 62 —The Vena-flask in use

'Ready for Use' Infusion Sets.— Since the Vacoliter, which is manufactured in Canada, is no longer available in Britain, several manufacturing chemists have put up normal saline, saline and glucose, glucose, and sodium sulphate solution in convenient flasks with the necessary interceptor, needle, and tubing, ready for immediate use. Such an apparatus is ideal in an emergency, for the sterility of both the apparatus and the solution is unquestionable.

I have used, at various times, all these substitutes for the Vacoliter, and, perhaps, the best (for several original features have been introduced) is the Vena-flask (British Drug Houses, Ltd.). The apparatus is very simple to assemble. The metal cap is removed and the Vena-dispenser screwed in (*Fig.* 61). The tubing is attached to the projecting right-angled metal tube nearest the bottle.

This is important, as its fellow is the air-inlet. The flask is then inverted and hung on a stand (*Fig.* 62). It is important to be sure that all air is out of the tubing before inserting the needle into the patient's vein.

Changing the Flask.—In all cases where intravenous infusion is in progress it is highly important that the nurse should be vigilant in calling attention to the fact that the contents of the flask are running low. In no case should any type of container be allowed to run dry, otherwise the tremendous danger of air embolisms is at hand. To change a Vena-flask all that is necessary is to apply a hæmostat to the tubing 1 in. from its attachment to the Vena-flask, and to re-attach the tubing to a full flask, which is then hung on the stand. The hæmostat is then removed.

CONTRA-INDICATIONS TO INTRAVENOUS INFUSIONS

Continuous intravenous saline, used intelligently, is an extremely valuable addition to the treatment of many urgent surgical conditions. The contra-indications to its use are few, but they are definite, and should be noted carefully.

1. **The Failing Heart.**—A history of dyspnœa on exertion, uncompensated valvular disease, or any possibility of cardiac weakness should call for hesitation in increasing the bulk of circulating fluid. When in doubt as to whether the poor pulse is due to cardiac weakness or to another cause, I have many times placed the patient on continuous intravenous fluid and a pressor drug, e.g., cortin, and waited for an hour or more to see if the blood-pressure improves. *If it is does not*, the infusion is discontinued. *If it does*, the flow is reduced to 30 drops per minute and the patient is again visited after a lapse of an hour or so.

2. **Pulmonary Congestion.**—In all conditions where there are signs of œdema or consolidation of the bases of the lungs the method is most inadvisable.

3. **Hypertension.**—If the blood-pressure is high it is obviously courting danger to burden the circulation still further.

4. **Bright's Disease.**—In all its stages this disease is a grave contra-indication. On the other hand, in obstructive anuria and oliguria, after the obstruction has been removed, and in many of the surgical uræmias, continuous intravenous 5 per cent glucose—or better, continuous intravenous sodium sulphate (made by dissolving 42·85 g. of Glauber's salt in one litre of water)—used with discretion is a real therapeutic advance.

INTRAVENOUS INFUSION

SINGLE MASSIVE DOSE

Intravenous infusion given in a massive single dose (a pint or more) has many times saved life. True, saline and other isotonic crystalloid solutions are but poor substitutes for whole blood or even plasma, but occasions arise when urgency forbids the delay in procuring the latter.

When a patient is collapsed his veins will be in a like condition; and it is necessary to insert a cannula into the vessel.



Fig. 63.—Funnel and tube in readiness for an intravenous infusion.

Technique.—Before commencing to expose the vein, the funnel and tube should be filled with the solution. To ensure the absence of air in the tube and nozzle, some fluid is permitted to escape. As soon as air-locks and bubbles are eliminated, the tube is clipped (*Fig.* 63).

After the administration, as the last ounce of fluid is gravitating into the vein, the cannula is withdrawn, and the ligature surrounding the vein is quickly tied. Having cut the ligature two skin sutures are required to complete the operation.

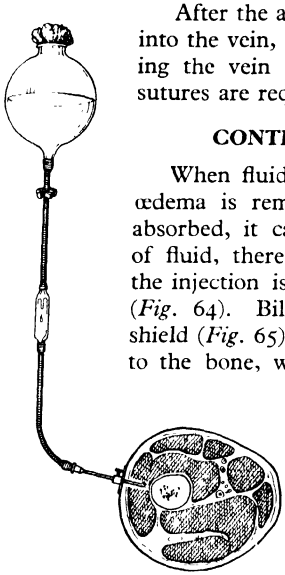


Fig. 64.—Continuous intramuscular administration of fluid in the lateral aspect of the middle third of the thigh.

CONTINUOUS INTRAMUSCULAR INFUSION

When fluid is given intramuscularly the danger of pulmonary œdema is remote. If more fluid is administered than can be absorbed, it causes local œdema. This route for administration of fluid, therefore, offers some advantages. The best site for the injection is the external side of the middle third of the thigh (*Fig.* 64). Billimoria and Dunlop's needle, with its adjustable shield (*Fig.* 65), is an asset. The needle is inserted nearly down to the bone, when the adjustable shield is fixed by turning the screw, making further penetration impossible. It is a good practice to insert the needle through a piece of sterile gauze, which comes to lie between the shield and the skin. Once the needle is in place satisfactorily it can be kept in position by adhesive plaster placed over the shield. A rate of about 40 drops a minute is suitable for most adults in need of fluid. When both thighs are used, a Y-shaped glass connexion is interposed in the tubing leading from the flask. Each tube leading from the Y-shaped connexion should possess an interceptor, so that the flow to each thigh can be regulated.

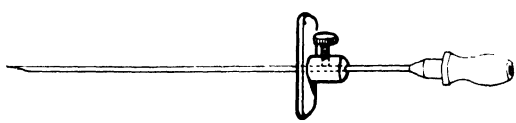


Fig. 65.—Billimoria and Dunlop's needle for intramuscular administration of fluid. (*Made by Messrs Thackray.*)

SUBCUTANEOUS SALINE INFUSION

This mode of administration of saline is inclined to be painful. It cannot be continued for more than a matter of hours, and the tendency is to replace it by the more certain methods described already. It is, however, a fundamental route in the case of infants (*see* p. 52).

RECTAL INFUSIONS

Rectal infusion has the advantage of simplicity; it requires neither special apparatus nor asepsis. A solution containing 60 gr. of salt to a pint of water, at a temperature of 115° F., is allowed to gravitate into the rectum through a funnel and tube connected to a catheter. The patient's hips are elevated, and the funnel is held at a height of 1 ft. The usual amount of infusion is half a pint every four hours.

The celebrated John B. Murphy, of Chicago, introduced continuous rectal saline infusion (proctoclysis), which was a distinct advance, especially in cases

of peritonitis. Slow, continuous delivery of the saline aided its absorption, and caused less disturbance to a patient in a critical condition. Some believe that the administration of saline or tap water by the rectal route satisfies almost every requirement (*Fig.* 66). It is true that sometimes tap water, as opposed to saline, is retained and absorbed more readily.

Nevertheless, a close observer soon realizes that a rectal infusion, even when given by an experienced and painstaking nurse, is frequently returned, particularly in cases where it is needed most. I am compelled to agree with Willard Bartlett, of St. Louis, that whoever wishes to adopt saline by the rectal route exclusively, should first administer it a few times in person and watch results.

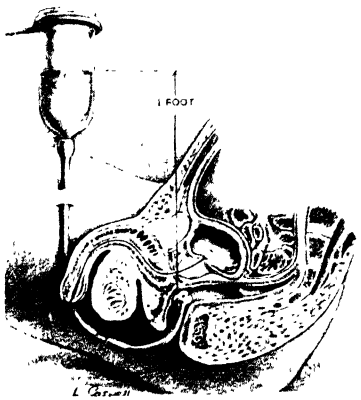


Fig. 66 — Diagram embodying the essential principles, as laid down by Murphy. Murphy employed a glass cannula, which is not readily available. A de Pezzer catheter as shown here, is equally effective

TRANSNASAL INTRAGASTRIC INFUSIONS

Safe and reliable, this method of ensuring an adequate or a high fluid intake has a great future. The value of the method has not yet attained general appreciation among the medical and nursing professions. The rising generation of house surgeons will do well to ponder on the indications for this route; to reflect how physiological it is to introduce a steady stream of water and if need be nourishment into the *upper* end of the alimentary canal during the whole of the twenty-four hours, and to develop its application in the right type of case. In the beginning he will be sure to find a certain amount of opposition, especially from the nursing profession. If he chooses his cases well he will soon convert his opponents. For full details of this route, *see* Chapter XVII.

MARROW INFUSIONS

Marrow infusions have a great field of usefulness. In collapsed patients there is difficulty, often considerable difficulty, in cannulizing a vein. Even when the cannula is within the vein the flow of parenteral fluids is sometimes unsatisfactory under these conditions. Again, all available veins may have been utilized.

Sternal puncture is a cruder procedure which is effected mostly by feel, and it can be carried out in a comparatively poor light. The only danger is that both plates of the manubrium may be perforated and the fluid introduced into the superior mediastinum. This disaster is practically impossible with the apparatus depicted in *Figs.* 67, 68 provided the simple instructions detailed here are followed.

It should be noted that there is no medulla in the sternum of a child, and this site must never be used in infants or children.

Technique of Sternal Marrow Infusion.—The patient lies supine. A wheal of local anæsthetic is raised in the skin in the middle line just above the

manubrio-gladiolar junction (*Fig.* 69). Using a larger, but short, hollow needle, the point is driven right on to the bone and about 2 c.c. of 1 per cent solution of novocain is infiltrated. This subperiosteal infiltration is an important detail. The area is then massaged with a swab so as to disperse the anæsthetic and enable one to feel the manubrio-gladiolar synchondrosis. The trocar and cannula is inserted just above this ridge, and the point is directed almost

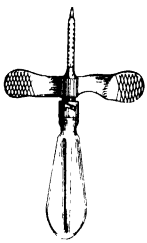


Fig 67.—Trocar and cannula for sternal puncture

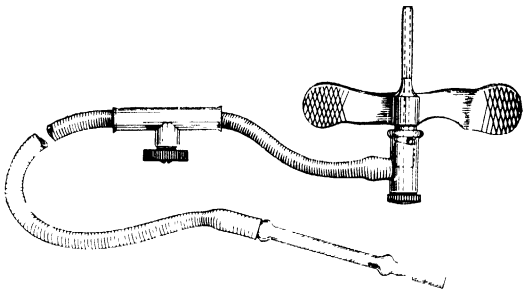


Fig 68.—Cannula attached to the unit provided with the apparatus. The glass tubing should be previously attached to the tubing and flask of parenteral fluid, which in no way differs from that of continuous intravenous infusion.

directly towards the floor, but with a very slight inclination towards the patient's head. An unhurried boring motion is imparted to the instrument. The pressure, at first slight, is increased. The feeling that the outer plate has been penetrated is unmistakable. Penetration being accomplished, the angle of the instrument is altered and the point is directed towards the patient's head. The wings do the rest—they ensure that the correct depth has been reached,

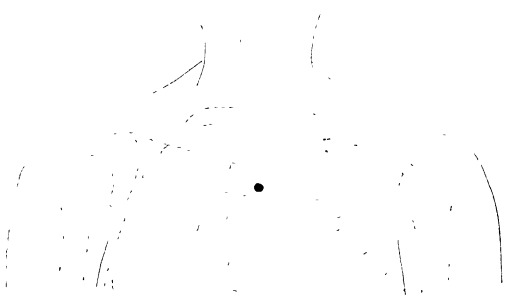


Fig. 69.—Site for sternal puncture.

they set the correct angle, and they prevent too deep penetration. The trocar is removed. The next step is to take a 10-c.c. to 20-c.c. Record syringe half-full of sodium citrate solution, which is in readiness. This is affixed to the cannula and some of the citrate solution is injected. The piston is withdrawn; if what appears to be blood (it is marrow) is easily and liberally withdrawn so that it colours the whole of the contents of the syringe (*Fig.* 70) the extremity of the cannula is correctly placed within the marrow cavity. More citrate is injected and the syringe is disconnected. Quickly the cannula is linked with the

infusion or transfusion unit, the tubing of which has been previously demonstrated to be free from air bubbles. Strips of adhesive plaster of an appropriate width are used to fix the wings to the chest wall, and narrow strips of the same material are placed to steady the attached tubing at the correct angle.



Fig. 70.—Having injected a small amount of citrate solution, the piston is withdrawn, and if red marrow is easily and liberally aspirated, the extremity of the cannula is correctly placed within the marrow cavity. This step is fundamental.

A large experience of marrow infusions in adults has taught me that this route is regularly perfectly satisfactory for the infusion of any crystalloid solution and for plasma infusions. For blood it is not nearly so good, but with practice many successful transfusions can be expected.

Technique of Tibial Marrow Infusion (Infants).—For infants the subcutaneous surface of the tibia is an admirable site for marrow infusions and one which I feel sure will soon become a standard procedure. A Witts sternal

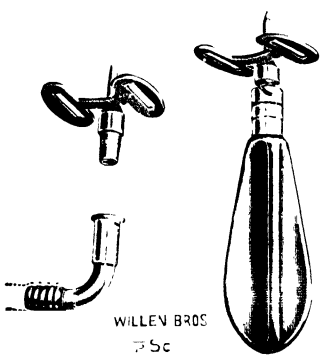


Fig. 71.—Thompson's trocar and cannula for tibial marrow infusion of infants.

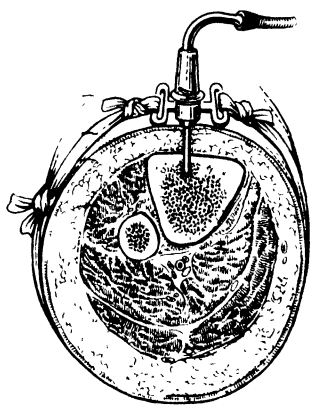


Fig. 72.—The tibial marrow must be cannulized at right angles to the subcutaneous surface of the tibia in its upper third. Thompson's cannula shown in situ.

puncture needle or a French's blood transfusion needle can be used, but Thompson's modification of a sternal puncture trocar and cannula (*Fig.* 71) is much more efficient, and is strongly recommended. Other excellent special instruments are available.

The best site for the tibial puncture is about 1 in. below the level of the tibial tuberosity. The trocar and cannula must be inserted at right angles to the surface of the tibia. The limb, therefore, must be rotated externally, so as to ensure that the flat surface looks directly upwards (*Fig.* 72).

Because of the possible danger of osteomyelitis developing, full aseptic precautions must be taken, which include the wearing of gloves and a mask. The very occasional development of osteomyelitis should not be a deterrent to employing this route, nor necessarily a reflection upon the technique. It has been shown that dehydrated infants who receive parenteral fluid by other routes develop osteomyelitis as frequently as do those who receive marrow infusions. The marrow infusion, therefore, probably only determines the site (J. B. Ellison). Even if this complication develops, it is not by any means necessarily fatal provided prompt treatment (usually drainage of the bone) is instituted.

Special Nursing Instruction.—The limb should be watched for œdema. After initial slowness, there is a tendency for the drip to speed up and run too fast. Another cause of œdema is the cannula becoming loose, and consequently the fluid escaping into the subcutaneous tissues.

INFUSIONS IN INFANCY

(excluding marrow infusions)

By ELLIOTT EMANUEL

A severely dehydrated infant requires 4 to 4½ oz. of fluid per pound of body-weight during the first 24 hours. The amount of fluid given by all routes must be charted.

Subcutaneous Infusion (*see* p. 48) is of considerable value in infancy. Suitable sites are the mid-axillary line 2½ in. below the axilla (with the needle pointing to the apex of the axilla) and the lateral aspect of the thighs. About 300 c.c. may be given to an 8-lb. infant in 12 hours; the needles are then removed and the fluid continues to be absorbed for several hours. Administration by syringe every 6 hours is sometimes more convenient. Sixty c.c. can be injected into each axilla or thigh by syringe, and should be dispersed by massage.

Continuous Intravenous Infusion.—The best solution to employ is either a mixture of 5 per cent glucose and normal saline in equal proportions or plasma.

Cannulæ: (*a*) *A ureteric catheter.* A No. 4 (French) ureteric catheter, stored in a tray with formaldehyde, is cut with sterile precautions into 2-in. lengths, and stored again. Immediately before use one of the cut pieces is soaked for 15 minutes in 1–4000 mercury oxycyanide, and into one end is inserted a No. 15 or 16 hypodermic hub, secured by a tight thread ligature. The catheter is slowly washed through with 10 c.c. of sterile water. It is then ready for insertion into a vein. After use, it should again be carefully washed through and stored. Its advantage is its flexibility, but it is expensive, troublesome to sterilize, and more difficult to introduce than: (*b*) *an ordinary hypodermic needle* with the sharp end cut off; this can be done with scissors. It is necessary to be sure of the patency of the lumen after the amputation of the point. While the naked needle can be efficient, Hamilton Bailey's infant's cannula (*see Fig.* 51), made by Vann Bros., has a collar upon it, which allows it to be tied into the vein with the same confidence as the adult cannula is secured.

The best vein to choose is the internal saphenous, just anterior to the medial malleolus. The leg is fixed to a narrow metal splint bent to a right angle extending from just below the knee to the toes. The vein is exposed in the manner described on page 43. Good illumination is essential. Sometimes venous

spasm prevents the commencement of free flow even though the cannula is correctly introduced; the child should be left alone with the leg warmed by a hot water bottle. The leg is raised on a sandbag 3 in. high; this serves to prevent reflux of blood into the cannula when the infant cries. The rate of flow is adjusted to 5 to 10 drops a minute, and every clock hour it is turned on full for two minutes, to wash out the vein. A strip of adhesive plaster calibrated in c.c. should be stuck on the flask, and full instruction should be given to the nurse as to how much fluid is to be given in an allotted time.

Intragastric Drip Infusion.—A fine (No. 5) rubber catheter is passed through the infant's nose and connected via rubber tubing to a flask and drip chamber. Water, saline, "Secway", or egg white is used, and should be warmed. Previous vomiting is apparently not a contra-indication. Up to 40 oz. may be given in twenty-four hours to a newly-born baby. (Allen and Rutherford.)

SPECIAL PRECAUTION FOR ALL INTRAVENOUS AND INTRAMEDULLARY DRIP INFUSIONS AND TRANSFUSIONS

Poor quality rubber tubing consequent upon the rubber shortage makes this subject topical; in hot climates there is always a special need for the precaution. When the rubber tubing is faulty (cracked or punctured) air is liable to be sucked into the lumen by the gravitating fluid and the danger of an embolus, usually regarded as a somewhat theoretical concept, becomes a reality. Devas, while a medical student at the London Hospital, made the following practical observation. If the screw clamp, instead of being on the rubber tubing between the reservoir and the drip chamber, is placed very near the needle or

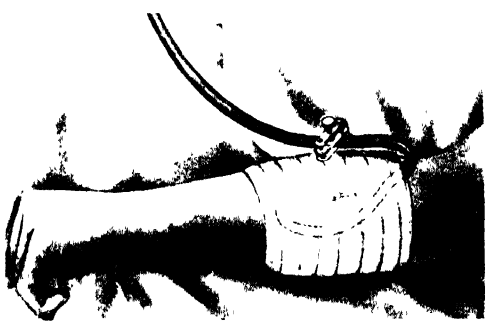


Fig. 73.—When the screw clamp is placed in this position the danger of air embolus is obviated

cannula (*Fig.* 73), this untoward possibility is obviated. It requires energy and pertinacity to get an alteration in accepted practice such as this carried out in any hospital.

CHAPTER VI

BLOOD TRANSFUSIONS AND PLASMA INFUSION

By HAMILTON BAILEY and J. A. EAST

THE ADMINISTRATION OF STORED BLOOD

So many hospitals have established a blood bank, or have become affiliated to a blood-collecting centre, that transfusion with fresh blood is tending to become superseded. This, of course, lightens the house surgeon's labour, but he should fully realize that there are still responsibilities to be shouldered. Transfusion is not merely hanging up a bottle of blood and allowing its contents to gravitate into a vein; there are fundamental precautions to be taken, neglect of which may offset the enormous boon of blood transfusion in general and the blood bank in particular.



Fig. 74. — Stored blood, showing supernatant plasma.

1. Verify that the Blood is in Good Condition.—On storing, preserved blood settles into its constituent layers (*Fig.* 74). The supernatant plasma should be of a lemon-yellow colour and tolerably clear. Cloudiness may be due to the presence of lipoids; it is to prevent an undue lipoid content that donors are requested not to have a fatty meal within four hours of giving blood. Hæmolysis may be due to: (*a*) infection; (*b*) age, i.e., over 21 days of storage; (*c*) freezing (stored blood should be kept at 38 F.); (*d*) warmth. (If a bottle has been removed from the refrigerator, it should be used within six or eight hours.)

Discard any bottle of blood which shows hæmolysis extending more than half-way up the plasma layer (*Fig.* 75).

2. Test the Recipient's Urine.—Severe albuminuria is a contra-indication to transfusion. A high degree of acidity calls for early administration of alkalis by mouth or intravenously.



Fig. 75 — This bottle of blood should be discarded.

3. Perform an Individual Compatibility Test.—Disabuse your mind concerning anything you may have heard regarding a 'universal donor' and make it an unwavering rule to cross-match the contents of every bottle of blood with the recipient's serum. If urgency forbids carrying out the simple instructions on page 208, a plasma infusion should be substituted.

4. Never on any account Mix Bloods.—Bloods of different groups which may separately be compatible, will become incompatible if mixed. For instance, bloods of both groups A (II) and O (IV) are theoretically suitable for a recipient of group A (II). Either use group A (II) and, if necessary, go on using it, or use group O (IV) and continue with it.

5. Become Familiar with the Use of the Hæmoglobinometer.—The only scientific method of telling how much blood a patient requires is to make repeated hæmoglobin estimations (*see* p. 167). Not more than one pint of blood should be given without proof that the patient is in need of more. In infants and children, 15 c.c. per lb. of body-weight is a good estimation of the amount required.

6. Take Precautions against Air Embolism.—Particularly when rubber tubing is supplied in sterile packets of unknown age, the possibility of a perforation should receive more than passing thought. If the screw clamp is placed an inch or so above the needle or cannula in the vein, sucking in of air through defective tubing is largely prevented (Devas).

The house surgeon should never weary of instructing the nurse to apply a pair of Spencer Wells forceps to the tubing when the blood in the bottle is within 2 in. of emptying, in case he is prevented from being present at the moment the bottle requires changing.

7. Guard against Reactions.—Unquestionably reactions are more common when stored blood is used; fortunately these are usually of a minor character. Nevertheless, if the occasional severe reactions which usher in fatal complications, notably anuria, are to be prevented, the administrator must be constantly vigilant, for such tragedies can be averted by prompt and intelligent action. Severe reactions almost invariably occur early in a transfusion. Therefore, *give the first few ounces of blood slowly* (25 to 30 drops a minute) and stay with the patient until you are satisfied that the transfusion is agreeing with him. A former resident medical officer of the Royal Northern Hospital, who gained great experience in the administration of stored blood, injected ½ gr. of ephedrine subcutaneously as soon as the drip commenced in every case; he was convinced that the number of untoward reactions was considerably minimized in this manner. When a severe reaction ensues, *stop the transfusion at once* and proceed by every means to render the patient's urine alkaline at the earliest possible moment. The best method is to inject intravenously 10 c.c. each of an isotonic solution of sodium lactate and a saturated solution of sodium bicarbonate. These ampoules, ready for use, can be obtained from Crookes' Laboratories. Of course, it is no use ordering them when they are needed; we strongly recommend that they are there, ready for an emergency, during every transfusion.

REACTIONS FOLLOWING BLOOD TRANSFUSIONS

This is a convenient place to consider untoward reactions which can occur during any blood transfusion, i.e., either stored or fresh blood.

Minor Reactions manifest themselves in the form of headache, nausea, or a shiver (as opposed to a real rigor). When the reaction is very slight, reduce the rate of delivery to 20 to 30 drops a minute, and if you are not perfectly satisfied, stop the transfusion forthwith.

Anaphylactic Reactions are more likely to occur when the same donor is employed for a second transfusion. Fever, nausea, dyspnœa, and circulatory collapse, together with an urticarial rash, are common symptoms. Stop the transfusion at once and administer either ½ gr. of ephedrine or ½ c.c. of fresh 1–1000 solution of adrenaline very slowly. Morphine in suitable doses is usually indicated.

Hæmolytic Reactions.—The first symptoms often appear while the transfusion is in its very early stages. The patient complains of pain in the lumbar

region and sometimes also in the chest. A rigor, circulatory failure, and difficulty in breathing may follow rapidly. Later, jaundice, hæmoglobinuria, and oliguria are in evidence. If the patient survives these comparatively early phenomena of hæmolytic shock, anuria due to precipitation of hæmoglobin in the renal tubules is likely to follow. If the transfusion is stopped at once and the urine is rendered alkaline at the earliest possible moment, a fatal issue can often be prevented. Comparatively rapid alkalinization of the urine can be effected by injecting 2 per cent sodium bicarbonate intravenously when the ampoules already referred to are not available. In any case, such treatment should be followed up by administering sodium citrate and sodium bicarbonate, 30 gr. each, by mouth three or four times a day for a week.

The Rhesus Factor.—Landsteiner and Wiener in 1940 discovered that serum of rabbits or guinea-pigs immunized with the blood of a Rhesus monkey would agglutinate blood of 85 per cent of white Americans. These individuals were called Rh positive, while the remaining 15 per cent were Rh negative. This Rh factor (possessed by Rh-positive individuals) is dominant and inherited, according to Mendelian laws.

Rh factor has antigenic properties and produces antibodies if introduced parenterally into the circulation of the Rh-negative individual. The antibodies thus produced can traverse the barrier of placenta between the mother and the developing fœtus and agglutinate fœtal blood. A Rh-negative mother can therefore have antibodies to Rh factor if she has been transfused with Rh-positive blood. Furthermore, she can, under certain circumstances, which are not fully clear so far, produce antibodies in her circulation if she herself is Rh negative but is carrying a Rh-positive fœtus—the fœtus having inherited it from a Rh-positive father.

In 90 per cent of cases of hæmolytic disease it is found that the mother is Rh negative, while the infant and his father are Rh positive.

So far no method of desensitizing the mother to this Rh antigen has been discovered.

As far as possible, therefore, when a transfusion is necessary for a woman of childbearing age, and especially a pregnant woman, Rh-negative blood of a compatible ABO group should be given, unless it is known that the woman herself is Rh positive. (The determination of Rh grouping is done, so far, only in a small number of laboratories in this country.)

If Rh-negative blood is not available, unless absolutely necessary, one should only give plasma or serum.

Infants suffering from fœtal hæmolytic disease are usually anæmic, the degree of which depends on the severity of the disease. These infants may require 200–250 c.c. or more of blood in divided doses. This blood should be the same Rh subgroup as that of the mother, but not from the mother herself as she has antibodies present. The father's blood should never be used.

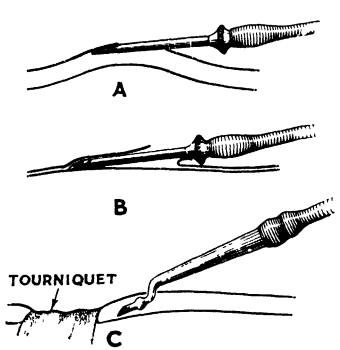


Fig. 76.—Technical obstructions to flow of blood: A, Angulation of cannula so that tip impinges against wall of vein; B, Cannula insinuated along fissure in adventitial coat; C, Failure to remove tourniquet.

TECHNIQUE OF ADMINISTRATION

Blood can be transfused into a vein, into a corpus cavernosum, or into bone-marrow.

GENERAL DIRECTIONS (ALL ROUTES)

Mixing. — Never stir or vigorously shake the bottle of blood; gentle rotation and simple inversion of the bottle two or three times is all that is required.

Temperature.—Stored blood should not be heated, but, particularly if it has just come out of a refrigerator, it should

be warmed by putting the bottle into a basin of water at 99° F. The temperature must be verified by a thermometer, for preserved blood clots easily if it is unduly heated. Gravitation of the blood at room temperature is satisfactory.

Changing Bottles.—When the bottle is nearly empty, the rate of flow through the interceptor is damped down in order to allow plenty of time for the empty, or, rather, nearly empty, bottle to be changed for a full one. A hæmostat is clamped on the tubing just above the interceptor; the bottle is removed from the stand on which it is hanging, and the rubber tubing is unfastened from the glass connecting tube piercing the cork. The fresh bottle, with a new filter, is connected to the tubing. The bottle is hung upon the stand and the hæmostat removed. Transfusion continues.



Fig. 77 — Inserting the filter, with tubing and needle attached.



Fig. 78 — The bottle of blood having been inverted and hung up, some blood is allowed to issue from the needle in order to eliminate the possibility of air bubbles being present in the tubing.



Fig. 79 —The needle having been inserted into a vein, the tourniquet is released

Filters.—All preserved blood must be filtered before being given to the patient. Three types of filter are in use :—

a. The gas mantle filter, which is very efficient, but a fresh one is needed for each bottle of blood.

b. The wire gauze filter, which, after cleansing and sterilizing, can be used over and over again.

c. The glass bead filter, which consists of pouring glass beads, provided in a test-tube, into the bottle of blood, has also the advantage of indestructibility.

INTO A VEIN

The choice of vein and the mode of entry differ in no respect from that described in connexion with the administration of saline and other infusions (*see* Chapter V).

Only too often when transfusion is needed most, the veins are so collapsed that they cannot be entered without tying in a cannula. With practice, a needle, as opposed to a cannula, can be employed successfully in an increasing number of cases. A few minor technical errors which have been known to mar one's early transfusions are shown in *Fig.* 76. The steps of the standard technique are shown pictorially in *Figs.* 77–79.

INTO A CORPUS CAVERNOSUM

For the certain, comparatively rapid, introduction of citrated blood this route is extremely effective. The syringe technique is necessary (*Fig.* 80). Using large hollow needle, a corpus

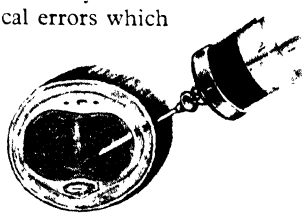


Fig. 80 —Citrated blood being transfused into a corpus cavernosum.

cavernosum is entered either from the lateral aspect or from the dorsum just to one side of the dorsal vein.

INTO BONE-MARROW

Blood may be given by this route into the sternum in the case of an adult (*see* p. 49) or into the tibia in the case of an infant. While bone-marrow is an excellent receptor of electrolytic solutions and plasma, the gravitation of undiluted blood is apt to be slow. A blood-saline drip is, however, often effective.

DRIP BLOOD TRANSFUSION COMBINED WITH DRIP SALINE INFUSION

This has an ever-widening field; in fact, in a number of cases in civilian practice it is the ideal method of replenishing the circulation. There are a number of apparatuses available; Officer's pattern (*Fig.* 81) is satisfactory.

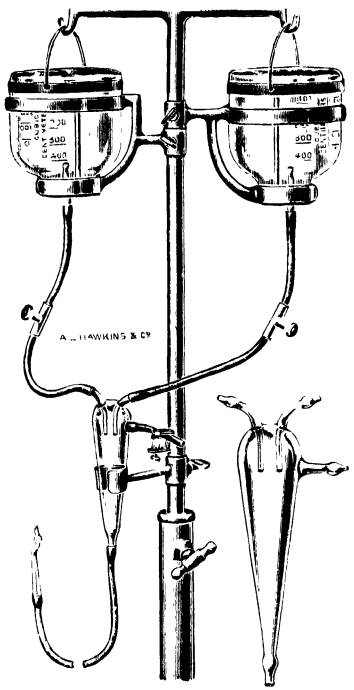


Fig. 81.—Officer's apparatus for continuous drip blood transfusion. One receptacle contains blood and the second saline, so that either fluid may be administered alternately.

The essential feature of the unit is the mixing chamber shown in the inset. A stand with a cross-bar is most desirable; so are the screw clamps which are depicted on the tubing. The standard bottle of blood and one of the proprietary flasks of saline can be substituted for the special glass receptacles; indeed, they are more convenient, for the latter have to be sterilized and filled. These practical points are mentioned because at the time of writing difficulty is experienced in obtaining the glass containers, but those essential parts mentioned above can be purchased.

When the apparatus has been assembled and air bubbles have been eliminated and the cannula inserted, commence with the saline. As soon as this is dripping satisfactorily, turn on the blood. In an average case alternating drops at 30 per minute each is a good working rule which can be modified to suit particular requirements. This type of transfusion can be continued for days, when necessary, but it is desirable to change the vein each twenty-four hours. In these long-continued transfusions one must be especially vigilant that the bloods are not mixed and that each new pint of blood is cross-matched.

It is wise to render the patient's urine alkaline, and keep it alkaline, during the period of transfusion.

THE ADMINISTRATION OF FRESH BLOOD

Collecting the Blood.—A suitable donor of the group to which the patient belongs or, failing that, a group O (IV), is selected. When possible the blood is taken when the donor is fasting, and on the average one pint is collected. Cross-matching, of course, is essential.

Anti-coagulant.—Isotonic (3·8 per cent) sodium citrate solution is available in ampoules (*Fig.* 82) containing 50 c.c., which is sufficient for 450 c.c. of blood.

Apparatus.—The apparatus necessary is illustrated in *Fig.* 83.

Technique.—On no account should a vein of a donor from a transfusion service be exposed; withdrawal of the blood must be effected with a hollow needle. On the other hand, if the donor is a friend or relative of the patient, it is permissible to tie in a cannula for the withdrawal of the blood when he or she has poor veins.

The donor lies with his bared arm abducted to a right angle. His elbow, well extended over a sandbag, is supported on a separate table. Having obstructed the *venous* circulation (about 40 mm. of Hg) by inflating the cuff of a sphygmomanometer applied high above the elbow, the antecubital region is prepared with ether and decked with sterile towels. The skin immediately over the selected vein is anæsthetized with a few minims of 1 per cent novocain solution. A skin incision of insignificant length directly over the vein simplifies the insertion of the needle. To forestall clotting, a small amount of citrate is run through the tubing and its attached needle (*Fig.* 84). The needle is now thrust into the vein, preferably with the point towards the donor's hand, and blood flows through the tubing into the flask. The flask is placed in a bowl of sterile water at a temperature of 100° F., and the bowl is held by a nurse who constantly, but gently, rotates the flask therein.

Fig. 82.—Ampoule containing 50 c.c. of 3·8 per cent sodium citrate solution.

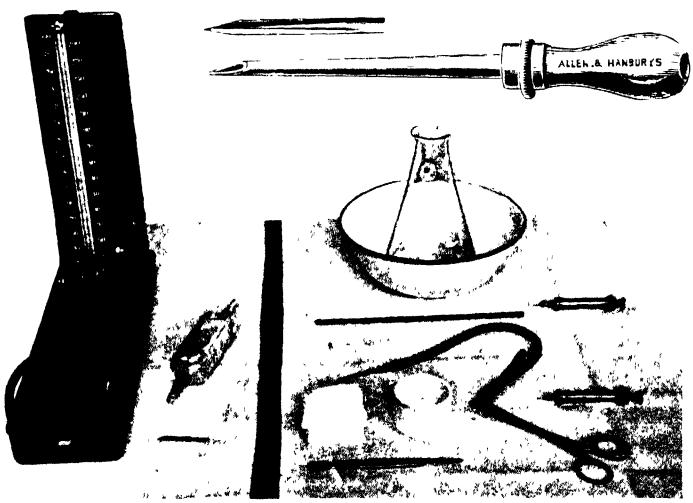


Fig. 83.—Instruments in readiness for collecting blood. Ether for sterilizing the skin is placed in the gallipot; two syringes are employed, one being filled with novocain and the other (without needle) with citrate to run through the tubing and needle before use. *Inset*. French's blood-collecting needle

The flow of blood is hastened by requesting the donor to clench and unclench his hand, but this should not be resorted to unless it is necessary. One must be careful to steady the needle while the movements are in progress,

or the needle may become displaced. When the requisite quantity of blood has been obtained the pneumatic tourniquet is removed, the needle withdrawn, and the puncture sealed.

Care of the Collected Blood.—The citrated blood is gently stirred with a glass rod by an assistant who sees that the water in the surrounding bowl is kept at 100° F. To remove froth, the solution is strained through six thicknesses of folded gauze before being transferred to the recipient.

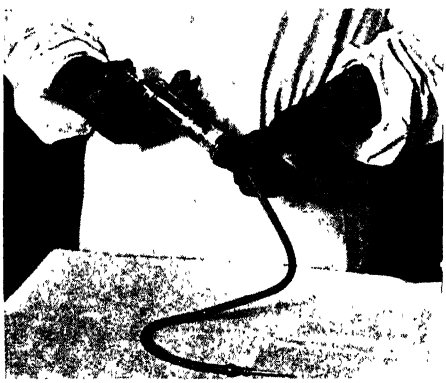


Fig. 84.—Citrate solution is run through the tube and needle. This precaution obviates clotting therein

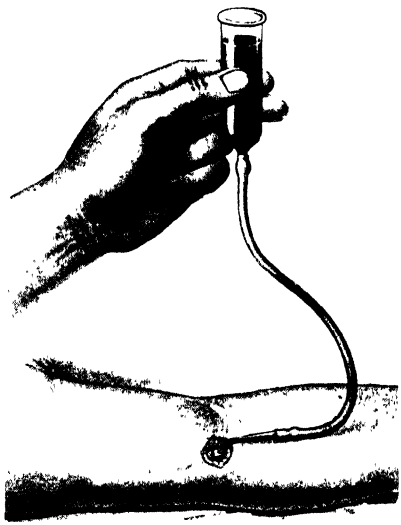


Fig. 85.—Gravitating citrated blood into a vein.

Treatment of the Donor.—The donor, who is placed in the care of a nurse, is kept warm and supplied with light nourishment. He should remain recumbent for two hours (or more if necessary), and be excused from work for the rest of the day. When the transfusion is completed, he is interviewed by the surgeon and instructed to return for examination of the arm on the next morning

Administration of Fresh Blood.—The blood can be gravitated into a vein of the recipient in precisely the same way as a massive dose of normal saline solution is given (*see* p. 47). The simple apparatus (*Fig.* 85) is filled with saline solution, and once the saline is seen to be flowing satisfactorily, blood is poured from the receptacle into the reservoir, through gauze. Finally, before the cannula is removed, a few ounces of saline are permitted to gravitate into the vein. This ensures that every drachm of blood is utilized. The administration of blood must proceed slowly, at least fifteen minutes being taken to give 500 c.c.

TRANSFUSION WITH A STERIVAC

This is a simple and efficient method, based on Baxter's Transfuso-Vac system. An advantage in using this method is that the blood collection is 'closed', i.e., the blood is not exposed to the air. If need be, the collected blood can be stored. The apparatus consists of: (*a*) a Sterivac, which is a doubly sealed bottle, containing the required amount of sodium citrate solution in a vacuum; (*b*) the donor set, which combines, together with a needle and tubing, a special valve; and (*c*) the recipient set, which consists of a needle and tubing, a

metal lever for lifting out the metal knobs from the holes in the stopper, and a stainless steel filter drip.

Assembling the Apparatus.—The Sterivac bottle is opened by breaking the seal, and raising the metal disc, with aseptic precautions. The donor set and Sterivac are connected by piercing the rubber stopper in the position indicated, with the pointed end of the special valve (*Fig.* 86).



Fig. 86.—The rubber stopper is pierced with the special valve, to which is attached the tubing and needle

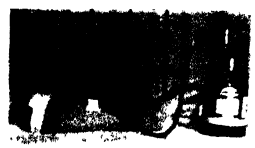


Fig. 87.—Blood flows into the flask by virtue of the vacuum



Fig. 88.—Inserting the dripper into the Sterivac full of blood

Collecting the Blood.—The forearm of the donor is prepared as usual, and the needle of the donor set inserted in a vein. The valve is slowly opened by rotating the knob in an anti-clockwise direction. The suction of blood into the bottle commences (*Fig.* 87). The rate of flow can be regulated by turning the knob in the appropriate direction. All the time blood is being withdrawn the Sterivac is gently rotated, so as to mix blood and citrate well. As soon as the necessary amount of blood has been collected, the valve is closed, and the needle is withdrawn from the vein. The blood, which is now enclosed in a vacuum, can be stored.

Administration.—Under aseptic ritual the metal plugs are lifted out of the stopper with a lever. The dripper, which is connected to the tubing and needle or a cannula, is inserted into the bigger hole in the stopper (*Fig.* 88). The smaller hole carries a glass tube which allows air to pass into the bottle, thus permitting gravitation of the contents of the Sterivac.

PLASMA (OR SERUM) INFUSION

Indications.—

Shock.—Whereas electrolytic solutions too often prove of very temporary benefit, the infusion of plasma, which tends to be held in circulation rather than pass into the tissue spaces, is the most effective remedy available at present.

Severe Burns.—Plasma is the rational fluid to introduce into the circulation because there is hæmoconcentration, and it is desired to reduce, not increase, the number of erythrocytes.

Hæmorrhage.—While transfusion with matched blood is ideal, unless the hæmoglobin is below 50 per cent, a plasma infusion is usually as effective as a blood transfusion, and delays in cross-matching, etc., are minimized.

Plasma or serum are supplied in two forms: (*a*) liquid; (*b*) dried. Liquid plasma can be kept in a refrigerator for months at 4° C.; dried plasma can be kept almost indefinitely at room temperature. Dried plasma (*Fig.* 89) is

reconstituted by dissolving 30 g. of powder in 400 c.c. of pyrogen-free distilled water. The Medical Research Council bottles have labels with marks on them showing how much water to add. Vigorous shaking for about five minutes is necessary to dissolve the desiccated plasma.



Fig. 89.—Dried plasma is reconstituted by filling up to the mark with pyrogen-free distilled water

One of the boons of plasma, especially that of the dried form, is that it can be ready for an unexpected emergency. Another is that cross-matching is unnecessary.

Administration.—Plasma is administered in the same way as blood. It should be warmed in the same manner as stored blood. As a general rule, the first pint is gravitated comparatively rapidly, i.e., 80 to 100 drops per minute. Later the drip is slowed down to 40 to 60 drops per minute.

Massive Plasma Infusion for Shock.—Excellent results have been obtained in patients apparently moribund from shock by the administration of as much as three pints of plasma in half an hour. Two veins can be utilized simultaneously or, what we have found of signal value, is to cannulize the bone-marrow of the sternum as the preliminary step (*Fig.* 90). It is truly remarkable that in some cases of profound shock, although a comparatively large vein has been cannulized, the plasma drips into it very slowly (owing to its collapsed state), yet one can observe plasma running into the bone-marrow without hindrance. As the condition of the patient improves, so the gravitation into the vein speeds up.

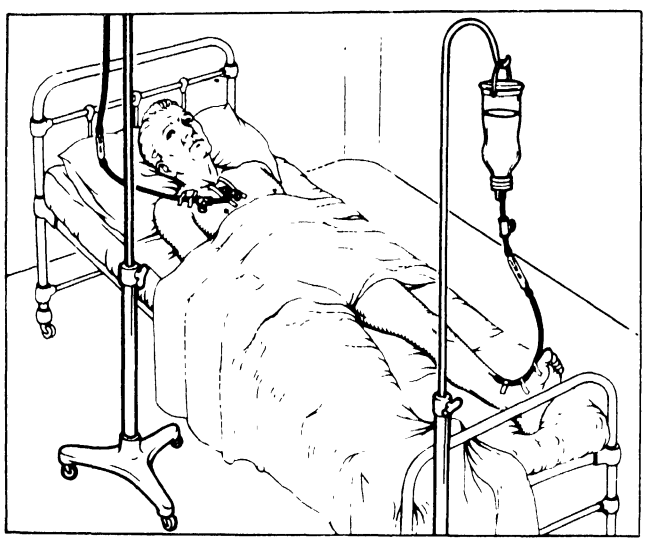


Fig. 90.—Massive plasma infusion in progress.

CHAPTER VII

THE ADMINISTRATION OF SERA

By A. E. HODGSON AND C. ALLAN BIRCH

Apparatus.—All parts of the apparatus should be standardized in such a way that hollow needles, syringes, adaptors, and lumbar puncture needles fit one into another accurately. The glass and metal (Record) type of syringe is the best; they can be obtained in all sizes, the 20-c.c. size with an eccentric nozzle being the most useful for serotherapy. After an injection of serum is completed, the syringe should be taken to pieces at once; if this is not done, the piston is liable to become glued in the barrel by serum.

Serum.—The vials of serum are placed in water at 100° F. In order to avoid shock, it is essential that serum, given intrathecally or intravenously, should be at blood heat. When serum is warm its injection intramuscularly is less painful, and its absorption is more rapid.

Sera are issued in long-necked glass vials or rubber-capped bottles of various sizes. In the former, the neck of the vial is tapped, so that no serum remains there, and, grasping the neck in a sterile swab, it is filed and snapped off. The serum is then drawn into the syringe, avoiding bubbles. Rubber-capped bottles allow a part of the serum to be withdrawn. The cap must be sterilized with ether or spirit. To ease withdrawal, first draw out the syringe piston to the level of serum to be aspirated. Then plunge the needle through the cap, and force the air into the bottle; this permits the abstraction of the correct volume of the contents of the bottle without difficulty. Alternatively, pierce the cap with a hollow needle, leaving it in situ to admit air, whilst the serum is being drawn off via another hollow needle.

METHOD OF ADMINISTRATION

Preliminary Precautions.—Inquire into the patient's history. In known allergic cases, and patients subject to spasmodic asthma or hay fever, or those who have received an injection of serum at some previous time, a state of hypersensitivity may be present. This hypersensitivity may be tested by injecting intradermally 0·1 c.c. of a 1–10 dilution of the serum to be used or of normal horse serum. A similar injection from another syringe of 0·1 c.c. normal saline acts as a control. Normally each wheal disappears in a few minutes. In hypersensitive patients a large wheal with surrounding erythema develops (*Fig.* 91) for an hour or so. In such instances, and if tests are inconclusive or omitted, an attempt to desensitize must be made by giving



Fig 91.—Positive Dick test. Photographed 24 hours after the intradermal injection of one skin-test dose of scarlet fever streptococcus toxin. (*By kind permission of Messrs. Parke, Davis & Co.*)

serum in a special manner, thus: at intervals of half an hour, inject subcutaneously 0·05, 0·1, 0·2, 0·5, 1·0, and 2·0 c.c., with 0·3 c.c. adrenaline and follow intramuscularly in a further half hour with the therapeutic dose. If serum is to be given intravenously it is wise to give several small doses diluted with normal saline (not adrenaline) at half-hourly intervals before the main dose.

Modern inoculation measures to produce active immunization against diphtheria by means of T.A.F., A.P.T., etc., do not hypersensitize the subject and therefore in no way contra-indicate the injection of serum.

ROUTES

The Subcutaneous Route has been discontinued, as serum thus injected is not absorbed effectively.

The Intramuscular Route is the most usual, and serum given by it is absorbed almost entirely within a few hours. The buttock is the best site, and here 50 c.c. or more can be injected. For small amounts, 2 to 5 c.c., the sites indicated on p. 35 are efficient.

The Intrathecal Route has fallen into some disfavour during recent years, greater reliance being placed, in tetanus particularly, in large doses of serum administered intravenously. The intrathecal injection must be made very slowly, and in no circumstances should the amount of serum injected be more than two-thirds of the volume of the cerebrospinal fluid withdrawn. After the injection a pillow should be placed beneath the pelvis and the foot of the bed blocked for an hour.

The Intravenous Route allows absorption to commence in a period of minutes, hence this is the route of choice in urgent conditions.

Technique of Injecting Serum Intravenously.—The injection may be made in two ways:—

1. *With a Syringe*: The average 20-c.c. syringe holds, in fact, about 23 c.c., and this volume, in the case of diphtheria serum of the modern highly concentrated type, may represent 160,000 units or more. The serum is drawn up into the syringe, almost, but not quite, filling it. Bubbles are expelled. The nurse holds the arm steady, her left hand compressing the upper arm and her right holding the patient's hand. If one syringe will not hold the full amount of serum to be injected, a second, already charged, should be at hand. Without withdrawing the needle, the emptied syringe is detached, and the tip of the index finger is held over the butt of the needle to prevent escape of blood until the second syringe can be attached and injection completed.



Fig. 92.—Apparatus for administering serum intravenously by gravity.

2. *By Gravity*: A funnel, or the barrel of a large syringe, and rubber tube apparatus is used. The tube is about three and a half feet long, with the funnel at one end, and an adaptor to which the serum needle (size 18) is fitted, at the other; about ten inches from the needle, a glass tube is interposed for a window (*Fig.* 92). Administration by gravitation is employed when large amounts of serum, impracticable with a syringe, are necessary. Gravitation has the advantage that the process can be started with saline, and the serum can be added gradually, until pure serum is flowing. The drip method can be employed (for its disadvantages, *see below*). Gravitational methods are not suitable for children.

DRIED SERUM

The production of diphtheria antitoxin serum in a desiccated state marks a new advance in serological technique. It is in the form of an easily soluble whitish flocculent powder, and its antitoxic elements are not adversely affected by the drying process. In its preparation much of the undesirable protein content is eliminated, and it is hoped that by further fractional dehydration this will be almost entirely extirpated, with, at the same time, a much greater unit concentration.

The serum, at present representing 50,000 standard units of diphtheria antitoxin (as issued by Messrs. Sharpe & Dohme), is supplied under vacuum in a sterile state in a special vial (*Fig.* 93, A) with a rubber cork protected by an elongated neck. In another rubber-corked vial of like construction, 15 c.c. sterile water is available. After filing, the neck of this is broken, the needle of

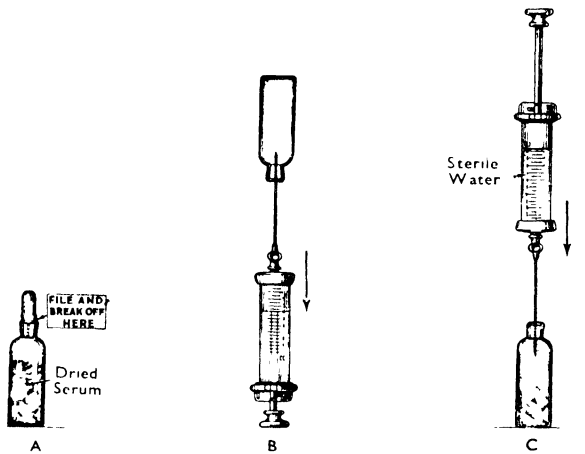


Fig. 93.—A, Vacuum vial containing serum; B, Withdrawing the sterile water C, Preparation of solution.

the syringe is thrust through the rubber cork, and by inverting the vial, the sterile water is withdrawn into the syringe (*Fig.* 93, B). The stem of the serum vial is then similarly broken, the needle is pushed through the rubber cork and the sterile water is introduced, the transfer being easy by reason of the vacuum (*Fig.* 93, C). With a little shaking the serum quickly dissolves, and this is helped if the sterile water vial and the syringe have both been kept warm at about blood heat beforehand. The solution is then withdrawn and is ready for injection.

A small vial of normal horse serum is included with the outfit for use in cases where hypersensitivity tests and desensitization may be needed.

This development promises many advantages, including a longer keeping period, easy portability, preparation of fresh material on the spot, and the avoidance of deterioration as a result of variations in temperature and other climatic and geographical conditions. It is expected that in time other specific antitoxic sera will be available in a similar form. Already antimeningococcus serum and antianthrax serum may be obtained in the dried state from Messrs. Sharpe & Dohme.

THE HAZARDS OF SERUM INJECTIONS, WITH SPECIAL REFERENCE TO THE INTRAVENOUS ROUTE

Reactions may be manifested either early or late ; they vary greatly in severity.

EARLY REACTIONS

Anaphylaxis.—Sudden, fatal anaphylactic seizure has been recorded. The patient says he cannot breathe and there is extreme pallor and spasm of the respiratory muscles. Although one of us (A. E. H.) has worked in large infectious diseases hospitals for nearly thirty-five years, he has never seen a case of this kind. Nevertheless, during and after the administration of any serum we must be prepared to recognize and treat promptly anaphylactic phenomena. Sudden pallor, dyspnœa, and muscular spasm of the platysma are dangerous signs. Discontinue the serum and give hypodermically 5 to 8 min. of adrenaline at once. A syringe duly charged with this dose of adrenaline, or ephedrine ($\frac{1}{2}$ gr.) if preferred, should always be at hand when injecting serum. Our practice is to give adrenaline 5 min. at the time of the injection of the serum as a routine. When the injection is completed a drink of hot tea or brandy is given, and hot-water bottles are placed near the patient.

Rigors.—More or less severe rigors usually follow within half an hour of an intravenous injection of serum. In my experience rigors are more frequent and severe when gravitation methods are employed, and they reach their zenith of frequency when the drip method has been used. The probability of the rigors occurring should be explained to the patient. Rigors are not to be regarded with alarm, and they pass off after a varying period.

Œdema, particularly of the face, is an occasional untoward symptom, and is usually accompanied by a feeble pulse. Adrenaline and nikethamide should be administered forthwith and warmth applied to the body. Rapid recovery is usual.

General Malaise.—Under this heading various symptoms are included. A sense of heat, palpitation, and beating in the head are all fairly common, and the patient should be warned beforehand that such symptoms are to be expected.

Severe Local Reaction.—Sometimes within half an hour or less at the site of the injection an angry, reddened area appears.

LATE REACTIONS

Serum Rash.—This usually appears eight to twelve days after the first injection, and the first sign of it is seen at the site of injection—an important diagnostic point. Although it often becomes generalized, it disappears last at the injection site. It commonly assumes an urticarial form, and less often is erythematous. The urticaria is irritating ; it may be localized or widespread. It may fade in an hour or two, or persist for two or three days, ebbing and flowing in intensity. The itching is intense, the temperature usually raised, and there is accompanying general malaise.

' Serum Pains '.—These are often coincident with the rash. There is pain in muscles, joints, and lymphatic glands. Serum pains may light up a rheumatic diathesis and its attendant dangers into activity.

' Serum Disease '.—Serum disease is a general term which includes the above phenomena, which are often associated with anorexia, nausea, furred tongue, and sore throat. There may be oliguria. This serum disease often renders the patient seriously ill.

Treatment.—Little can be done to prevent serum disease with certainty. Calcium gluconate, chloride, or other preparations given twice daily from the

time of the injection of the serum for a fortnight have a prophylactic effect and should be prescribed in cases of known or anticipated severe reactors.

DOSE OF ANTI-SERA

Anthrax	80 c.c. at once and 60 c.c. next day intravenously; thereafter 50 c.c. daily intramuscularly until improvement occurs.			
Dysentery	Up to 100 c.c. intravenously and repeated.			
Streptococcus	20 c.c. to 40 c.c. intravenously every 6 hours (concentrated serum is 5 times as strong).			
Diphtheria	20,000 units if early, and up to 100,000 units if late or severe.			
Scarlatina	6000 units as soon as diagnosis is made.			
Tetanus ..	Prophylactic . 3000 units Therapeutic: 200,000 units intravenously and 50,000 units every 7 days until reflex spasms subside (not intrathecally).			
*Gas gangrene**	Prophylactic .	9000 international units		*Cl. Welchii* antitoxin
		4500 ,,	,,	*Cl. septique* ,,
		9000 ,,	,,	*Cl. œdematiens* ,, intramuscularly
	Therapeutic	27000 ,,	,,	*Cl. Welchii* antitoxin
		13500 ,,	,,	*Cl. septique* ,,
		27000 ,,	,,	*Cl. œdematiens* ,, intravenously

* Medical Research Council's recommendations.

CHAPTER VIII

EXAMINATION OF THE URINE

By E. G. B. CALVERT

THE urine of all new cases should be examined, whether the presence of abnormalities in it be suspected or not. This chapter contains a brief account of the more important tests and their significance.

The Specimen for Examination.—As variations occur in the composition of the urine during the day and night, it is best to examine a specimen from the total collection for the twenty-four hours, or one passed about two hours after a meal, otherwise certain abnormalities may not be found. Thus, in a case of glycosuria, sugar is present in the urine obtained an hour or two after a carbohydrate meal, but it may be absent from samples collected either before breakfast or at other times when the patient has been without food for several (four or more) hours. Often the comparison of a number of separate specimens is of diagnostic value—for example, in cases of orthostatic albuminuria, where albumin is absent from the early morning urine; also in cases of advanced chronic nephritis, where there is little alteration in the specific gravity, from one specimen to another, throughout the twenty-four hours, in contrast to the widely varying density of normal urine.

Examination of the urine may be divided into: (I) Physical; (II) Chemical; and (III) Microscopical.

I. PHYSICAL EXAMINATION

The following should be noted: (1) Volume; (2) Colour and transparency; (3) Odour; (4) Consistence; (5) Specific gravity; (6) Nature of any deposit which may occur on standing.

1. Volume.—The healthy adult passes on an average 50 oz. (approximately 1500 c.c.) of urine in the twenty-four hours, but there may be considerable physiological variations, depending on the fluid intake, the state of the bowels, the temperature of the skin, and other factors.

The day urine (twelve to fourteen hours) should be measured separately from the night urine. Normally, the volume of the latter is about one-fifth to one-third of the former. When kidney function is defective, as in chronic nephritis, the volume of the night urine approximates to that of the day urine, and may equal or even exceed it.

Increase in the volume of urine, if persistent to any degree, usually indicates some pathological condition—for example, polyuria is found in diseases of the vascular-renal system associated with high blood-pressure; also in diabetes mellitus, diabetes insipidus, and certain forms of hysteria.

Abnormal decrease in the output of urine occurs when the arterial pressure is lowered, as in some forms of myocardial failure and in cases of cerebral irritation and shock following injuries, or when the venous pressure in the kidneys is raised as in congestive heart disease and acute nephritis. Very marked

diminution is also observed in subacute nephritis, nephrosis, ureteric obstruction, diarrhœa and vomiting, and in all fevers.

Suppression of urine may occur at the beginning of acute nephritis, or may result from irritation in the urinary tract—for example, from a stone in the renal pelvis or an injury to the urethra.

2. Colour and Transparency.—Normal urine is of a pale lemon or straw colour, but the depth of tint varies greatly, depending on the degree of dilution and on the reaction. Other things being equal, the more acid a urine the deeper is the colour.

Red or smoky urine suggests the presence of blood, while a yellowish-green to brownish one is associated with jaundice.

The urine becomes orange-coloured when *urobilin* is present in considerable quantity, as in cases of defective liver function or of severe hæmolysis. Urobilin is not present in fresh normal urine, but a trace may appear on standing, being derived from its precursor, *urobilinogen*. Bile-pigment in the intestine is broken down by bacterial action to stercobilinogen and stercobilin. A small amount of the stercobilinogen is absorbed from the bowel and so returned to the liver; eventually some of it is excreted by the kidney as urobilinogen. Urine containing an excess of urobilinogen or urobilin gives a bright red colour when 2 drops of a 3 per cent solution of paradimethylaminobenzaldehyde in 50 per cent HCl are added to 5 c.c. of the specimen. The colour may take a few minutes to develop. Before deciding that a test is negative it is advisable to warm the solution. A clearly positive result indicates impairment of biliary function.

Carbolic acid urine and the urine of the rare condition known as alkaptonuria gradually become dark on exposure to air, due to oxidation changes. In carbolic acid poisoning the urine may be olive-green when passed.

The taking of rhubarb or senna often makes the urine an orange or a reddish-brown colour; pyramidon makes it a reddish-orange or cherry-red; salol a darkish-green; santonin a greenish-yellow or yellow; pyridium a reddish-orange; methylene-blue (sweets and pills) a green to blue; eosin (sweets) a fluorescent pink; prontosil rubrum a bright blood-red; antipyrin a reddish colour suggesting the presence of blood.

The urine, normally, is clear when passed. At room temperature a faint cloud of mucus settles out. Turbidity or opalescence of a specimen is due to various substances in suspension. If this persists after thorough filtration then bacteria are present.

3. Odour.—In decomposing urine the odour is ammoniacal, and in ketonuria fruity. Turpentine (which imparts the smell of violets), asparagus, santonin, and cubebs produce other departures from the normal. Communication between the bowel and the urinary tract causes a fæcal odour.

4. Consistence.—An alkaline urine containing pus tends to be ropy. Much sugar or bile lessens the mobility of the urine, and urine containing albumin or bile is more frothy than normal.

5. Specific Gravity.—This is taken with a urinometer, graduated for a temperature of 15° C. The normal range for the twenty-four-hour specimen is from 1015 to 1025, but higher or lower figures may be found in health. Readings should be made at room temperature (15 to 20° C.), as the density of warm freshly-voided urine is increased appreciably by cooling. Normally, there is considerable fluctuation of specific gravity, from one specimen to another, throughout the twenty-four hours, but in chronic nephritis a certain degree of

fixation occurs and at a low level (near 1010 in the worst cases) if no œdema is present. Sugar in the urine raises the specific gravity. In untreated diabetes mellitus the readings may be as high as 1060, but are usually between 1025 and 1050. Exceptionally low figures, for all samples, are the rule in diabetes insipidus.

6. Deposits.—Mucus, phosphates, urates, and free uric acid are the normal urinary constituents which may settle as a deposit easily visible in a conical glass.

Mucus.—A cloud of mucus will sink if the urine is dilute, but will float if the urine is very concentrated.

Phosphates.—The phosphates of calcium and magnesium (earthy phosphates) are deposited in alkaline or neutral urines. The disappearance of the deposit on the addition of acetic acid distinguishes it from that of pus. The diagnosis of the latter, however, must only be made by microscopical examination.

Urates and Uric Acid.—In acid, concentrated urines—for example, in fevers and congestive heart failure—the urates of sodium, potassium, and ammonium may form, on cooling, a red-brick amorphous ('brick-dust') deposit. The colour is due to urinary pigments which have been carried down at the same time. Where there is little pigment, as in the urines of women and children, the deposit may be yellowish or whitish. All varieties are easily recognized by their disappearance on heating the specimen. The heating should be gradual in order to avoid clouding by any albumin which may be present. Urates are dissolved by strong nitric acid, but not by acetic acid.

In very acid urines a small amount of free uric acid may be deposited, and is found in the form of red or dark-brown crystalline grains—known as the 'cayenne pepper' deposit.

Uric acid separating out, either in the crystalline or amorphous state, in the urinary tract constitutes the condition referred to as 'gravel'; sometimes a calculus is formed.

The deposition of salts, or their acids, in the urine does not mean that these salts or their acids are necessarily in excess, but merely that the factors which ordinarily keep them in solution have been altered. Thus, a high degree of acidity and a deficiency of pigment and salts are conducive to the sedimentation of uric acid, though excess of the latter is also a factor.

Uric acid occurs in small quantities in normal urine, mainly as a urate of sodium. Its output is increased in febrile conditions, acute gout, and after the administration of certain drugs—for example, salicylates, but especially after cinchophen and other derivatives of quinoline carboxylic acid. There is a physiological increase in uric acid excretion when excessive amounts of protein, particularly nucleo-protein, are consumed. In leukæmia, where there is great destruction of leucocytes, the output is usually very high.

II. CHEMICAL EXAMINATION

This consists of: (1) Taking the reaction of the urine; (2) Testing for abnormal constituents; (3) Estimating, in certain tests of renal function (*see* Chapter XXX), the percentage of urea; (4) The estimation of diastase in the urine in pancreatic disorders.

REACTION OF THE URINE

The reaction should be taken when the specimen is fresh, as an acid urine may become alkaline from bacterial decomposition within a few hours.

The urine is generally acid to litmus (red reaction), but it may normally be alkaline for some hours after meals—the so-called 'alkaline tide'. In decomposing urine the reaction is alkaline, due to ammonia. The ammonia may be recognized by its smell and by the dispersal by heat of the blue colour obtained with red litmus paper.

In treating urinary infection with alkalis the early morning sample ought to be tested, as the night urine is the most difficult to make alkaline. When this turns litmus blue (*p*H over 7·0) then sufficient alkali is being given (pH of litmus: 4·5 to 8·3; neutral or amphoteric at 6·8, though the true neutral point is 7·0). Neutral-red as an indicator (pH: 6·8 to 8·0) is described on p. 235.

In the mandelic acid treatment of urinary infection the urine is made acid to the point of lowering the *p*H below 5·3. The normal range of *p*H in the urine is from 4·8 to 7·4 (average 6·0), and this can be covered by the following four indicators: B.D.H. '4460'—i.e., improved methyl-red (4·4 to 6·0); brom-cresol purple (5·2 to 6·8); brom-thymol blue (6·0 to 7·6); and phenol-red (6·8 to 8·4). The important one, of course, for the mandelic acid treatment is the B.D.H. '4460', which produces colours varying from green, through yellow, orange, and pink, to red as the urine changes from alkaline or faintly acid to strongly acid. To test: 5 drops of the methyl-red indicator are added to 5 c.c. of urine. A slightly pink reaction means that the urine is sufficiently acid, a yellow tint that it is not acid enough, while a deep red colour shows that it is too acid.

The colorimetric measurement of the urinary *p*H is easily carried out by means of the Lovibond comparator.

Briefly, this method consists in placing 10 c.c of fresh urine (filtered or centrifuged, if not clear) in one of the comparator tubes, adding 0·5 c.c. of the indicator solution, mixing, and then comparing the colour obtained with that of a tube of untreated clear urine upon which is superimposed one or other of a series of coloured glass discs; the discs are graded in depth of tint to represent the *p*H range of the indicator in steps of 0·2 *p*H. When the colours are matched the *p*H value of the urine is read off from the disc. The comparator, indicator solutions, and details of the technique may be obtained from The British Drug Houses Ltd., London.

ABNORMAL CONSTITUENTS

The following are the abnormal constituents most frequently found in the urine: (1) Proteins—(*a*) albumin, (*b*) proteose, and (*c*) Bence-Jones protein; (2) Sugars; (3) Acetone bodies; (4) Blood; (5) Bile; (6) Pus; (7) Glycuronic acid.

1. Proteins.—

a. ALBUMIN.—There are three groups of albuminuria—the benign, the febrile or toxic, and the organic:—

Benign Albuminuria.—Also described as physiological, functional, postural, orthostatic, or cyclical. It occurs mostly in rapidly growing and poorly developed children, especially boys, and is often associated with lordosis. The early morning urine, or the urine after a day or two in bed, is free from albumin, but not the urine collected when the patient is up and about. The albuminuria following strenuous exercise, mental strain, or exposure to cold is also benign in nature. Venous congestion in failing heart conditions may cause a temporary albuminuria, and the urine, unlike that of nephritis, is usually loaded with urates. Congestion also probably accounts for the transitory albuminuria frequently present after an epileptic fit.

Febrile or Toxic Albuminuria.—This may be classed as intermediate between the benign and the organic, for if the toxic action is prolonged an organic lesion may be established.

Organic Albuminuria.—May be due to many causes—for example, all forms of nephritis, lipoid and amyloid nephrosis, infarction of the kidney, tuberculous disease, malignant growths, pyelitis, cystitis, urethritis, and stones anywhere in the urinary tract.

Tests for Albumin.—If the urine is not quite clear it should be filtered; a second filtering may be required. Turbidity then generally means infection. The turbidity may be removed by shaking up with a little powdered barium carbonate and filtering again.

Boiling test: This is a reliable test. Place about an inch of the clear urine in each of two test-tubes. Use one as a control; bring the other to the boil. If clouding occurs it may be due to albumin or earthy phosphates. Add a few drops of 5 per cent acetic acid, when clouding from phosphates will disappear, but that from albumin will remain. If, on the other hand, no clouding occurs after the boiling, it is still necessary to add the acetic acid; a cloud now indicates albumin, and a clear urine means that no albumin is present. Always add the acid after boiling, whether clouding occurs or not.

The test can be carried out in one test-tube by two-thirds filling it with urine and boiling the upper portion, the lower part being used as a control.

Salicyl-sulphonic acid test: A saturated solution of salicyl-sulphonic acid is used. The test is a very delicate one, easy to carry out, and the solution is non-corrosive.

Into each of two test-tubes put an inch or so of urine, cleared, if necessary, in the way already mentioned. One tube is used as a control; into the other put a few drops of the solution. Clouding indicates albumin or proteose, but with proteose the cloud disappears on heating and reappears on cooling.

Quantitative estimation of albumin: This is done in Esbach's albuminometer. The urine must be made clear and acid, if not already so. If the specific gravity is over 1008, add water to bring it to this figure. Fill the special test-tube with the urine to the mark U, and add Esbach's reagent (picric acid 10 g., citric acid 20 g., and distilled water 1 litre) to the mark R. Close the tube with a rubber stopper, mix gently, leave in the upright position for twenty-four hours, and then read off the level of the precipitate. The figures represent grammes of dried albumin per litre of urine. To get the percentage, divide by 10. If necessary, correct for dilution by multiplying by the number of times the urine was diluted. The method is sufficiently accurate for clinical work.

b. PROTEOSE.—This is a metabolic product of protein, which on further breakdown yields peptone. Proteose may appear in the urine during the resolution of a lobar pneumonia, in acute yellow atrophy of the liver, during involution of the uterus, in extensive suppuration, or in any other condition where marked autolysis of the tissues is occurring. Proteosuria is probably most common in cases where much pus has collected in the body—for example, in empyema. Proteose is distinguished from albumin by its not being coagulated by heat, and by the fact that its precipitate with salicyl-sulphonic acid disappears on heating.

c. BENCE-JONES PROTEIN.—The Bence-Jones protein in the urine is found almost exclusively in cases of bone-marrow neoplasm—either multiple myeloma (in about 50 per cent of these) or secondary carcinoma (less often). Sometimes it occurs in chloroma, myelogenous leukæmia, and tuberculous disease of bone. It has qualities identical with bone-marrow extract and so is probably produced from leucocytes and other marrow cells. The Bence-Jones protein is recognized by its coagulation at 50° to 60° C., solution again near boiling-point, and re-precipitation on cooling.

2. Sugars.—Several sugars appear in the urine, but only glucose and lactose are of general clinical interest.

GLUCOSE.—This is by far the most common sugar found in the urine. Although glucose in the urine (glycosuria) is one of the chief findings in diabetes mellitus, it must be clearly understood that every patient with glycosuria has not necessarily got diabetes mellitus. For an account of diabetes and its differential diagnosis a text-book on the subject should be consulted.

Tests for Glucose.—

Fehling's test: To half-an-inch or so of Fehling's No. 1 solution in a test-tube add an equal quantity of the No. 2 solution and mix. Then add about one-quarter to one-half inch of urine (freed of albumin if much present), mix again, and boil. If the urine contains any considerable quantity of glucose a yellow or red precipitate of cuprous oxide will appear; with less glucose the precipitate is greenish. If no reaction, add another one-quarter to one-half inch of urine and boil again. Should no precipitate occur then or on cooling, it may be concluded for clinical purposes that glucose is absent.

To free the urine of albumin for the test, add a few drops of 5 per cent acetic acid, boil, and filter.

Fehling's solution is also reduced by lactose and pentose, and by the following if in considerable concentration: Glycuronic acid (glycuronates), uric acid and urates, creatinine, homogentisic acid (of alkaptonuria), and the products of certain drugs—for example, after taking chloral, chloroform, aspirin, camphor, benzoic acid, menthol, or oil of turpentine. In the case of the drugs it is actually a compound of the drug and glycuronic acid, or the latter component, which causes the reduction (*see* GLYCURONIC ACID, p. 77). With ammoniacal urine Fehling's test may give a false result, as free ammonia prevents the precipitation of cuprous oxide.

Benedict's test: This is more reliable and more delicate than Fehling's test, and should always be used. Of the substances, other than glucose, which have been mentioned as being capable of reducing Fehling's solution, only lactose, pentose, and homogentisic acid will reduce Benedict's solution.

Benedict's qualitative solution contains: Crystallized copper sulphate 17·3 g.; anhydrous sodium carbonate 100 g.; crystallized sodium citrate 173 g.; water to 1000 c.c.

The technique of the test must be exact. Add 8 drops of urine (freed, if necessary, of albumin, as in Fehling's test) to 5 c.c. of Benedict's solution in a test-tube and boil for two minutes. A positive result from a very low concentration of sugar may appear only on allowing the mixture to cool. If the amount of glucose is as small as 0·1 per cent a greenish opalescence occurs but no precipitate. With 0·2 per cent of glucose there is, on standing, only a slight yellow precipitate and the supernatant fluid is blue or blue-green. If about 0·5 per cent there is a pronounced yellow to orange precipitate; supernatant fluid is a faint blue or blue-green to green. With 1 to 2 (or more) per cent the precipitate is heavy and varies from orange-brown to bright red; bluish tint of supernatant fluid gone.

If there should be any doubt about the reducing sugar being glucose, then the phenyl-hydrazine test or the fermentation test, or both, will decide.

Phenyl-hydrazine test: Half fill a test-tube with urine and add 5 drops of glacial acetic acid, a saltspoonful of phenyl-hydrazine hydrochloride, and 2 saltspoonfuls of sodium acetate. Dissolve with heat, filter into another test-tube, and place this in boiling water for half-an-hour. Then allow to cool slowly. If the sugar present is glucose the characteristic bright yellow sheaves of needle-shaped crystals (phenyl-glucosazone) will be seen microscopically. The osazones of lactose and pentose differ appreciably from these in appearance and also are not so easily produced.

Fermentation test: This is a certain test for glucose, because no other substance found in the urine will ferment and produce carbonic acid gas.

Mix thoroughly a little bakers' yeast with the urine and fill a fermentation-tube with this emulsion (a test-tube filled and inverted in some of the same emulsion in a dish would do equally well). Controls are necessary, as it is possible to have a yeast which will not ferment glucose, or one which will produce gas apart from fermentation. Therefore fill two other tubes, one with yeast in a urine containing no sugar, and the other with yeast in a urine to which glucose has been added. The three tubes are now placed in a warm place overnight. Then, if the control with the added glucose shows gas at the top, and the other one shows none, the finding of gas in the tube containing the suspected urine proves that there was glucose present.

Quantitative estimation of glucose: For clinical work, a sufficiently accurate idea of the amount of glucose in urine can be obtained from the simple Benedict's test already described; therefore it is thought unnecessary to include the somewhat complex titrimetric and polarimetric quantitative methods, details of which may be found elsewhere.

LACTOSE AND PENTOSE.—Lactosuria is sometimes found during lactation, and sometimes in breast-fed infants suffering from enteritis. Pentosuria is a rare, and probably harmless, deviation of carbohydrate metabolism, requiring no treatment. Pentose is often present in the urine after the ingestion of certain fruits (cherries, plums, grapes).

Bial's test for pentose: Place 5 c.c. of Bial's reagent (orcin 1·5 g., conc. HCl 500 c.c., 10 per cent ferric chloride 25 drops; keep in amber bottle) in a test-tube, heat until the solution begins to boil, remove from flame, and add about 3 c.c. of urine. The mixture turns green if pentose is present. Bial's test gives a deep red colour with urine containing lævulose.

3. Acetone Bodies.—Ketonuria, or the presence of acetone bodies in the urine, occurs in the ketosis of diabetes mellitus, and in prolonged vomiting and starvation. The acetone bodies are aceto-acetic acid (diacetic acid), acetone, and β-hydroxybutyric acid. It has been held that aceto-acetic acid and acetone are derivatives of β-hydroxybutyric acid, but some authorities now maintain that the last two are derived from aceto-acetic acid, and that β-hydroxybutyric acid is the result of an attempt at detoxication by the liver (Hurtley).

Tests for Aceto-acetic Acid (Diacetic Acid) and Acetone.—The following are the tests for aceto-acetic acid and acetone (there is no colour reaction for β-hydroxybutyric acid in the urine):—

Ferric chloride test for aceto-acetic acid: Add dilute ferric chloride, drop by drop, to the urine until all the ferric phosphate is precipitated. The contents of the test-tube may now be filtered. Extra ferric chloride will produce a brownish-red colour if aceto-acetic acid is present in considerable quantity, and such result would indicate that there is a severe degree of ketosis. As the reagent is not very sensitive for aceto-acetic acid, and gives no reaction with acetone, the test may be negative in the presence of considerable ketosis, and this is particularly apt to occur if the urine is not tested when fresh, since aceto-acetic acid is converted into acetone on standing. Fallacies arise if the patient is taking drugs like aspirin, salicylates, salol, and antipyrin; the colour, however, with these is generally purplish and darker. Prolonged boiling of the urine, prior to the test, will not alter the result when drugs are responsible, but in the case of aceto-acetic acid this volatile substance will be driven off and a negative reaction obtained.

Rothera's test for aceto-acetic acid and acetone: This is the best urinary test for ketosis. It detects both aceto-acetic acid and acetone, is very delicate, and has no fallacies.

Place about half an inch of ammonium sulphate crystals and a tiny pinch of powdered sodium nitroprusside (or half an inch of a powdered mixture of 100 parts of ammonium sulphate and 1 part of sodium nitroprusside) in a test-tube, half fill the tube with urine, and shake until saturation. Then add half an inch (2–3 c.c.) of concentrated ammonia and mix.

A positive result is the development of a permanganate or purplish colour. The deeper the colour and the more rapid its development, the greater the amounts of aceto-acetic acid and acetone. Brownish or reddish tints are counted as negative.

Ingram's test for aceto-acetic acid and acetone: The ammonia in Rothera's test is here replaced by sodium carbonate. Thus: 3 g. of sodium nitroprusside is powdered and mixed with 100 g. of ammonium sulphate and 50 g. of sodium carbonate. About half an inch of this powder mixture is put in a test-tube and a small quantity of the urine added—until saturation. The colour reaction is as for Rothera's test, but its development is not quite so rapid, though usually complete in two minutes.

4. Blood.—Hæmaturia means the presence of red blood-corpuscles in the urine, and hæmoglobinuria the presence only of blood-pigment. The distinction is made by microscopical examination for the red corpuscles.

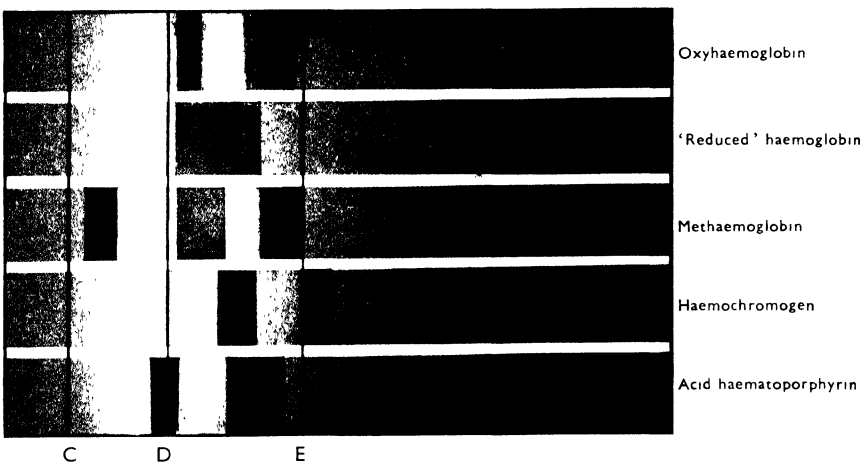


Fig. 94.—Spectra of hæmoglobin and hæmoglobin derivatives.

Tests for Blood.—In addition to the microscopical examination, which should be carried out in all cases where blood is suspected, the following tests may be employed for blood-pigment as found in both hæmaturia and hæmoglobinuria :—

Guaiac test: To 1 in. of urine in a test-tube add 2 to 3 drops of tincture of guaiac. A milky liquid results, owing to the deposition of the resin in the tincture. Now pour carefully down the side of the test-tube some fresh sensitive ozonic ether. If blood-pigment is present a blue colour develops at the junction of the fluids.

Iodides also give a bluish colour, but this is throughout the fluid and not restricted to the line of junction, as with blood.

Pus gives, on the addition of tincture of guaiac alone, a greenish or bluish-green colour which disappears upon heating.

The guaiac test for blood-pigment is not a very sensitive one and the urine has often to be at least faintly 'smoky' or reddish before the test is positive. Still, it is valuable in conjunction with naked-eye examination. The benzidine and spectroscopic tests are considerably more sensitive. In the benzidine test so much care is required with the cleanliness of test-tubes, etc., in order to avoid false positives, that it is not suitable for ordinary use, and is therefore not described here.

Spectroscopic test (*Fig.* 94): This is a reliable and quick method of recognizing blood-pigment. The urine should always be filtered and, if very dark, diluted. By

looking, with a spectroscope, through a specimen in a test-tube or small flat glass bottle the spectrum of oxyhæmoglobin, methæmoglobin, or 'reduced' hæmoglobin may be seen. The absorption bands of hæmochromogen are more distinct and so may be detected when those of hæmoglobin cannot. Hæmochromogen may be obtained by adding 5 drops or so of caustic potash and then 3 to 4 drops of ammonium sulphide to about 10 c.c. of the urine and warming gently.

Oxyhæmoglobin spectrum: This shows a narrow dark band just to the violet side of the D line, and a broader and fainter band in the green near the yellow (that is, to the red side of the E line). The addition of a few drops of ammonium sulphide will change the spectrum of oxyhæmoglobin to that of 'reduced' hæmoglobin. To obtain the D line: Sprinkle sodium chloride into a bunsen flame which is being viewed through a spectroscope.

'Reduced' hæmoglobin spectrum: There is a single broad darkish band, with ill-defined edges, between the D and E lines; sometimes it extends to the red side of the D line.

Methæmoglobin spectrum: A characteristic narrow dark band is present in the red (between C and D); a few drops of ammonium sulphide will remove the band.

Hæmochromogen spectrum: This has a very dark band midway between D and E, and another dark band almost on the E line.

HÆMATURIA.—Blood intimately mixed with the urine passed suggests a renal origin. When it comes from the bladder it often appears at the end of micturition, when from the urethra it appears at the beginning of the act. The colour of the specimen varies with the amount of blood present. The urine may be very dark, or the presence of blood may not be detected by the naked eye. If renal bleeding is slight the colour is 'smoky'—largely due to the conversion of hæmoglobin to methæmoglobin. Red blood-corpuscles form red or brown deposits.

Causes of Hæmaturia.—The causes of hæmaturia are numerous—for example:—

a. Systemic affections: Hæmorrhagic fevers, scurvy, purpura, leukæmia, erythræmia, and hæmophilia.

b. Renal affections: Nephritis, papilloma and other new growths, calculus, hydronephrosis, polycystic disease, tuberculosis, infarction (for example, from septic endocarditis), congestion from heart failure, rupture of glomerular vessels in hypertension, oxaluria, pyelitis, angioma and nævi of the renal pelvis, and from the action of certain drugs, such as turpentine, cantharides, carbolic acid, and hexamine.

c. Affections of the urinary passages: Calculus, papilloma and other new growths, tuberculosis, bilharziasis, varix, cystitis, prostatitis, vesiculitis, urethritis, polypi, caruncle, granulations, and stricture.

d. Lesions of adjacent organs or tissues and injuries affecting the urinary tract.

HÆMOGLOBINURIA.—Methæmoglobin is the usual pigment found, and is recognized by its spectrum (*see Fig.* 94). Hæmoglobinuria is the result of some hæmolytic action. It may be due to chemical substances like potassium chlorate, quinine, naphthol, and arseniuretted hydrogen, or may be due to malaria (blackwater fever), syphilis, toxæmia from severe burns, or incompatibility in blood transfusions.

Paroxysmal hæmoglobinuria occurs mostly in patients with Raynaud's disease, especially where the Wassermann reaction is positive, and in young persons with congenital syphilis. Attacks follow exposure to cold, particularly during exertion.

HÆMATOPORPHYRINURIA.—This occurs in individuals particularly susceptible to drugs such as sulphonal, sulphanilamide and other sulphonamides, trional, and veronal. The passage of the characteristic dark port-wine-coloured urine, in these cases, generally indicates a severe, and often fatal, poisoning. The pigment may be recognized spectroscopically. First look for the absorption bands of alkaline hæmatoporphyrin . these closely resemble those of methæmoglobin. Then after making the urine strongly acid with a few drops of concentrated HCl examine for acid hæmatoporphyrin—a narrow band on the D line and a broad band between the yellow and the green (*see Fig.* 94). A rare congenital form of hæmatoporphyrinuria may be associated with sensitivity to light and with hydroa vacciniforme. In this variety the urine is sometimes more brown than red and may appear normal between attacks.

5. Bile.—Bile-pigment is found in the urine of all forms of jaundice resulting from obstruction of the biliary passages. In the fresh specimen of urine the pigment present is bilirubin, but this may change gradually to biliverdin on standing. Urine containing bile is yellowish-green to brownish in colour, and is more frothy than normal. The froth is bile-stained, whereas that of drug-coloured and normal urines is whitish.

Tests for Bile.—

Nitric acid test: Place some urine on a filter-paper, or, better still, filter the urine several times through a filter-paper, and then add a drop of yellow concentrated nitric acid. A rainbow ring of colours will result if bile is present. Of these colours the green (biliverdin) is alone characteristic of bile.

Iodine test: Use a 10 per cent alcoholic solution of iodine, or tincture of iodine diluted with alcohol until it is light reddish-brown in colour. Place the urine in a test-tube and pour the iodine solution slowly down the side of the tube; a green layer forms at the junction of the two liquids if bile is present.

Test for Bile-salts.—

Hay's sulphur test: Some powdered sulphur is sprinkled on the surface of the specimen of urine. With normal urine the sulphur will float, but if bile-salts are present it will sink.

Apart from a possible exception in some cases of nephritis, the presence of bile-salts in the urine is always indicative of liver damage or bile-duct obstruction.

*Test for Urobilinogen or Urobilin.—**See* p. 69.

6. Pus.—Pus may come from the kidney, pelvis of the kidney, ureter, bladder, prostate, or urethra. If present in the urine in small quantity it may be recognized only by means of the microscope. When in considerable amount it may form a light-coloured deposit which is readily diffused on shaking.

Tests for Pus.—Pus is not soluble in acetic acid, and this differentiates it from phosphates; also, the addition of a little caustic potash solution converts it into a ropy gelatinous mass.

Fresh ozonic ether, or fresh hydrogen peroxide, mixed with pus, causes an effervescence of oxygen.

As mentioned already (*see* p. 75), pus generally gives with tincture of guaiac alone a greenish or bluish-green colour, which disappears on heating.

In all cases, however, the diagnosis of pus in the urine must only be made by microscopical examination.

7. Glycuronic Acid.—This is a product of the incomplete oxidation of glucose, and is used in metabolism to detoxicate phenols, alcohols, and aromatic acids. Normal urine contains a trace, but always in combination as a glucoside. For example, compounds are formed with bodies like phenol, indoxyl, and skatoxyl, and therefore the output is increased in intestinal stasis. In similar manner, comparatively large amounts of glycuronic acid are excreted in combination with drugs such as camphor, aspirin, chloral, benzoic acid, antipyrin, oil of turpentine, menthol, chloroform, and morphine, but with some of these the dose must be fairly large. On the assumption that the conjugation of glycuronic acid occurs in the liver, camphor and aspirin have each been used to test hepatic function—failure to find the compounds (glycuronates) in the urine indicating very serious damage. On the other hand, glycuronates often appear, quite apart from giving drugs, in considerable quantity in the urine in chronic obstructive jaundice, and if, as in the case of drug-glycuronates (*see* p. 73), Fehling's solution should be reduced, it is the glycuronic acid component which is responsible. However, unlike glucose, glycuronic acid does not reduce Benedict's solution or ferment with yeast.

Tollen's Test for Glycuronates.—To 5 c.c. of urine in a wide test-tube add 1 c.c. of a 1 per cent in alcohol solution of naphthoresorcin and 5 c.c. of strong HCl. Heat slowly and keep boiling for one minute. Cool in the air for three minutes and then under the tap. Shake with an equal volume of ether. The ether on settling out is red or

violet in colour if glycuronates are present, and spectroscopic examination reveals a band on the D line and another to the right of this. Pentose also gives to the ether extract a reddish colour, but Bial's test for pentose (*see* p. 74) will differentiate.

ESTIMATION OF THE PERCENTAGE OF UREA IN THE URINE

The percentage of urea is conveniently estimated by using Gerrard's ureometer (*Fig.* 95).

The apparatus consists of a calibrated burette (*b*) attached to a reservoir (*c*) which can be raised or lowered. The top of the burette is connected by rubber tubing to a bottle (*a*). With the clip (*d*) open, water is poured into the reservoir (*c*) until, with (*c*) raised, the surface of the water in the lower part of (*c*) is on a level with that of the water in (*b*) at the mark zero. Then 25 c.c. of 40 per cent caustic soda is placed in bottle (*a*) and 2 c.c. of bromine added, thus producing a fresh sodium hypobromite solution.

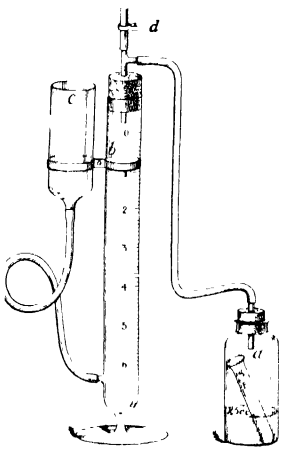


Fig 95.—Gerrard's ureometer.

Albumin, if present in the urine, should be removed by adding a few drops of 5 per cent acetic acid to 20 c.c. of the specimen, boiling, and filtering The volume is then made up to the original 20 c c. by the addition of distilled water.

Measure 5 c.c. of the urine into the special small tube provided, and lower this tube into the hypobromite solution in (*a*) without spilling any of the urine Tightly stopper (*a*) and close (*d*). Now mix the 5 c c. of urine with the hypobromite solution by tilting (*a*). Nitrogen is liberated and the water in (*b*) is displaced downwards. Cool (*a*) in cold water for a few minutes, and then, by lowering (*c*), bring the water in (*c*) and (*b*) to the same level. The reading of the level in (*b*) will give the percentage of urea in the urine (grammes per 100 c.c.). The method is accurate enough for clinical purposes.

If the burette is marked in c.c., instead of being calibrated as above, the percentage is obtained by multiplying the number of c.c. of nitrogen given off from the 5 c.c. of urine by 0 056.

Urea is the chief nitrogenous waste product found in the urine, and ordinarily represents 80 to 90 per cent of the total nitrogen found there, but if the person is on a low-protein diet it may represent only 60 per cent. Normally the urea output varies greatly with the diet, and is highest when large amounts of protein are consumed. Thus the amount excreted by a normal adult may be as much as 40 g. in the twenty-four hours, or as little as 20 g., but it is usually about 30 g., and with an average concentration of 2 per cent. Muscular exertion and marked mental activity increase the excretion of urea. Pathologically it is increased in fevers and in diabetes mellitus, and decreased in acute yellow atrophy and cirrhosis of the liver and in Bright's disease.

ESTIMATION OF DIASTASE IN THE URINE

A small quantity of the starch-digesting ferment diastase occurs normally in the urine. Estimations of diastase are valuable in the diagnosis of pancreatic disease. A *unit* of diastase is that amount which just digests 1 c.c. of 0 1 per cent soluble starch in thirty minutes at 37° C. The normal *diastase index* (i.e., number of units per c.c. of urine) is between 6 and 30. In acute pancreatitis the urinary output of diastase is greatly increased; the index reaches 100 to 1000. There is, as a rule, a raised index in cholelithiasis, especially with stone in the common bile-duct. A slight rise is generally found in malignant disease of the head of the pancreas, but in chronic pancreatitis the index is normal.

Technique of Estimation.—Serial dilutions of urine (preferably from a twenty-four-hours' collection, but if test is urgent use the first available specimen) are incubated with

a fixed quantity of soluble starch for thirty minutes at 37° C. in order to determine the smallest volume of urine which will completely digest the starch. Into a series of clean test-tubes measure the following amounts of urine: 0·6, 0·5, 0·4, 0·3, 0·2, 0·1, 0·09, 0·08, 0·07, and 0·06 c.c. (smaller amounts will be required if the diastase content is high). Measurements lower than 0·1 c.c. are best made by diluting the urine 1–10, and so on, with 1 per cent sodium chloride solution. Make up the contents of each tube to 1 c.c. with the salt solution, add 2 c.c. of 0·1 per cent soluble starch to each, mix and incubate (or place the tubes in a water-bath) for thirty minutes at 37° C. Then cool the tubes under the tap, add to each a drop or two of weak iodine solution (e.g., Gram's iodine diluted 1–10 with water), and select from those tubes giving no blue reaction the one containing the least quantity of urine. This tube contains the amount of diastase which is just sufficient to digest the starch. For example, if the tube has 0·2 c.c. of urine, then 0·2 c.c. of urine can digest 2 c.c. of starch solution, and therefore 1 c.c. of urine can digest 10 c.c. of starch solution—i.e., the diastase index (or number of units per c.c. of urine) = 10 (a normal result).

III. MICROSCOPICAL EXAMINATION OF THE URINE

This is of great importance; it may provide the first evidence of disease of the urinary tract, or may decide the question of a doubtful diagnosis.

A centrifuge may be used to facilitate the collection of deposits.

Classification.—The following is, more or less, the usual classification of the subject:—

1. UNORGANIZED DEPOSITS:—
   - *a Crystalline and Amorphous Deposits found in Acid Urine*—Uric acid, amorphous urates, calcium oxalate, cystin, leucin and tyrosin, hippuric acid, creatinine, and calcium sulphate. Crystals of sulphapyridine, sulphathiazole, or similar sulphonamide (mainly their acetyl derivatives).
   - *b Crystalline and Amorphous Deposits found in Alkaline Urine.*—Calcium phosphate (amorphous and 'stellar'), ammonium-magnesium (or 'triple') phosphate, ammonium urate, calcium carbonate, and magnesium phosphate. In *(a)* and in *(b)* the first three are common, the others rare.
   - *c. Other Unorganized Deposits found in Acid, Neutral, or Alkaline Urine.*—Cholesterol, fat, hæmatoidin, indigo, and melanin.
2. ORGANIZED DEPOSITS.—Red blood-corpuscles, leucocytes and pus cells, epithelial cells, tube casts; also, prostatic threads, spermatozoa, fibrin, blood-clots, mucus-corpuscles, mucus-threads, mucus-casts (known also as cylindroids), and connective tissue.
3. MICRO-ORGANISMS AND ANIMAL PARASITES.
4. FOREIGN BODIES.

UNORGANIZED DEPOSITS

Crystalline and Amorphous Deposits Found in Acid Urine.—

Uric Acid.—This has already been mentioned as forming, to the naked eye, the 'cayenne pepper' deposit (*see* p. 70). Microscopically, uric acid is seen to consist of yellowish-brown or reddish-brown crystals, mostly of the whetstone or rhombic-prism type (*Fig.* 96, A). Variations in colour are due to the amount of pigment in the urine and to the thickness of the crystals—for example, thin plates may be light-yellow or almost colourless. Crystals are frequently arranged as rosettes, crosses, sheaves, combs or brushes, irregular plates, and other formations.

Amorphous Urates (mostly sodium urate).—These, whether pigmented ('brick-dust' deposit) or colourless, dissolve on heating. Microscopically they appear as moss-like masses of minute amorphous granules. In very rare instances sodium urate is crystalline, and in the form of small fans or clusters of fine needles.

Calcium Oxalate.—This is found as small, colourless, highly refractive octohedra, not unlike envelopes (*Fig.* 96, C), but may appear also as small

dumb-bells. Calcium oxalate crystals are apt to occur in the urine after the ingestion of rhubarb, strawberries, spinach, or sorrel. It is not uncommon to find them in cases of dyspepsia, neurasthenia, or chronic pancreatitis. Oxaluria is occasionally responsible for recurrent hæmaturia or for pain suggesting renal calculus

Cystin.—Cystin is a sulphur-containing amino-acid, which is rarely found in the urine in more than minute traces. Sometimes it occurs in considerable amounts in the urine in several members of the same family, and may be hereditary. With the increased excretion a fawn-coloured deposit may form. Microscopically, this appears as hexagonal plates (*Fig.* 96, G). A cystin calculus may develop if urinary infection is present.

Leucin and Tyrosin.—These usually occur together and are mostly found when there is rapid destruction of liver tissue, as in acute yellow atrophy of the liver, phosphorus poisoning, and yellow fever; also occasionally in typhoid fever, small-pox, erysipelas, scarlet fever, and leukæmia.

Leucin is in the form of yellowish or brown spherical masses with concentric markings, tyrosin in the form of clusters or sheaves of fine needle-like crystals (*Fig.* 96, E, F). They may resemble fat-globules and fat-crystals respectively, but are distinguished by being insoluble in ether. Leucin and tyrosin are never seen in normal urine.

Hippuric Acid.—This is the only normal urinary constituent which is produced by the kidney itself; it is synthesized from benzoic acid and glycine. When the excretion of hippuric acid is increased by the administration of benzoic acid or benzoates, or by a vegetable diet, a deposit of colourless plates and prisms may occasionally form. These somewhat resemble 'triple' and 'stellar' phosphates, but appear in acid urine and are not soluble in acetic acid.

Creatinine.—Creatinine sediments are rare, and occur chiefly after prolonged muscular exertion, but also in severe acute nephritis, typhoid fever, and pneumonia. The formation consists of colourless barrel-shaped and whetstone-shaped plates and prisms.

Calcium Sulphate.—Crystals of calcium sulphate resemble 'stellar' phosphates, but occur in acid urine. They are rare, and their clinical significance is unknown.

Crystals of Sulphapyridine, Sulphathiazole, or similar Sulphonamide (mainly their acetyl derivatives—from Hepatic Acetylation).—These may form in the renal tubules, pelves, and ureters (when dosage of sulphonamide full or high, urine output low, reaction acid) and cause serious obstruction to urinary excretion. The crystals are of numerous shapes—e.g., arrow-head, whetstone, striated dumb-bells, shell-forms or rosettes with radial striations, hexagonals, irregular plates, prisms, spherulites of small needles clumped together to resemble sheaves of wheat or spiny burrs.

Crystalline and Amorphous Deposits Found in Alkaline Urine.—

Calcium Phosphate.—There are two varieties, amorphous and crystalline (or 'stellar' phosphate).

Amorphous calcium phosphate deposits are white and flocculent and dissolve with acetic acid. Microscopically, minute colourless granules are seen. These may be in masses of various sizes, but not in moss-like arrangements as in the case of urates.

Crystalline calcium phosphates ('stellar' phosphates) occur in star-shaped clusters of colourless prismatic crystals or singly (*Fig.* 96, H). They are frequently found with 'triple' phosphates, but otherwise are uncommon.

Ammonium-magnesium Phosphate ('triple' phosphate).—These deposits appear in ammoniacal urines. Microscopically, they consist of large prismatic rhombic crystals—described as 'knife-rest' crystals (*Fig.* 96, D). If the urine is excessively ammoniacal there may be irregular plates, or fern-like or 'feathery' forms.

Ammonium Urate.—Deposits are often found in alkaline urine, and especially in association with those of calcium phosphate and ' triple ' phosphate. Microscopically, small rounded spinous masses are seen (*Fig.* 96, B).

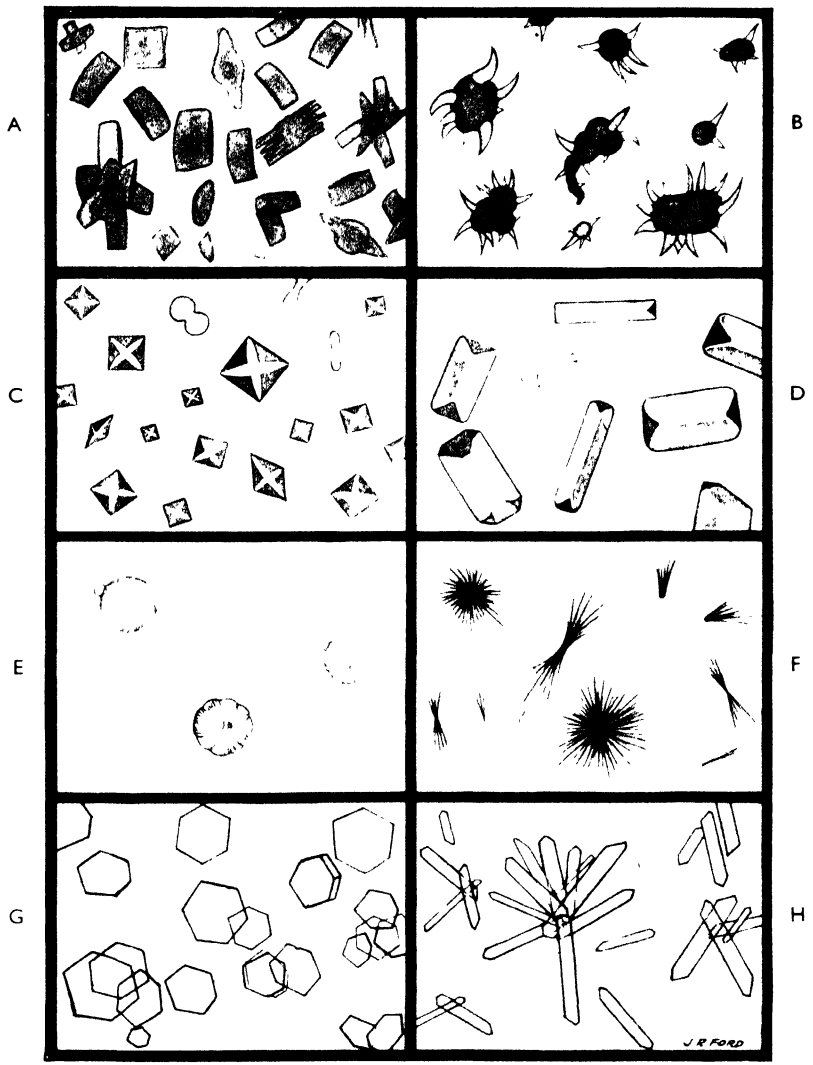


Fig. 96.—Microscopical characters of crystalline urinary deposits A, Uric acid. B, Ammonium urate. C, Calcium oxalate. D, Ammonium-magnesium phosphate. E, Leucin F, Tyrosin. G, Cystin H, Stellar phosphates.

Calcium Carbonate.—This is occasionally found as a deposit in the urine, alone or with phosphates, and occurs mainly in cases of bone disease and after drinking large quantities of certain mineral waters. Calcium carbonate is dissolved by acetic acid

and the evolution of gas distinguishes it from phosphates. The deposit consists usually of small, amorphous, highly refractive granules; sometimes small dumb-bell shapes are seen.

Magnesium Phosphate.—Crystals of magnesium phosphate may appear with calcium carbonate deposits, but are very rare. They take the form of colourless, highly refractive, small, quadrilateral prisms.

Other Unorganized Deposits Found in Acid, Neutral, or Alkaline Urine.—

Cholesterol.—Cholesterol has been found occasionally in the urine, chiefly in cases of chronic cystitis, nephrosis, and chyluria. It appears as colourless, thin, irregular, rhombic plates, often notched on the corners and sides. The deposit is dissolved by ether.

Fat.—In cases of chyluria the urine is turbid or milky, owing to the fat it contains. Microscopically, enormous numbers of fat-granules or fat-globules are seen, and usually some red blood-corpuscles and pus cells. A careful search should be made in the urine and blood, especially in night specimens, for the *Filaria sanguinis hominis* which almost always is the cause of chyluria.

Lipuria (that is, fat in the urine) may also be found in the lipæmia of diabetes, chronic inflammation of the urinary passages, neoplasms of the kidney, phosphorus poisoning, pregnancy, and after the liberation of fat into the circulation by the fracture of long bones. The fat-globules are not only free in the urine but also often appear within epithelial cells and pus cells and on the surface of tube casts. They have a dark contour, refract light strongly, and vary considerably in size; the larger ones may occasionally contain, or be accompanied by, extremely thin needles of fat. Cholesterol plates occur in a small proportion of cases.

Sometimes the presence of fatty or oily matter in the urine may be traced to the lubrication of a catheter, or to the accidental or deceitful addition of milk or other fatty or oily liquid to the specimen.

Hæmatoidin.—Crystals of hæmatoidin are derived from old blood-clots, and appear as small, rust-brown, irregular plates or masses, which are often surrounded by fine needles, attached in cilia-fashion. The needles may also be lying free, or joined together in stellate, dendritic, or brush-like figures.

Indigo.—Indigo is a decomposition product of indican. It occurs mostly in putrid urine, and is seen as small, bluish, rhombic crystals, or as needles or irregular masses.

Melanin.—This is sometimes found in the urine in cases of melanotic tumours as small, dark-brown or black, irregular masses or granules. The intravesical use of silver salts may produce black particles of similar appearance.

ORGANIZED DEPOSITS

Red Blood-corpuscles (*Fig.* 97, B, 3).—These are recognized by their shape and colour. Considerable alterations may occur, however, in their appearance, depending on the length of time they have been in the urine, and for other reasons; they may be swollen, lacking in colour, crenated, or shrunken.

Leucocytes and Pus Cells (*Fig.* 97, B, 1, 2).—Leucocytes occurring as part of a hæmorrhage must not be mistaken for pus cells. The presence of the latter indicates inflammatory changes in the urinary tract, but in women the possibility of contamination from the vagina must be excluded. In acid urine the cells usually retain most of their ordinary appearance, but in alkaline urine they are swollen and opaque, and require the addition of acetic acid to bring the nuclei into view.

Epithelial Cells.—Apart from a few superficial cells from the bladder, and also, in the female, a certain number from the vagina, the presence of epithelial cells in the urine is pathological and particularly so if accompanied by pus cells.

Epidermal scales from the prepuce in the male, and the clitoris and labia in the female, are frequently found, but are easily differentiated from epithelial cells; the scales have a shrunken appearance, are highly refractile, and do not contain a nucleus.

The type of epithelium present in the urine will often indicate which part of the urinary tract is affected.

Renal Epithelium.—As found in the urine, the cells from the convoluted tubules are round or slightly irregular (*Fig.* 97, A, 1), and those from the collecting tubules globular; both sorts are about one-third larger than pus cells. They do not require acetic acid for the delineation of their nuclei. The finding of renal epithelium and pus cells in urine, excreted over a period of rest, means the existence of some pathological process in the kidney. In the subacute and chronic forms of nephritis the epithelial cells show degenerative changes.

Cells from the Renal Pelvis.—These are mainly club-shaped (*Fig.* 97, A, 3), globular, or lenticular; some are quadrilateral, others irregular.

Ureteric Cells.—Found with those from the renal pelvis. They are round or globular, or slightly irregular, and smaller than similar cells of pelvic origin. They cannot be distinguished from the epithelial cells of the prostate.

Bladder Epithelium.—The lining of the renal pelves, the ureters, and the urethra, while of the transitional variety, does not show the three layers of typical cells distinctly as in the case of the bladder. The superficial vesical cells are flat and quadrilateral (*Fig.* 97, A, 4), with concavities on the under surface into which fit the cuboidal cells of the middle layer; those of the deepest layer are columnar or club-shaped (*Fig.* 97, A, 2). The latter, which are also present in places in the middle layer, are not distinguishable from the club-shaped cells of the renal pelvis. The rather large superficial flat cells and the cuboidal epithelium are, however, characteristic of the bladder. Superficial cells joined together may often be seen.

Urethral Cells.—These are flat (*Fig.* 97, A, 6), cuboidal, or club-shaped, and, as a rule, readily diagnosed by their comparatively large size and their irregularity of outline.

Vaginal Epithelium.—Vaginal epithelium, consisting of large squamous cells (*Fig.* 97, A, 5), is easily recognized.

Tube Casts.—These come from the uriniferous tubules of the kidneys, and may be hyaline, epithelial, granular, 'blood', 'pus', fatty, or waxy.

Hyaline Casts (*Fig.* 97, F, 2).—These are translucent and somewhat difficult to detect unless iodine is added. They occur in all kidney affections. It should be noted, however, that in normal people the urine, even when excreted over a period of rest, may contain occasional hyaline casts and also a few red blood-corpuscles.

Epithelial Casts (*Fig.* 97, C, 1).—Numerous in acute nephritis, and also in the subacute form. They are hyaline casts studded with epithelial cells. In acute nephritis the cells, though more or less coarsely granular, are intact, but as the disease enters the subacute or chronic stages they show degenerative changes.

Granular Casts.—Granular casts occur in subacute and chronic nephritis. The granulation, probably due in most cases to disintegration of epithelial cells, may be fine or coarse (*Fig.* 97, E, 1, 2) or a mixture of the two. With further degeneration the granules become changed into fat-globules.

Blood Casts (*Fig.* 97, C, 3).—Found in acute nephritis and other forms of renal congestion.

Pus Casts (*Fig.* 97, C, 2).—Occur in renal suppuration.

Fatty (*Fig.* 97, D) *and Waxy* (*Fig.* 97, F, 1) *Casts.*—These represent corresponding degenerations of the kidney.

Other Organized Deposits.—

Prostatic Threads.—Found in the urine in cases of chronic prostatitis, especially when the prostatitis is due to gonorrhœa. The threads, often perceptible to the naked eye, are seen microscopically to consist of mucus, prostatic epithelium, and pus cells; the epithelial cells have the same appearance as those from the ureters.

Spermatozoa.—Sometimes present, and are easily recognized.

Fibrin.—Fibrin appears in the form of characteristic wavy bands, which may be narrow and pale, or broad and, perhaps, reddish-brown in colour; the edges are more refractive than the centre.

Blood-clots.—These are seen as dark-brown masses of disintegrated blood-corpuscles.

Mucus.—Mucus occurs microscopically as corpuscles, threads, and casts.

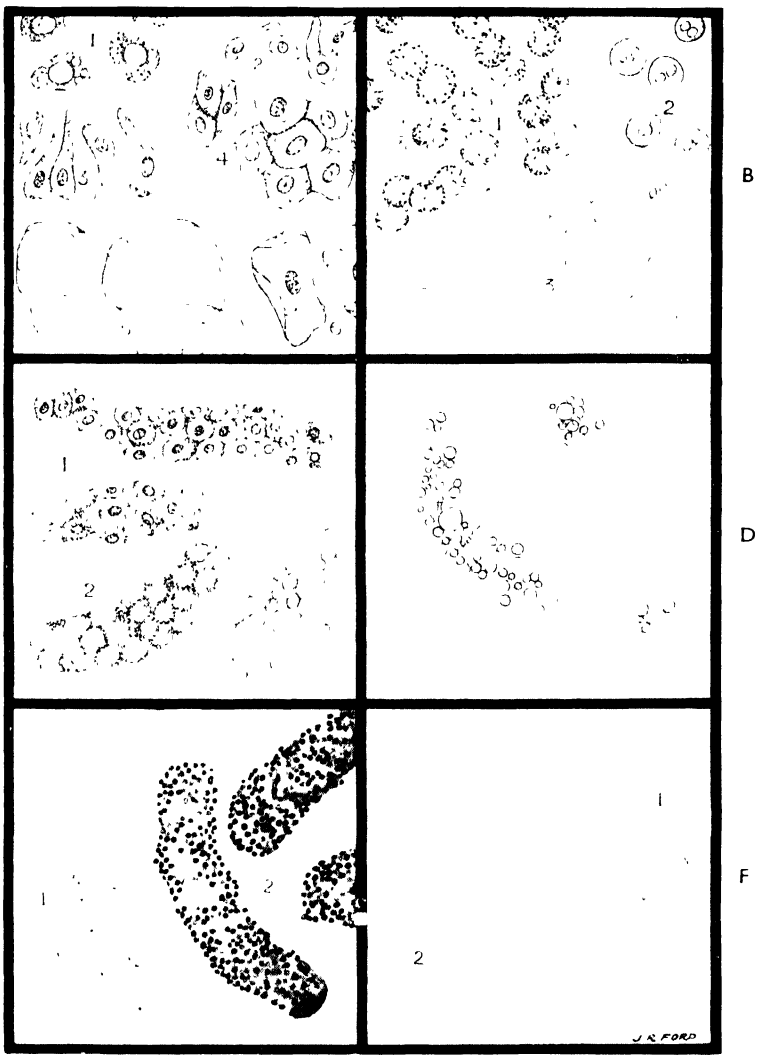


Fig. 97.—Microscopical characters of organized urinary deposits. A, Epithelium from (1) Renal tubules, (2) Bladder (deep); (3) Renal pelvis; (4) Bladder (superficial); (5) Vagina, (6, Urethra. B, (1) Pus cells, (2) The same treated with acetic acid; (3) Red blood-corpuscles. C, Casts (1) Epithelial; (2) Pus, (3) Blood. D, Casts, fatty. E, Casts: (1) Finely granular, (2) Coarsely granular F, Casts (1) Waxy; (2) Hyaline.

Mucus-corpuscles : Occur as pale, finely granular, non-nucleated corpuscles, and vary in size from that of a pus cell to that of a large epithelial cell

Mucus-threads : These are small in normal urine, but may be comparatively large when inflammation produces an excess of mucus ; they are pale, and striated longitudinally.

Mucus-casts (also known as cylindroids) : May be formed in any part of the urinary passages. They are distinguished from hyaline casts by their undulating contour, tapering ends, longitudinal striation, and, often, much greater length

Connective-tissue Shreds.—In the urine connective-tissue shreds may be derived from new growths, ulceration, suppuration, or other destructive process. The shreds are composed of compact, irregular bundles of moderately refractile, wavy fibres, and the finding of these denotes a severe and deeply seated lesion of the urinary tract. The urinary diagnosis of new growth, by the recognition of its particles as neoplastic tissue, is a rare occurrence, and mostly made in cases of villous tumour of the bladder.

MICRO-ORGANISMS AND ANIMAL PARASITES

Micro-organisms.—Urine in the bladder of a healthy person is probably free from infection, but when a specimen has been exposed to the air for a few hours it is found to be contaminated by the *Micrococcus ureæ* and various non-pathogenic fungi and infusoria. *M. ureæ*, by its conversion of urea into ammonium carbonate, is largely responsible for the ammoniacal decomposition of urine.

The actinomyces fungus is not found in the urine except in the rare cases where actinomycosis affects the urinary tract.

Pathogenic Bacteria.—In pathological conditions, the chief pathogenic bacteria which may occur in the urinary passages are : Gonococcus, tubercle bacillus, *B. coli communis* and its variants, *B. proteus*, *Staph. pyogenes aureus* and *albus*, *Str. pyogenes*, *Str. fæcalis*, and the typhoid bacillus. The *Leptospira* (or *Spirochæta*) *icterohæmorrhagiæ* is found in the urine in cases of spirochætosis icterohæmorrhagica (Weil's disease).

Any search for these organisms must be conducted with great care and thoroughness. The urine should be obtained by catheterization, especially in the female. When, in certain circumstances, the specimen cannot be got in this way the urinary meatus should be freed of infection and the urine passed directly into a wide-necked sterile bottle, which is then stoppered, and the sample sent for examination without delay.

Animal Parasites.—The *Trichomonas vaginalis* is a protozoon flagellate which is not infrequently present in the urine of females, and in association with leucorrhœa. In such cases the parasite is usually found in large numbers in the vagina. Considerable controversy exists regarding its pathogenicity.

The hooklets, membrane, and scolices of *echinococcal cysts* are on rare occasions discharged into the urinary passages.

In tropical countries the embryos of *Filaria sanguinis hominis* and the ova of *Schistosoma hæmatobium* are commonly found in the urine of affected patients.

Other parasites which may possibly find their way into the urine are the *Eustrongylus gigas*, the *Oxyuris vermicularis*, and the *Ascaris lumbricoides* and ova.

For an account of the micro-organisms and parasites mentioned, and for the technique employed in their recognition, the reader is referred to appropriate text-books.

FOREIGN BODIES

A great variety of foreign bodies may be found from time to time in specimens of urine. The following are some of those which may be readily recognized by the experienced observer: Fibres of cotton, silk, linen, and wool; hairs, starch grains from dusting powders, scales from wings of moths, particles of feathers, oil globules, dust of wood and cork, vegetable fibres and cellulose, sputum, vomit, and fæcal matter. The contamination of urine by fæces takes place, as a rule, outside the body, but may occur internally through a fistula. On an average, fæcal matter contains vegetable fibres and cellulose, grains of starch and chlorophyll, fat globules, partly digested muscle-fibres, connective-tissue shreds, squamous epithelium from the anus, various putrefactive micro-organisms, mucus, and crystals such as 'triple' phosphates and calcium oxalate.

CHAPTER IX

PREPARATION FOR OPERATION*

By JOHN BRUCE

"*Modern aseptic surgery has made the operation safe for the patient; it is now the aim of surgery to make the patient safe for the operation.*"—Lord Moynihan.

PRE-OPERATIVE preparation is largely in the hands of the house surgeon; consequently his obligations, both to the patient and to his surgical chief, are considerable.

Patients presenting themselves for operation fall into two classes—those in need of urgent operation, and those in whom the operation can be performed at a time selected by the surgeon.

In the first group, risks must be taken which are unjustifiable in the second, but even in emergency an intelligent interrogation and examination of the patient often reveals salient factors which influence the choice of anæsthetic or indicate important operative and post-operative precautions.

In the operations of so-called deliberate surgery, the pre-operative care may be simple and straightforward, or fraught with the greatest importance, depending on whether the patient is considered a 'good risk' or a 'bad risk'. In the latter event, pre-operative care is directed towards promoting the bad risk to the good-risk class.

GENERAL SYSTEMATIC EXAMINATION

It is not enough to examine the prospective site of operation; a meticulous survey of the patient's general state of health must be made soon after admission.

History.—Apart from the details of the actual complaint, inquiry should be directed to elicit any history of excessive bleeding (hæmophilia), drug idiosyncrasy (as to iodine or morphine), or any unusual behaviour during previous anæsthesia.

Mental Outlook should be assessed, and an appropriate atmosphere must be created between the house surgeon and his charge. Due allowance may have to be made for a nervous patient.

Signs of Other Disease.—Obesity, hyperthyroidism, cachexia, and dehydration are generally obvious. Each has an important bearing on pre-operative preparation.

Dental and Oral Hygiene.—The mouth, gums, and teeth must be examined in every case. Pyorrhœa and dental caries should be specially noted.

Cardiovascular System.—The state of the heart has to be assessed in the light of the strain to which it is to be exposed by the operation. The examination one commonly sees performed—too often, for the first time when the patient is on the operating table—and the report "Heart sounds clear in all areas" is useless. In younger patients (under forty) significant signs are: (1) Enlargement

* *Consent for Operation.*—No operation should ever be performed without written consent In the case of a minor, consent must be obtained from a parent or responsible relative (*see also* Chapter LXXX).

of the heart and great vessels; (2) A diastolic murmur; (3) Arrhythmia; (4) Present signs or previous history of congestive heart failure. In older patients, heart disease may be present without the above manifestations, and in this event, a history of breathlessness on exertion, swelling of the feet and ankles, or anginal attacks should be considered highly important.

The *blood-pressure* is particularly important. The house surgeon who takes the blood-pressure of every patient who has to undergo a major operation is an acquisition. If, on his own initiative, he reports in good time to all concerned that a patient has a (previously unsuspected) low blood-pressure, he deserves praise.

Respiratory System.—Upper-passage catarrh, bronchitis, tuberculosis, and bronchiectasis should be noted, both for their influence on the choice of treatment and selection of anæsthetic, and in the management of the post-operative period.

Examination of the Urine.—Apart from the special analysis conducted in cases of urinary disease, a routine chemical examination is carried out in all cases, for the presence of albumin, sugar, and acetone. If sugar is found, operative treatment has to be postponed until further investigations reveal or deny the existence of diabetes. Acetone in the urine is also important, as it indicates the possibility of severe acidosis developing.

Examination of the Blood.—If there is a suspicion of anæmia, a red blood-count should be carried out. The house surgeon who familiarizes himself with the use of a hæmoglobinometer and performs this simple estimation himself will acquire a habit which is bound to prove invaluable in whatever future clinical path he may tread.

THE PREPARATION OF THE 'GOOD-RISK' PATIENT

The 'good surgical risk' is the patient without signs of serious disability affecting the systems other than the one to be operated upon; who is well-nourished, and of stable mental outlook.

Time of Admission.—When possible, the patient should be admitted to hospital two days before the prospective operation. The house surgeon should see the patient as soon as possible after his arrival. If the examination is well conducted, the patient will acquire great confidence in his surgical attendants. For the same reason it is a good practice for the anæsthetist to visit the patient on the day before the operation.

Evacuation of the Bowel.—Purgation is unnecessary; indeed, it is harmful, for it results in irritation of the bowel and dehydration. If evacuation of the bowel has been regular, a soap and water enema on the morning of operation is adequate. If constipation has been present, the patient should be instructed to take his usual laxative the day before, and on the morning of the operation a soap and water enema is administered.

Oral Hygiene.—Dental sepsis favours the development of post-anæsthetic respiratory complications. In association with dryness, it predisposes to post-operative parotitis. If pyorrhœa is present the operation should, if possible, be postponed until the infected teeth have been removed and the gums have healed. Milder infection and dirty teeth should be treated by scaling, and, when necessary, temporary filling; and a reasonable degree of mouth hygiene established.

Diet.—Starvation is as dangerous as purgation; it favours the occurrence of acidosis, and disturbs the gastro-intestinal rhythm. In the ordinary case, a

light diet with low residue should be allowed, up to the evening before operation. On the following morning, a cup of tea or coffee and a small finger of toast may be permitted three hours before the operation.

Fluids.—The fluid intake should be generous, to counteract the tendency to fluid depletion in the immediate post-operative period. Glucose drinks are specially valuable the day before operation ; a jug of glucose solution or orange juice and glucose should be beside the patient's bed, and he should be encouraged to imbibe it.

Sleep.—A good night's sleep preceding the operation is most desirable. All the necessary pre-operative preparations should be completed early, and a sedative given in the late evening (8 or 9 p.m.). Nembutal (1½ gr.), sodium amytal (3 gr.), and soneryl (2 gr.) are all satisfactory for this purpose. There is no virtue in withholding the drug to see if natural sleep ensues ; it is given for the express purpose of allaying worry or emotional disturbance about the morrow's ordeal.

Preparation of the Field of Operation.—Save in the case of acute emergency, each patient should have a general body bath on admission ; and the condition of the skin, especially the area of the operation field, is scrutinized at the first systematic examination. The presence of septic spots, or boils, dermatitis of the ' weeping ' type, such as occurs in the groin and in the sulcus between large abdominal herniæ and the lower abdominal wall, and scabies with secondary infection, should be regarded as indications for the postponement of any save imperatively urgent operations.

Preparation of the Skin.—Custom decrees a fairly elaborate ritual of skin preparation. How far this is absolutely necessary may be judged against the fact that the wounds of urgent surgery, commonly prepared for the first time on the operating table, behave as a rule just as impeccably as any other.

Time of Skin Preparation.—As a rule, the skin receives its first preparation on the evening before operation. In children, this is unnecessary and may be frightening.

In orthopædic cases, e.g., bone-grafts, it is a common practice to prepare the skin forty-eight hours beforehand and repeat the procedure at twelve-hourly intervals. In most situations, this is not essential ; but in the case of operations upon the hands, and especially upon the feet, repeated preparations ensure greater cleanliness

The Ritual.—

Shaving.—The operative field, and a generous area of surrounding skin, is well soaped and shaved. Dry shaving is inexcusable, and bad for the razor, which should be kept keen and well cared for.

In the scalp, a preliminary cropping with barber's hair clippers is desirable, and the use of a shaving brush ensures a more satisfactory lather and an easier task than does a gauze or wool swab. In extensive operations on the skull, the whole head should be shaved.

In abdominal operations, the whole abdominal wall should be shaved, and, if necessary, the lower chest to the level of the nipples. In operations on the knee, shaving from the groin to the ankle is the rule ; in compound fractures of the lower leg or foot, preparation to the mid-thigh is sufficient.

Cleansing of the Skin.—The skin derives organisms from two sources—they may be *chance* inhabitants deposited from recent contacts from bedclothes or garments ; or *residents*, whose habitat is in the deeper crevices. The former can

be removed easily by mechanical cleansing. The destruction of the 'resident' organisms cannot be guaranteed by any method of preparation, but there is now more than abundant evidence that the contamination of the clean surgical wounds is not due to them, but to infection from without—from the air of the theatre, or the hands, arms, or throat of the surgeon or his team, or the instruments used; or to contact with organisms during changes of dressing in the post-operative period.

Reliance should be placed, therefore, on the removal of the surface 'casuals' by mechanical means. The skin is scrubbed with soap and hot water, particular attention being given to folds and crevices, and to the umbilicus in abdominal cases. The skin is then dried with a sterile swab, and wiped over with ether or methylated ether.

Antiseptic Applications are probably of little significance. Tincture of iodine (2½ per cent) is the favourite in this country, and has the virtue of colouring the field of operation. It is well to remember the risk of an iodine idiosyncrasy, and to inquire if the patient has had previous trouble from this source; it is also essential to prevent the solution trickling down on to the scrotum when the lower abdomen is being painted.

Spirit, mercurial preparations (biniodide, mercurochrome, metaphen), flavine, picric acid, and the dye antiseptics have all been, or are still, used. The choice appears to matter little.

Covering of the Prepared Area.—A sterile towel is the usual covering for the prepared part; it is held in place by a roller or a many-tailed bandage.

Preparation of the Skin in Emergency Cases.—This is often better deferred until the patient is in the theatre, and under anæsthesia. The acute abdomen may be too tender to allow thorough preparation, and in accident cases the exposure and the manipulations may increase the degree of shock if the patient is conscious.

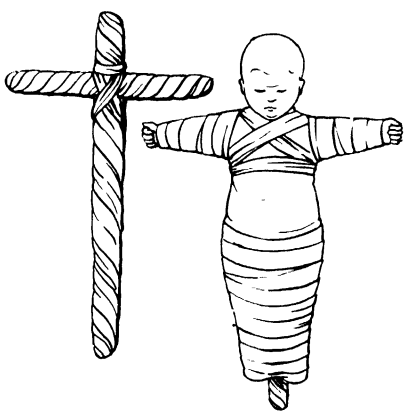


Fig. 98.—The crucifix method of forestalling operation shock in a young child.

Pre-operative Care in Children.—Special considerations arise in relation to pædiatric surgery. The liability to respiratory and exanthematous diseases renders long pre-operative residence in the ward undesirable. The possibility of the young patient having been in contact with infectious diseases before admission should be inquired into.

The operation should be postponed if there is pyrexia due to other than the disease for which the operation is being undertaken; and if there has been recent upper respiratory catarrh or tonsillitis.

The metabolic processes are very easily upset in childhood; pre-operative starvation, therefore, is even more dangerous in the child than in the adult. Diseases themselves associated with malnutrition cause rapid dehydration, glucose deficiency, and acidosis; and the spectre of the dehydrated sick infant is not readily forgotten. A high carbohydrate diet is essential, and abundant fluids, reinforced with glucose, and barley sugar to suck are important adjuvants. If,

for any reason, the oral administration of fluid is impossible, the intravenous route, via the saphenous vein in front of the ankle, is employed.

It is seldom necessary to prescribe a sedative on the night before operation, as in the case of adult patients. When such is required, luminal, 1 gr., is useful.

Forestalling Shock.—In the case of an infant, a good method is to wrap warm cotton-wool over as much of the body as possible, and then bandage the baby firmly to a frame, which can be improvised easily (*Fig.* 98).

Pre-operative Care in the Elderly.—A patient of advanced years often requires special understanding and kindness on the part of the staff. The young house surgeon would do well to bear in mind that the aged are apt to be set in their ways, and too strict an insistence on non-essential routine, or too abrupt a discipline, may spoil the confidential relationship on which much depends.

In a more practical sphere, the elderly person is a more serious surgical risk. The natural decay of tissues leads to a lowering of the reserves of vitality, especially the ' cardiac ' vitality. A form of chronic respiratory disease is often present, and there is always a risk of basal pulmonary congestion. Dehydration is also common, and, in hospital practice at any rate, so is chronic undernutrition.

It is wise, therefore, to insist on frequent changes of posture in bed ; on movements of the limbs ; on a generous diet, with abundant fluids. If the undernutrition is so severe that there is wasting and retention of nitrogenous products, a blood transfusion is indicated before the operation.

In elderly males the condition of the prostate should be investigated ; it may necessitate postponing the operation until attention has been given to the urinary system, or it may decide the steps to be taken if the almost inevitable post-operative retention of urine occurs.

PRE-OPERATIVE PREPARATION IN 'BAD-RISK' CASES

Obesity.—The obese are bad subjects for operation, especially in middle life or later. The cardiac muscle is generally flabby, and the cardiac reserve diminished. They are also more liable to respiratory troubles and to the development of local wound sepsis.

It is a wise measure to insist on a preliminary period of dieting to reduce the weight before undertaking an operation which is not urgently necessary. In emergency operations, of course, added risks must be faced ; where possible, chloroform and ether anæsthesia should be avoided.

Thyrotoxicosis.—It must be appreciated that in a thyrotoxic subject the risks of a minor operation are practically the same as those attending thyroidectomy ; the only operative procedure which is justifiable, therefore, apart from those actually of a life-saving nature, is the operation for the relief of the thyroid condition. The pre-operative management of thyrotoxicosis is detailed in Chapter XXV.

Cardiac Disease.—The pre-operative preparation of the cardiac ' poor-risk ' patient is outside the scope of this section. In brief, it may be stated that only life-saving operations are permissible in the presence of cardiac failure, until the heart condition has been treated adequately, and evidence of compensation is forthcoming. The whole question must be left in the hands of a physician.

Respiratory Disease.—Upper respiratory infections favour post-operative bronchitis, pneumonia, and collapse of the lung. Asthma, on the other hand, does not materially affect the surgical risk, but operation should, if possible, be

avoided during or immediately after an attack. The gravest conditions from the surgical point of view are bronchiectasis, lung abscess, and tuberculosis. Quiescent tuberculosis often flares up after general anæsthesia, especially in elderly subjects.

Extensive respiratory disease is again a matter for expert medical assistance

Diabetes.—The pre-operative preparation of the diabetic subject is discussed in Chapter X.

Dehydration.—About 70 per cent of the body-weight is made up of the body fluids. Depletion of these fluids is now recognized as a common and important side effect of many surgical states in addition to those like pyloric stenosis, in which it is very obvious. Normally, 2½–3 litres of fluid are lost each day—1½ litres in the urine, and 1–1½ litres by evaporation from the skin and lungs (the 'insensible' loss); in health, this is made good by the intake of fluids and food

The water balance may be upset by inadequate intake or excessive loss, or a combination of the two. An excessive loss occurs in febrile states (by sweating) and as a result of vomiting, diarrhœa, accumulation of fluids in the bowel in obstruction, and discharging biliary or intestinal fistulæ. In the latter conditions, the 'insensible' loss from the skin and lungs is at first maintained, and the urinary output suffers. Later, the interstitial fluids are drawn upon, and ultimately the blood-plasma and the intracellular fluids. Depletion of the body fluids by one-quarter is said to be always fatal; in any case, the danger which threatens from loss of water is often greater than that of the disease itself.

It should be our aim to anticipate and prevent disturbance of the water balance, or to treat dehydration at the earliest possible moment.

To Avoid Potential Dehydration, as in febrile states, e.g., septicæmia and osteomyelitis, an additional litre of fluid should be given, to provide for the additional evaporation from the skin. The fluid intake, therefore, should be :—

Fluid for urine	1500 c.c. (2½ pints)
Fluid for normal vaporization .	1000 c.c. (2 pints)
Fluid for additional vaporization	1000 c.c. (2 pints)
Total fluid required ..	3500 c.c (6½ pints)

This intake can generally be ensured by the provision of liberal drinks.

To Avoid Potential Dehydration after Operation, it should be borne in mind that in many instances only a proportion of the fluid requirements of the patient can be obtained by imbibition; the bulk of the 2½ litres necessary should be given by rectal or subcutaneous infusion, or, if these routes are contra-indicated, by intravenous drip.

To Avoid Dehydration in Cases of Vomiting.—

a. Pyloric stenosis: In pyloric stenosis, up to 1500 c.c. (2½ pints) of gastric juice are lost by vomiting or accumulation in the stomach. The intake from oral administration of fluid is nil, therefore the fluid requirements are :—

Fluid for urine	1500 c.c. (2½ pints)
Fluid for vaporization	1000 c.c. (2 pints)
Fluid to replace gastric juice vomited	1500 c.c. (2½ pints)
Total fluid required . ..	4000 c.c. (7 pints)

In this case, and in the type following, the fluid has to be administered other than by the mouth; the intravenous route is the most satisfactory.

b. Loss of all intestinal juices (intestinal obstruction, vomiting, and diarrhœa): The total amount of the intestinal juices is in the neighbourhood of 8 litres. To avoid dehydration, therefore, the fluid requirements are :—

Fluid for urine	1500 c.c. (2½ pints)
Fluid for vaporization . ..	1000 c.c. (2 pints)
Fluid to replace intestinal juices lost	8000 c.c. (14 pints)
Total fluid required . ..	10,500 c.c. (18½ pints)

Treatment of Established Dehydration.—From clinical examination, it is not possible to tell how much fluid depletion has occurred. A useful clinical rule is : *If the patient shows clinical signs of dehydration, he may be assumed to have lost 6 per cent of his body-weight in fluids.* This must, therefore, be replaced. In a 10-st. (60 kilos) patient, a 6 per cent loss of body-weight - 3·6 kilos (equivalent to 3600 c.c. - 6 pints). In addition to this amount, an additional quantity must be given to cover the daily loss (3000 c.c.). The dehydrated 10-st. patient, therefore, requires 6600 c.c. (11 pints) during his first twenty-four hours. This is given by intravenous infusion.

Salt Loss, and the Nature of the Fluid to be Given : Sodium chloride is lost along with the fluid in all dehydrated states ; the amount of salt lost in cases of increased perspiration is insignificant. The administration of 5–10 g. of sodium chloride daily is sufficient under these circumstances to maintain a proper level of blood-chloride. In pyloric stenosis or high intestinal obstruction, on the other hand, there is considerable loss of chlorides in the vomit ; the remaining sodium radicles combine with the carbonic acid of the plasma to form an excess of bicarbonate and an increase in the alkali reserve of the plasma. This is the dangerous state of *alkalosis*, and the introduction of sodium chloride is an imperative necessity.

To calculate the amount of salt required, two tests are of assistance :—

1. If the vomit has been measured, an equal volume of physiological saline should be given intravenously to restore a normal level.

2. If the volume of the vomit is not known, the blood-chloride should be measured (normal 575 mg. per cent). Then give by injection 55 c.c. of normal saline per kilo of body-weight for each 100 mg. that the plasma chloride is reduced.

In a 10-st. (60 kilos) individual, 3300 c.c. (6 pints, 12 oz.) of saline are required for each 100 mg. fall in the chlorides.

If, as is usual, the degree of dehydration demands a larger quantity of fluid, saline should not be used to supply the remainder. An excess of salt leads to water-retention in the tissues, and consesquently to œdema, which will embarrass the lungs and hinder tissue healing. One method of overcoming this risk is to substitute 5 per cent glucose solution for the normal saline after the requisite amount of salt has been given. A better method is to employ continuously a solution of one part of normal saline to four parts of 5 per cent glucose in distilled water.

Acidosis : This is the opposite of alkalosis, and comes about through loss of alkali, with lowering of the alkaline bicarbonate reserve, or through the retention of abnormal acid products of fat metabolism.

Conditions associated with diarrhœa, or intestinal fistulæ, and low small-intestine obstruction, carry off much of the alkali secreted to the upper reaches

of the intestine, which would normally be re-absorbed, and the alkali deficit may become critical.

The retention of the ketone products (β-hydroxybutyric acid and aceto-acetic acid) of fat metabolism is due to lack of carbohydrate which is essential for the complete combustion of fat. In surgical work, this carbohydrate deficiency may result from lowering of the glycogen reserves of the liver, or from lack of exogenous carbohydrate through starvation.

The treatment of acidosis is the administration of saline and glucose. The saline restores the basic sodium, the excess of chloride being excreted by the kidneys; while the glucose prevents or corrects the formation of acid by-products by ensuring the proper combustion of the fats.

CHAPTER X

DIABETES AND OPERATIONS

By E. NOBLE CHAMBERLAIN

UNTIL the discovery of insulin an operation on a diabetic patient was a nightmare, but whilst it still remains a matter for anxiety and careful thought, its terrors are diminished by the immediate co-operation of the physician and surgeon.

The Operation.—If the operation is one of convenience only—e.g., simple hernia or minor orthopædic measures—the necessity for it must depend very largely on the patient's age and the discomfort he is suffering. A hernia in an old man clearly has a different significance from one in a young man who must earn his living by heavy manual work. In general, operations of convenience should be avoided, but if the patient's activity or comfort is seriously impaired by his condition no hesitation is necessary. With adequate pre-operative and post-operative treatment the risks are slight. It is scarcely necessary to emphasize the necessity of testing the urine before *any* operation, to avoid overlooking unsuspected diabetes.

Urgent conditions such as perforation of viscera or acute appendicitis require immediate operation and must only be postponed for a period deemed safe by the surgeon. Such postponement as the surgeon considers legitimate may, however, allow the physician a few valuable hours in which to undertake pre-operative treatment of the diabetes.

Similarly in the important decision of when to operate for gangrene, that common and dangerous complication of diabetes, any deferment of surgery must be utilized for control of the diabetes.

Apart from patients whose surgical condition warrants operation irrespective of their diabetes, there are many cases where this disease is aggravated by other complaints—particularly sepsis—which can be dealt with by operation with great benefit to the diabetic state. Chronic sepsis from dental infections, sinus disease, and urinary or alimentary infection furnish examples. In these instances the time chosen for operation will depend upon the response of the diabetes to the usual medical measures, and a reasonable period may be devoted to these without the fear of delay which exists in urgent surgical diseases.

Special mention must also be made of hyperthyroidism, which of itself is often accompanied by hyperglycæmia and glycosuria. These indicate a lowered carbohydrate tolerance resulting from the lessened production of insulin which is caused by the antagonistic effects of the excessive thyroid secretion on the pancreas.

Partial thyroidectomy is thus the rational line of treatment. When genuine diabetes is suspected owing to the grade of hyperglycæmia or ketosis, the patient should receive pre-operative treatment as in other operations.

The Anæsthetic.—It must be remembered that all general anæsthetics tend to cause hyperglycæmia. Local and spinal anæsthesia are therefore preferable, but may be supplemented by avertin or evipan without undue risk. Chloroform should never be used, for even in a healthy subject it may be followed by acidosis, which would be intensified in a diabetic and constitute a serious danger. Nitrous-oxide–oxygen or ether may be used, but the former is preferable.

Pre-operative Treatment.—This will depend upon several factors, especially the grade of the diabetes and the severity of the operation.

Trivial operations in a mild diabetic need no special measures. The patient should merely be carefully standardized as regards diet and insulin and brought to the table with his carbohydrate metabolism as accurately balanced as possible.

The same holds good, of course, for more serious operations, though in an emergency time may not permit such an ideal state. It then becomes necessary to protect the patient especially against acidosis, and the time before operation should be used to *remove any ketosis* and diminish the chances of this occurring after operation. To do this it is important to avoid starvation, vomiting, and severe purgation—all of which tend to precipitate ketosis. The patient should continue on the amounts of foodstuffs which have been found previously to be adequate for his diabetic needs, but the actual constituents of his solid diet must be replaced by fluids, such as skimmed milk (to remove excess of fat) and fruit juices

An excess of carbohydrate, e.g., 30 g. extra glucose, given two hours before operation with 10–20 units of insulin, tends to diminish still further the risks of ketosis.

When ketosis is pronounced, every hour which the surgeon can allow with safety before operating is vital, as insulin and glucose must be given 2-hourly until ketones disappear from the urine. This may be judged by the usual tests. Remember that a positive ferric chloride test indicates considerable ketosis, whilst Rothera's nitroprusside test detects much smaller amounts. A reasonable dose would be 20 units of insulin and 30 g. of glucose 2-hourly until the ketones disappear, but larger doses may be necessary, especially if severe sepsis renders the insulin relatively ineffective.

Once the ketosis has disappeared, the insulin may be adjusted to avoid excessive hyperglycæmia. A little sugar in the urine, however, is harmless and avoids any risk of hypoglycæmia. When time permits, it is probably safer to substitute soluble insulin for zinc protamine insulin, if the patient has been taking this, owing to the uncertain absorption and prolonged effects of the latter preparation. The same advice holds good for the newly tried globin insulin. Blood-sugar examinations when available are most valuable both before and after operation in enabling the dosage of insulin to be accurately adjusted. They also avoid the occasional error of mistaking renal glycosuria for true diabetes and endangering the patient by unnecessary use of insulin.

Post-operative Treatment.—As before operation, the main risk is ketosis, a risk increased by the anæsthetic and operative interference. Further, a general anæsthetic may cause vomiting, which again increases the ketosis. Herein lies one of the values of local or spinal anæsthesia.

The urine must be tested after operation at regular intervals of 2 hours, catheterizing the patient if necessary, and glucose given in similar doses to the pre-operative measures, aiming at keeping a trace of sugar in the urine but no acetone.

Often a single dose of 20 units of insulin and 30 g. of glucose will accomplish this, but further doses may be necessary. When all ketosis has disappeared, the glucose (and correspondingly the insulin) may be gradually reduced until the patient resumes his normal pre-operative diet and quantity of insulin. Should vomiting occur, the glucose must be given intravenously until all ketosis has gone.

A final caution is necessary in dealing with cases of serious sepsis. The removal of this by operation may result in great improvement in carbohydrate tolerance, rendering the previous dose of insulin too high. The signs of hypoglycæmia must therefore not be overlooked.

CHAPTER XI

PRE-OPERATIVE MEDICATION AND BASAL NARCOSIS

By J. L. HOPKINS

A LARGE variety of drugs are used in the premedication of patients before operation. Those most commonly used will be described.

Atropine.—Atropine inhibits the secretion of saliva and bronchial mucus, which is increased by the use of ether or any other irritating vapour.

In chloroform anæsthesia the use of atropine is important, as it reduces the risk of vagal inhibition. Primary cardiac failure, which occurs from time to time during the induction stage of chloroform anæsthesia, is believed to be due to vagal inhibition.

The usual dose of atropine is gr. $\frac{1}{100}$, but this can be increased if necessary to gr. $\frac{1}{75}$. Children tolerate atropine well, and infants under six months can be given gr. $\frac{1}{200}$ with safety. The dose should always be given by hypodermic injection half an hour before operation.

Morphine and Atropine.—This is a popular and safe form of premedication which gives the patient a feeling of well-being and slight drowsiness without producing depression of the respiratory centre. The usual dose for an adult is morphine gr. $\frac{1}{4}$ and atropine gr. $\frac{1}{100}$. For aged or debilitated patients, and those between 12 years and 18 years of age, the dose of morphine should be reduced to gr. $\frac{1}{6}$. [The injection is given not less than half an hour before operation.]

Morphine and Hyoscine.—The combination of morphine and hyoscine produces a greater degree of drowsiness than morphine and atropine, and consequently less general anæsthetic will be required. Hyoscine has a similar action to atropine in so far as it reduces the secretion of saliva and bronchial mucus; but its disadvantage is that, especially in combination with morphine, it depresses the activities of the respiratory centre. This form of premedication should be given from three-quarters of an hour to one hour before operation. The usual dose is morphine gr. $\frac{1}{4}$ and hyoscine gr. $\frac{1}{120}$. In young patients the dose of morphine should be reduced to gr. $\frac{1}{6}$. Hyoscine is best avoided in elderly patients.

Many prefer to replace the morphine gr. $\frac{1}{4}$ by omnopon gr. $\frac{1}{3}$. Omnopon is a mixture of all the alkaloids of opium. Burroughs Wellcome put up morphine, hyoscine, and atropine combined in a single tabloid known as Hyoscine Compound. There are two strengths: Compound B contains morphine gr. $\frac{1}{4}$, hyoscine gr. $\frac{1}{100}$, and atropine gr. $\frac{1}{150}$; it is this dosage which is given unless the patient is young, old, or frail, when Compound A, which contains morphine gr. $\frac{1}{6}$ and a correspondingly smaller dose of the other substances, is substituted. [This is considered heavy premedication and is most useful in cases which are undergoing spinal or local anæsthesia.]

Morphine and Hyoscine combined with Sodium Pentothal.—This is a combination of drugs which is widely employed to give the patient the advantages of both premedication and basal narcosis.

The patient is given a dose of morphine gr. $\frac{1}{6}$, and hyoscine gr. $\frac{1}{150}$ one hour before operation, and before the induction of general anæsthesia 4 to 5 c.c. of a 5 per cent solution of sodium pentothal are injected intravenously. This is enough to render the patient unconscious and the subsequent deepening of anæsthesia is easier, quicker, and smoother.

Only sufficient pentothal to render the patient unconscious should be used, because an excessive dose produces a degree of respiratory depression which makes deepening of anæsthesia by ether more difficult and slower.

Sodium pentothal, which has replaced evipan, should be injected more slowly than the latter; also great care should be taken to avoid injecting any of the solution outside the vein, as sloughing of the tissues almost always follows.

The tendency at the present time is to replace morphine and hyoscine by omnopon gr. $\frac{1}{3}$ and scopolamine gr. $\frac{1}{150}$.

Paraldehyde.—Paraldehyde is a safe and efficient basal narcotic. It is given per rectum in a 10 per cent solution of saline. The dose is one drachm per stone of body-weight. A No. 8 rubber catheter, well lubricated, is passed about six to eight inches into the rectum, the patient lying on the left side with the buttocks raised on a pillow. The solution is run into the rectum from a funnel attached to the catheter by rubber tubing, and not less than five minutes should be taken to complete the injection. When all the solution has gravitated into the bowel, the catheter is clamped. A dose of atropine is then given, and the room darkened. It is not long before the patient falls into a profound sleep. Paraldehyde should be given from three-quarters of an hour to one hour before operation.

Avertin (Tri-brom-ethyl alcohol).—This drug is given per rectum in a $2\frac{1}{2}$ per cent solution of distilled water. The standard dose for basal anæsthesia is 0·1 g. per kilo of body-weight. This dose may be varied if necessary to suit different types of patients; elderly people and those with a low basal metabolic rate will only require a dose of 0·09 g. per kilo body-weight, while children and patients suffering from hyperthyroidism will tolerate a dose of 0·11 g. per kilo. The makers supply a table giving the amount of "avertin fluid" and distilled water required for any given weight.

When the solution is being prepared it requires vigorous shaking. *Great care must be taken to ensure that the temperature of the solution does not rise above* 104° F. Overheating may cause the avertin to break down, forming dibrom-acetaldehyde, which causes violent rectal irritation. To safeguard against this contingency a few drops of Congo red should be added to the solution immediately before administration. The solution should then be bright pink in colour; if the colour changes to blue or even shows a tendency towards blueness, it should be thrown away and a fresh solution made.

Avertin is given by means of a catheter, tubing, and funnel in the same way as paraldehyde, and is followed by a hypodermic injection of atropine. The solution should be given half an hour before operation, as the maximum concentration of avertin in the blood is reached in that time.

Nembutal.—This substance belongs to the barbiturate group of drugs, and acts by producing a state of drowsiness. Nembutal is given orally in capsules each containing gr. $1\frac{1}{2}$. The following is a useful guide to dosage in children:—

2–3 years ..	.. 1 capsule containing	gr. $\frac{3}{4}$
3–5 years ..	.. 1 capsule containing	gr. $1\frac{1}{2}$
5–10 years ..	.. 2 capsules, each containing	gr. $1\frac{1}{2}$
Over 10 years	.. 3 capsules, each containing	gr. $1\frac{1}{2}$

On no account should this method of premedication be followed by any other barbiturate such as evipan or sodium pentothal, as the risk of cumulative effects is great.

Nembutal can also be used intravenously by injecting a 10 per cent watery solution at a rate not exceeding 1 c.c. per minute until the patient loses consciousness.

Sodium Soneryl (Butobarbital sodium).—This is another drug of the barbiturate group used to produce basal anæsthesia when given orally. It is said to be of lower toxicity than nembutal, and the amnesia produced is neither so marked nor so long as it is after nembutal. Sodium soneryl is given one hour before the induction of a general anæsthetic or an operation under local anæsthesia. The drug is put up in capsules containing 0·15 g. in each, and the most suitable dose is estimated according to the weight of the patient. The following is a table of doses :—

ADULTS

Weight	*No. of Capsules*
7 to 8½ st.	3
8½ to 10½ st.	4
10½ to 12½ st.	5
12½ st. and above	6

CHILDREN

Weight	*No. of Capsules*
5 to 6 st.	2 to 2½
4 to 5 st.	1½ to 2
3 to 4 st.	1 to 1½
2 to 3 st.	½ to 1
Under 28 lb.	½

CHAPTER XII

ASSISTING AT OPERATIONS

By NORMAN M. MATHESON

As in so many other technical matters in which dexterity comes from repetition, practice solves most of the early difficulties. Let familiarity with the tools come first. Master every appliance on the operating table and handle over and over again all commonly used instruments ; a hæmostat carried in the coat pocket can, in a day or two, be opened and closed with the left hand as expeditiously as with the right. Some instruments, e.g., tissue forceps, are almost habitually used in pairs, so when one is asked for the second should be ready. Gentleness in all actions is of the utmost importance, and should be cultivated from the very commencement of one's first surgical appointment—likewise tidiness, for there is a proper place for most instruments. A few minutes' pre-operative rehearsal is never superfluous, and a worthy assistant needs no prompting as to the virtues of punctuality. Anticipation of an individual surgeon's wants, so highly desirable for the quiet progress of an operation, can as a rule be soon attained by observation of the personal conventions. Judiciously restrain all undue haste and restrict any unwarranted movement. An assistant with a cold or cutaneous infection should at all times seek a deputy for theatre work.

Preliminary Preparation.—Make a practice of wearing a cap and mask whenever one enters the theatre, and always change to the boots provided in the ante-room.

From the radiographs, select the pertinent ones and place the most suitable in the viewing box. If the suction apparatus is to be used, see that it is in working order. Test all electrically illuminated instruments. In all cases of intestinal obstruction with vomiting, aspirate the gastric contents immediately prior to the induction of anæsthesia—whether it be by spinal injection or inhalation anæsthetic.

The Mask.—This should consist of several layers of gauze and must be made to cover the nose as well as the mouth. It should project well under the

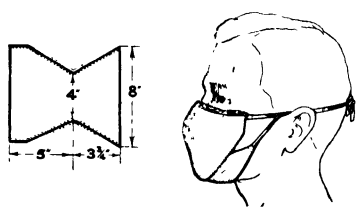


Fig. 99.—' Nosebag ' mask as recommended by the M. R. C.

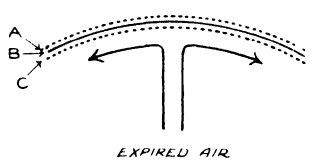


Fig. 100.—Mask to prevent expired air from contaminating the wound. Cellophane (B) is introduced between layers of gauze (A, C).

chin ; this is a special feature of the ' nosebag ' type of mask recently recommended by the Medical Research Council (*Fig.* 99). A sheet of cellophane or thick paper included between the layers of the gauze (*Fig.* 100) provides a

satisfactory means of preventing expired air from reaching the wound. It is particularly useful on those occasions when the face is to be in close proximity to the part. When working in hot weather in a heavily sandbagged theatre perspiration from the brow may be distressing even in those usually unaffected by this troublesome inconvenience. Two or three layers of gauze wrapped transversely around the head before donning cap and mask mitigate the possibility of soiling the wound from drops of perspiration.

Preparation of the Hands under Normal Conditions.—After a preliminary wash in the ante-room, the hands and forearms are to be thoroughly scrubbed with soap in freely flowing hot water; the sterile brush should be firm, but not too hard.

In this important preliminary a definite ritual is followed, commencing at the fingers and finishing at least at the level of the elbows. No region is disregarded, but the finger-tips, the spaces between the fingers, and the ulnar borders of the forearms and hands receive special consideration. Systematic scrubbing is of as much consequence as the time expended, for haphazard washing must always be ineffective—even when continued longer than the generally allotted time of five minutes. Following this initial cleansing, the hands and arms are soaked in spirit.

Precautions.—

1. When drying, the hands must be raised by flexion of the elbows to prevent moisture from running to the cleansed forearms and hands from proximal parts of doubtful sterility.

2. Take care to see that the mackintosh worn while scrubbing is not splashed with water; otherwise the gown, which is to be donned soon afterwards, becomes saturated from the underlying mackintosh, thereby imperilling the sterility of the operative field.

Preparation of Hands under Emergency Conditions.—The following technique of Craig et al. can be recommended as a method which is applicable should war conditions abolish the sterilization amenities of a modern theatre, and to eliminate rubber wastage by heat sterilization under emergency conditions.

1. Ordinary toilet of nails, etc.; wash hands and forearms and dry.

2. Put on non-sterile rubber gloves previously inspected and patched if necessary. The gloves should be well pulled on to obviate wrinkles and the risk of resultant unwashed areas.

3. Wash gloved hands in soap and water for three minutes.

4. Put on sterile gown and fasten the sleeves at the wrists over the gloves with small rubber bands previously sterilized in 1–50 lysol. The gown sleeves should be long to avoid exposing areas of bare wrist.

5. Steep hands in 1–50 lysol for two minutes.

6. Rinse in saline.

Gloves.—These should be carefully selected, and proved to be free from punctures; a tight glove soon becomes uncomfortable, and a loosely fitting one impedes fine work. Before attempting to put on gloves, see that the hands are well dried and evenly powdered. If each pair of gloves is sterilized in a separate bag, this can conveniently be employed to draw the glove on the hand. If not placed in separate bags, have the cuffs turned down before sterilization. To avoid all contact between the skin and the outside of the gloves, partially draw the first glove on the hand by grasping its inner surface at the rim of the

turned-down area (*Fig.* 101) and touching that surface alone. Then similarly draw on the second glove. Make the final important adjustment of the cuffs in the manner shown in *Fig.* 102, thereby ensuring that the outer surface of the glove remains perfectly sterile. Cotton gloves, worn over the rubber ones, give useful protection and a firmer grip when dealing with rough irregular fragments of bone.



Fig. 101.—Showing the powder-bag and the method of holding the glove



Fig 102.—The final adjustment in putting on gloves—turning back the cuff so as to maintain sterility of the outer surface



Fig. 103.—Once the sterile gloves have been put on, keep the elbows flexed.

When once gloved, at all times hold the arms so that the hands are above the level of the waist, for dependent hands are most likely to make contact with unsterile objects. (*Fig.* 103).

Gowns.—Shortness of the sleeves is a not uncommon fault, and although all is well when the operation commences, sooner or later an area of the forearm becomes exposed, often unbeknown to the wearer. Stockinette sleeves are useful to maintain the sterile junction between gown and glove. Remove the gown from its container with care; it is very easy for a small portion of the contents to be dragged out and become contaminated on the drum wall or remain protruding after the lid is closed. When donning a gown, insist that the back

is always as completely covered as the front. The unseen, unprotected, part will almost certainly come in contact with a sterile table when the assistant turns to rinse his hands, as he must during the course of an operation of any duration.

Position of the Patient.—This important prelude well repays careful consideration, but as the position of the patient varies so much according to the requirements of the specified operation, no attempt is made to give comprehensive instructions.

Sandbags should always be in readiness, and a preliminary trial of the adjustable bridge of the operating table is time well spent. It is advisable to arrange the shoulder supports *before* all operations at which the Trendelenburg position is at all likely and in most cases where high spinal anæsthesia is employed ; their use may be hastily required.

Whereas the postural nerve palsies are well known and usually sufficiently guarded against, it must be emphasized that the possibility of pressure gangrene of the limbs demands the same meticulous attention. Under no circumstance is the whole hand to bear the weight of a recumbent patient. If the arms are to be by the side, see that the fingers are fully extended and never flexed. The thumbs—and no more than the thumbs—should lie beneath the buttocks. Whenever a lateral attitude is adopted, ascertain that the peripheral pulse of the dependent limb is not impaired.

Finally, when the correct position is assumed have the overhead light so adjusted as to illuminate the operative area really well.

Preparation of the Part.—Apply all lotions with swabs held on long forceps, and prepare an area well wide of the site of the proposed incision. Stand well



Fig 104.—Preparation of the abdominal wall. With a gauze swab soaked in flavine in spirit and held with long forceps, a wide area has been prepared, the umbilicus being the last part to receive attention. The process is repeated a second time with a different swab and forceps

away from the patient and pay special attention to regions such as skin creases, which are known to harbour infection. Commencing peripherally, proceed towards the umbilicus, which should be the last area to be painted (*Fig.* 104). Repeat the process a second time with a different swab and holder. Avoid excess of lotion. On no account should this be allowed to flow over the skin and saturate dependent parts of the patient. It should be remembered that tincture of iodine is very irritating if copiously applied to certain tissues, e.g.,

the skin of the scrotum. All parts not immediately concerned with the operation are covered with sterile mackintoshes and thereafter draped with sterile towels, which are retained in position by skin clips. These clips, when correctly placed, lie evenly on the part. Applied reversely, the upturned end soon becomes entangled in a suture or ligature.

Position of Assistant.—Posture plays a definite role when assisting at long operations. Stand well above the wound—on a stool if necessary—with the arms hanging loosely from the shoulders. To work with the arm even slightly elevated becomes fatiguing as time goes on.

Remember that the midline of a wound is essentially the surgeon's province; therefore one must endeavour to keep that region clear by retracting laterally, by holding sutures laterally, and by arranging hæmostats so that they lie naturally away from the midline. Keep the hands from the wound when not in use in that sphere and do not obstruct the surgeon's view by leaning too far forwards.

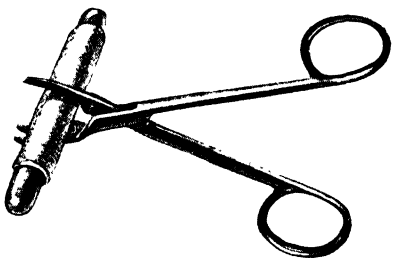


Fig 105.—Breaking ligature container with special forceps.

Ligatures and Sutures.—Catgut, as commonly used, is supplied in sealed glass containers; the glass is strong, but to facilitate opening the manufacturers place a score mark on the tube. On either side of this the thumbs are placed and the tube is bent towards one. Haphazard struggling to break the ampoule, generally time-consuming and often unsuccessful, is not without danger, for the fingers can be severely injured by the sharp edges of the resulting fragments. A safe and satisfactory method is to wrap the container in gauze to collect broken pieces of glass, and to get an assistant to crush it in the jaws of a pair of Cheatle's forceps or with the specially designed ligature tube breaker of Denis Browne (*Fig.* 105).

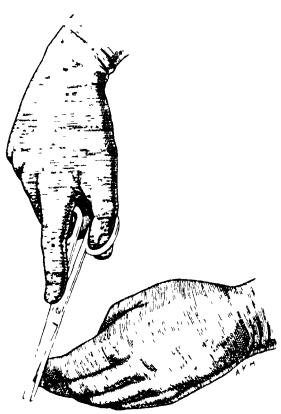


Fig. 106.—Cutting ligatures. Blades of scissors supported by fingers of the left hand.



Fig. 107.—Simple knot for attaching suture to needle.

It is desirable to develop the habit of cutting all ligatures with blunt-nosed scissors; until proficiency is attained, support the blades on the forefinger of the left hand (*Fig.* 106). Occasionally a ligature, cut too long, needs further

trimming. Always remove the detached fragments with forceps, otherwise there is nothing to be gained by cutting them off.

For the beginner skin scratches at right angles to the wound are well worth while as a guide to the accurate insertion of stitches. Suturing may be provoking at first, the short end of the catgut slipping from the eye of the needle

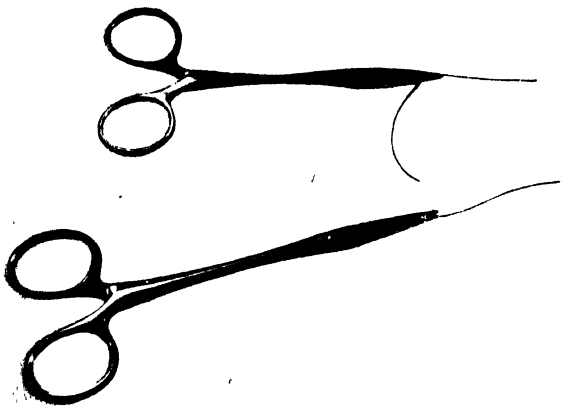


Fig 108 —Applying hæmostats to silkworm-gut sutures Correctly applied in the lower figure If attached as shown in the upper, constriction remaining after removal leaves a weakened area apt to break as the knot is tied

after every few stitches ; until experience is acquired attach the suture to the needle by means of a simple loop as shown in *Fig.* 107.

Owing to the natural tendency for silkworm gut to curl, apply forceps to all such sutures, and see that the forceps are attached really near the ends of the strands (*Fig.* 108). If applied towards the wound, the constriction remaining after the forceps are removed is a weakened area very prone to break when the



Fig. 109 —Reef knot.

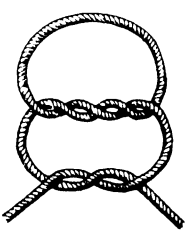


Fig. 110.—Surgeon's knot.

knot is tied. Arrange all through-and-through sutures in parallel rows, so that there is no confusion when the strands are ligated.

Knots.—Seldom is it the assistant's task to employ elaborate knots. The reliable reef (*Fig.* 109) and the equally simple surgeon's knot (*Fig.* 110) are all that are usually demanded of him ; such knots should be accurately placed and securely tied with both hands. There must be no jerking. A steady even pull

until the loop is taut is all that is ever necessary, and particularly is this so in applying the first turn of a knot. When using the modern synthetic preparations which have replaced silkworm gut, make a point of drawing the second loop tightly—it is prone to slip. Apply a third loop in necessary cases. When tying, do not incline over the wound, thereby obstructing the operator's view; and having tied, withdraw the hand which holds the ligature somewhat to one side so as to allow a clear field for the surgeon to cut.

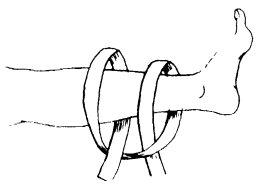


Fig. 111.—The essential features of the clove-hitch knot.

The Clove Hitch.—With the present interest in the traumatic surgery of the limbs the clove-hitch has once more come into prominence. The great advantage of this simple knot is that it becomes firmer the more it is pulled upon yet it can be released in a moment. Moreover, it has no tendency to slip. *Fig.* 111 shows the essential features of the knot.

Hæmostasis.—The correct and effective application of artery forceps constitutes one of the main duties of an assistant. He must be familiar with both the straight and the curved variety of hæmostat, and be able to take either from its allotted place without the slightest hesitation.

Apply the point of the hæmostat gently to the bleeding vessel and include only the minimum of tissue within its grasp. Elevate the handle when the ligature is being placed, and depress it really well when the knot is to be tied. Release slowly and evenly—usually after the first hitch of the knot is secure—and then return the hæmostat to its proper place. Otherwise, forceps soon collect around the wound and hamper an orderly technique.

Threading Needles.—To thread a needle quickly and neatly is an acquisition which well repays the house surgeon's attention. Frayed ends and a discrepancy between the size of the eye and the width of the suture are obvious sources of

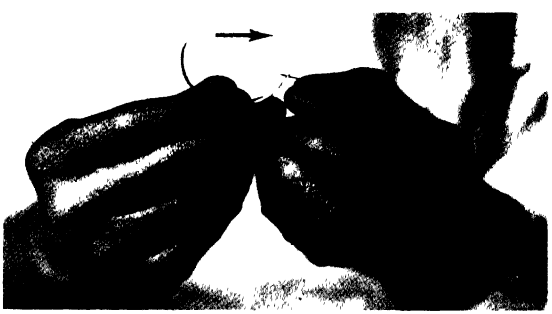


Fig. 112.—Threading needle on suture

trouble. Choose a needle with an eye too large rather than too small and remove frayed ends with an oblique deliberate cut with sharp scissors. Secure the shaft of the needle firmly between fingers and thumb of the right hand. Holding the strand in the left hand and well away from its extremity, pass the eye of the needle around the end of the steadied strand (*Fig.* 112). Approximation of the finger tips, as shown in the illustration, aids steadiness of movements.

Swabbing of Wound.—Small swabs are better not used, and sodden ones are to be discarded early. To be efficient the mopping must be directed to the site of the severed vessel. The pressure should be firm, but only momentarily applied. Although there should be no rubbing of the wound, an occasional light stroke along the skin margin is permitted to deal with superficial oozing. In small or deep wounds, make a practice of using swabs held with dressing forceps. Swabs for insertion into cavities should have tapes attached and be clamped with hæmostats.

Retracting.—Retractors are to be held with a firm but gentle pull, upwards as well as outwards, and from the beginning they should be grasped so that there is no overlapping of the arms. Changing of the grip at a critical moment should not be necessary. Remember that there is an insidious tendency to relax the hold as the operation proceeds, and that too much depression of the handle is apt to cause an abrupt unanticipated jolting of the blade from the wound. Distinct care is to be exercised when retracting in the neighbourhood of vessels, for the thin walls of veins can be damaged with surprising ease, particularly in the axilla, groin, and when retracting in a Battle's incision.

Dressings.—Supervise the application of dressings, paying particular attention to those of the neck, axilla, and inguino-scrotal region. When possible, discard gloves before handling cotton-wool and adhesive plaster. If a tourniquet has been used, see that it has been released when not required; in every case in which hæmorrhage is likely to recur from wounds of the limbs, arrange for the tourniquet to be conveyed with the patient during his transit to the ward.

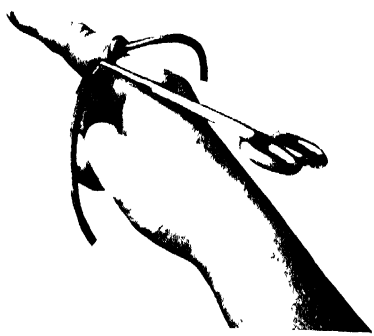


Fig. 113.—The surest way to prevent infection from a finger prick is to encourage bleeding. Apply a tourniquet proximal to the prick.

Pricked Finger.—Should an assistant have the misfortune to prick or otherwise abrade his skin, however slightly, during the course of an operation, the surgeon is to be notified at once. Relieved of his duties, the assistant immediately removes the gloves, and prompt strong sucking of the finger is an effective initial treatment. To encourage further bleeding apply a rubber band proximal to the prick (*Fig.* 113). Should the accident occur in an infected wound, a prophylactic course of chemotherapy is a wise precaution. The first dose should be three tablets of sulphanilamide, dissolved in citric acid to promote absorption. Commencing two hours later and continuing at four-hourly intervals one uncrushed tablet should be taken for four days.

CHAPTER XIII

REPAIR OF OPERATIVE INCISIONS

By N. M. MATHESON

IN the closure of operative wounds divided structures must be accurately readjusted, layer by layer, and with the obliteration of dead spaces and the avoidance of all trauma. Close, but not tight, coaptation of skin margins is essential if a neat scar is to be secured.

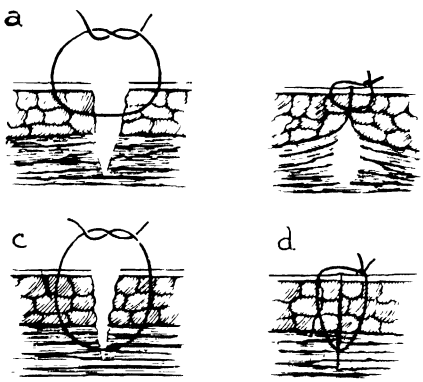


Fig. 114.—The interrupted deep suture *a* and *b* improperly placed, leaving a cavity when tied, *c* and *d* correctly placed, closing wound without cavity. (*After Hertzler and Chesky*)

One of the greatest causes of failure of a clean wound to heal by first intention is imperfect hæmostasis. All bleeding points must be ligated. Should there be oozing from the cut surface, the wound must be drained. Another cause of unsatisfactory healing is the insertion of too many sutures, especially if tied too tightly; tension at the wound margins is strictly to be avoided. In abdominal wounds pay special attention to the suturing of the peritoneum, for of all the layers a badly united peritoneum is the most potent cause of post-operative herniation.

As a rule, *buried* (catgut) and *superficial* (nylon or horsehair) sutures are used, and in many instances deeply placed non-absorbable *tension* stitches are employed to relieve the stress which tends to separate wound margins.



Fig. 115.—Closure of wound. Deep silkworm-gut sutures supported by rubber tubing threaded parallel to the incision. Michel clips for skin approximation

Interrupted rather than *continuous* stitches are inserted whenever much strain is likely to be imposed upon the suture line. Simple methods of suturing are just as effective as the more elaborate refinements.

Needles.—There are many different kinds of needle, and most surgeons have their special preference. Straight cutting needles are employed for the skin, and large curved cutting needles for the insertion of deep sutures and for sewing fascia.

Deep Tension Sutures (*Fig.* 114).—Silkworm gut or one of the synthetic substitutes is employed. There is always a certain amount of tension on these stitches; unless precautions are taken they tend to cut through the more superficial structures. To shield the skin many contrivances have been devised, perhaps the most common being to pass short lengths of rubber tubing along the protruding portions of the sutures

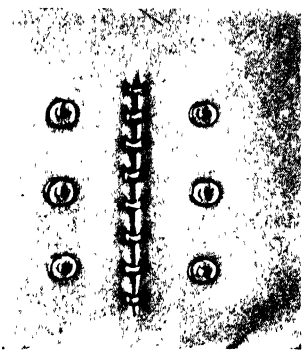


Fig. 116.—Relief of tension on deep sutures by means of the Emesay suture button

(*Fig.* 115). When much tension exists Emesay suture buttons are particularly satisfactory, especially if small squares of vaseline lint are placed beneath them to prevent them causing pressure necrosis of the skin (*Fig.* 116).

In the centre of these buttons is a special nipple which can be firmly squeezed around the stitch and so take the stress. A button is attached to one end of the suture before it is passed. Having inserted the stitch, the loose end is pulled taut, and a second button is slipped on and fixed in position by crushing the projection with the special forceps. In the absence of these special buttons, ordinary trouser buttons have proved efficient substitutes (H. Bailey).

Interrupted Sutures.—Each reef knot is so applied that the twist lies at one side and not over the line of the wound (*Fig.* 117). The skin surfaces should be approximated exactly, without too much tension. It is better that the edges should be a little everted. No strict rule can be laid down as to the depth

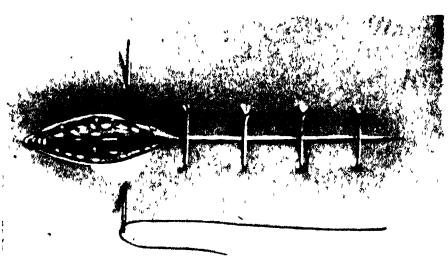


Fig. 117.—The interrupted skin suture.

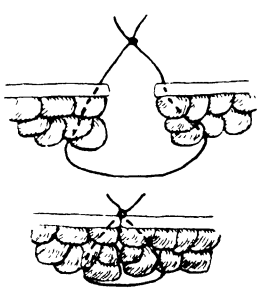


Fig. 118.—Interrupted suture for accurate approximation of skin margins. Note the points of entrance and exit right at the margin of the incision. (*After T. P. Kilner.*)

at which superficial sutures should be passed, but it is often advisable to place them deep enough to arrest oozing from the wound edges. Nylon, and occasionally horsehair, are the materials chiefly employed.

To secure accurate apposition and yet avoid scarring by transverse stitches a minor modification of the interrupted suture is particularly useful in the repair of incisions on the face or neck. The needle enters at one skin margin, takes a

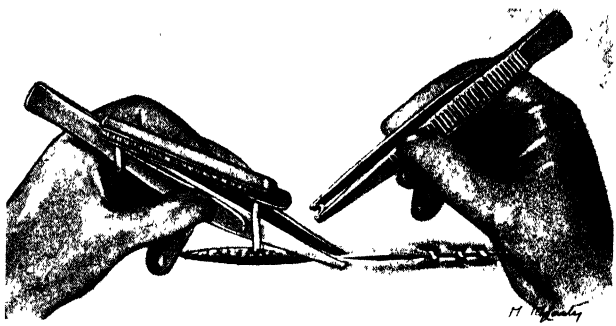


Fig. 119.—Michel's clips.

full bite of the deeper tissues, and emerges close to the opposite skin margin (*Fig.* 118).

METAL CLIPS.—Another way of bringing the edges of the wound together is by means of *Michel's clips* (*Fig.* 119). Michel's clips are held over the wound and at right angles to it by means of a special pair of forceps, and are then pressed down on to its edges, while at the same time the blades of the forceps are forced together, causing the pliable bridge to bend in the middle. The clips thus bring the edges of the wound into

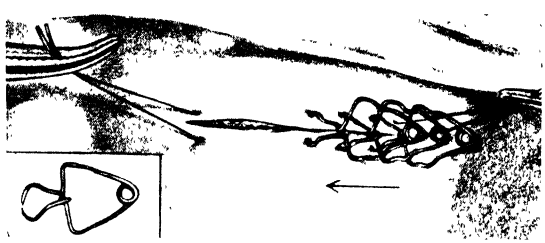


Fig. 120.—Method of closing a wound with van Herff's clips.
(*Inset.*—One of the clips.)

apposition with slight eversion. They should not be applied too tightly, for excessive pressure at the point of insertion favours skin necrosis; it is a good practice to leave a small interval between the wound margin and the bend of the clip to facilitate removal. They are removed, usually on the fourth or fifth day, with special forceps.

Kifa Clips are the same in principle, but are provided with flanges to facilitate removal.

Van Herff's serrefines (*Fig.* 120) are valuable for suturing small wounds, especially about the face. Their fine points leave little scarring.

To avoid drawing a double strand of suture through a delicate structure, when an eyeless needle is not at hand, a useful expedient is to insert a small hypodermic needle so as to approximate the edges. Through the lumen of the needle the finest of sutures is passed as a single strand.

Continuous Suture.—The simple continuous suture (*Fig.* 121) produces more perfect hæmostasis from the edges than does the interrupted, but has the disadvantage that, should infection supervene, it is impossible to liberate pent-up infection without sacrificing the whole length.

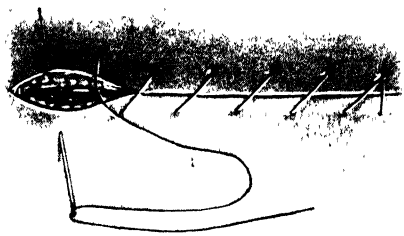


Fig. 121.—The simple continuous suture.

The Subcuticular Suture (*Fig.* 122).—This type of continuous suture is employed when a linear scar is desirable. Having closed the deeper parts of the wound, a long strand of fine catgut is threaded on a narrow needle and the end tied in a rather large knot. From the skin at one extremity of the incision the needle passes into the subcuticular tissue and the suture proceeds parallel to and immediately beneath the surface, first on one side and then on the other, until the opposite angle of the wound

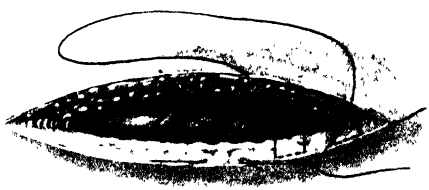


Fig. 122.—The subcuticular suture.

is reached. Here the needle again passes through the skin and the suture is conveniently concluded with the aid of an Emesay button.

DRAINAGE OF WOUNDS

While there are many advantages in being able to dispense with a drainage tube, provision must be made for the escape of exudates except in the case of wounds which are small, or adjudged to be perfectly healthy, and when hæmorrhage is known to be controlled perfectly.

1. Superficial Wounds.—

Silkworm Gut.—For small wounds, particularly of the face, a strand or two of silkworm gut issuing from an angle of the wound provides all the drainage required.

Rubber Tissue (*Fig.* 123, *a*).—This is used to drain superficial structures. It can be obtained from an old surgical glove and fashioned to meet the demands of the particular case. The selected length, insinuated into the subcutaneous space by means of a pair of sinus forceps, drains to the exterior at a convenient place in the wound, usually at one angle.

Corrugated Rubber (*Fig.* 123, *b*, *e*).—When a thick discharge is anticipated, *corrugated* rubber is preferred, serrated if necessary to prevent its slipping from the wound. If, as Professor Learmonth suggests, one row of serrations is cut

to point one way and the other row to point in the opposite direction, the corrugated strip can be prevented from moving either in or out of the wound.

Whenever small rubber drains are inserted *before* a wound is closed, care must be taken that they are not penetrated by a deep suture.

2. Deep Wounds.—When the object of a drain is to prevent fluid remaining within a wound, the cavity must be *drained from the bottom.* If necessary, a stab incision is made to achieve this object. When employing penicillin locally, the tube is now inserted into a non-dependent part—an important exception to the rule that cavities are to be drained from below.

Rubber Tubing (*Fig.* 123 *c*, *d*).—Rubber tubing conforms to the shape of the wound and is sufficiently firm not to kink. The end should be bevelled to

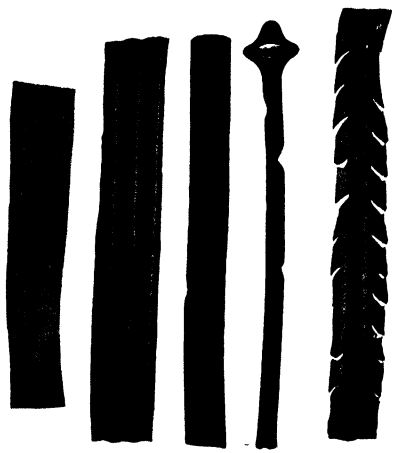


Fig. 123.—Commonly used rubber drains. *a*, Glove drain, *b*, Corrugated drain; *c*, Fenestrated rubber tube, *d*, Self-retaining drain, *e*, Corrugated rubber with serrations to prevent drain from slipping out of wound.

facilitate introduction, and the walls fenestrated or split lengthwise. The perforations of all abdominal drains must be small to prevent intestine or omentum prolapsing through the openings.

Size of the tube: Since all drains act as foreign bodies, the tube should be as small as will freely carry off the discharges. There must, however, be no curtailment in length, for it should be able to reach to the depths of the cavity.

Introduction of tubes: A tube may be directly placed in the required position before the wound is closed or inserted after the suturing is complete. Thin forceps guide the tube to its correct position. Angulation is to be meticulously avoided, and a drain should not be allowed to rest in direct contact with large vessels.

Fixation: In order that a tube may not slip in and out, it should be retained in position by means of an anchoring suture which attaches it to the skin. In passing this stitch, care must be taken to insert it, not through the middle of the tube, but somewhat to one side; otherwise when the knot is tied the lumen will be largely obliterated. In addition, a safety-pin is inserted through the tube.

Removal of tubes: For the same reason that the tube should be as small as will be efficient, it should be removed as soon as it is safe to do so; and if it is inadvisable to remove it altogether, it should be rotated and shortened each time the wound is dressed. While it is impossible to lay down strict rules, all tubes in the vicinity of vessels or intestine must be shortened early. Drains conducting serous exudates may often be removed on the day after their insertion. Most abdominal drains should be removed in twenty-four or forty-eight hours. Strictly localized abscesses require much longer drainage, sometimes for several days, smaller and smaller tubes being inserted until no longer needed. In empyemata, particularly, much discretion is to be exercised before removing the tube; seldom should it be finally discarded before the tenth day, and then only if the discharge has become small in amount and the cavity largely obliterated, as shown by the insertion of lipiodol.

Other references to the drainage of wounds will be found in various parts of the book.

REMOVAL OF SUTURES

First dislodge blood-clot from projecting parts of the suture by swabbing with hydrogen peroxide. Then paint with tincture of iodine. Seize the knot with Spencer Wells forceps (*Fig.* 124), raise the stitch from the skin, and then snip the suture *flush with the skin* on one side and withdraw from the other.



Fig. 124.—Removal of sutures. The knot is raised with Spencer Wells forceps and the stitch cut flush with the skin.

SECONDARY SUTURE

Secondary suture is employed when a wound, at one time infected, has been cleansed by antiseptic dressings or by the natural process of repair. As soon as the bacteriological swab shows that most of the infecting organisms have been eliminated, and when the granulations appear healthy, secondary suture may be employed with safety. After cleansing the wound and adjacent parts with soap and water, flavine in spirit is applied to the skin surface. It is advisable of freshen the skin margins and undercut the edges, but the main bulk of the granulations may be left alone. As dead spaces are to be avoided at all costs, the sutures are passed on large curved needles to the very depths of the wound. The ends are temporarily clipped with hæmostats and the wound insufflated with sulphanilamide powder. The sutures are then tied with all precautions to avoid tension (*see Fig.* 115, p. 108) and the part immobilized and elevated.

CHAPTER XIV

POST-OPERATIVE HYPNOTICS AND SEDATIVES

By HENRY COHEN

DESPITE our incomplete knowledge of the physiology of sleep, of this we are certain: that accompanying sleep there is a depressed activity of the cerebral cortex, and that *any* factor, physical or mental—be it pain, cough, nausea, vomiting, anxiety, despair, or the like—which tends to perpetuate cortical activity, hinders sleep. It follows then that sleep will elude us unless we secure tranquillity of the nervous system, either (1) by removing or subduing disturbing influences, or (2) by depressing the higher brain centres and so rendering them less sensitive to these disturbances. Some drugs used in the treatment of insomnia exert both actions; with others, one or other action is dominant.

Before considering the use of sedative drugs in detail, it must be stressed that minor and apparently trivial discomforts—a hard pillow, a tight bandage, a cold draught, noise, or even unaccustomed silence—will prevent sleep, and correction of these is an essential part of the treatment of insomnia.

The more potent hypnotics are not free from danger: (1) They may result in habit formation (addiction); (2) They may exert toxic effects on vital organs, e.g., the kidneys or liver; or (3) Their depressive effects may extend to the lower nerve-centres, and by interfering with such vital functions as respiration and circulatory efficiency, endanger life. The first two dangers are of less importance after operation, for here sedatives are used for a limited time only. Where, however, the patient gives a long history of insomnia preceding operation, the more potent drugs must be prescribed with great care, lest the comfort induced by them is sought after the post-operative discomforts have passed. Sedative drugs vary not only in their pain-relieving (analgesic) and sleep-inducing (hypnotic) properties, but also in the *duration*, *intensity*, and *rapidity* of their action. No one drug can be ideal for all eventualities. The problem presented by each patient differs. Long experience has shown that the practitioner who is familiar with the effects of and indications for a few well-tested drugs will achieve greater success by their rational use than his colleague who is inveigled into trying every new hypnotic about which he receives glowing and alluring advertisements. In the appended Table is given a list of the most commonly used hypnotics, with special reference to the rate, duration, and intensity of their action, and their relative analgesic and hypnotic properties.

A knowledge of the action of the drugs in the Table should enable the practitioner to choose the most suitable hypnotic for any patient under his care. Proprietary preparations of the opium alkaloids (e.g., omnopon, pantopon) and of the barbiturate series of hypnotics are occasionally found to be better tolerated by the patient, and to have fewer undesirable side-effects, than the official B.P. preparations, which, however, should be one's first choice. Mild analgesics (e.g., aspirin) can be used with the milder sedatives if there is but slight discomfort

Hypnotic and Sedative Drugs: Dosage, Actions, and Indications

Preparation	Dose (by mouth)	Acts in	Acts for	Main Action	Habit Tendency	Remarks
Opium and its derivatives, e.g., Morphine hydrochloride, Diamorphine hydrochloride (½–½ gr.)	⅛–⅓ gr	hr ½	hr 6–8	Most powerful hypnotic and analgesic	Almost inevitable with continued use, whichever preparation is employed	Valuable pre-anæsthetic hypnotic given ½ hour before operation; potentiates action of general anæsthetic. Use with caution in post-operative respiratory complications
Bromide of Potassium or Sodium or Ammonium	20–30 gr.	½–½	4–6	Mildly hypnotic	Nil	Especially useful in mental anxiety. Palatability increased by giving in beef tea or in effervescing mixture
Chloral Hydrate	15–20 gr	½	6–8	Moderately hypnotic, negligibly analgesic, except in larger doses	Very slight	Helpful, combined with bromides, in the restlessness following minor operations
Paraldehyde	60–100 minims	½	6–8	Moderately hypnotic	Negligible	Useful especially in alcoholics, unpleasant taste can be partially masked by tr. aurantii or aq cinnamomi. Safe hypnotic in post-operative respiratory and cardiac disturbances
Barbituric Acid Series —						An almost infinite number of proprietary preparations of this group are marketed. Despite extravagant claims by their manufacturers, they possess no advantages over the official preparations for most patients
1. Barbitone (Veronal)	5–10 gr	½–1	6–8	Moderately hypnotic, very mildly analgesic	Mild habit commonly develops	
2. Soluble Barbitone (Medinal)	5–10 gr	½	6–8			
3 Phenobarbitone (Gardenal or Luminal)	1–2 gr	1	8–10	Strongly hypnotic, very mildly analgesic	Rarely habit forming	
Sulphone Group —						Rarely used because of — 1. Inconstancy of action 2. Severe toxic effects, e.g., hæmatoporphyrinuria 3. Habit formation
1. Sulphonal	10–20 gr	4–5 (inconstant)	10–12	Strongly hypnotic, mildly analgesic	Common	
2. Methylsulphonal (Trional)	10–20 gr	½–1	8–10			
Urea Group —						Useful in restlessness from mental anxiety
1. Carbromal (Adalin)	10–15 gr	½	4	Moderately hypnotic	Very slight	
2 Bromural	5–10 gr	½	4			

or pain. The doses given in the Table are for adults. The dose of these preparations for the child is best estimated by the formula :—

$$\text{Dose for child} = \text{Dose for adult} \times \frac{\text{age of child}}{20}$$

e.g., a child of 10 years is given half doses. Owing to the peculiar sensitivity of the child's nervous system to opium and its derivatives, these should be used in even smaller doses than are arrived at by this formula ; in infants under 2 years of age opiates are best avoided.

The nature of the operation which the patient has undergone and his general condition will sometimes decide the best channel of drug administration. Where oral medication is inadvisable or impossible, e.g., immediately after gastric operations or in severe post-operative vomiting, hypodermic injections can be used. By this route the soluble barbiturates and opium derivatives can be given, the dose being approximately half that by mouth. Paraldehyde is a useful hypnotic administered rectally in doses of 120–240 minims diluted with ten times its volume of normal saline.

It cannot be too strongly emphasized in conclusion that though drugs play an important part in the treatment of post-operative restlessness and insomnia, all distressing symptoms, e.g., pain, cough, distension, etc., demand treatment in order that the desirable aim of using the smallest effective dose of hypnotic drugs be achieved.

CHAPTER XV

POST-OPERATIVE PULMONARY COMPLICATIONS

By F. DUDLEY HART

POST-OPERATIVE pulmonary complications are by no means rare, and are an ever-present possibility and source of anxiety to the surgeon in charge. Much can be done, however, both in prevention and cure, and a thorough examination and carefully taken history will enable those pre-operative measures to be started which lessen to a marked degree the chance of pulmonary complications after operation. The patient will often fall into one of the groups mentioned below; if so, appropriate prophylactic treatment is immediately commenced. In arranging for the date of operation too much attention is often paid to the patient's surgical condition, to the exclusion of all other systems.

Physical Examination.—A thorough physical examination is first made, paying particular attention to respiratory and cardiovascular systems, and the patient questioned as to previous illnesses. The worst subject for operation is the elderly male with chronic bronchitis and/or sluggish circulation, possibly with a degree of cardiac decompensation. He is questioned as to his exercise tolerance, for it should be remembered that a man with an apparently normal heart who cannot walk up ten stairs without pausing for his breath is a worse subject for operation than a man with marked cardiac murmurs but an excellent exercise tolerance.

Few town dwellers are free from bronchitis after the age of fifty, and males are worse than females in this respect. In the London male working population chronic bronchitis is unduly prevalent, and whenever possible operation should be delayed in such subjects until the summer months. A chronic catarrhal condition of the nose and throat commonly coexists.

On examination the shape of the chest is important. The barrel-chested bronchitic with hyper-resonant percussion note, chest held in inspiration, and diffuse râles on auscultation, has a much reduced vital capacity, and an abdominal operation will further diminish it—particularly an upper abdominal one. In the young it cannot be too strongly emphasized that persistent post-tussive crepitations in the upper zones nearly always mean pulmonary tuberculosis, and a radiograph should be taken to verify this and to ascertain the extent of the disease. Coarse basal crepitations, more marked in, or confined to, one base, usually mean bronchiectasis. Finer moist sounds at both bases are found often in elderly subjects with a degree of pulmonary congestion. The fingers should be examined for clubbing, and the position of heart and trachea noted, for bronchiectasis is commonly present in a collapsed lower lobe, with displacement of heart and mediastinum to the affected side. Clubbing is not always present in this condition; the earliest sign of it is a filling out of the nail base, with diminution of the normal obtuse angle on the dorsum of the terminal phalanx. Cyanosis and dyspnœa should be looked for. A mild degree of cyanosis is best seen in lips and nail-beds, and a lilac colour of the latter should suggest pulmonary disease. Mild dyspnœa may be brought out by the exertions of examination. Pallor of the ears, nail beds, and palms of the hands indicate a degree of anæmia.

Prophylactic Measures.—In emergency surgery there is no time to carry out prophylactic measures, but a few simple facts should be borne in mind:—

1. *Atropine* dries up the bronchial secretion and tends to make the sputum of a bronchitic subject more tenacious and less likely to be coughed up. Nevertheless, given pre-operatively for inhalation (ether) anæsthesia its practical advantages outweigh its theoretical disadvantages. It should not be given after operation.

2. *Postural drainage*, if it can be carried out, will empty the bronchi of a bronchiectatic subject and make him a better subject for anæsthesia of any sort.

3. *Morphine* should be given as little as possible pre-operatively as it tends to depress the cough reflex.

In non-emergency cases in hospital for some days before operation, much can be done to improve the patient's condition. The group with chronic bronchitis and emphysema is given intensive breathing exercises to improve the vital capacity and to aerate all parts of the lung. Fluids are pushed to five pints or more a day. Smoking should be stopped or rigidly curtailed but for the early morning 'chest emptier' which acts as the morning dose of expectorant. If there is difficulty in producing sputum, expectorants may be given, but they are often of little use. Ammonium carbonate in doses of 5 to 8 gr. t.d.s. is the most effective. Potassium iodide in doses of 5 to 10 gr. t.d.s. helps to liquefy the sputum. Atropine should not be given to this class of patient. If the cough is wearing out the patient and is not productive of sputum, linctus codeinæ is the most efficient sedative. Nasopharyngeal catarrh can be improved by inhalations of menthol or Friars' balsam. Benzedrine inhalations will help to clear an obstructed nose. Oral hygiene is attended to, and mouth-washes and gargles ordered.

Subjects with bronchial spasm may be given ephedrine tablets, gr. ½ t.d.s., and a mixture containing stramonium and potassium iodide. With a recent exacerbation of symptoms in such cases it is wise to delay operation until the patient's condition improves.

In many cases there is an element of cardiac decompensation. In such cases pulmonary congestion is the cause of the shortness of breath and the cough. Such cases may show no signs of venous congestion elsewhere (œdema of the legs, distended veins in the neck, hepatic enlargement, etc.), and the failure may be confined to the left heart. These patients usually have high blood-pressure. Rest, propping up on several pillows day and night, digitalis, and 'Mersalyl' (mercurial preparation) usually effect a remarkable improvement.

Another group to be watched is that with sluggish circulation, low blood-pressure, and atheroma of the arteries, for post-operative thrombosis is relatively common, and this may lead to pulmonary embolism. Clotting in the popliteal, femoral, and iliac veins is perhaps more common than is thought, and if the lungs are congested pulmonary infarction is the more likely to occur. The two lines of preventive treatment are therefore: (1) To relieve the pulmonary congestion by strict rest; and (2) To improve the peripheral circulation by massage and active and passive movements of the legs, raising and depressing them for several minutes two or three times a day, taking the level of the 4th rib anteriorly as the resting point. Tab. thyroid gr. ¼–2 twice or thrice daily has been advocated.

Prophylactic measures after operation are of even greater importance. There are four main 'don'ts': (1) Don't have abdominal binders so tight that they interfere with respiration; (2) Don't immobilize the patient completely, but encourage simple movements of limbs and trunk; (3) Don't depress the cough reflex unnecessarily; (4) Don't give atropine.

There are two classes of patient to watch with particular care: (1) The bronchitic or 'bubbly' subject, particularly if aged and stout, recovering from an upper abdominal operation; (2) The patient with sluggish circulation.

The former is a potential case of massive collapse of the lung or pneumonia, and so should be encouraged to expectorate his sputum and to use all parts of his lungs as much as possible. Fluids should be given in plentiful amounts—5–8 pints a day by mouth—and breathing exercises instituted to encourage basal expansion

and abdominal (diaphragmatic) breathing unless this causes too much pain. He should not be kept still in one position, but be encouraged to move about in bed. Morphine should only be given if pain is severe and wearing the patient out; in such cases it should not be withheld. Atropine should never be given. A linctus is useful if the cough is very troublesome. Overbreathing may be encouraged by CO_2 inhalations if collapse of the lung seems imminent. In some cases, where anæsthesia has been indifferently administered, or narcosis unduly heavy, the patient may remain "bubbly" and somewhat cyanosed for several hours after operation. Such patients are in grave danger of more serious complications and may even die of asphyxia if their condition is not relieved. Much can be done in such cases by intubation and aspiration. If the patient is still unconscious, a wide-bored Magill endotracheal tube is passed to permit of free ingress of air while suction is applied to a catheter passed through its lumen; if conscious, cocainization is necessary, the throat and nose being sprayed with 2 per cent butyn or 10–20 per cent cocaine. By this relatively simple method a free airway is regained and much retained sticky secretion removed from the upper respiratory tract. The houseman on his night round after the afternoon's operation list should be on the lookout for such cases and deal with them then and there.

The second group should continue with those measures started before operation—massage, movements, and, if thought advisable, small doses of thyroid extract. A careful watch is kept for signs of thrombosis in the legs, as these may be slight and easily overlooked. Expose the legs daily and note: (1) If one leg cools more slowly than the other. (The dorsal surfaces of the middle phalanges of one's hands are very sensitive to differences in temperature and make good thermometers.) (2) If there is tenderness over one leg. These two signs may be the only ones, or there may develop pain, œdema, and cyanosis with fullness of the small superficial veins in the affected leg. Delayed cooling and slight tenderness, especially if associated with a rise in temperature and pulse-rate, enables the diagnosis of thrombosis to be made even though the more obvious signs may not occur. The affected leg is immobilized slightly flexed at the knee and raised a little on a suitable support—pillows or a splint. When elevation has lessened the swelling an elastic stocking or an Elastoplast bandage may be applied, for this eases the pain and prevents a return of the swelling. The patient is encouraged to use the other leg and "to be active from the waist up", but not to use the affected leg. Massage and active and passive movements may be ordered for the unaffected leg. Purging is, as always, contra-indicated, and the bowels should be controlled by laxatives and enemata.

Heparin: Heparin has been used successfully in the prevention of post-operative thrombosis and pulmonary embolism. The usual procedure is to keep the clotting time between 15 minutes and 20 minutes by introducing heparin in a continuous intravenous drip. It is best instituted immediately after operation or at the first sign of thrombosis in the leg. The dose is 200–300 mg. daily. It acts chiefly by inhibiting thrombin formation.

Pulmonary complications which may follow operation range from slight tracheitis to pulmonary embolism. Only the more important are discussed here.

POST-OPERATIVE BRONCHITIS

Post-operative bronchitis is usually an exacerbation of a similar pre-existing condition. Precipitating factors are constriction and immobility of the chest,

badly administered anæsthesia—especially if overmuch ether is given—and chilling and exposure on the trolley or operating table. Symptoms usually commence within thirty-six hours of operation: cough, a variable amount of frothy or mucopurulent sputum, substernal discomfort, and general distress. There may be a degree of fever lasting a few hours or days, depending on the severity of the condition. As coughing causes pain in the abdominal wound, the tendency is for the patient to cough less than he should, and so remain unduly bubbly. The physical signs are those of an ordinary bronchitis—diffuse rhonchi and crepitations. If the larynx is affected hoarseness or aphonia is present. A dry, very hacking cough indicates tracheitis.

Complications.—Bronchopneumonia; collapse of the lung.

Treatment.—Remove pain as much as possible, for this leads to an increase in coughing and greater production of sputum. Usually the more common analgesics, such as aspirin and/or codeine, are sufficient. Morphine should only be given if severe pain is not controlled by such drugs. Fluids are given generously and the patient is encouraged to move about in bed to some extent. Sleep should be sound but not stuporous; therefore sedatives such as bromide or chloral or the milder barbiturates are given accordingly. If the cough is very irritable and non-productive, a soothing linctus, such as linctus codeinæ, is given occasionally. If there is respiratory distress a steam kettle may give relief, with creosote or tinct. benz. co., 60 minims to 1 pint added. A Gamgee pneumonia jacket may give the patient comfort. Care is taken to encourage deep breathing and to avoid constriction of the chest. If the breath-sounds become weaker at one base in a chest full of moist sounds it is wise to stimulate respiration (and thereby expectoration) by giving vigorous breathing exercises and CO_2 (5 per cent) and O_2 (95 per cent) inhalations by a mask; a glass funnel is useless. Physical signs such as are described above often precede massive collapse of the lower lobe of a lung, which can be prevented by these timely measures.

ACUTE SUPPURATIVE BRONCHITIS

(Septic Bronchitis)

Acute suppurative bronchitis is not common after operation. It occurs within twenty-four hours of the patient leaving the table, and is characterized by shivering, high fever, dyspnœa, and cyanosis. Physical signs are diffuse bubbling râles and a weakness of the breath-sounds. The purulent sputum becomes very copious. A fatal bronchopneumonia often ends the scene.

Treatment.—Abundant fluids are given by the mouth. Brandy soothes the patient. An oxygen tent may give relief. The contents of the bronchi may be aspirated through a bronchoscope, but the patient is usually very ill, so should not be moved more than is absolutely necessary. Of the stimulants strychnine gr. $\frac{1}{30}$, injected subcutaneously, and lobeline 3 mg. in 1 c.c. of water, intravenously, are the most useful.

MASSIVE COLLAPSE OF THE LUNG

Massive collapse of the lung is the collapse of all lobes of one side due to obstruction of the lumen of the main bronchus from within, from without, or from a combination of both. A single lobe may collapse from obstruction of its main bronchus.

Such a condition occurs post-operatively from mucus inhalation in a partially immobilized lung with impaired basal (diaphragmatic) movement, and though

perhaps more frequent after a 'bubbly' general anæsthesia, also occurs after non-inhalation anæsthesia. Collapse may be seen after inhalation of a foreign body (toy whistle, peanut, etc.), plugging of a bronchus narrowed by a growth, or may arise from various other causes. Symptoms may be slight or absent, or there may be severe discomfort in the side, dyspnœa, and shock. Unproductive cough and cyanosis may be present. Physical signs are restricted movements, impaired resonance, breath-sounds absent or tubular, with shift of heart and/or trachea towards the affected side and raising of the diaphragm on that side. The sternomastoid sign may be present on the side of the collapse, the sternal origin of the muscle being more prominent and more tense on palpation just above the manubrium sterni than on the opposite side. The condition may be indistinguishable from pneumonia, but the onset is more acute, and it tends to occur in the first forty-eight hours after operation. The temperature commonly rises abruptly at the onset. A radiograph will verify the diagnosis, and should always be taken if the condition is suspected, as many cases give no physical signs.

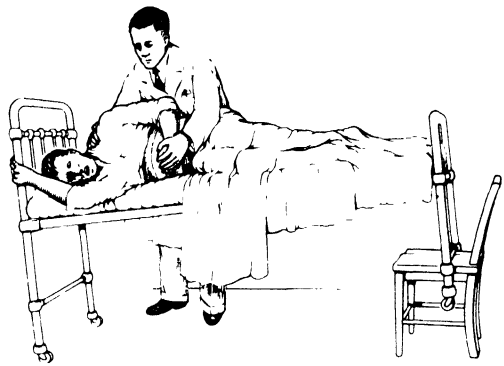


Fig. 125.—The knees are drawn up and the foot of the bed raised on a chair. An abdominal binder, the patient's hand, and the clinician's hand all guard the abdominal incision. The clinician's other hand keeps the patient on his side. This hand also detects the clearing of rhonchi as mucus is coughed up. (*After A. E. Moore.*)

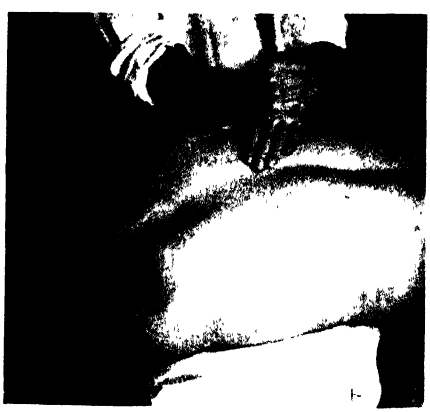


Fig. 126.—Postural-percussion drainage in massive collapse of the lung.

Treatment.—*Prophylactic.*—The measures outlined on pages 117 and 118 are all important. It is essential for the 'bubbly' post-operative patient to clear his chest by coughing; therefore he is told to support the abdomen in the region of the wound with his hands and cough up all sputum, even though this may cause some discomfort. A better method is shown in *Fig.* 125; by adopting this procedure the patient is enabled to rid himself of much sputum. Body movement is encouraged, fluids given in plenty, and breathing exercises taught.

After collapse has occurred the same measures are persevered with, and the following should also be tried:—

1. Roll the patient on to the sound side and lower the head, so that the affected lung is the highest part, being raised on pillows. Encourage the patient to cough, and with the left hand flat over the collapsed lung strike smartly

with the right fist on the back of the left hand (*Fig.* 126). This postural-percussion drainage, if practised soon after collapse has occurred, loosens the plug of mucous, which is dislodged towards the trachea and coughed up, allowing re-expansion to occur. This method is not as brutal as it sounds, and may even be carried out on the first day after operation. Laying the patient flat and rolling him first to one side of the bed and then to the other, a dozen times, often proves useful and may be repeated at intervals of four hours.

2. Combine with the above, if unsuccessful, CO_2 (5 to 10 per cent) and O_2 (95 to 90 per cent) inhalations by mask, to cause overbreathing and expansion of the lung. Respirations become deeper; coughing may develop and bring up the plug shortly afterwards.

3. If, after some days, collapse is still present, an artificial pneumothorax may be induced. The excessively high intrapleural negative pressure subsequent on collapse (− 44 to − 40 or thereabouts) is thus reduced, and the displaced mediastinum returns to its normal position. This is only very rarely necessary, as most cases respond to the simpler methods mentioned above.

If the collapse be caused by a foreign body, bronchoscopy and removal is the obvious treatment, but if mucus or soft tissue has been the cause, it is so rapidly sucked into the smaller bronchi that anything but immediate bronchoscopy is generally useless. A patient a day or so after an operation is usually in no fit state for bronchoscopy, even if indicated.

POST-OPERATIVE PNEUMONIA

Pneumococcal lobar pneumonia is a rarity after operation, and a consolidation of one area alone should suggest collapse rather than pneumonic consolidation. Bronchopneumonia may occur rapidly, within a few hours of operation, in a weak and enfeebled subject; the sooner it occurs the more severe it tends to be. It is more common several days later, often superimposed upon a post-operative bronchitis.

Treatment.—This in no way differs from that of an ordinary bronchopneumonia, and is largely palliative. The most useful measures are: (1) The oxygen tent for the cyanosed, distressed patient; (2) Strict rest and skilful nursing—the patient should not have to move to do anything, but is kept still, propped up on several pillows; (3) Plentiful glucose drinks and other fluids; (4) Tepid sponging to reduce high temperatures; (5) Brandy or whisky as sedatives; (6) Care of the mouth; (7) Attention to any abdominal distension; (8) Sedatives to ensure rest. This is most important, for the entire treatment is aimed at giving the patient as much help as possible, to aid his natural recovery, but with little interference. Rest and sleep are therefore essential. The patient should receive as little handling as will allow him to spend a comparatively comfortable day and a restful night. A Gamgee jacket is useful, applied so that it fastens down the sides and allows for easy examination of the chest. Antiphlogistine may be applied over an area of pleurisy, subject to the patient's approval. Careful watch should be kept for cardiac or peripheral failure. Venesection is often helpful if congestive cardiac failure supervenes.

Collapse or Pneumonia.—These two conditions are so frequently confused that it is as well to compare them. Correct and immediate diagnosis is essential, as the treatment for the two conditions is exactly opposite. A radiograph should always be taken at the earliest opportunity. The following are the main points:—

Pneumonia	*Collapse of the Lung*
Gradual onset.	Sudden onset.
Occurs usually after fifth day.	Occurs usually within 72 hours of operation.
Physical signs of consolidation (air entry somewhat reduced, breath-sounds bronchial, vocal resonance and fremitus increased).	Physical signs of SILENT consolidation (markedly diminished or absent air entry, vocal resonance and fremitus decreased).
No mediastinal displacement. Sternomastoid sign negative.	Mediastinal and diaphragmatic displacement. Sternomastoid sign positive on affected side.
Patient toxic.	Patient rarely toxic.
Treatment: Immobility.	Treatment: Mobility.

The last point is most important. While the patient with pneumonia is treated by strict rest, the patient with collapse is encouraged to move and is given 'the freedom of the bed'. Collapse is the more common post-operative condition, and follows fractures of ribs and femora as well as abdominal operations. It should therefore be suspected in all cases presenting *sudden* pulmonary symptoms and signs within fourteen days of operation. The signs and symptoms may be very deceptive. Cardiac displacement is *the* important sign, for the signs of consolidation given by the collapsed lobe may be obscured by a compensatory emphysema of the other lobe or lobes. The importance of the condition lies in the rapid onset of bronchiectasis in the collapsed lobe if expansion does not occur within a few days.

"Collapse-pneumonitis".—Many cases of post-operative pulmonary consolidation fall into a class presenting signs suggestive of collapse *and* inflammation, i.e., inflammation and impaired bronchial drainage. These are the cases occurring shortly after operation—1–5 days usually—which have clinical and radiological signs of basal consolidation without definite diaphragmatic and mediastinal displacement.

They should be treated essentially as cases of collapse, but if the temperature chart and pulse of the patient suggest pneumonia the more vigorous methods should be withheld and chemotherapy instituted—sulphapyridine or sulphathiazole. With both drugs the tablets are best given crushed up with 5–10 gr. of sodium bicarbonate and a little mucilage added.

The dosage for an adult is 2–3 g. statim, then 1 g. four-hourly until the temperature has been normal, or almost so, for 12–24 hours. Sulphathiazole is less likely to make the patient vomit and may be preferred in gastric cases. In cases unable to swallow, the soluble form of either drug may be given intravenously, though this will not remove the tendency to vomit. An even less toxic drug is sulphadiazine; nausea, vomiting, and mental depression are much less common with this drug. As it is more rapidly excreted it is best given 3 g. statim and 1½ g. three-hourly. A striking response will only take place if the organism responsible (usually the pneumococcus) is sensitive to chemotherapy.

PULMONARY SUPPURATION

This may occur in four forms: (1) Diffuse suppurative pneumonitis; (2) Necrotizing pneumonitis; (3) Lung abscess; (4) Empyema.

1. Diffuse Suppurative Pneumonitis.—This condition is uncommon, and is to all intents and purposes indistinguishable from bronchopneumonia.

The patient is very ill, the prognosis bad. It may occasionally progress to a chronic form (*see* NECROTIZING PNEUMONITIS). Treatment is palliative, though bronchoscopic aspiration may be performed if the patient is in a condition to stand it. Chemotherapy—sulphapyridine, sulphathiazole, or sulphadiazine—should be instituted and a course of penicillin injections started, as outlined below.

2. Necrotizing Pneumonitis.—This term is used to cover the group of cases, not uncommon in the surgical wards in the Italian campaign, where, at a variable time after operation, often several weeks, a progressive cavitating condition appears in the lungs. In some cases it is due to clostridia, in others to *Staph. aureus* or an anaerobic streptococcus, in others no apparent causative organism is isolated. The condition is most commonly seen in the orthopædic wards of a military hospital, not infrequently after amputation of a limb for gas gangrene or treatment of an infected compound fracture. The prognosis is grave. Areas of lung break down to form scattered lung abscesses. The patient coughs up large amounts of extremely foul-smelling blood-stained purulent sputum. The pleura may also become involved, pockets of thin offensive pus forming. Clubbing of the fingers may develop in a week or two. The patient is extremely ill, the pulse and respiration-rate slowly and relentlessly rising, while the temperature remains between 101 and 104 F. Many cases are fatal; the best that can be hoped for is prolonged convalescence and residual symptoms of bronchiectasis.

Treatment.—Chemotherapy should be instituted as described above, and, if available penicillin given intramuscularly in three-hourly doses of 10,000 Oxford units day and night for 5–10 days, repeating the course later as found necessary. Alternatively, the drug may be given by continuous intramuscular drip into the antero-lateral aspect of vastus lateralis, 100,000 units in 100 c.c. fluid per diem, the amount being carefully regulated. Any pleural pockets of pus must be aspirated and replaced with sodium penicillin, 30,000–50,000 units in 1–3 oz. saline. Postural drainage is necessary to drain the abscess cavities. Transfusions of fresh blood often help, particularly if there is a degree of anæmia.

3. Lung Abscess.—This condition may occur as a blood-borne infection or from inhalation of foreign bodies and/or infected material. As it most commonly occurs after operations on nose, throat, or mouth (e.g., dental extractions, tonsillectomy), infection by inhalation seems the more likely as a general rule. Aspiration abscesses are usually one or two in number; embolic abscesses multiple.

The onset of signs and symptoms is usually seven to seventeen days after operation. The patient suddenly develops a high temperature which continues as an intermittent fever. He sweats, has a marked tachycardia, and looks ill. A cough may then appear, at first unproductive. In many cases the sudden expectoration of foul purulent matter in large amounts (10 to 20 oz.) leads to spontaneous resolution. A bad odour may become apparent in the breath, and this often immediately precedes spontaneous resolution. Slight hæmoptysis may occur. Physical signs are dependent on the position of the abscess and the condition of the rest of the lung. Radiographs—antero-posterior and lateral—should be taken to verify the diagnosis and to locate accurately the collection of pus.

Treatment.—A waiting period of two to six weeks is commonly advocated, with postural-percussion drainage (as outlined in the section on MASSIVE

COLLAPSE) and bronchoscopic aspiration. If after this time resolution has not occurred the thoracic surgeon is called in. If copious expectoration occurs, and the abscess becomes an open one, draining into the bronchus, postural drainage is performed on the Nelson bed, the position of the patient depending on the site of the abscess. Chemotherapy may help in some cases, but is often unsatisfactory, and the waiting period should not be extended unless definite radiological improvement takes place. Delay in operation may be disastrous.

4. Empyema.—This is uncommon except after lobectomy.

PULMONARY EMBOLISM

Pulmonary embolism is the most dangerous of all post-operative complications. It occurs more particularly in the older patient, especially if stout and with poor circulation, usually six to sixteen days after operation. The embolus usually comes from a femoral or iliac thrombosis, though there may be no sign in the leg of this condition, and is immediately preceded by a slight rise in temperature. The effect produced varies with the condition of the patient's lung and the size of the embolus. A small embolus which produces no effect in a normal lung may cause all the signs and symptoms of pulmonary infarction in a congested one.

There are two main types :—

1. The large embolus which lodges in the bifurcation of the pulmonary artery, temporarily occluding one, commonly the right, or both branches. The onset is dramatic in its suddenness. The patient in a moment becomes very shocked, pale, and sweating, with a sense of impending death and a strong desire to go to stool. The blood-pressure falls, the pulse becomes rapid and often irregular, and may become imperceptible. If the right heart fails, cyanosis replaces pallor. A sense of constriction or actual pain is felt in the centre of the chest and the patient feels himself rapidly ' slipping away '. Death often occurs within a few minutes, but may be some hours or days later. A patient may recover, only to die from a second embolus at any time within the next two weeks. Recovery occasionally takes place.

Treatment.—Treatment is for shock. An injection of morphine may be given. Masterly inactivity is the line to take, with the patient on strict absolute rest.

2. The smaller embolus, which passes through the pulmonary artery, usually without causing symptoms, lodges in the lung, and causes symptoms and sometimes signs of pulmonary infarction with overlying pleurisy. The right base is the area most commonly affected. The patient experiences pain in the affected area on taking a breath or on coughing, and often coughs up blood-clot within forty-eight hours. The onset may sometimes be more gradual, simulating muscle pains. The physical signs vary from nothing at all to those of consolidation with overlying pleurisy. The findings are so uncertain that the diagnosis has often to be made on the history of sudden pleurisy arising within sixteen days of operation. The expectoration of blood-clot verifies the diagnosis. Radiographs show a clouding of the affected lung field with obliteration of the costophrenic angle.

Treatment.—Palliative. Rest and analgesics are of most importance. A search is made for signs of thrombosis in the legs, and adequate treatment is instituted.

It will be noted that of the pre- and post-operative measures, the giving of fluids by mouth in as large amounts as the patient will take, and encouragement of movements of legs, diaphragm, and chest, are of primary importance in almost

all the above conditions. Inertia, hypoventilation of the lungs, dehydration, and repression of the cough reflex are to be avoided at all costs in the patient both before and after operation. Once the complication has occurred, treatment is sharply divided according to two main groups : (1) Those conditions requiring strict rest and masterly inactivity ; and (2) Those conditions requiring the opposite line of treatment.

Fat Embolism.—Fat embolism is probably more common than was previously thought. Usually occurring after fractures—simple or compound—it may also occur after laceration of soft structures and severe burns.

Clinical Picture.—After the injury there is usually an interval varying from a few hours to four days in which the patient is comparatively well apart from the shock and other symptoms directly due to the injury. He then becomes very dyspnœic, pale and/or cyanotic, sweats, and is restless. Temperature, pulse, and respiration-rate rise, but the blood-pressure remains approximately normal. There is little coughing, but frothy sputum, sometimes tinged with blood, may appear round the lips. The patient is too ill to complain of much ; cerebral symptoms such as fits, palsies, and stupor may supervene at this stage. Purpura may be present, the commonest type being small petechial hæmorrhages over the upper part of the chest, the shoulders, and the anterior part of the neck.

Prophylaxis.—Unnecessary or rough handling of the affected part should be avoided, and delay in reduction and immobilization of a fractured bone avoided. Early immobilization of the affected part is the most important single prophylactic measure.

Treatment.—Anoxæmia should be relieved by administration of oxygen by mask or in a tent. Morphine should only be given when absolutely necessary owing to its respiratory depressant action. In the general management of the case it should be remembered that :—

a. There is often a degree of pulmonary œdema, and therefore intravenous infusions are frequently contra-indicated. Injections of atropine may or may not lessen the pulmonary œdema.

b. If there is venous engorgement or other signs of heart failure, venesection of a few ounces is indicated, providing there are no contra-indications (anæmia, shock, etc.).

c. If intravenous infusion therapy is essential it is best given early before pulmonary symptoms become marked—blood, plasma, or serum. Salines are contra-indicated.

d. Pneumonia may supervene and requires the appropriate treatment.

e. Restlessness is best treated by barbiturates.

USEFUL PRESCRIPTIONS

Sedatives for Troublesome Unproductive Cough.—

Linctus Codeinæ.

℞	Syr. Codein. Phos.	m. 20
	Glycerini	m. 20
	Succi Limonis	m. 18
	Spirit. Chlorof.	m. 2

Sig. : To be given when the cough is very troublesome, particularly at night.

Linctus Simplex.

℞ Theriacæ m. 20
Spirit. Chlorof. m. 2
Aquam ad m. 60

Sig. ℥: As directed, when the cough is troublesome.

Expectorants.—To assist in the production of sputum where secretion is present in the bronchi but is unable to be expectorated.

Mist. Nucis Vomicæ cum Ammonio.

℞ Tinct. Nuc. Vom. m. 3
Ammon. Carb. gr. 7
Spirit. Chlorof. m. 5
Infus. Quassiæ ad fl. oz. 1

Sig.: To be taken every four hours.

Mist. Pot. Iod.

℞ Pot. Iod. gr. 10
Ammon. Carb. gr. 5
Spirit. Chlorof. m. 5
Aquam ad fl. oz. 1

Sig.: Three or four times daily as directed.

Expectorant and Antispasmodic.—

Mist. Pot. Iod. cum Stramon.

℞ Tinct. Stramon. m. 5
Extract. Glycyrrhizæ Liq. m. 20
Pot. Iod. gr. 4
Spirit. Chlorof. m. 5
Aquam ad fl. oz. 1

Sig.: Three or four times daily as directed.

Inhalations.—For catarrhal conditions of the nasopharynx, larynx, and large bronchi. The steam is inhaled with a towel enclosing head and container.

Vapor Creosoti.

℞ Creosoti m. 10
Mag. Carb. Lev. gr. 10
Aquam ad. m. 120
Aquæ Ferventis (temp. 60° C.) fl. oz. 20

Sig.: The vapour to be inhaled as directed.

Vapor Mentholis.

℞ Menthol. gr. 1
Spirit. Rectif. ad m. 60
Aquæ Ferventis (temp. 60° C.) fl. oz. 20

Sig.: Vapour to be inhaled as directed.

Solutio Creosoti Co. Inhalation for use on oro-nasal inhalator.

℞ Creosoti
Spirit. Menthol. (20 per cent) } equal parts
Spirit. Chlorof.

CHAPTER XVI

POST-OPERATIVE BREATHING AND OTHER EXERCISES

By JOCELYN M. W. REED

POST-OPERATIVE chest complications occur in a high proportion of cases, particularly after upper abdominal operations. When there is no concerted attempt to organize adequate breathing exercises during the immediate post-operative period it has been computed that from 25 to 30 per cent of abdominal cases develop pulmonary complications. It is therefore most important to ensure that the patient expands his lungs adequately and expels pulmonary secretion. Inadequate respiratory movements result from several causes.

1. Pain and spasm from the abdominal incision tends to restrict movements of the lower chest.
2. Post-operative reaction, coupled with some degree of shock, tends to cause shallow respiration.
3. Excessive bronchial secretion produced during anæsthesia, notably by ether vapour, may not be cleared adequately by coughing
4. Blocking of bronchioles by viscid mucus may result in atelectasis.

The importance of the cough reflex in keeping the bronchial tree clear is obvious, but it must be remembered that pain and discomfort prevent the patient from making his normal full cough effort. Lower chest inspiration with good expiration helps to develop the cough reflex.

Breathing exercises can be divided into pressure expansion exercises for the bases of the lungs and diaphragmatic exercises.

Pressure Expansion Exercises.—Inspiration is made against firm pressure applied by the hands of the physiotherapist.

Exercises which aim at expanding the bases of the lungs are best performed one side at a time for the first week or ten days. Bilateral movements are relegated to cases with lower abdominal incisions and are not carried out strongly until the wound has consolidated. During unilateral exercises the contralateral side is supported.

Postero-lateral Basal Expansion Exercise.—Light pressure is applied to the chest wall with the hand well up over the postero-lateral aspect of the base. The patient breathes in and tries to push or expand his ribs *backwards* and outwards against the pressure of the hand. On expiration the ribs sink again naturally and a little extra pressure is given towards the end of this phase in preparation for the next inspiration. The other hand helps to keep the opposite side steady by holding the *antero-lateral* aspect of the chest wall.

The effort of expansion being directed posteriorly avoids strain on wounds close to the costal margins.

Before the operation the patient is taught to apply the pressure himself by hand or by using a belt. The belt method (*Figs.* 127, 128) is easier after operation, especially for men, for it allows the shoulders to remain relaxed. Each

side is exercised by about three groups of five breaths, with a few moments' rest between each group.



Fig. 127.—Active inspiration with belt pressure. The expansion has pulled the left hand across the middle line, the right hand remaining steady.



Fig. 128.—Inspiration with belt pressure. Note the relaxation of the upper chest and shoulders.

Before and during the teaching of these exercises, strict attention must be paid to relaxation of the shoulders and upper chest during inspiration. It is

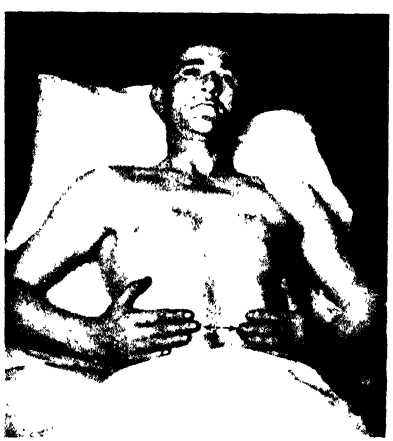


Fig. 129.—Diaphragmatic breathing. Inspiratory phase. Note the upper chest is not expanded.



Fig. 130.—Diaphragmatic breathing. Expiratory phase. Showing contraction of the abdominal muscles.

clearly unsatisfactory to introduce the exercises to any patient immediately after operation; he must realize what will be expected of him, and be taught what

to do for several days before the operation. Spasmodic and occasional use of the exercises are of little value, the patient must be prepared to concentrate and practice. In the first few days after operation the exercises are adapted to the patient's condition and rate of respiration. As a rule, the exercises should start within 12 to 24 hours after the operation. On the first day they last for 10 to 15 minutes. On the next day two treatments of 15 minutes each can be employed and the duration and effort increased until the patient is able to undertake the exercises himself, several times a day, in addition to the actual treatment sessions. The first few days are the most important.

Diaphragmatic Breathing Exercise. — The upper abdominal muscles are gently contracted on expiration and are consciously relaxed on inspiration (*Figs.* 129, 130). The contraction effort should be just enough to pull the rib margins slightly downwards and inwards and the relaxation to let them expand. *On no account should the abdominal wall bulge forward on breathing in.* During pre-operative training the patient is taught to feel the rib movement with his fingers.

For the first few days after the operation the physiotherapist supports the wound area during these exercises.

EXCESSIVE BRONCHIAL SECRETION

In cases where there are bronchial secretions that cannot be coughed up, the patient is taught to accentuate *expiration*, and should lie on his side while doing the exercises. The patient can be lowered further still, and if necessary, the foot of the bed is raised. Vibratory percussion can be given over the bases of the lungs during the long expirations.

POST-OPERATIVE EXERCISES IN THORACIC CASES

Breathing exercises are of great importance after operations upon the thorax. The following instructions were arranged by Mr. Holmes Sellors and myself, and they follow the principles which have been adopted at most of the special chest hospitals.

Continual practice and effort are both essential if the expansion of the chest is to be improved.

Set aside fixed periods each day for the exercises. Do not become slack or forget them

IMPORTANT POINTS

1. Think and concentrate on expanding the chest in the direction required
2. Apply pressure carefully over the part to be exercised. Place the flat of the hand well over the area and press firmly with the palm.
3. Breathe in quietly through the nose, breathe out completely with the mouth slightly open.
4. Do each exercise 18 to 24 times in groups of 6, with a few moments' rest between each group.

Side Expansion of Lower Ribs (*Fig.* 131).—

Lie with the knees bent, or sit with the back well supported.

Place the hands well round the sides of the lower ribs.

Breathe in and expand the ribs outwards against the pressure of the hands.

Relax the pressure at the height of inspiration to obtain the fullest expansion.

Breathe out fully and at the end of the act press with the hands so as to expel as much air from the chest as possible.

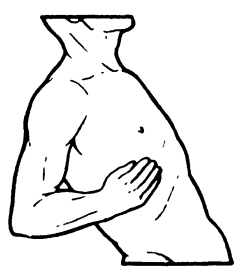


Fig. 131

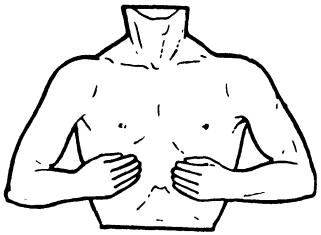


Fig. 132

Diaphragmatic Movement (*Fig.* 132).—
Lie as above.
Place the fingers over the front of the lower ribs to feel the movement.
Keep the upper part of the chest still and breathe in.
Expand gently round the front part of the waist under the hands.
Breathe out slowly, first sinking the chest and then pulling in the upper part of the abdomen powerfully.

Expansion of the Lower Chest on One Side (*Figs* 133, 134).—
Place the hand over the area to be exercised (use the other hand to check movement on the opposite side).



Fig. 133.—Expansion of the lower chest on one side only. Expiratory phase. Note the difference in the distance between the two thumbs from the midline

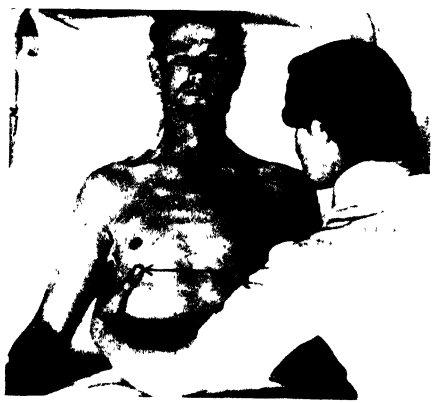


Fig. 134.—Inspiratory phase. The patient has pushed out the physiotherapist's left hand against pressure

Breathe in, expanding the ribs outwards against the pressure of the hand.
Concentrate on making the effort only over the required area
Release the pressure in the final stage so that the height of expansion is not held back.
Breathe out and help the finish with pressure of the hand

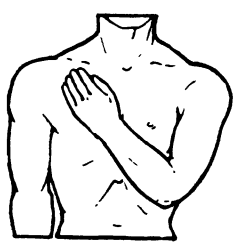


Fig. 135

Expansion of the Upper Chest on One Side (*Fig.* 135)—

a. Place the hand over the upper part of the chest with the fingers just below the collar-bone. Use the right hand for the left chest and vice versa.
Breathe in, expanding the chest upwards and forwards against the pressure of the hand. Keep the shoulders down and try to drive upper ribs up under the collar-bone.
Breathe out and drop the upper part of the chest. Press with the fingers at the end.

b. Apply pressure with fingers of opposite (or knuckles of same) hand just below arm-pit.
Breathe in and expand outwards against the pressure. Keep the shoulder and arm quite still.
Breathe out and relax. Press the fingers in at the end of expiration.

Backwards Expansion of Lower Ribs on One Side only (*Fig.* 136).—

Sit slightly bent forwards.

Place the hand as far round on the back as possible—the thumb will be pointing downwards.

Breathe in and expand the ribs backwards against the firm pressure of the hand. Slacken the pressure at the height of inspiration.

Breathe out and relax the lower ribs. Straighten the back and spine slightly as the final pressure is given.

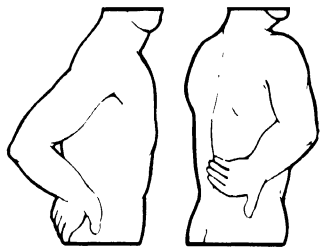


Fig. 136.

CONCENTRATE AND PERSIST

GENERAL PRINCIPLES IN POST-OPERATIVE EXERCISES

In all exercises expiration should be a little longer than inspiration. Inspiration should be performed silently through the nose. When it is necessary to accentuate expiration, a blowing sound through the lips will help in difficult cases.

Graded exercises of the limbs and trunk are given while the patient is in bed to avoid circulatory stagnation and loss of muscle tone. At the same time the abdominal and anti-gravity muscle groups require strengthening.

These general exercises, taken in classes where possible, hasten convalescence.

A typical exercise that has been found very useful (combining abdominal muscle strengthening and breathing control) is as follows: The patient lies in a nearly recumbent position with knees semi-flexed. He then draws one knee up as close to the chest as possible, at the same time breathing out and contracting the abdominal muscles. The knee is returned to the starting position, and this is followed by inspiration (chiefly using the diaphragm). The opposite knee is similarly drawn up on the expiratory phase. The third movement consists of drawing up both knees in the same way—while breathing out, and when the starting position is resumed full diaphragmatic inspiration follows.

When the patient is allowed out of bed more strenuous exercises in classes are given, and more arduous breathing exercises are included.

A common error to avoid is the patient's tendency to shuffle round the ward in bedroom slippers; shoes or boots should be worn on most occasions to help the patient regain his normal gait.

CHAPTER XVII

TRANSNASAL GASTRIC, DUODENAL, AND INTESTINAL INTUBATION: TECHNIQUE AND USES

By HAMILTON BAILEY

COMPLETE familiarity with a gastric tube is bound to stand the house surgeon in good stead. By mastering the technique, not only will he be enabled to benefit numbers of patients in surprisingly different ways, but his prestige will rise among the nursing staff; many nursing sisters are themselves proficient in passing the tube. They will call upon him in cases of difficulty. Should the house surgeon later become a house physician, his medical chief will value his adroitness with the tube as much as a surgical chief appreciates skill with the stethoscope in a house surgeon who has completed a term of office as a house physician. Withal, there are but few branches of medicine and surgery where familiarity with this technique will not be of great assistance to him throughout his career.

For many years readers of *Pye's Surgical Handicraft* have had their attention drawn to the inestimable value of the intranasal gastric tube as a means of preventing vomiting, of emptying and irrigating a dilated stomach, and of keeping the stomach empty. In other words, the use of the tube has been presented as a means of *withdrawing* fluid gastric contents. Until about a year ago I did not appreciate the possibilities of the tube as a means of *giving* fluids (and drugs) in cases where the patient will not, or cannot, imbibe a sufficient quantity. Here is a method whereby an adequate fluid intake can often be ensured. Unlike proctoclysis, the intake can be measured and recorded with scientific accuracy. It is to the work of Ransome, Gupta, and Patterson, practising in tropical India, where in both medical and surgical (especially medical) cases a high fluid intake is often the breath of life, that we owe the full appreciation of a transnasal gastric tube as a means of giving, as opposed to withdrawing, fluid.

PASSING THE TUBE

Ryle's tube (*Fig.* 137) is generally employed. After boiling it, the tube should be tested for patency and integrity by syringing water through it. The tube is lubricated with sterile liquid paraffin. The nasal route for the passing of the tube is much the best. There are occasions when nasal obstruction prevents this route being chosen, but they are comparatively infrequent. The alternative route (the mouth) must then be utilized, but an indwelling tube through the mouth is liable to cause nausea and other discomfort. In addition, the patient is inclined to chew the tube, whereas once the tube is in place via the nose, it can be left in place for many hours—even days—without cause for complaint.

Choosing the nostril which is the more patent and having cleansed it, the bulbous end of the tube is pushed along the floor of the nose. The passage past the turbinates is assisted by tilting the tip of the nose upwards with the

left finger and thumb. Retching occurs; instruct the patient to swallow; if he continues to retch instead of swallowing, instruct him to sip and swallow some water. A glass half filled with water should be at hand. Once the end of the tube is past the level of the cricoid cartilage, as a rule, the tube can be passed onwards readily. That the end of the tube has reached its destination can be ascertained by the withdrawal of some gastric contents.

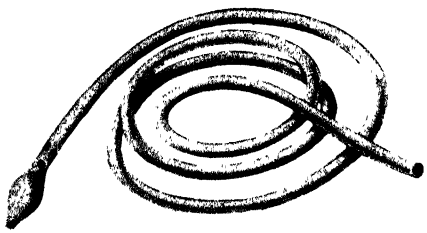


Fig. 137.—Ryle's tube

My gastric aspiration tube (*Fig.* 138) was designed to empty the stomach by the nasal route when the measure was required urgently. This tube is a little easier to pass than Ryle's tube, for in the distal end there is a coiled spring, which helps to stiffen the tube.

Refinements of Technique.—A good method for a nervous patient is for him to gargle and then swallow 2 c.c. of 2 per cent solution of anethaine (Glaxo Laboratories Ltd.) twenty minutes before the passage of the tube, or to suck one or two tablets of benzocaine (Bayer Products Ltd.).

The method I use to instruct my house surgeons and nursing sisters to employ is depicted pictorially in *Figs.* 139–144.

Special Cases.—

Unconscious Patients (without a swallowing reflex).—The patient must be held in a sitting position, leaning somewhat forwards. The mouth is opened and a mouth gag inserted. The tube is passed through the nose in the usual manner until the tip is felt in the pharynx. Employing two fingers passed into the mouth, the tip of the tube is pushed onwards and guided past the epiglottis. In this manner more and more of the tube is milked down the œsophagus. That the tube has reached the stomach (and not gone down the trachea) is proved by aspirating gastric contents. Seemingly insultingly elementary, this is a point which must never be forgotten in a patient without a swallowing reflex.

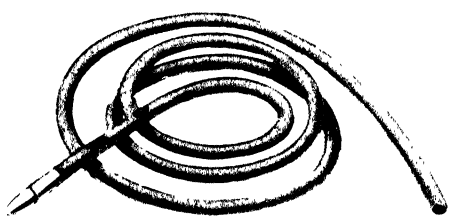


Fig. 138.—Hamilton Bailey's tube

Refractory, Non-co-operative Patients.—Much judgement must be exercised. No one method is suitable for all cases. Psychological methods often work wonders; should the house surgeon possess a strong or a persuasive personality, he can often convince the patient that the passage of the tube will be of such benefit to the sufferer that once it is in place the patient will be thrilled with well-being. Efficient surface anæsthesia (*see above*) reduces the number of failures by at least 30 per cent. In very selected cases intravenous anæsthesia



Fig 139.—The patient sits up in bed with his head supported at the angle shown The nostrils are inspected, and if there is obvious deviation of the septum, the wider nostril is selected This is cleansed with a bland antiseptic, e.g., flavine solution, by means of a pledget of cotton-wool on forceps The nostril is then packed with a piece of wool soaked in 2 per cent anethaine



Fig 140.—2 c.c. of anethaine are poured into a medicine glass, the patient gargles this for half a minute, and then swallows the solution.



Fig 141.—A tumbler of water is handed to the patient Hamilton Bailey's gastric aspiration tube is passed down the nostril after the cotton-wool has been removed Steadying the patient's head while he drinks, the tube is passed onwards



Fig 142.—As soon as it is judged that the end of the tube is in the stomach, the sister is asked to attempt aspiration If fluid is not withdrawn, the tube is passed on farther



Fig. 143.—Once the tube is satisfactorily in place it is fixed to the cheek with adhesive plaster.



Fig. 144.—Aspiration is continued until the stomach content is quite clear. The patient may drink as he pleases, and this helps to wash out the stomach.

Figs. 139-144.—'Ideal' transnasal intubation. There is little reason why this technique should not be practised as a general rule.

can be resorted to. The dose should be very small and the anæsthesia produced light enough to preserve the swallowing reflex. An alternative method is to produce twilight sleep with intramuscular sodium luminal or subcutaneous scopolamine-morphine before attempting to pass the tube.

CARE OF THE INDWELLING TUBE

A tube traversing the nose can remain in place for days without causing perceptible rhinitis, but only if reasonable care is given to the prevention of infection. On pulling down the indwelling tube for an inch or so, too often I find that it is encrusted with nasal secretion and the patient winces as the tube is moved, for it has become stuck to the mucosa. In such cases it does not seem to have occurred to anyone that the outside of the tube must be kept clean and lubricated. An encrusted tube becoming adherent to the mucous membrane will surely give rise to purulent rhinitis, which in turn predisposes to pneumonia. The nasal mucous membrane is far less vulnerable than the mucous membrane of the urethra. If the same care and attention is given to the prevention of infection in this instance as is expected in the case of an indwelling urethral

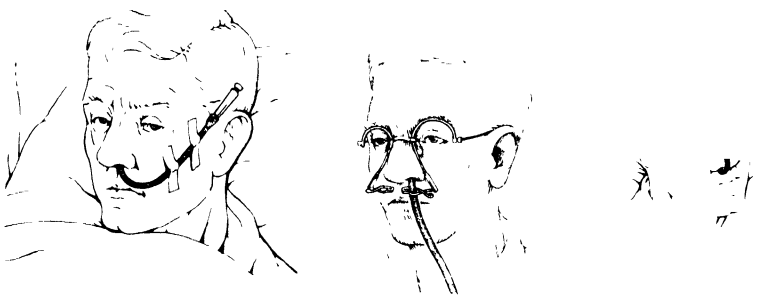


Fig. 145.—A, When gastric *aspiration* is required the tube is fixed to the cheek, as shown B, Isaac's spectacle-frame holder * An excellent alternative to A C, When fluid is to be *administered* via the tube, it is fixed to the forehead

catheter (*see* Chapter *XXXII*) a standard of surgical cleanliness will be attained which will banish rhinitis as a complication of transnasal therapy. Obviously the nostrils should be cleansed before the tube is passed. When the end of the tube has been proved to be in the desired position, withdrawal of it for a couple of inches will allow the portion in contact with the nares to be smeared with sulphanilamide ointment. The tube is then advanced again for 2 in. and the ointment is carried into the nose. When the house surgeon does his round he should pull down the tube and inspect it. When encrustations are present he should clean the tube himself, lubricate it, advance it again and fix it in position. If he follows this advice, soon the excellent practice will become a routine nursing procedure in the ward.

Fixing the Tube in Position.—Once the tube is in place satisfactorily it can be strapped to the cheek with adhesive plaster (*Fig.* 145A). An excellent alternative is Isaac's spectacle-frame holder (*Fig.* 145B). When the tube has to be employed as a means of gravitating fluid into the stomach it is strapped to the forehead near the middle line (*Fig.* 145C).

*Made by Hamblin Ltd., Wigmore Street, W.1.

ASPIRATING THE CONTENTS OF THE STOMACH

No patient should be allowed to suffer the misery of repeated vomiting; in all conditions where vomiting is repeated the stomach content is watery and consequently it can be aspirated easily.

With a tube through the nose the patient can drink as he pleases, for, if necessary, the fluid can be aspirated soon afterwards. This, indeed is an effective way of washing out the stomach.

Management.—In most instances it is essential to know how much the patient would vomit if the tube was not in place. The house surgeon must, therefore, instruct the nurse as follows : Say, the gastric aspiration tube was passed at 9 a.m. ; two pints of fluid are allotted to the patient and he may drink this as he pleases. All the contents which are aspirated are collected in a bucket. At, say, 3 p.m. the contents of the bucket are measured and the quantity that he has drunk is

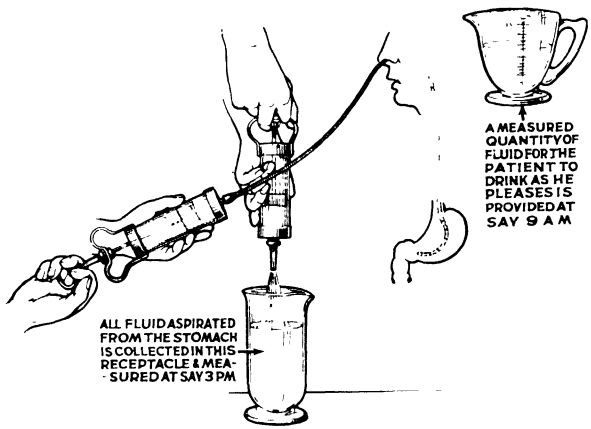


Fig. 146.—The principles involved in recording and charting the amount of fluid aspirated from the stomach

subtracted therefrom (*Fig.* 146). This will give the amount of regurgitated fluid in the six hours. The figure is charted, and where necessary the same procedure adopted for the next six hours.

As a rule the gastric aspiration tube is not left in place more than forty-eight hours. After this time it is advisable to remove the tube and boil it, after which it can be replaced if necessary, preferably through the contralateral nostril.

Final removal of the tube : Before withdrawing the tube finally it is a good practice to give a ' gastric mobility test '. The patient drinks half a pint of barley water coloured with cochineal or indigo-carmine. If after one and a half hours none of this coloured fluid can be aspirated, it is proof positive that the stomach is passing its contents onwards and aspiration is no longer necessary.

Continuous Gastric Aspiration.—To connect the gastric aspiration tube to some form of suction apparatus ensures that the stomach is kept empty constantly. While aspiration carried out continuously by suction (*see* p. 206) is efficient, it has little, if any, advantage over syringe aspiration performed by a skilful nurse.

Aspiration can be carried out by any well-fitting syringe. For instance, a Janet's 6-oz. glass syringe with a metal plunger is often admirable for the purpose. Because so often a suitable, really efficient smooth-working syringe cannot be found when it is required, I strongly recommend that a number of the simple adaptors illustrated in *Fig.* 147 are made available in every

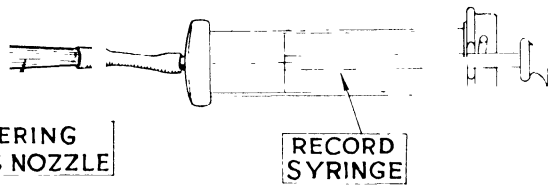


Fig. 147.—Glass and rubber tubing adaptor extremely easily constructed makes a perfect fitting for a Record syringe

hospital. These allow the end of any pattern of aspiration tube to be fitted to a Record syringe—10-c.c. or 20-c.c.—with such accuracy that there is no loss of suction.

GRAVITATING FLUID INTO THE STOMACH BY THE DRIP METHOD

The receptacle is hung 1–2 ft. above the level of the patient's head (*Fig.* 148). Once a transnasal gastric tube is in place fluid can be gravitated into the stomach at a given rate. The uses of this method of ensuring an adequate or a high intake of fluid are legion. Take the case of the renal patient who will not drink a sufficient amount. Instead of the nurse's time being expended coaxing the patient to imbibe, she can attend to other matters while the interceptor shows that the patient is definitely receiving the fluid that was ordered. Again, many are the times where we should hesitate before employing the intravenous route for replenishing the circulation because the patient has myocarditis or his lungs are not in a satisfactory state. It is doubtful if he will drink enough, especially during the night. Here is an indication for employing the transnasal tube as an alternative to the speculative rectal route for the administration of sufficient fluid. In this connexion it should be remembered that it has been proved that little, if any, glucose is absorbed when it is given per rectum. Of many other pertinent examples where this expedient is valuable, the patient who has had a perforation high in the stomach sutured can be cited. By means of a transnasal gastric tube he can receive a steady drip of nourishment below the sutured area, which is consequently put at rest. During the first 48 hours the tube is used to aspirate the stomach, if such is needful.

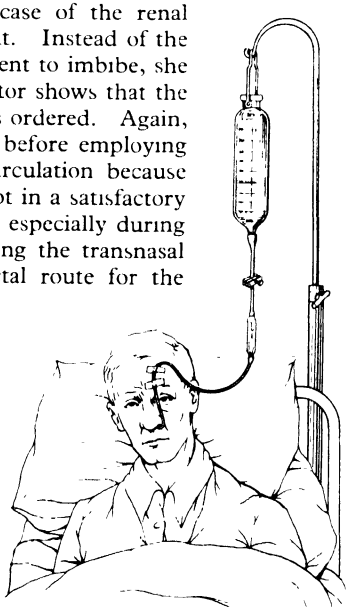


Fig. 148.—Transnasal gastric intubation as a means of gravitating fluid by the drip method

High Calorie Continuous-drip Feed.—Sister D. M. Butts of the Royal Northern Hospital, who has had a large experience in this method, has supplied the following details.

CALORIES APPROXIMATELY 3000

	CARBOHYDRATES	PROTEINS	FATS
Milk (2½ pints)		50	50
Eggs (6)		36	36
Horlick's Malted Milk 3	58	14	7 5
Sugar (5 oz.)	145		
Cream (2 oz.)			
Orange juice (3 oz.)			
Glucose (1 oz.)			
	133 5	-	Calories 3059

Method of Administration.—Mix the Horlick's malted milk, cream, and sugar into a smooth paste, taking great care to dissolve all small lumps. Add cool milk and thoroughly beaten-up eggs. Mix all to the consistency of thin cream, and pass through a sieve. Add the strained orange juice and the glucose. Pour the mixture into an intravenous saline flask, and before connecting the apparatus to the Ryle's tube with a glass connexion, make sure that air is excluded from the tubing by allowing some of the mixture to run through. The feed is allowed to drip continuously throughout the twenty-four hours at about 60 to 80 drops a minute.

Absolute cleanliness is essential. The apparatus must be boiled daily and washed through before the reservoir is replenished. It is a wise precaution to mix only half or a quarter of the whole amount at one time, especially in warm weather.

INTESTINAL ASPIRATION

The Miller-Abbott Double-lumen Tube* (*Fig.* 149).—The Miller-Abbott tube for small-intestinal intubation has made aspiration of the contents

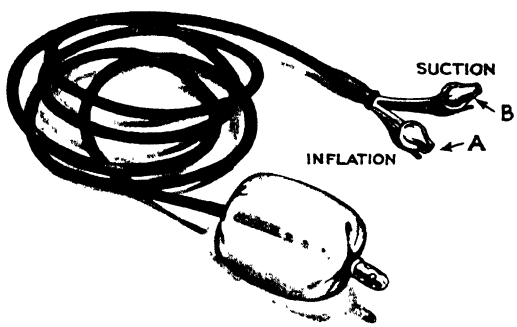


Fig. 149.—The Miller-Abbott tube.

of the small intestine possible. This form of therapeutics has opened up a new field in the preparatory stages of the treatment of advanced intestinal obstruction. It may well prove a life-saving measure in paralytic ileus.

* The tube is made by the G. P. Pilling & Son Co., Philadelphia. The nipples A and B do not fit British-made syringes. Messrs. John Bell & Croyden, London, have altered these nipples so that A fits a Record syringe and B a Janet's syringe.

The Miller-Abbott tube is a double-channelled rubber tube of considerable length, and has its lumen doubled throughout, viz. : ●. The small channel is used to inflate the balloon, the larger to aspirate the contents.

Rendering the Tube Surgically Clean.—It is not essential to have the tube sterile, but it should be as clean as it can be made without injuring it. Wash it in soapy water, rinse in plain water, and then immerse it in spirit for five minutes. Allow the spirit to evaporate before use.

Overcoming Difficulties with the American-gauge Nipples.—These nipples do not fit a Record syringe. If two adaptors of the pattern illustrated in *Fig.* 146, are placed one on each of the nipples, the difficulties, often formidable, of procuring syringes which accurately fit the Miller-Abbott connexions are banished, and the only syringe required is a 10-c.c. or 20-c.c. Record syringe. For simplicity's sake I urge that this all-important, practical point is studiously observed.

Testing the Tube.—Syringe water through the compartment of the tube which is to be used for suction. Inflate the bag with 20 c.c. of air. Apply a hæmostat to the rubber connexion (*Fig.* 150). Test the bag for leaks under

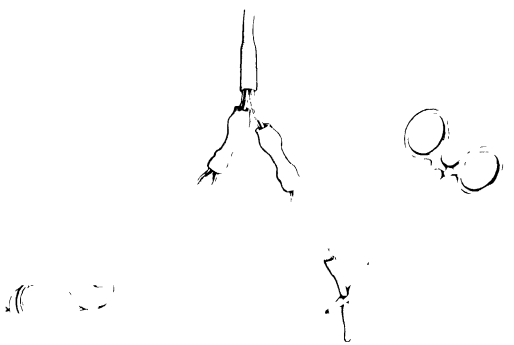


Fig 150.—Arrangement of adaptors to overcome the difficulties connected with the American gauge nipples.

water, using moderate pressure. See that inflation is maintained. Having completed these tests deflate the bag.

Surface Anæsthesia (*see* p. 134) is most desirable in this instance

Method of Passing the Tube through the Nose.—Even a collapsed bag is bulky. The following expedient simplifies the passage of the bag through the nose. A Ryle's tube is passed until the bulbous tip can be felt in, and retrieved from, the pharynx. This is brought out through the mouth, the metal tip of the Miller-Abbott tube fits the butt end of the Ryle's tube snugly. Thus attached (*Fig.* 151), the bag, lubricated with liquid paraffin, can be piloted into the pharynx and out of the mouth by traction on the forward end of the Ryle's tube. The patient is given a short rest and a little water to drink. Several inches of the nasal end of the tube are lubricated. Grasping the tube between the finger and thumb about an inch above the bag, the tip is directed into the commencement of the œsophagus while the tongue is hooked forward with the left index finger. Quickly the left hand takes on the role of advancing the tube in the pharynx, while the right pulls on the tube entering the nose. Thus the mouth is cleared of 'slack'. If the patient brings up the bag, the process must be repeated. There should be no undue difficulty in getting the bag into the

œsophagus, and if the patient drinks the bag will be carried down by peristalsis, as can be seen by the well-lubricated tube being drawn into the nose without the assistance of the operator. This part of the procedure being completed, the deflated bag is passed down the œsophagus while the patient swallows water ; there is usually no difficulty about this. Once the tube is in the stomach

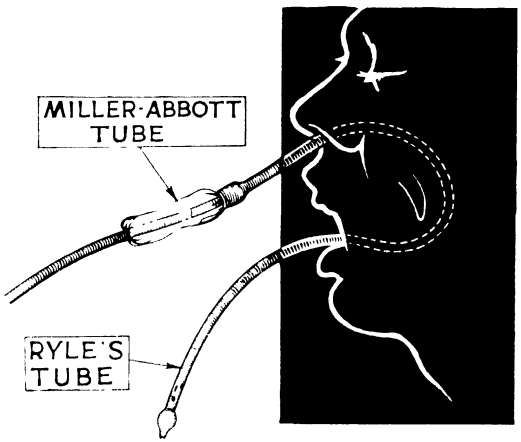


Fig. 151.—A method of passing the bag of a Miller-Abbott tube through the nose

it is filled with 30 c.c of air and is drawn back until the balloon is felt to come up against the cardiac orifice. The balloon is deflated and the patient is made as comfortable as possible, lying somewhat on his right side. With the patient partaking of water at frequent intervals, and the bag deflated, the contents of the stomach are aspirated. While this is going on the deflated bag is slowly, but steadily, advanced inch by inch, keeping the entering tubing well lubricated.



Fig. 152.—With the tube in this position note that there is sufficient slack to allow the bag to enter and pass the pylorus



Fig. 153.—If too much tubing is passed into the stomach it spells failure for the reason which is obvious by reference to this diagram.

It is advanced until it is judged that the pylorus has been reached ; usually this is between the 60 (--) cm. mark and the 75 (—) cm. mark. In order to prevent the temptation of pushing in too much tubing, when the position shown in *Fig.* 152 has been reached, the tubing should be strapped to the nose with adhesive plaster. If one dwells for a moment on *Fig.* 152, it is not difficult to appreciate that there is quite sufficient tubing in the stomach for the bag to enter and pass the pylorus. The novice puts in far too much tube at this stage, and ruins the chances of successful entry of the pylorus, for the tip of the bag becomes coiled probably towards the cardia (*Fig.* 153). Now comes the time for patience.

Every half hour the balloon is inflated with 10 c.c. of air and one tries the tension on the tube for the hoped-for tugging sensation which signifies that the bag has passed the pylorus. The aspiration of undiluted bile or intestinal contents —undiluted by the water the patient is imbibing—also signifies that the tube has passed the pylorus. If the bag has definitely passed the pylorus, inflate with a further 15 c.c. of air, making 25 c.c. in all. If success is not achieved, try inflating the bag with 10 c.c. of air and then waiting two hours.

If a portable X-ray apparatus is available far less skill and patience is required. The first thing to do is to manœuvre the tube into the position shown in *Fig.* 152. Probably the bag will then be carried through the pylorus in a few hours, provided the amount of tubing inserted into the stomach is not sufficient to allow coiling in the wrong direction.

Removing the Tube.—As with the gastric aspiration tube, there should be no haste in withdrawing it. The tube can remain in position without aspirating the contents, and only when it is evident that a relapse is improbable is the tube removed. The bag is deflated, and with gentle traction the tube is slowly withdrawn, taking about ten to fifteen minutes over the process.

To become an adept with the Miller-Abbott tube requires patience and determination. The house surgeon who masters its technique has achieved something really worth while. The entry of the bag into the duodenum followed by observing foul, obstructed intestinal contents being aspirated, with a corresponding improvement in the patient's general condition, is a tremendous satisfaction.

CHAPTER XVIII

THE ADMINISTRATION OF ENEMATA

By EVELYN C. PEARCE

IN order to get the best result, it is desirable that an evacuant enema should be retained for at least fifteen minutes. For this and for other reasons, the patient should be told the purpose of an enema and his co-operation sought.

Technique.—Two principles have been invoked: (*a*) force (Higginson's syringe); (*b*) gravity.

Higginson's Syringe.—This method is falling into disuse. The rigid nozzle constitutes a real danger, which is only circumvented by the attachment of a rubber rectal catheter. This avoids the possibility of perforating the rectal mucosa, a calamity not unknown when an enema is given by a careless or ignorant person. Another objection is that fluid is injected too forcibly into the rectum. Finally, Higginson's syringe is difficult to sterilize, for it cannot be boiled without detriment.

The Gravitation Method is applicable in every instance. Distension of the rectum by a volume of fluid injected rapidly (two pints in five to ten minutes), will result in emptying the bowel, as when an evacuant enema is given. By reducing the rate of flow, reflex irritation of the rectum is avoided, and the fluid injected is retained. Twenty minutes may be occupied injecting from four to six ounces of fluid, as, for example, when a starch and opium (sedative enema) is given.

The rate of flow is best regulated by means of a clamp on the tubing; alternatively, it can be regulated by the height at which the reservoir or funnel containing the fluid is elevated.

Preparation of the Patient.—If possible, the bladder should be empty. The lower bowel should be as free of gas as possible, particularly before giving an injection which is to be retained; to ensure this a flatus tube should be passed. A clean flatus tube with a length of rubber tubing attached (*Fig.* 154) is brought to the bedside in a bowl of warm water or weak antiseptic lotion; the end of the tube is lubricated, and inserted for several inches into the rectum; the passage of flatus will be indicated by bubbles passing through the fluid in the basin in which the free end of the rubber tubing lies. The flatus tube may be left in situ for fifteen to thirty minutes, whilst preparations for giving the enema are completed.

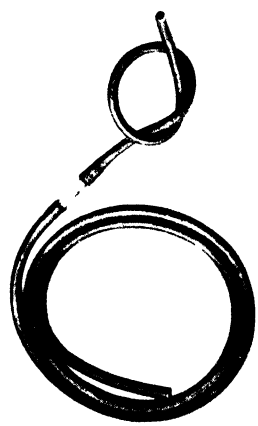


Fig. 154.—Flatus tube attached, by means of a glass connexio to a piece of rubber tubing.

Position of the Patient.—It is convenient when giving an evacuant enema to have the patient in the left lateral position with his knees drawn up and his buttocks well over to the right side of the bed, against which the nurse stands

with the apparatus and prepared injection on a trolley or bedside table. The bedclothing should be re-arranged so that the patient is covered, and is not exposed. The injection made, he may continue to lie in this position, and if he experiences difficulty in retaining the enema, or is fraught with the desire to return it immediately, the nurse standing by may press a folded towel firmly against the anus, or press the buttocks together, until this first impulse passes. When the time comes for the patient to evacuate, he is turned on to his back and the bedpan inserted. If there is delay in having an action, a hot drink may help.

Although the left lateral position is a convenient one, an enema can be given with the patient in many positions, and it is often advisable to give the injection without disturbing the patient, e.g., in Fowler's position.

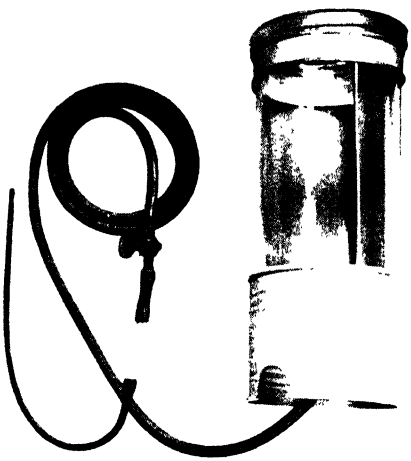


Fig. 155.—Reservoir for fluid, tubing with control tap inserted, connexion tube, and rectal catheter.

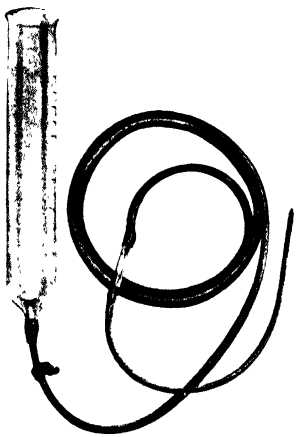


Fig. 156.—Graduated funnel, tubing with controlling clamp attached, connexion, and rubber catheter

Preparation of Apparatus.—That commonly employed is shown in *Figs* 155 and 156. The articles used should be clean, but need not be sterile. After use the apparatus should be washed thoroughly and disinfected or sterilized, preferably by boiling for twenty minutes. It should be drained and dried before being put away; if this is done, the articles will be ready for use, and then need only be immersed either in warm water or in some weak, non-irritating antiseptic lotion. When at the bedside, and before inserting the rectal tube or catheter, the apparatus should be filled with fluid, some being allowed to run through the tubing and into the catheter, so that air is expelled from the apparatus.

Lubricant.—A rectal catheter should be lubricated with liquid paraffin or vaseline, or some other non-irritating grease. It is inadvisable to use glycerin, as by its action the impulse to empty the bowel may be stimulated before this is desirable.

Conditions in which an Enema is Contra-indicated.—Whenever there has been an injury to, or when an operation has been performed on, the organs

in relation to the perineum, the advisability of giving an enema should be considered carefully. For example, an enema should not be given for some days after perineorrhaphy, nor for some time after Wertheim's hysterectomy An enema should not generally be given after an operation on the bladder; in particular, it is contra-indicated soon after prostatectomy, because it may initiate bleeding from the prostatic bed. In obstetric cases, when there is malpresentation, an enema may cause rupture of the membranes; it is also contra-indicated when there has been severe injury to the birth canal and perineum during labour.

Report on the Result of an Enema.—It is important to observe whether the result consists of a large, soft, solid, normal stool, contains hard fæces, presents any abnormalities, or if the returned enema fluid is merely coloured; and if possible the passage of flatus should be noted.

Colostomy Enemata.—The gravity method is essential. Enemata should not be used in cases of colostomy unless there is some special indication. Washing out the colon tends to upset its natural function and induces a state of catarrh. When enemata are essential they should be given at the same time each day, preferably in the morning. This helps to form a 'habit' of evacuating the bowel at the same time each day. The colostomy opening and surrounding skin must be kept scrupulously clean and dry.

Preparation of Enemata.—Details for the preparation of various enemata are given below. Where bulk is not specially indicated, it is usual to give from one to two pints in the case of adults, a smaller quantity being given to children proportionate to the age. The temperature of the fluid should be taken, as the rectum is sensitive to heat, and an enema should not be hotter than 80° to 90° F.

1. Soap and Water Enema.—The soap used is important. Soft green soap B.P., 1 oz., is dissolved in 1 pint of warm water. Yellow soap is a good substitute. Fancy, antiseptic, or soda-containing soaps should be avoided; they tend to produce an extremely irritable, blotchy rash. If there are any particles of undissolved soap, the solution must be strained through gauze.

2. Cleansing Enema.—The bowel is washed out with plain warm water until the contents return clear. It is used in the final preparation for operations on the rectum.

3. Glycerin Enema.—This is used when it is undesirable to introduce a bulky enema. One part of glycerin is mixed with 2 parts of water, or equal quantities of glycerin and water are used, and the total amount, not exceeding 5 fl. oz., is given by gravitation. The glycerin causes an increased secretion from the mucous glands in the bowel wall, so that the fæces are softened and lubricated.

Pure Glycerin, 60–120 minims, may be introduced by means of a special glycerin syringe: this method is now usually replaced by the use of a glycerin suppository.

4. Olive Oil and Gruel Enema.—One tablespoonful of fine oatmeal is stirred into 12 fl. oz. of water; this is slowly brought to boiling-point and allowed to simmer for 20 minutes; it is strained through muslin and 5 fl. oz. olive oil are stirred in; the enema must be allowed to cool, and is given through a rectal tube and funnel at a temperature of 100°. This is an emollient enema, and may be given as a routine on the third day after the majority of rectal operations.

5. Olive Oil Enema.—Olive oil, 5–8 fl. oz., is given slowly into the rectum, the buttocks being raised on a pillow. This enema is useful in cases of fæcal impaction of the rectum, especially after breaking up a hard fæcal mass digitally, and may be followed some hours later by a soap and water enema. A smaller olive oil injection (3 fl. oz.) may be given with the object of being retained and having a soothing action on the rectal mucosa—for instance, in ulcerative colitis.

6. Turpentine Enema.—Turpentine is valuable in tympanitic distension; it increases peristaltic action and helps to expel gas; ½ to 1 fl. oz. of turpentine is usually employed. As a precaution against burning the rectal mucosa with turpentine, an equal amount of olive oil or the white of an egg is added and the whole beaten to form an emulsion. This is then added to one pint of soap and water and injected slowly.

7. Ox Bile Enema.—Purified ox bile, ½ fl. oz., is mixed with 5 fl. oz. enema saponis. This is useful in cases of meteorism or paralytic obstruction, and it may be given through a colostomy.

8. Treacle Enema.—A useful evacuant enema which also relieves meteorism. It consists of 10 fl. oz. of black treacle added to 10 fl. oz. of enema saponis.

9. Starch and Opium Enema.—Starch, ¼ oz., is stirred into 5 fl. oz. of cold water, brought to the boil, and cooled. To this mucilage 30 min. of tinct. opii are added. This is given slowly and evenly into the rectum through a catheter and funnel in cases of ulcerative colitis, with the object of checking diarrhœa and reducing tenesmus.

10. Anthelmintic Enema.—This is used for clearing the colon of thread-worms. It consists of a hypertonic solution of saline (1–2 tablespoonfuls of common salt to one pint of water). Alternatively, an infusion of quassia chips may be given. For an injection ½ to 1 fl. oz. of the infusion is added to one pint of water.

11. Coffee and Brandy Enema.—Five fl. oz. of strong black coffee are prepared. Having filtered it to eliminate the grounds, ½ fl. oz. of brandy is added.

12. Magnesium Sulphate Enema.—One to two ounces of magnesium sulphate may be given in either 4–8 fl. oz. of warm water or starch mucilage. The mixture should be a 25 per cent solution. A stronger solution of magnesium sulphate is irritating to the rectum. A magnesium sulphate enema is often employed in cases of head injury, in order to reduce intracranial tension.

CHAPTER XIX

THE HOUSE SURGEON AND THE RADIOLOGICAL DEPARTMENT (I)

By N. M. MATHESON

The house surgeon spends a good deal of time in the radiological department, and he has to perform many important duties there.

THE INJECTION OF RADIO-OPAQUE MEDIA INTO SINUSES AND CHRONIC ABSCESS CAVITIES

The length and course of fistulous communications and the dimensions of abscess cavities can be well displayed by contrast media (*Figs.* 157–159). Troublesome regurgitation of the solution at an external orifice is conveniently avoided by employing an olivary-tipped cannula applied firmly to the surface opening. For the deeper channels a tube should be passed well into the track before the injection commences, and to delineate deep narrow channels a watery preparation is often more suitable than a viscid oil. For this purpose lipiodol emulsion No. 2 is eminently satisfactory, as it is a bland perfectly miscible fluid which can be induced by gravity to permeate the depths of the finer ramifications of a cavity. In all cases, before taking the radiograph, it is essential to cleanse the skin of any of the opaque medium which becomes spilled thereon.

To Outline a Fistula-in-ano (*Fig.* 160.)—Lipiodol is injected by means of a Eustachian catheter, or the nozzle of a 5-c.c. or 10-c.c. Record syringe may be inserted directly into the external fistulous opening. The situation of the anus should be marked by placing a lead marker in the anal canal before taking the radiograph.

To Outline a Chronic Empyema Cavity (*Fig.* 161).—The patient is placed on his sound side and in such a position that the mouth of the sinus is the highest point. The opaque medium is then introduced into the sinus and the patient is rocked gently, so as to distribute the medium into all parts of the cavity. It is usually best to take the films with the patient in the position indicated, both antero-posterior and lateral exposures being required.

SIALOGRAPHY

Injection with the newer watery preparation of lipiodol or one of the preparations used for excretory pyelography (uropac has given excellent sialograms) affords a precise means of depicting the duct system of the parotid gland (*Fig.* 162). To apply a surface anæsthetic, e.g., anethaine, on a small pad of gauze tucked into the cheek in the region of the duct for three or four minutes, renders the procedure almost painless. The introduction of a lachrymal duct dilator is a useful preliminary measure (*Fig.* 163). A lachrymal duct syringe answers the purpose for introducing the opaque medium. Having filled the syringe with the chosen medium, the injection is made slowly. The special

Examples of the Value of Radiography following the Injection of Opaque Media

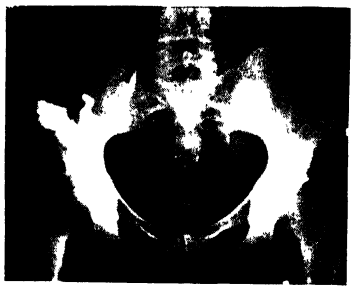


Fig 157.—Lipiodol injected into a sinus connected with a psoas abscess. (*Hamilton Bailey*.)



Fig 158.—Showing that a sinus situated above the clavicle communicates with a rounded cavity beneath the clavicle. Case of tuberculous adenitis. (*Hamilton Bailey*.)



Fig 159.—Discharging sinus connected with necrosis of the great trochanter. Note the downward extension of the abscess cavity which is revealed by this method of examination. (*Hamilton Bailey*.)

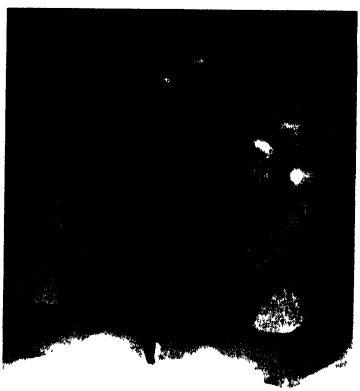


Fig. 160.—Fistula-in-ano visualized by an injection of lipiodol. (*W. B. Gabriel*.)



Fig 161.—Chronic empyema cavity visualized by injecting lipiodol. (*T. Holmes Sellors*.)



Fig 162.—Sialogram in a case of chronic parotitis. Note the great distension of Stensen's duct. (*Hamilton Bailey*.)

syringe shown in *Fig.* 164 renders the technique of the injection more precise. About 1 c.c. suffices for the average sialogram, but the procedure should be stopped at the appearance of swelling over the gland or at the onset of pain.

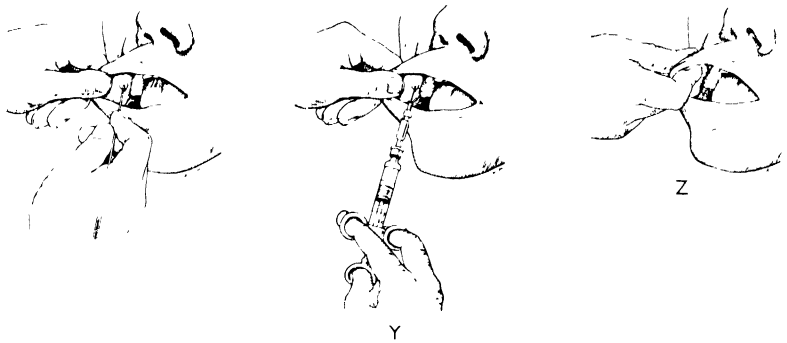


Fig. 163.—Technique of sialography. X, After cocainizing the mucous membrane around the opening of Stensen's duct the orifice is dilated with a probe. Y, The lipiodol is then injected, usually from 1 to 2 c.c. is required. Z, As soon as the injection is completed a piece of gauze is placed over the orifice of the duct and is kept in position until all is in readiness for the radiograph. (*After Blady and Hocker.*)

The lateral radiograph is taken first with the patient lying on his side with the head extended, and then another film taken in the postero-anterior direction.

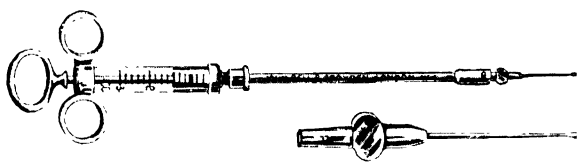


Fig. 164.—Hamilton Bailey's sialography syringe.

A good alternative method is to catheterize the duct with a fine ureteric catheter, which can be cut short and kept for the purpose.

EXCRETORY UROGRAPHY

(*see also* p. 157)

Contra-indications.—Excretory urography is contra-indicated in uræmic individuals. Under these conditions it yields little data and may be attended by grave danger. In any case of doubt a blood-urea estimation and a urea clearance test are desirable preliminaries. Particularly prone to reactions are patients with an idiosyncrasy to iodine. Thyrotoxicosis, grave anæmia, and hepatic insufficiency are also contra-indications. With these exceptions excretory urography is perfectly safe if carried out as follows:—

Preparation.—Mild aperients are given on the two nights which precede the examination. For eight hours before the injection the intake of fluids is limited and diuretic drugs are excluded. No food is given on the morning of the test and the bladder should be empty when the drug is injected. If possible the patient should be up and about prior to the examination.

Solutions and Dosage.—Uroselectan B and perabrodil, or the newer pyelectan and uropac, are the preparations usually employed. They are supplied in ampoules of 20 c.c., which constitutes an adult dose.

Technique.—A preliminary film is taken to exclude stones or other calcifications. The examination is carried out on a radiological couch fitted with a Potter-Bucky diaphragm. A 20-c.c. Record syringe is filled from an ampoule of the sterile solution, previously warmed to body temperature, and the contents are *slowly* injected into a suitable antecubital vein rendered prominent by the application of a tourniquet. With the point of the needle well in the lumen of the vein, and proved so by a good regurgitation of blood, reactions are unlikely.* Immediately after the completion of the injection the puncture is sealed and compressed with a bandage.

Exposures are usually taken by the radiographer at two, eight, and twenty minutes after the injection. Then the bladder is emptied and a further film taken to show the lower segments of the ureters. Later films, up to twelve hours or more, are important when hydronephrosis is suspected.

Subcutaneous Urography.—When the small calibre of the veins prohibits the intravenous route, a condition encountered particularly in childhood, subsidiary methods are available. Perabrodil in isotonic solution is suitable for injection into the subcutaneous tissues. It is diluted with double its volume of sterile distilled water, the dose of the diluted solution being from 40 to 100 c.c. according to the patient. This is injected in two equal parts into the thighs, and, employing suprapubic compression, photographs are taken at the end of half an hour, and thereafter at 15-minute intervals as required.

Oral Urography.—Also in those circumstances in which intravenous injection is impossible or inadvisable, satisfactory radiological information can be obtained by the oral route. Hippuran, when administered by the mouth, is given dissolved in 75 c.c. of syrup, in doses of 12 g. for adults and children over 13 years and 10 g. for children under 13 years. Continuous abdominal pressure is maintained, and plates are taken at 60, 90, 120, and 150 minutes following the ingestion of the drug.

Intramuscular Urography.—A more recent innovation in these difficult circumstances is excretory urography by the intramuscular route. Specially prepared *diodone* is the solution used. After anæsthetization of the skin with novocain, the injection is made into the thighs in doses varying from 10 to 20 c.c in children, to from 20 to 30 c.c. in adults. By moving the needle occasionally the fluid is more widely diffused. Employing suprapubic compression, the first film is taken after five minutes and further ones after thirty minutes (Hunt and Popma).

RETROGRADE PYELOGRAPHY

We will assume that ureteric catheters have been placed in position and the patient has been taken to the radiological department.

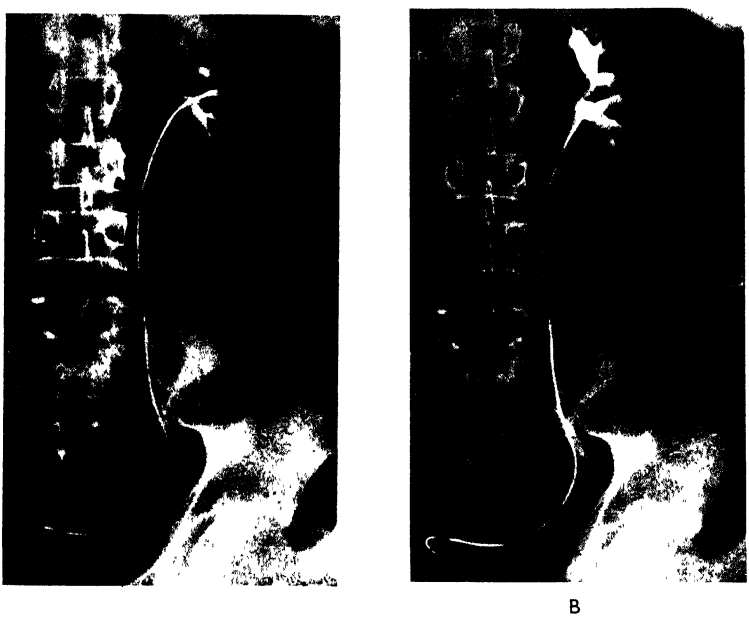
Solutions.—Sodium iodide in a 12·5 per cent concentration casts a good shadow, is readily procurable, and can be conveniently sterilized by boiling. Uroselectan B and abrodil in 20 per cent solutions are particularly free from irritation, and are now on the market in small ampoules especially prepared for retrograde use. Uropac is also an excellent medium ; the solution as supplied

* The house surgeon should be extremely vigilant when injecting these radio-opaque media. Cellulitis, superficial sloughing, and permanent injury to the median nerve have all resulted following injection into the perivenous tissues. So frequent are these happenings that they have become a matter of serious concern to societies protecting medical practitioners. If the patient complains of pain during the injection, it is foolhardy to continue it. Stop the injection at once and apply a hot fomentation to the arm. Warn the patient that the arm may become painful and the skin inflamed, and arrange for him to report to you daily for four or five days.—*Ed.*

in the ampoules should be diluted with four times its volume of sterile distilled water.

Amount to be injected.—The normal pelvis and calices require, on an average, 7 c.c. of solution to fill them. In the case of a hydronephrosis considerably more fluid can be injected. The criterion of the quantity to be injected is furnished by the conscious patient. He should be made to understand clearly that he is to report the moment he feels even slight discomfort in the loin.

Technique.—A sterile towel is placed beneath the available portion of the ureteric catheter. The hands are sterilized and a sterile 20-c.c. syringe is filled



B

Fig. 165.—A, Retrograde pyelogram showing pelvis incompletely filled. B, More solution has been introduced and pelvis is now completely filled.

with the warm contrast medium. To have a bubble of air in the syringe serves as a simple means of estimating the pressure exerted; when the bubble is compressed, undue pressure is being applied. A hypodermic needle of a suitable size to fit the end of the catheter is fitted to the syringe, or a special pyelographic point can be employed. Slowly and steadily the contrast medium is injected. At the occurrence of the first discomfort the procedure is interrupted and a film exposed. The film is developed and examined. If the pelvis is incompletely filled a further injection is made. In order to avoid accidents the following are useful rules:—

1. *It is wiser to inject too little than too much solution. If there is any doubt, it is better to restrict the amount to* 3 *c.c., since, if evidence of incomplete filling* (*Fig.* 165) *is forthcoming, the amount can always be increased at a later date.*

2. *On no account should an injection be made against resistance, and on no account should a painful response be neglected.*

When the final films have been taken, aspirate the fluid from the renal pelvis and remove the catheter.

CYSTOGRAPHY

The Catheter Method.—The technique is simple and a 3 per cent solution of sodium iodide is usually sufficient to cast a good shadow (*Fig.* 166); stronger concentrations are liable to irritate the mucosa and are generally unnecessary. If, however, a greater density is demanded, a 5 per cent emulsion of silver iodide can be recommended.



Fig. 166.—Retrograde cystogram showing multiple diverticula of the bladder.

Having passed a catheter, the urine is evacuated and a plain film exposed to show possible calculi or encrustations of the bladder wall. From a funnel and tube the warm solution is slowly introduced into the bladder until the point of discomfort, when the catheter is occluded and a penile clamp applied to prevent regurgitation along the urethra. Incomplete filling is the commonest cause of error in the interpretation of the cystographic picture. A film exposed at this stage, with the patient in a moderate Trendelenburg position, clearly shows the size and shape of the bladder and any irregularities thereof. As, however, the vesical shadow might mask a pouch, a further picture is taken after evacuating the fluid through the catheter. The emptying of a diverticulum may be gauged by placing the patient in the prone position for a few minutes and taking yet another film. Films in the vertical position are taken when cystography is used to demonstrate funnel-neck deformities or obstructions due to urethral valves.

The Excretory Method.—Where urethral obstruction renders catheterization difficult, or when inflammation makes instrumentation undesirable, cystography by the descending route possesses evident advantages. An exposure made about twenty minutes after the intravenous administration of 20 c.c. of uroselectan B or perabrodil often gives an excellent shadow of the bladder.

URETHROGRAPHY

Solutions.—Lipiodol (5 per cent) in sterile olive oil gives a bland solution with good contrast capacity. Neo-hydriol fluid casts an excellent shadow, and, being less viscid than lipiodol, it readily permeates the small para-urethral recesses.

Contra-indications.—For fear of embolism, recent intra-urethral manipulations call for delay in performing the examination, and the presence of urethral hæmorrhage is an absolute contra-indication.

Position for Radiography.—The correct position is important, as an uninterrupted view of the entire urethra is essential. This may be obtained by placing the patient in the dorsal recumbent posture, inclined somewhat to the left, with the left

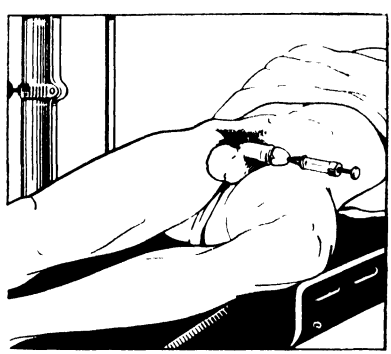


Fig. 167.—Urethrography. Position of patient on the X-ray table

leg flexed at the hip and the right leg extended (*Fig.* 167). A preliminary radiograph to include the whole pelvis is then taken.

Technique. — After evacuation of the bladder, the external meatus is scrupulously sterilized and the warm solution injected from a 20-c.c. Record syringe fitted with a conical rubber tip, the glans being compressed to prevent regurgitation of the medium. Instillation proceeds steadily and gently with adequate protection of the surgeon's hands when the films are being taken. At no time during the injection should undue pressure be exerted. Having inserted about 15 c.c., it is necessary —in order to secure a satisfactory picture of the posterior urethra — to continue the injection of the remaining 5 c.c. while the exposure is being made. Spasm of the sphincters is obviated by asking the patient to attempt micturition towards the completion of the injection, the X-ray being taken whilst the patient is endeavouring to urinate (*Fig.* 168).



Fig. 168.—Urethrogram. Case of bore stricture of the bulbous urethra.

In the majority of cases the above method suffices. To obtain a very complete urethrogram, a slightly more elaborate technique (J. Kemble) may be employed; five radiographs are required :—

1. A plain anteroposterior view of urethra, prostate, and bladder regions.
2. A–P view with 10 c.c. of radio-opaque fluid injected.
3. A–P view with injection of 20 c.c. of fluid completed.
4. Right oblique view at an angle of 45°.
5. Left oblique view at an angle of 45°.



Fig. 169.—Radiograph of normal seminal vesicles following lipiodol injection. The outline of the vasa deferentia is clearly seen (*From Sicard and Forestier's collection.*)

THE GENITAL TRACT

Seminal Vesiculography.—Uroselectan B (20 per cent) and lipiodol (40 per cent) are excellent contrast agents; they can be conveniently introduced by means of a small needle inserted into the lumen of the vas after its identification through a short incision made under local anæsthesia just below the external abdominal ring. From 2 to 3 c.c. is an average dose to give a complete vesiculogram (*Fig.* 169).

To prevent the shadow of the pubic bones from obscuring that of the vesicles, the radiograph is taken with the patient raised slightly at the shoulders. Overflow of the medium into the bladder, if masking the view, is removed by allowing the patient to micturate.

A peripheral injection can also be made, but as a rule the lumen is only outlined as far as the globus minor.

Hysterosalpingography.—First, pregnancy must be irrefutably excluded, by biological tests if necessary. With the patient in the lithotomy position, the vagina is irrigated with flavine solution and the cervix exposed by the aid of a speculum. The cervical lips are grasped with tenaculum forceps, the canal being then dilated if necessary. A strong 20-c.c. syringe, attached by rubber tubing to an olivary-tipped uterine cannula, is filled by pouring warm undiluted lipiodol into the barrel and then replacing the piston. The conical end of the cannula, inserted into the cervical canal, is maintained firmly in position, for, unless its junction with the cervix is tight, reflux of the oil is particularly prone to occur. Under control of the fluorescent screen, the lipiodol is gently injected, the procedure being stopped at the onset of pain. The amount inserted should at first be small, in the region of 3 c.c., larger quantities being later introduced according to the radiological findings.



Fig. 170.—Hysterosalpingograph. Right Fallopian tube patent, left occluded.

Under normal conditions the uterine cavity is seen as a dense triangular opacity, from the upper angles of which the Fallopian tubes proceed laterally as linear shadows which widen at their ampullary extremities. The radiological demonstration of a few drops of oil within the abdominal cavity is conclusive evidence that the tubal pathway is patent. (*Fig.* 170.)

THE GASTRO-INTESTINAL TRACT

Preparation for Opaque Meals.—Powders containing bismuth are omitted for three days prior to the test. No aperient should be taken the night before the



Fig 171.—Pneumoperitoneum. Crescents of gas below the diaphragm. Direct film taken with portable apparatus in a case of perforated peptic ulcer.



Fig 172.—Plain film of the abdomen in lateral position, showing fluid levels in a case of intestinal obstruction.

examination, and no food or drink whatever be allowed on the morning of the examination. The meal is best given at about 9 a.m. or 9.30 a.m., and the subsequent taking of food must necessarily depend on the emptying time of the stomach. It is important, in cases where an examination of the whole

gastro-intestinal tract is required, that the stomach be quite empty of the opaque meal before any other food is taken, otherwise this will mix with the opaque residue and complicate the findings.

Preparation for Opaque Enema.—A mild aperient should be given on the two nights before the examination, followed by a plain warm water enema on the morning of the examination. It is extremely important that all fæcal material should be cleared from the colon before the opaque enema is given, and that no soap be used for the colonic lavage.



Fig. 173.—Opaque enema showing typical deformity of early intussusception.

Radiography as a Diagnostic Aid in Acute Abdominal Conditions.—Apart from excluding calculi, direct radiography of the abdomen is sometimes employed in urgent surgery. By using a modern portable apparatus, valuable information is obtained with little discomfort to a patient in Fowler's position. In the flat plate, the characteristic crescent of translucency beneath the dome of the diaphragm (*Fig.* 171) establishes the presence of pneumoperitoneum in the anomalous case of perforated peptic ulcer. This radiological demonstration of pneumoperitoneum can be an invaluable help when rupture of the intestine is suspected, particularly in air-raid casualties afflicted with multiple injuries. On the left side, however, be careful not to mistake the shadow of gas in the gastric fundus for that of air in the peritoneal cavity. Distended coils of intestine with horizontal fluid levels confirm an obscure intestinal obstruction (*Fig.* 172). An opaque enema is particularly helpful in the atypical or early case of intussusception (*Fig.* 173).

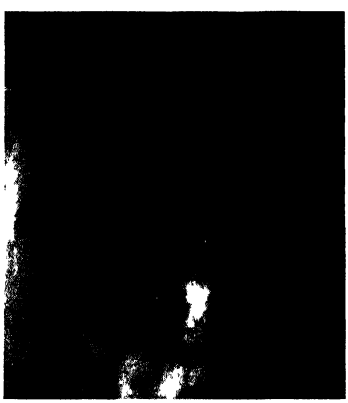


Fig. 174. — Cholecystogram showing multiple filling defects due to multiple gall-stones

CHOLECYSTOGRAPHY

Opaque Media. — Of the preparations available, opacol and shadocol are not unpleasant to take and are commonly employed, full details of the respective doses being supplied by the manufacturers.

Preparation and Radiography. — An aperient, preferably one to which the patient is already accustomed, should be given thirty-six hours beforehand—and to obviate gas formation it is advisable to have the patient up and about as much as possible prior to the test. Pitressin injected intramuscularly in doses of 1 c.c. (two and a half hours and half an hour before taking the films) is of considerable value in dispelling confusing intestinal shadows. In all cases of a suspected lesion of the gall-bladder, a preliminary radiograph is indispensable.

On the day preceding the examination the patient is allowed his usual diet up to and including tea. At 6 p.m. he takes a light meal (free from fats), and one hour later swallows the dye well stirred in half a glass of water. During the subsequent hour water is taken in sips, but thereafter no food is permitted until the examination is completed on the next day, the first radiograph being made at the fifteenth hour following the ingestion of the dye. Should the initial film show only a faint shadow, a further plate is exposed one hour later (*Fig.* 174). When a good outline of the gall-bladder has been obtained, a fatty meal consisting of cream, butter, and eggs is given and radiographs are again taken; these show the emptying capacity of the gall-bladder, and often detect stones which may only be visible in the partially evacuated viscus.

INTENSIVE ORAL CHOLECYSTOGRAPHY

P. Kerley's method of intensive or double-dose cholecystography usually takes about an hour for the complete examination; the technique is simple and, with the aid of a compressor, sufficiently good concentration is obtained.

Immediately after lunch on the day prior to the examination, the patient takes 2 g. of the dye. At 7 p.m. he has a fat-free dinner and takes 4 g. of the dye an hour after this; during the evening a bottle of alkaline water is drunk. The examination takes place between 10 a.m. and 11 a.m. on the next day. If the first pictures in the prone position show a good shadow, another picture is taken in the erect posture. Further plates are taken 5, 10, and 30 minutes after a fatty meal.

POST-OPERATIVE CHOLANGIOGRAPHY

The injection of an opaque substance to visualize the biliary tract is now a standard post-operative procedure in cases where the common bile-duct has been drained. With the aid of a portable apparatus it can be carried out with the patient in bed.

The ramifications of a biliary fistula are well shown, and, what is most desirable, the radiological picture supplies positive proof as to whether the common duct is patent or not (*Figs.* 175, 176). Sometimes calculi are discovered in the ducts when least suspected, and characteristic deformities of pancreatic compression may be forthcoming.



Fig. 175.—Showing great distension of the common bile-duct and constriction of its lowermost part due to a carcinoma of the pancreas. Post-operative cholangiograph.

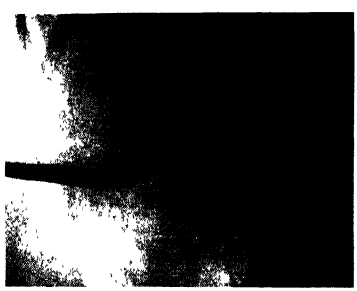


Fig. 176.—Radiograph after lipiodol has been injected down a T-tube lying in the common bile-duct, showing that the pathway to the duodenum is unobstructed. (*W. B. Gabriel.*)

The Opaque Medium. — Pure lipiodol is too viscid and its dense shadow sometimes masks a calculus. *Lipiodol and olive oil* (equal parts) is most satisfactory. *Hippuran* is also to be recommended.

Preliminary Preparations and Precautions.—Cholangiography is always to be performed with the patient fasting. To demonstrate whether or not there exist any calcifications in the upper abdomen, a direct film is a necessary preliminary. The injection must be slow and should cease if the patient experiences any pain.

Technique.—A 20-c.c. glass syringe is eminently suitable. First ascertain that its nozzle will accurately fit the tube draining the biliary tract. Discrepancies in size are readily overcome by rubber tubing and a glass connexion. Remember to hold these laterally during the examination so that their shadows are not superimposed upon those of the injected ducts.

A small pack of gauze around the drainage tube is a useful safeguard to protect the abdominal wall from any opaque solution which might regurgitate around the tube during the injection and so obscure the films.

Place the opened ampoule of the opaque substance in a bowl of warm water. Fill the syringe with the warmed contrast medium and take care to exclude all air bubbles, for these give ' false shadows ' which closely simulate calculi on the radiological film. Commence the injection slowly and proceed slowly, stopping if the patient indicates any pain. After 10 c.c. have been introduced, remove the protective gauze, and take the first film, while the patient holds his breath. Usually this amount is sufficient, but if not, a further 5 c.c. is injected and a second plate taken. Finally aspirate the fluid introduced.

EXCRETORY UROGRAPHY IN INFANTS

By ELLIOTT EMANUEL

Excretory Urography has the same advantage and limitations for children as for adults. Iodoxyl (uropac, uroselectan B) is the compound commonly used. The sagittal sinus must be avoided owing to the risk of thrombosis or extravasation into the subarachnoid space, and the cephalic vein is to be preferred to the median basilic owing to the risk of median neuritis if fluid is extravasated. The dose is 6 c.c. at one year, plus 1 c.c. for each year of age to 20 c.c. at 15 years. Infants should be starved of fluid for six hours before this investigation, and older children for twelve hours. A mild laxative is given on the previous evening, and children should, if possible, be up and walking about in the twenty-four hours before the injection is given, in order to dispel intestinal gas. If a child has a history of any allergic manifestations, a syringe with 1–1000 adrenaline should be at hand. Intramuscular administration of the dye must sometimes be resorted to, although the intravenous route is superior. Diodone (uriodone, perabrodil, diodrast) is preferable to iodoxyl as it is less irritant; a total of 10 to 20 c.c. is injected through a wheal of procaine into the upper outer quadrant of each buttock, the amount being divided between the two sides, and the position of the needle in the muscle varied to distribute the fluid. Excretion is slower than with intravenous injection, and visualization may be best after two hours or later.

CHAPTER XX

THE HOUSE SURGEON AND THE RADIOLOGICAL DEPARTMENT (II)

By F. DUDLEY HART

BRONCHOGRAPHY

By bronchography is meant the outlining of the bronchial tree by introduction of a suitable non-toxic radio-opaque substance. Iodized oils which are radio-opaque are used for this purpose, and the ones commonly used are said not to cause iodism unless swallowed. Neo-hydriol (May & Baker) should be gently heated to body temperature, as should also lipiodol (Lafay). The latter is now difficult to obtain.

The lipiodol may be introduced into the respiratory tract in a variety of ways : (*a*) By injecting through the cricothyroid membrane ; (*b*) By injecting directly into the bronchi via a bronchoscope ; (*c*) By injecting over the back of the tongue ; (*d*) Through the nose ; and so on. For general purposes the first—given a reasonable degree of skill—is best, as it is usually the quickest, gives the best pictures, and is somewhat easier to perform than the others.

Indications.—To reveal any abnormality in size or shape of any of the larger bronchi, and to localize such abnormalities, only one side of the chest should be filled at a time. This should be done completely at the one sitting, anteroposterior and lateral films then being taken. Lateral views, so essential to localization of a lesion, are of no use when both sides of the chest have been filled, for the picture is then a confused blur. Lateral views should be taken as a routine in addition to anteroposterior views. In seven to ten days the lung will have cleared sufficiently for the other side to be done.

Contra-indications.—A weak, feeble, or febrile patient should not be subjected to bronchography, nor patients with marked cardiac decompensation. Cocaine-sensitive patients should not receive this drug. In a case of pulmonary tuberculosis it complicates the radiograph and may do harm to the patient.

Precautions.—Sensitivity to the substances used should be tested for some days beforehand. Three minims of 5 per cent cocaine hydrochloride are injected subcutaneously, and the patient watched for the next half hour. A transitory feeling of discomfort may be disregarded, but anything more considered as a danger sign. Reactions are faintness, flushings, dilated pupils, nausea, sickness, or acute distress.

Reactions to iodine only occur when lipiodol is swallowed, and this should not happen. The reactions occur some days later—skin rashes and puffiness of the face. Potassium iodide, 20 to 30 gr., is used as a test for iodine intolerance. Many patients during and after bronchography cough the oil into their mouth and then swallow it. They should therefore be warned against this and, after the films have been seen and passed as wet plates, encouraged to expectorate as much as possible. If lipiodol on screening is seen to have entered the stomach of an iodine-sensitive patient, it should be washed out immediately afterwards. Instead of lipiodol, bromipin may be used in iodine-sensitive cases if there is no

sensitiveness to bromides. Before starting bronchography it is wise to make sure that bronchiectatic areas are as nearly as is possible emptied of secretion, and adequate postural and postural-percussion drainage (*see* p. 121) should be carried out for several days beforehand. If this is not done the bronchi fail



Fig. 177.—Armamentarium for bronchography.



Fig. 178.—Position of patient for injection to fill the basal bronchi

to fill, or the oil may give a false appearance of a blocked bronchus. If a cavity is large and full of fluid secretion the oil may float on the surface as globules, giving no hint as to the size of the cavity.

Armamentarium.—This is illustrated in *Fig.* 177. The special needle for instillation of the oil on the left of the picture should be short, with a shaft of not more than 2 cm. in length, and of wide bore (2 mm. at least).

Technique.—

1. Prop the patient up on the couch with the shoulders raised on several pillows and the laryngeal promontory pointing upwards, and inject 10 minims or so of novocain over the cricothyroid membrane, felt as a depression just below the promontory of the larynx.



Fig. 179.—The position for filling the middle lobe or the corresponding bronchus on the opposite side.

2. With a longer, thicker needle inject 4 minims of 5 per cent cocaine hydrochloride into the larynx through the area anæsthetized. Withdraw the plunger and suck in air first, to be certain the point of the needle is in the trachea and not in the surrounding tissues. Inject rapidly and withdraw the needle at once, as the patient immediately coughs and may break the needle in his neck.

3. Pour the neo-hydriol (20 c.c.) into the special 25-c.c. syringe, attach the special needle, and introduce into the larynx. Withdraw the plunger as before, and when in the larynx raise the patient's opposite shoulder to allow the lipiodol to run only into the side required. Introduce 7 c.c. and wait one minute. This fills the basal bronchi (*Fig.* 178).

4. With the needle and syringe in situ, make the patient sit and lean with the opposite shoulder forwards to look down towards the floor on the affected side. Inject 6 c.c. and wait two minutes. This fills the middle lobe on the right side or the corresponding bronchus on the left (*Fig.* 179).

5. Lay the patient on the affected side, inject as rapidly as possible the remaining 7 c.c., and *rapidly* elevate the feet, so that the patient is lying with his head 12 inches or more below his heels, half on his side, half on his face. Remove the needle and leave him thus for two to three minutes. This fills the apical bronchi (*Fig.* 180). For this stage, if it is impracticable to elevate the couch at the foot, a stretcher may be used on which the patient lies from the beginning.



Fig. 180.—Position for filling the apical bronchi.

6. Take the films from a distance of 6 ft., anteroposterior and lateral, or any other view desired. Screen if desired. Warn the patient not to cough or swallow

from the time of the injection of cocaine to the time the radiograph has been seen and passed. The films are taken in full unforced inspiration and should be of fairly great penetration (i.e., an increase in 10–15 kv. on normal exposure).

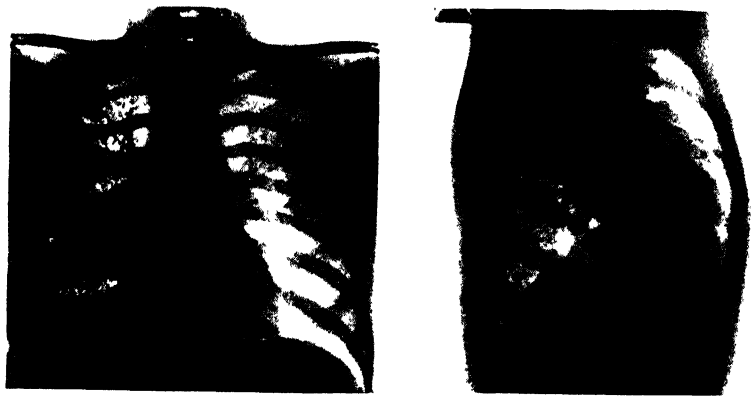


Fig. 181.—A, Right bronchogram, normal filling. B, Right bronchogram, lateral view normal filling.

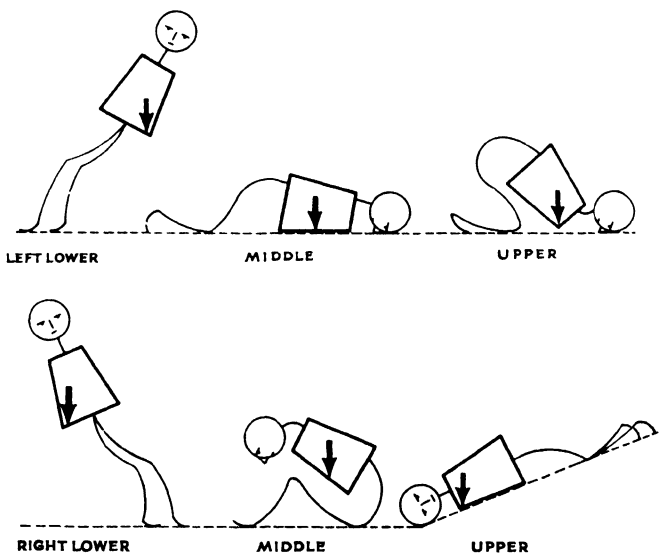


Fig. 182.—By adopting the positions indicated all lobes can be filled

(*Fig.* 181.) Only by using these postural methods can one be sure of filling all the zones of a lung. If the lesion is thought to be in the apex, the picture should be taken with the patient still in the position shown in *Fig.* 180.

Holmes Sellors points out that all lobes can be filled if suitable postures are adopted, and he has furnished the series of self-explanatory diagrams (*Fig.* 182) which make further description unnecessary.

In cases of bronchiectasis when postural drainage is being practised, screening two to four days later may reveal iodized oil in cavities undrained. This calls for improvement in the technique of posturing for the affected area.

BRONCHOGRAPHY IN INFANTS

By ELLIOTT EMANUEL

The procedures employed with adults, using local anæsthesia, are inapplicable to children under ten, and since a general anæsthetic is necessary, use may be made of the fact that under deep anæsthesia lipiodol introduced into the pharynx is aspirated into the bronchial tree. Postural drainage of the lungs is instituted for a week, and one side is chosen for visualization, say the left. The patient is given atropine and a basal narcotic and deep ether anæsthesia is induced. He is now raised into a sitting position with the trunk inclined to the left, the chin forward, and the tongue pulled forwards with tongue forceps. Warmed viscous lipiodol (neo-hydriol, iodatol, oleum iodisatum) is introduced into one nostril by means of a syringe attached to rubber tubing 2 in. long, and may be heard gurgling as it passes the larynx ; 6 c.c. is appropriate for a child of 4, 10 c.c. for a child of 10. When half the amount has been introduced the trunk is bent well forward for two minutes to fill the ventral bronchi ; the remainder is now introduced and the trunk bent backwards (always with an inclination to the left) to fill the dorsal bronchi. Anteroposterior and lateral films are now taken.

CHAPTER XXI

THE HOUSE SURGEON IN THE PATHOLOGICAL DEPARTMENT

By B. JOAN HARAM

THE house surgeon is the liaison officer between the pathological and the surgical departments. He will find this work interesting and stimulating; his keenness in this direction quickly bears fruit to the mutual advantage of all concerned.

I. THE COLLECTION OF SPECIMENS FOR PATHOLOGICAL INVESTIGATION

A. GENERAL

1. It is most important that all specimens be clearly labelled with the patient's name, age, ward, the nature of the specimen, and the date of collection.

2. Each specimen should be accompanied by a request form giving a few clinical notes concerning the patient, including the length of his illness (an essential point in the case of blood sent for the Widal reaction, for example), and stating the nature of the investigation required.

3. All specimens should reach the laboratory as soon as possible after collection.

B. PROCEDURE FOR CERTAIN SPECIAL INVESTIGATIONS

1. Tissues for Histological Examination.—These should be put into suitable containers and immediately covered with 10 per cent formol saline. Soft tissues such as the brain should be placed on a layer of cotton-wool. The amount of fixative must be adequate for the size of the specimen.



Fig. 183.—Screw-capped bottle for pathological specimens. (*United Glass Bottle Co.*)

Material from diagnostic biopsies, such as endometrial or bronchial epithelium, must be handled particularly carefully.

The best fixative for these small specimens has been found to be *formol-corrosive*, prepared as follows: 10 parts of commercial formalin are added to 90 parts saturated aqueous solution (5 6 per cent) of mercuric chloride. To this is added enough saturated acid fuchsin to give a pale pink colour.



Fig. 184.—A swab stick. This pattern enables the surgeon in the operating theatre to handle the stick without contaminating his sterile gloves.

2. Specimens for Culture.—Pleural, ascitic, or cerebrospinal fluid, and samples of pus should be sent in sterile test-tubes or screw-capped bottles (*Fig.* 183). In the case of pleural fluids, part should be collected into a dry container and part into a tube holding a few crystals of potassium oxalate to prevent coagulation.

3. Throat, Nasal, Cervical, and Other Swabs.—Sterile swab sticks in sterile test-tubes are supplied for use in the wards and theatres (*Fig.* 184). The swab is rubbed over the affected area and quickly returned to the container, which is sent to the laboratory before the material to be examined has had time to dry.

In the absence of the pathologist it is advisable to culture the swab in a tube of some routine medium. If diphtheria is suspected, the swab should be cultured on Loeffler's medium (*Fig.* 185), an opaque white substance consisting of inspissated serum.

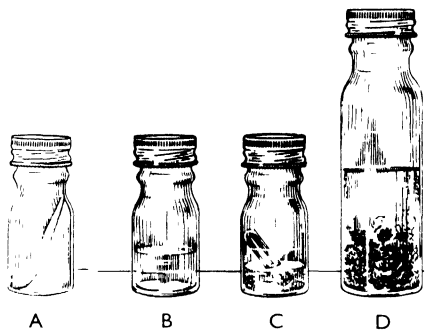


Fig. 185.—Bottles containing media. A, Sloped medium (nutrient agar) for culture of various swabs; B, Fluid medium (serum broth), for culture of various swabs; C, Durham's fermentation tube in lactose peptone water, for routine culture of urine; D, Cooked meat medium, for anaerobes.

Culturing a Swab.—The technique, which requires a little practice, is shown in *Fig.* 186. It is advisable to loosen the screw cap of the bottle before commencing the procedure. After completing the culture the swab should be smeared over the centre of a microscope slide (*Fig.* 187). The smear can then be stained and examined if required.

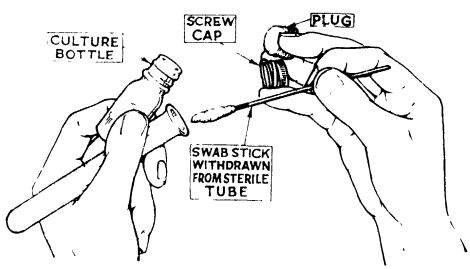


Fig. 186.—The technique of inoculating culture medium.

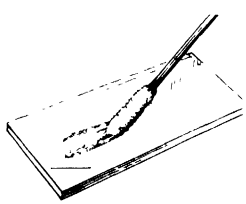


Fig. 187.—Method of making a smear on a microscope slide.

In the case of a vaginal discharge to be examined for *Trichomonas vaginalis*, the swab should be rotated in a tube containing about 2 c.c. of warm saline and examined immediately.

If this is impracticable, the tube should be placed in the incubator. The trichomonas have pear-shaped bodies, a single nucleus, and three to five flagellæ. They are 5–7 μ in size (*see Fig.* 198).

4. Collection of Blood.—Certain investigations are carried out on serum and others on plasma. The principle tests are performed as follows :—

a. On serum :—

Wassermann reaction.
Kahn reaction.
Gonococcal complement-fixation test.
Calcium content.
Sodium content.
Potassium content.
Phosphatase content.
Cross-matching with donor's red cells.
Widal and other agglutination reactions.

b. On whole blood (i.e., non-coagulated blood) or plasma —

Urea content.
Uric acid content.
Inorganic phosphorus content.
Protein content.
Chloride content.
Cholesterol content
Sugar content.
Sedimentation rate.

To Obtain Serum.—From 5 c.c. to 10 c.c. of blood are withdrawn by venepuncture, using a sterile syringe free from alcohol or other spirit. The blood is transferred to a dry sterile test-tube, centrifuge tube, or screw-capped bottle and allowed to clot. The amount of serum obtained is approximately half the volume of the blood withdrawn.

To Obtain Whole Blood or Plasma.—Blood is withdrawn as in the case of serum, but placed in a tube containing several crystals of potassium oxalate and shaken to prevent clotting.

Exceptions —

a. For blood-sugar estimations, sodium fluoride is used instead of oxalate. This prevents glycolysis

b For the sedimentation-rate estimated by Westergren's method, 3 8 per cent sodium citrate is used as the anticoagulant, 1 6 c.c of blood being added to 0 4 c.c. of citrate.

c For chloride and inorganic phosphate estimation, the blood must be centrifuged immediately after collection and the plasma separated without delay.

d. For blood-culture, the skin in the antecubital fossa is cleaned especially thoroughly with spirit and ether, and 5 to 10 c c of blood removed with a sterile, dry syringe. Varying amounts of blood are then added to three or four culture tubes containing different fluid media such as broth, glucose or serum broth, and cooked meat medium

A convenient tube for the collection of blood is sold by Bayer Products Ltd., and is called a Behring venule (*Fig.* 188). Plain tubes and tubes containing

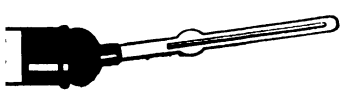


Fig. 188.—The Behring venule.

oxalate, fluoride, broth, etc., are supplied. The needle is encased in a glass sheath. A ' vacuum " in the tube draws up the blood from the vein. These tubes are particularly convenient when specimens of blood have to be sent through the post.

II. THE TECHNIQUE OF CERTAIN EXAMINATIONS

A. EXAMINATION OF BLOOD

The following are among the most important of the investigations which the house surgeon may be called upon to carry out himself.

1. Cross-matching and Blood Grouping as a Preliminary to Transfusion.—Now that stored blood is readily available to most hospitals through the Blood Transfusion Service, the house surgeon will in many cases find it necessary only to cross-match the patient's serum with the red cells from the bottle of Group O blood which he proposes to use.

For this test about 0·5 c.c. to 1·0 c.c. of blood is obtained from the patient's ear (*Fig.* 189). The blood is collected in a small dry tube and centrifuged or allowed to clot. When the serum has separated, a drop is placed on a slide and a drop of the stored Group O cells is removed from the bottle with a sterile pipette and mixed with the serum. If no agglutination occurs after 10 minutes, the donor's cells are compatible with the patient's serum. In a desperate emergency it may be justifiable to transfuse a patient with a bottle of Group O blood without a preliminary cross-matching, but a certain amount of risk always attends such a procedure

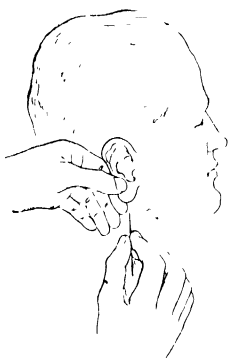


Fig. 189.—Method of obtaining a specimen of blood from the lobule of the ear.



Fig. 190.—A glass slide is labelled A and B as shown, with a skin pencil. A drop each of stock serum Group A and Group B is placed appropriately

When it is desirable to transfuse a patient with blood of his own group, this is ascertained in the following manner: A few drops of blood are collected from the ear as before, but transferred to a small tube containing a little 2 per cent sodium citrate. A microscope slide is labelled A at one end and B at the other, and a drop each of stock serum Group A and Group B is placed at the appropriate end of the slide (*Fig.* 190).

A drop of the patient's citrated blood is added to each drop of serum and mixed with a platinum loop. The latter is carefully dried in a flame or on blotting paper between the two manipulations. The slide is gently rocked and examined with the naked eye in a good light. If agglutination occurs, the redness of the drop becomes patchy and may be likened to granules of cayenne pepper. If no agglutination occurs after ten minutes the patient belongs to Group O. If agglutination occurs with the A serum the patient belongs to Group B, if with the B serum the patient belongs to Group A, and if with both sera, to Group AB. (*Fig.* 191.)

The international classification of the blood groups has now almost entirely superseded the classification of Moss.

If more convenient, the patient may be grouped by pricking the ear and adding one drop of blood directly to the Group A serum and another drop to the

Group B serum, care being taken to wipe the ear thoroughly between squeezing out the two drops of blood. By this method no anticoagulant or collecting tube is necessary.

After establishing the group of the patient and selecting a suitable donor of the same group, a cross-matching test should always be carried out as a confirmatory measure.

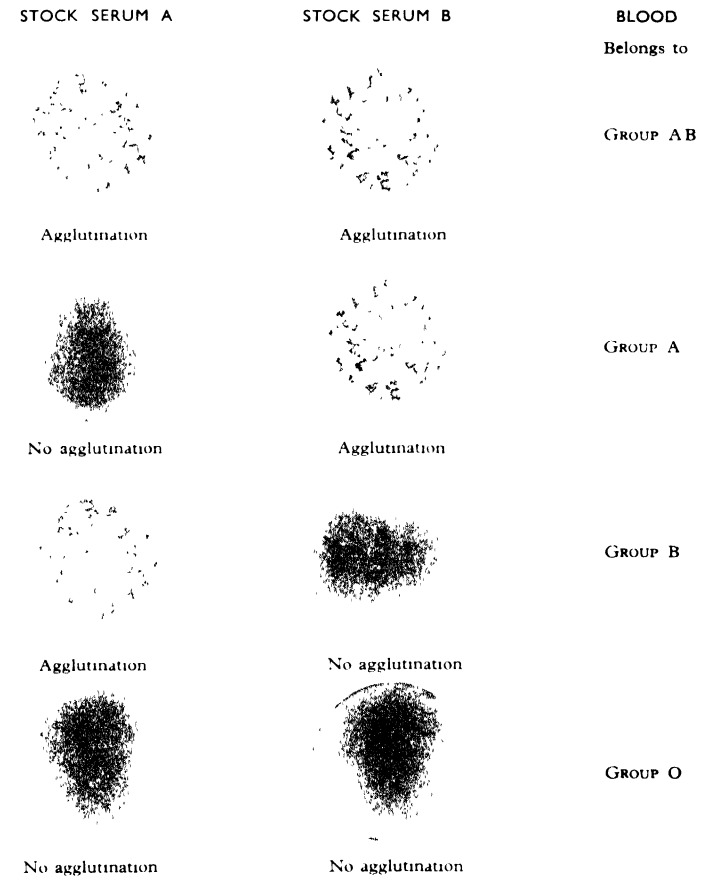


Fig. 191.—Chart showing method of identifying the different blood groups.

2. Estimation of Hæmoglobin.—The house surgeon will probably find it most useful to be familiar with the Sahli method as this can be used by daylight or by artificial light, and most laboratories are equipped with the apparatus (*Fig.* 192).

The Sahli Method.—The graduated tube is filled to the mark 10 with $N/10$ hydrochloric acid. The patient's ear is pricked, and after wiping away the first two drops, 20 c.mm. of blood is collected in the marked pipette. The tip is

wiped and the blood blown out to the bottom of the acid, the pipette being rinsed by drawing acid in and out a few times. The hæmoglobin is converted into acid hæmatin and the apparatus is allowed to stand until conversion is complete. This may take 5 to 30 minutes according to the graduation of the instrument. The fluid is then diluted with distilled water until it matches the standard.



Fig. 192.—Sahli's haemoglobinometer.

As different instruments have standards which represent different amounts of hæmoglobin per 100 c.c. of blood, it is essential that the observed reading be adjusted so that 100 per cent is equivalent to 14·5 g. of hæmoglobin per 100 c.c. blood.

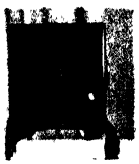


Fig. 193.—The Lovibond comparator.

The Lovibond Comparator (*Fig.* 193) is a pocket-sized apparatus for hæmoglobin estimation. Discs are supplied containing a range of colours. In place of the test-tube a special blood cell is provided. This consists of a welled slide fitted with a cover plate. Whole capillary blood, fresh or oxalated, is run into the cell, which is placed in position in the comparator, and the colour is matched against the standard. A disadvantage of this apparatus is that it can be used with accuracy only in daylight.

3. Leucocyte Count.—A leucocyte count is often required urgently. The ear is pricked as before and blood drawn up to the mark 0·5 on the white-cell pipette (*Fig.* 194)

Diluting fluid consisting of 1 per cent acetic acid coloured with crystal or gentian violet is then sucked up until the level of the fluid reaches the 11 mark.

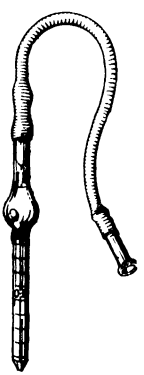


Fig. 194.—Pipette for counting leucocytes. Note the markings 0·5, 1, and 11, and the white bead.

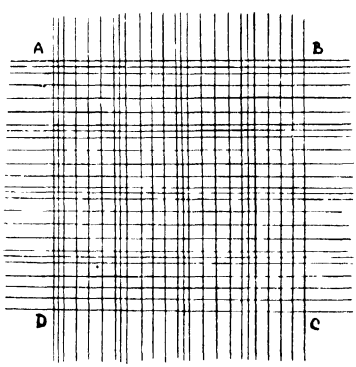


Fig. 195.—Thoma ruling of counting chamber as seen with ⅙-in lens. All cells in the area ABCD (1 sq. mm.) are counted

The ends of the pipette are covered by the thumb and middle finger respectively and the pipette is shaken in order to mix the diluent with the blood, care being taken that no fluid escapes. The count must be made within an hour of collecting the blood. After a further mixing of the contents of the pipette, about a third is blown out and a drop is then run in under the cover slip of the counting chamber, which must be scrupulously clean. The cells are allowed

to settle for five minutes. If a Thoma chamber is used, all the leucocytes in the whole of the cross-ruled area are counted. (*Fig.* 195.)

Calculation: The area is 1 sq. mm., and the volume one-tenth of a c.mm. The blood has been diluted 20 times (i.e., blood was drawn up to the 0 5 mark and diluted to the 11 mark). The total number of white cells per c.mm. is, therefore, the number counted multiplied by 200.

4. Differential Cell Count.—When collecting blood for hæmoglobin estimation or cell count, blood-smears should invariably be made. The appearance of the film will establish the presence of any degree of anæmia, leucocytosis, or leucopenia; in fact, a well-spread and carefully stained film may be a more reliable guide to diagnosis than a cell-count carried out by a tyro.

The smear must be made on a clean grease-free slide. A small drop of blood is placed at one end, and the end of another slide is placed over the drop and moved along to make the smear (*Fig.* 196). The more acute the angle formed by the spreading slide to the smeared slide, the thinner will be the blood-film which results. When dry, the smear may be stained with Leishman's stain or Jenner's stain.

Leishman's Stain.—The slide is covered with the stain for two minutes to fix it. About the same amount of distilled water is added and well mixed, a metallic sheen on the surface of the stain denoting that the correct proportions have been attained. After at least five minutes the film is washed with distilled water, leaving the water on the slide until the film has a mauvish-pink appearance. It is then left to dry.

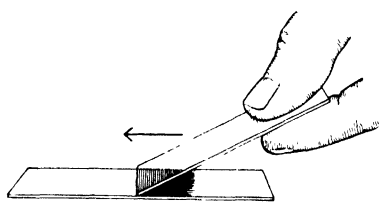


Fig 196.—Making a blood-smear

Jenner's Stain.—The slide is covered with the stain and left for about half an hour. It is then washed and distilled water allowed to remain in contact with the smear until a satisfactory differentiation is obtained. Usually a minute or two is adequate.

Before making the differential count the whole of the film should be examined with a low-power objective in order to acquire a general impression of the blood-picture and to see whether the smear has been evenly spread. Polymorphonuclear leucocytes tend to congregate at the edges of a film, so that to obtain a truly representative count the cells should be counted over a wide area, including those in the centre as well as those at the edge.

5. Sedimentation Rate.—The blood is collected into citrate as described, and after thorough mixing, drawn up into a Westergren tube which is graduated in mm. from 0 to 200. The tube is placed vertically in a special stand, the red cells gradually sediment, and the clear column of plasma is measured after one hour. The answer is expressed as follows: Erythrocyte Sedimentation Rate, x mm. in one hour.

B. EXAMINATION OF PUS

(*Figs.* 197, 198)

The colour, consistency, and smell should be noted, also the presence or absence of bubbles of gas, or the 'sulphur' granules which occur in actinomycosis.

A 'wet' preparation should be made by placing a drop of pus on a slide, mixing with a drop of methylene blue, covering with a coverslip, and examining

with a one-sixth objective. Polymorphs, epithelial cells, and crystals should be identified.

Smears for Staining.—To find out what organisms are present, a loopful of pus is spread thinly on a slide and stained.



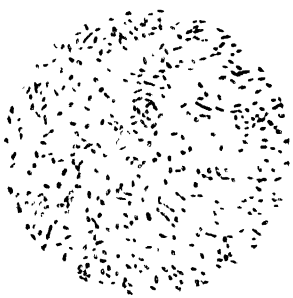
Staphylococcus pyogenes aureus.



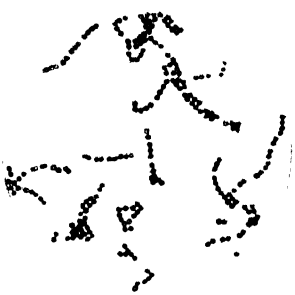
Gonococcus in pus.



Bacillus welchii, a bacillus of gas gangrene



Bacillus coli communis.



Streptococcus of scarlet fever.



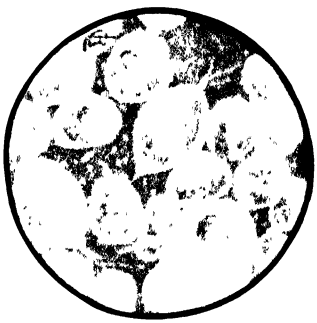
Bacillus tuberculosis (hominis) in sputum.

Fig. 197.—Illustrations of micro-organisms. (*Copyright of Messrs. Burroughs Wellcome & Co. (The Wellcome Foundation Ltd.). Reproduced by kind permission.*)

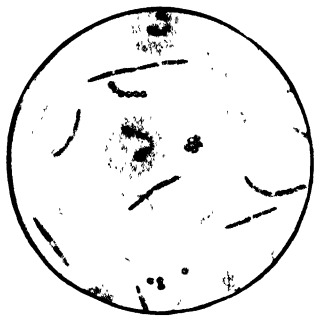
a. Gram's Method.—The smear is fixed by passing the slide quickly through the flame of a Bunsen burner. Débris is removed by washing with a 2 per cent solution of acetic acid. The slide is then covered with crystal or methyl-violet, which is almost immediately washed off with Gram's or Lugol's iodine.

After one-and-a-half to two minutes, the iodine is washed off with absolute alcohol or industrial spirit until no more violet stain comes away. The film is then counter-stained with neutral red or dilute carbol-fuchsin, and after ten or twenty seconds washed with water, blotted, and dried.

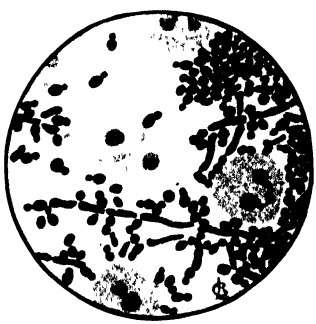
The slide is examined with a one-twelfth objective and it should be possible to recognize, or at least suspect, the presence of staphylococci, streptococci,

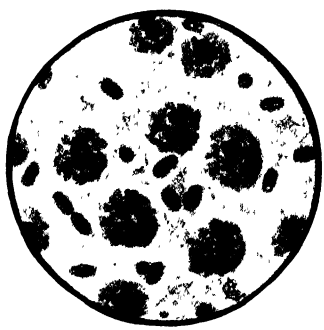


Trichomonas from a vaginal discharge.



Vincent's spirillum.





Pneumococci.

Fig. 198.

pneumococci, actinomycotic filaments, gonococci, and some of the Gram-positive bacilli such as *B. welchii* and *B. anthracis*.

b. Ziehl-Neelsen's Method.—This is used for the identification of tubercle bacilli. The smear is fixed as before and covered with strong carbol-fuchsin stain. The slide is heated until steam rises, and kept gently warmed for about ten minutes, care being taken to prevent the stain from drying. The slide is washed in water and then covered with alcohol. After five minutes the alcohol is washed off and the slide immersed in a small bath or jar containing 25 per cent sulphuric acid. After decolorizing for at least fifteen minutes it is removed,

washed in water, and counterstained with methylene blue for about thirty seconds. The excess is washed off and the slide is blotted, dried, and examined with the one-twelfth objective.

c. Weak Carbol-fuchsin.—If Vincent's stomatitis (*Fig.* 198) is suspected the smear made from the ulcer is stained for a minute with 5 per cent carbol-fuchsin and then washed with water. The typical fusiform bacilli and spirochætes show up clearly by this method.

The same stain can be used to reveal the presence of monilia found in thrush and also frequently present in vaginal discharges. These yeasts are oval bodies rather larger than a red blood-cell.

C. EXAMINATION OF CEREBROSPINAL FLUID

A full examination of the cerebrospinal fluid is somewhat outside the scope of the house surgeon, but a cell-count, using a Fuchs Rosenthal counting chamber, can be easily performed.

About 1 c.c. of the fluid is pipetted into a test-tube and stained for a few minutes with a loopful of crystal violet. A drop of the fluid is then run in under the coverslip on the counting chamber. All the cells in the cross-ruled area of the chamber are counted and the number obtained is divided by three. This gives the number of cells in 1 c.mm. of fluid, since the ruled area holds approximately 3 c.mm. of fluid. If the cells are too numerous to be counted by this method, a Thoma chamber is used instead and the necessary calculation made.

A purulent fluid from a case of meningitis should be centrifuged and the deposit stained by Gram's method. This will often reveal the causative organism such as the meningococcus, pneumococcus, or *B. pfeiffer.*



Fig. 199.—Film of fluid expressed by prostatic massage in a normal man. Stained Gram basic fuchsin, it shows prostatic cells, corpus amylaceum, polymorphonuclear leucocyte, urethral epithelial cells, with a few cocci and a diphtheroid. (Oil immersion. 1000.)



Fig. 200.—Film of prostatic fluid in a case of chronic prostatitis. Stained as in *Fig.* 199, it shows prostatic cells, urethral epithelial cells, numerous pus cells (very degenerated), staphylococci, streptococci, diphtheroid bacilli.

D. PROSTATIC AND VESICULAR MASSAGE

In cases of suspected acute or chronic vesiculitis, diagnosis can often be established by examination of the secretion obtained from prostatic and vesicular massage per rectum.

A drop collects at the external meatus and is placed on a microscope slide. This is immediately covered with a cover slip and excess fluid absorbed by means of blotting paper, the cover being lightly compressed during the process.

The bladder should always be emptied before massage. The slide is then examined microscopically with a one-sixth objective (*Fig.* 199).

A pathological fluid is more viscid than the normal secretion. On microscopical examination pus cells and bacteria (*Fig.* 200) are often plentiful.

E. EXAMINATION OF URINE

This is dealt with in Chapter VIII.

F. RENAL FUNCTION TESTS

The techniques for these are described in Chapter XXX.

G FRACTIONAL TEST-MEAL

This procedure is described in Chapter L.

III. PREPARATION OF PATIENTS FOR CERTAIN INVESTIGATIONS

1. *Basal Metabolic Rate.*—On the evening before the test, the patient's bed should be screened off from the rest of the ward. He should be given nothing to eat or drink after 7 p.m On the morning of the test he must not be disturbed for washing or other purposes and breakfast is omitted.

It is always advisable for the patient to be reassured and to have the test described to him on the day before it is to be carried out, as thyrotoxic patients, especially, tend to be apprehensive if they are screened without explanation and see complicated and imposing pieces of apparatus being assembled around their beds.

Besides being told the age and sex of the patient, the pathologist must also know his height and weight before performing this investigation.

2. *Examination of Stool for Occult Blood.*—No meat, green vegetables, or medicines containing iron, bismuth, or other heavy metals should be given for three days before submitting the specimen for this test, and the patient should be forbidden to clean his teeth with a toothbrush during the same period.

IV. TABLE OF LABORATORY NORMALS

DISTRIBUTION OF EUROPEANS IN THE FOUR BLOOD GROUPS.—
Group AB (I), 5 per cent.
Group A (II), 41 per cent.
Group B (III), 12 per cent.
Group O (IV), 42 per cent.

HÆMOGLOBIN.—
100 per cent (Haldane).
80 per cent (Sahli).

RED BLOOD-CELLS —
4,200,000 to 6,400,000 per c.mm.

WHITE BLOOD-CELLS.—
Total: 5000 to 10,000 per c.mm.
Differential:—

Polymorphs	Neutrophil, 60 to 70 per cent.
	Eosinophil, 2 to 4 per cent.
	Basophil, 1 per cent.

Large monocytes, 4 to 8 per cent.
Lymphocytes, 20 to 30 per cent.

IV. TABLE OF LABORATORY NORMALS—*continued.*

ERYTHROCYTE SEDIMENTATION RATE (Westergren's Method).—
3 to 5 mm. in one hour (men).
4 to 7 mm. in one hour (women and children).

BLOOD CHEMISTRY.—
Calcium, 9 to 11 mg. per 100 c.c.
Chlorides, 560 to 620 mg. per 100 c.c. (Plasma.)
Cholesterol, 100 to 220 mg. per 100 c.c.
Phosphatase (acid), 1 to 3 units. (King and Armstrong.)
(alkaline), 3 to 13 units. (King and Armstrong.).
Phosphorus (inorganic), 2 to 4 mg. per 100 c.c.
Potassium, 18 to 21 mg. per 100 c.c.
Proteins (total), 6·0 to 8·6 mg. per 100 c.c.
Sodium, 325 to 350 mg. per 100 c.c.
Sugar, 80 to 120 mg. per 100 c.c.
Urea, 20 to 40 mg. per 100 c.c.
Uric acid, 2 to 4 mg. per 100 c.c.

METHOD OF COLLECTING SPUTUM IN INFANTS

By ELLIOTT EMANUEL

Young children are rarely able to provide sputum. Tubercle bacilli, when present, are most easily found in early morning stomach washings. A No. 10 catheter is used, joined by a glass connexion and a piece of rubber tubing to a glass funnel. The tip is lubricated with sterile glycerin, passed into the mouth, and swallowed. Sterile water is poured into the funnel and at once syphoned back into a sterile bowl; this is repeated several times until about 200 c.c. of water have been used. The whole of the washings is sent to the laboratory.

CHAPTER XXII

NEWER METHODS OF DRESSING WOUNDS: FACTORS IN WOUND HEALING

By HAMILTON BAILEY

SUCTION DRAINAGE

THE uses of suction are manifold. For intestinal leaks, particularly those high in the alimentary tract, e.g., a duodenal fistula, suction is a method of 'dressing' without an equal; it is also of inestimable value in suprapubic bladder cases and in certain thoracic cases. Indeed, with a little ingenuity, by means of suction any profuse discharge can be carried off into a receptacle, instead of being allowed to soak into dressings.

It is more than likely that in days to come every surgical bed will have beside it a tap from a general suction plant, and the house surgeon of the future will wonder how we did without it. There is, however, no need either to await this millennium or to bemoan that the authorities have failed to provide equipment, for suction can be improvized or provided in some form for a matter of a few shillings.

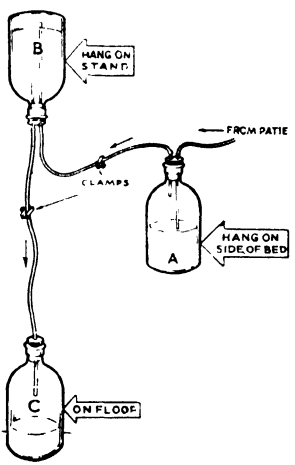


Fig. 201.—The Wangensteen apparatus

Wangensteen's Apparatus provides mild suction and is suited particularly to gastric aspiration; suction ensures that the stomach is kept empty constantly. Three Winchester quart bottles are required (*Fig.* 201). A negative pressure is established by water gravitating from bottle B to bottle C. When the time comes for bottle A to be emptied, the screw-clamp connecting it with the suction apparatus must be screwed up tightly, otherwise the water will run out of bottle B.

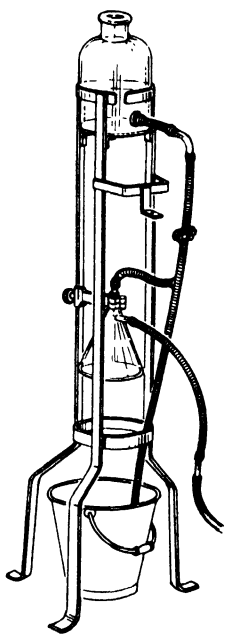


Fig. 202.—Cathcart's suction drainage apparatus.

Cathcart's Apparatus (*Fig.* 202) is to be found in some hospitals. An improvized form, based on its principles, can be constructed without excessive trouble. I have used it intermittently for many years and found it quite effective in certain cases of empyemata and for drainage of suprapubic bladder wounds.

Electric Pumps.—It is unfortunate that, owing to the fact that there are two varieties of current, A.C. and D.C., one must purchase the appropriate pump for the particular current, as the two are not interchangeable.

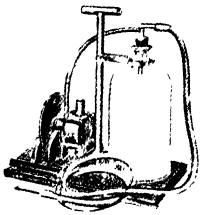


Fig. 203.—The "Silent" suction pump.

The "*Silent*" *pump** (*Fig.* 203) is a splendid piece of apparatus, and provided it is looked after with reasonable care, it stands up to a great deal of work.

For lung cavity drainage there is a special model of the "Silent" pump equipped with a pressure gauge. The volume displacement of this pump is about double that of the standard pattern, in order to compensate for air leaks in the system through only partially closed bronchi

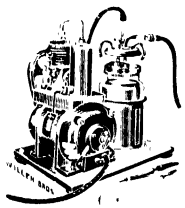


Fig. 204.—The "Aeris" pump

The "*Aeris*" *pump*† (*Fig.* 204) is another admirable model. It is made of aluminium and is, therefore, light.

Water Pumps.—A water pump is extremely efficient and can be employed wherever there is a running water tap reasonably near the patient's bed

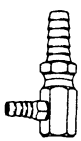


Fig. 205.—The "Camden" pump.



Fig. 206.—Gallenkamp's pump

The "*Camden*" *pump*† (*Fig.* 205) costs 30s. Fittings are supplied to fit the various shapes and sizes of taps found in wards and bedrooms. The size and shape of the tap must be stated when ordering

Gallenkamp's pump‡ (*Fig.* 206) is known as B5064 and costs 18s. The firm provides a piece of rubber tubing to be fitted on to the tap. Unfortunately, they have designed this fitting for a laboratory tap, and it requires some manipulation to make it fit the ordinary domestic tap. However, I have had these pumps in use at several hospitals, and they have given extremely good service.

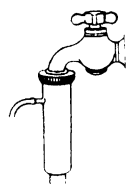


Fig. 207.—Gray's pump

Gray's pump† (*Fig.* 207) costs 16s. 6d., or 24s. with the tubing. It has the advantage that by means of its conical locking collar it can be fitted to any standard half-inch tap

Pumps Operated by Oxygen Pressure.—While very effective suction is obtained, a cylinder lasts only about forty minutes. Therefore, this type of apparatus is ill-adapted to ward work and is of more use in the operating theatre.

The *M.I.E. Suction Apparatus*.§ Suction is effected by affixing the special reducing valve to a cylinder of oxygen.

When applying suction to any wound, certain commonsense principles must be envisaged. For instance, it would be useless to expect urine to be sucked through a de Pezzer catheter when the bladder has been closed tightly around it,

* Genito-Urinary Manufacturing Co. Ltd., 28a, Devonshire Street, W.1.
† Willen Bros. Ltd., 44, New Cavendish Street, W.1.
‡ A. Gallenkamp & Co., Ltd., 19, Sun Street, E.C.2.
§ Medical and Industrial Equipment Ltd., 12, New Cavendish Street, W 1.

there would be no air inlet. When suction is to be used in the mouth of a wound, e.g., a fæcal fistula, a rampart of adhesive plaster must be erected. If this is done early, and the rampart is reinforced by a covering of a paste of kaolin and water, excoriation, so frequent in high fæcal fistulæ, is prevented.

PRINCIPLES IN THE DRESSING OF WOUNDS

When working in the surgical wards the house surgeon, the nursing staff, and the student dressers should become 'air-minded'. They should visualize the air in the ward circulating over used bed-pans, and scores of other obvious



Fig. 208.—The original packing is removed and a healthy granulating cavity, which bleeds slightly, presents. The area is draped with sterile towels



Fig 209.—After swabbing away blood-stained exudate, the cavity is insufflated with sulphanilamide powder.



Fig. 210 — The wound is repacked, care being taken that the vaseline gauze does not touch the skin. A sterile towel brought to the wound edge makes this possible



Fig 211 —Sufficient vaseline gauze is inserted to fill the cavity snugly and just overflow the skin edge



Fig. 212.—After insufflation of the surface with sulphanilamide powder, a piece of tulle gras is placed over the area.



Fig. 213—A Viscopaste bandage has been applied. It is left undisturbed for a week, unless there is some indication for it to be undone.

sources which charge the air with virulent bacteria. They should then think of the responsibility of uncovering an open wound, particularly a clean open wound, in such an atmosphere. That this conception is not far-fetched can be

demonstrated by observing how much better are the results of the 'closed' treatment of open wounds than those obtained by ward dressings.

The Closed Method of Dressing Open Wounds.—In an operating theatre, not in the ward, the wound, which has been left undisturbed since the operation (at the conclusion of which it was packed with vaseline gauze), is exposed. Before removing the packing the surrounding skin is cleansed, and, if necessary, shaved. The packing is removed and the area draped with sterile towels. The various steps of the dressing are shown pictorially in *Figs.* 208–213.

The Management of Infected Wounds.—In cases where the wound is obviously infected, the foregoing method of treatment has usually, but not necessarily, to be altered. The first step should be to ascertain the main infecting organism. With this objective a specimen of the discharge must be sent to the bacteriological department (*see* Chapter XXI). Armed with the report, some form of general (i.e., appropriate sulphonamide therapy) and local (i.e., penicillin; proflavine powder) treatment can be formulated. This immense, ever-changing subject, cannot be considered here in all its aspects.

Irrigation of Wounds is required infrequently. The main indications are anaerobic infections and wounds with pockets. The following greatly modified Carrel-Dakin technique will be found practical. A piece or pieces of fine rubber tubing 9 in. long, of a size which fits the nozzle of a Record syringe, are prepared as shown in *Fig.* 214. The tube is led into the wound and fixed to the skin by a stitch. The wound is packed lightly with gauze wrung out in the solution which has been chosen for irrigation. Over this there is a layer of Gamgee and over this again jaconet. The sister-in-charge is instructed to inject a measured quantity of the chosen solution down each tube every three hours. The quantity should usually not be greater than the Gamgee tissue can absorb in twelve hours, when it is changed. There are a large number of antiseptics from which to choose. In my practice I find hydrogen peroxide, flavine, and azochloramid a liberal selection.

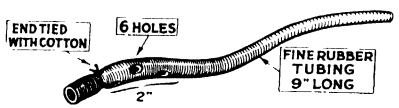
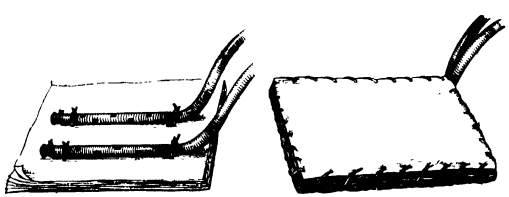


Fig 214.—Fine rubber tube prepared for wound irrigation

Osmotic Dressings.—The idea is to create a flow of lymph from the wound to the dressing. This form of dressing should be looked upon as an alternative in cases which are not responding to one of the more standard methods. A 10 per cent solution of sodium sulphate in 1–1000 proflavine is a satisfactory solution. Gauze, thoroughly wet with the solution, is packed lightly into the wound, which is covered with adhesive plaster or bandaged over grease-proof paper.


Fig 215.—Edmunds's sandwich dressing.

Edmunds's Sandwich Dressing is an excellent method of 'cleaning up' an infected superficial granulating area. The sandwich consists of a tube or tubes of the type shown in *Fig.* 214 sewn into six or more layers of gauze, as shown in *Fig.* 215. The granulating area is covered by a single layer of tulle gras. The sandwich, soaked in the chosen solution, is placed next, then jaconet, followed by wool, and the whole is

bandaged. The pad is kept moist by injecting 1 oz. of fluid down the tube every six hours, or I have found it satisfactory to connect the tube with a drip apparatus, the interceptor of which is regulated to ten to fifteen drops a minute.

Open-air Treatment.—Especially in summer and only when a balcony is available, small granulating surfaces can be left exposed to the air, covered only with a single layer of gauze, to keep the flies away.

FACTORS IN WOUND HEALING

No member of a surgical team has better opportunities of observing the healing of wounds—operative and otherwise—than the house surgeon. I feel, therefore, that his attention should be directed to some of the newer thought connected with the subject, for it is he who can check results, add to our knowledge, and, indeed, standardize any benefits which accrue from this research.

Œdema of the Wound inhibits healing. If this is realized, the following measures to prevent the occurrence of œdema will occupy the house surgeon's attention :—

a. General.—Dilution of the large molecular content of the blood sets up intercellular œdema. The danger of over-administration of intravenous saline has already been emphasized ; œdema of the wound is a comparatively minor danger. If there is reason to suspect that there is protein anæmia from long-continued low nitrogen intake, a plasma or blood transfusion will tend to remedy the deficiency.

b. Local.—When possible, in order to minimize œdema in the neighbourhood of a healing wound, the aid of gravity should be invoked. If sutures, particularly deep sutures, are causing local œdema, it is often advisable to remove all or certain of them and to substitute ' corsettage ' to support the wound (*see* p. 301).

Vitamin C Deficiency.—Deficiency or absence of vitamin C has been shown to exist where a sutured wound has broken down after the stitches had been removed at the usual time. It is common knowledge that in the aged and under-nourished wounds heal more slowly and less firmly. Forty-four per cent of cases taken at random in surgical wards were found to be deficient in vitamin C, and all patients above 70 years of age showed a relative deficiency (A. H. Whipple). It is clear that a sub-scurvy state delays healing and predisposes to disruption of abdominal wounds. Burst abdomen is twice as common in men as in women, and Sokolov found it to be commoner in the first half of the year than in the second, and he attributes this to a lowering of the vitamin C content. R. T. Payne believes that many deaths following such operations as partial gastrectomy are due to failure of the suture line to unite, and this failure is related to anæmia and deficiency of vitamin C. It would therefore appear that the house surgeon should be vigilant in seeing that every patient whose tissues are endeavouring to repair a wound should be receiving an adequate intake of vitamin C, e.g., fruit and green vegetables. If, for some reason, it is impossible to supply the vitamin in this form, or the patient looks as though he is in need of an extra ration, it should be supplied in the form of ascorbic acid. The full dosage is 1000 mg. of ascorbic acid per day for three days, and afterwards to maintain saturation, 100 mg. per day for about three weeks, while the wound is healing.

Vitamin K (*see* p. 218) should be given in cases where there is bleeding from granulation tissue.

Protein *v.* Carbohydrate Diets.—After an operation the usual practice is to keep the patient on a light diet, mainly carbohydrate, at any rate for some days. The same is true in cases of suppuration. It has been shown that during the first few days after the infliction of any wound (operative or otherwise), the loss of body-nitrogen is relatively high; if the wound suppurates this loss continues. While the nitrogen loss is high, processes of healing are at a low ebb. It has been shown experimentally that a high protein diet hastens the repair of wounds; indeed, if nitrogen is supplied, the "lag" period is diminished and wound repair commences much earlier. It is, therefore, desirable that there should be a high protein intake from the commencement. Milk, grated cheese, egg albumen, and pounded fish are all suitable articles of food from the earliest days. Experiments in the intravenous introduction of total amino-acids of casein (usually together with routine glucose) carried out in the U.S.A. are very hopeful; preparations are just becoming available in this country at the time of writing.

Vitamin B Deficiency.—Patients with high intestinal fistulæ in particular, and those who have had conditions necessitating partial gastrectomy or excision of some part of the alimentary tract, are likely to be suffering from some degree of vitamin B deficiency. A good preparation for clinical trial in such cases is Heparglandol-B (Roche), which contains all the B vitamins combined with injectable liver extract, which has the advantage of helping to raise the red-cell count. In each ampoule of 2 c.c. there are:—

Aneurine (vitamin B_1)	3 mg.
Riboflavine (vitamin B_2)	1·2 mg.
Nicotinamide	20 mg.
Pyridoxin (vitamin B_6)	1 mg.
Pantothenic acid	3 mg

The dosage is 2 c.c. on alternate days for two weeks.

Accelerators of Wound Healing.—An endeavour to find a substance which will accelerate healing of wounds has occupied the attention of inquiring minds for many years. Carrel showed that processes of repair were set in motion by a protein derived from dead leucocytes, and that the same protein was present in embryonic tissue extract. This protein was marketed under the name of Epicutan in the form of a powder. It came from Denmark, and is not now available

Allantoin is another substance which has been the subject of investigations with the same object in view. Existent in allantoic fluid, in the comfrey root, and in the excretions of certain maggots, allantoin appears to facilitate the removal of necrotic material, to exhibit cell-proliferating properties, and to promote healthy granulations. In suitable cases my assistants and I are using this substance in two forms: (*a*) 4 per cent allantoin with 96 per cent sulphanilamide; and (*b*) pure allantoin. The latter is used only on clean wounds. Both are in powder form, supplied by Genatosan Ltd.

CHAPTER XXIII

THE MANAGEMENT OF HEAD INJURIES

By HAMILTON BAILEY

INJURIES to the head and brain are among the most important cases with which the house surgeon has to deal. As it is often impossible to estimate the amount of damage which has been sustained, it is imperative to examine patients with head injuries with scrupulous care, and when in doubt to consult with one's colleagues. Such a course leads to the admission of some cases unnecessarily, but this is far better than to overlook a fracture of the base of the skull.

It is necessary to train oneself to refrain from prejudgement in 'unconscious' cases. 'Drunk or dying?' has always been an anxious problem for the house surgeon. The succumbing of a patient following inaccurate diagnosis and discharge from hospital does the reputation of the institution and the medical profession an immense amount of harm. It is of paramount importance to examine unconscious patients thoroughly, and in this connexion the table on p. 185 is of service.

Dealing now with the case of undoubted head injury, it is important to make notes at once. Apart from the value of accurate notes for diagnosis and treatment, in this instance almost certainly notes will be required for some form of legal report. Where, exactly when, and how did the accident occur? Did the patient lose consciousness at once? Has he been conscious at any time since the accident?

After examining the patient, record the depth of consciousness and the position of wounds and bruises. If there is bleeding from the nose or ear, record this. Also make a note of the condition of the pupils and the result of gross neurological examination. *Above all, do not fail to examine the whole patient, for it is more than possible that he has other injuries.*

An excellent rule in connexion with head injuries is that every patient who has been even slightly concussed should be confined to bed for at least fourteen days.

SCALP WOUNDS

Shaving.—As a rule, it is best to shave the head completely. Cut the hair short with scissors, comb it, and then scrub it with a sterile nail brush with soap and water, and finally shave it (Rowbotham).

Anæsthesia.—To encircle the operative area with local anæsthetic, as shown in *Fig.* 216, meets every requirement.

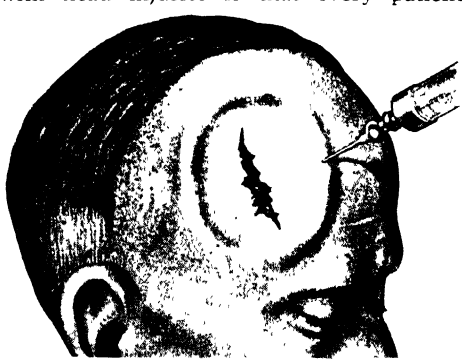


Fig. 216.—Method of infiltrating the scalp with loca anæsthetic in a case of a scalp wound. As a rule, it is better to shave the whole of the head.

Excision of the Wound.—The wound edges can be efficiently excised by employing the following technique. The integument is steadied and stretched by two towel clips (*Fig.* 217). Digital pressure prevents excessive blood-loss until spurting vessels can be picked up with hæmostats. The larger arteries are dealt with by undersewing them with a ligature on a needle. Minor bleeding points need not be ligated, the hæmostats being left on until the wound edges are approximated (*see later*).

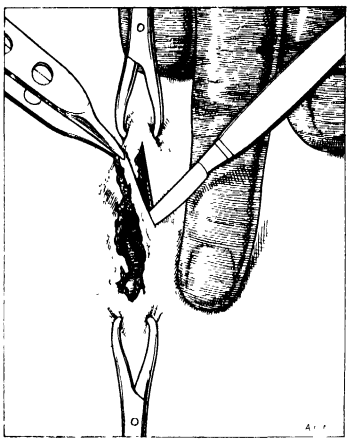


Fig. 217.—A method of excising a wound of the scalp.

A mechanical retractor (mastoid type) is applied and the depths of the wound inspected. Road grit, glass, hair, and such like are picked out, and the wound is irrigated with saline solution. All bruised, torn, and ragged tissue is snipped away until the whole area presents an indubitably clean-cut appearance. The wound is then dried, dusted with sulphanilamide, or better still, with both sulphanilamide and proflavine powder. The retractor is then removed

Suturing the Scalp.—The best method is to employ a series of interrupted fine thread or cotton sutures to approximate the galea. These are introduced by a curved cutting needle. Deep interrupted stitches are then passed through the scalp and tied—only tight enough to secure apposition (*Fig.* 218).

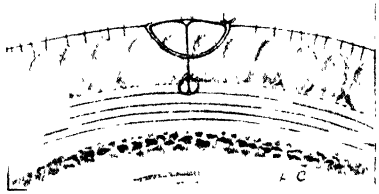


Fig. 218.—A method of suturing the scalp. The galea is first approximated with fine unabsorbable sutures.

Wounds of the Scalp with Loss of Substance.—By stripping the scalp from the pericranium the edges are more likely to come together. If there is difficulty, the reverse-S extensions (*Fig.* 219) usually permit apposition. When the loss of scalp tissue is considerable, the best practise is to leave the wound open and apply sterile vaseline packing; skin-grafting can be performed later.

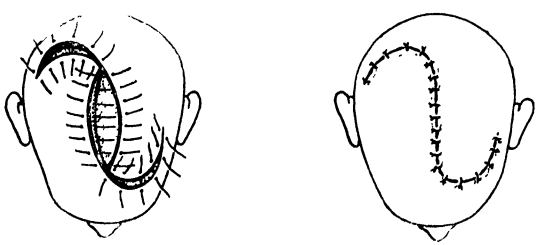


Fig. 219.—The reversed-S incision (*after Lockwood*).

Dressing Major Head Wounds, including Operative Wounds.—The method illustrated in *Fig.* 328, p. 289, cannot be bettered.

THE CARE OF THE UNCONSCIOUS PATIENT

The house surgeon should organize a system which ensures that the patient is watched carefully. For noisy, troublesome patients a male attendant is essential—it is not a nurse's duty to struggle with unruly patients, but to record the pulse, temperature, and respirations.

It is true that in most cases the less we do for a severe head injury the better—if left alone, many, perhaps 70 per cent, deeply concussed patients recover uneventfully. It is to try to save a larger proportion of the remaining 30 per cent that the following meticulous, watchful care is inaugurated.

Special Charts recording accurate observations should be the pride of those in attendance. The house surgeon himself commences with the first recorded reading, that of the blood-pressure.

The significance of a slowing of the pulse-rate is known generally, and the hourly pulse-rate is a routine in most hospitals. The diagnostic value of a very frequent temperature record is not appreciated so widely. W. O. Stevenson states that the temperature should be taken every fifteen minutes. A large thermometer, not necessarily a clinical one (*Fig.* 220), can be placed in the axilla or in the groin. It can be read in these positions without being removed. The rationale of this seemingly over-careful procedure is as follows: In deeply concussed patients no one knows when the stage of reaction is coming. If it is purely a stage of reaction the temperature rises precipitately to a maximum of 100·5° F., and then begins to fall. In cases of intracranial hæmorrhage it does not fall, but continues in its upward course and may reach 104° F.

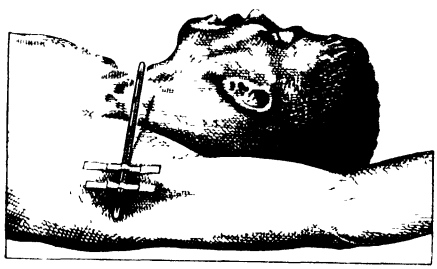


Fig. 220.—Method of strapping a commercial, as opposed to a clinical, thermometer. When the arm is placed by the side a reading can be taken without removing the instrument.

Nursing Instructions.—The house surgeon should tell the nurse to call him:—

1. If the temperature rises above 100·5° F.
2. If the pulse-rate falls to 60 or rises above 130.
3. If the respirations become stertorous or irregular.
4. If there is a discrepancy in the size of the pupils.
5. If there are fits or paralysis.

Radiography of the Skull.—It is highly important that, provided facilities exist, the house surgeon should ensure that radiographs of the skull are available. The question arises as to when these should be taken. In my opinion the patient's as well as the hospital staffs' interests are best served by arranging for radiographs to be taken before the patient is transferred to the ward, i.e., he is transported to the radiographic department *en route* to bed. Discretion, of course, must be used in individual cases, but this will be found to be the most practical solution of quite a difficult problem.

Posture.—The correct position in which to nurse an unconscious patient suffering from a head injury is to remove the pillow and allow the patient to lie

quite flat in bed. This routine should not be followed slavishly, but tempered with common sense. Should the depth of unconsciousness be such that bronchial secretions accumulate in the air-passages, Coleman's postural drainage for the unconscious (*Fig.* 221) should be adopted at once. The patient is placed in the lateral position and maintained there by sandbags. The foot of the bed is raised 15 in. on blocks. To have at hand a Hewitt's airway and if possible a sucker to clear away secretion as it accumulates, not only diminishes cyanosis, which must add to cerebral congestion, but the liability to pulmonary infection—a grave complication—is also lessened. Useful as is Coleman's postural drainage, it should not be maintained for more than three or four hours at a time.

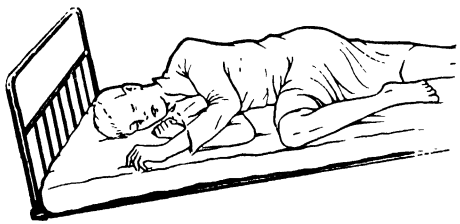


Fig. 221.—Coleman's postural drainage for the unconscious. The position is maintained by sandbags.

Feeding.—Even an unconscious patient needs nourishment. The passage of a gastric aspiration tube allows an adequate intake. Before feeds are poured down the tube, some sterile water should be allowed to gravitate. If this experiment is successful, food can follow.

An adult should be given a pint of a mixture of eggs, milk, and sugar three times a day.

The total fluid intake (parenteral if necessary) should be approximately four pints in twenty-four hours. More than this is desirable if sulphonamide therapy has been ordered.

The Bowels should be stimulated by laxatives, and should be emptied by enemata on alternate days. If the patient cannot swallow, a suitable dose of liquid cascara can be injected down the gastric aspiration tube.

Urinary Incontinence.—In male patients a length of wide colostomy tubing is affixed by adhesive strapping to the penis and shaved pubis and is allowed to drain into a receptacle at the bedside. For female patients the rubber bidet is most practicable (Alexander).

Restlessness and Delirium.—Morphine is contra-indicated in these cases. Paraldehyde per rectum is my standard sedative. Sodium luminal 3 to 5 gr. intravenously is recommended by Dandy.

Dott and Alexander at the Edinburgh Royal Infirmary have found that paraldehyde 3 c.c. intravenously produced after an attack of coughing a prompt and profound tranquility. They recommend that 1 c.c. be administered every two hours in an intravenous saline drip. I take it that the total dose is not more than 3 c.c.

FRACTURES OF THE SKULL

Fissured Fractures.—In the absence of some signs pointing to remediable mischief within the skull, fissured fractures should be left alone.

Many times I have been called to see a case where the house surgeon has found, or thought that he has found, a fissured fracture. The picture of a fissured fracture of the outer table with extensive comminution of the inner is riveted in the mind of the student. In reality I believe this to be the greatest rarity. Should there be some hidden lesion, physical signs will indicate that the skull must be opened.

In the absence of signs of cerebral compression all that is necessary in the first instance is that the scalp wound be treated in the manner described on p. 181.

Differential Diagnosis of Unconscious States

	Alcoholism	Apoplexy	Compression	Concussion	Post-epileptic	Opium Poisoning	Uræmia
Onset	Gradual	Sudden	Gradual	Sudden	Preceded by fit	Gradual	Sudden or gradual
General condition	Can be roused	Cannot be roused	Cannot be roused	Can be roused	Cannot be roused	Cannot be roused	Cannot be roused
Pupils	Dilated	Dilated, immobile	Dilated, immobile, unequal	Equal, react	Variable	Pin-point	Variable, probably contracted
Pulse	Full	Slow, full, tension	Slow, full, heaving	Slow and weak	Becoming less rapid	Slow and compressible	High tension
Respiration	Deep, slight stertor	Slow, stertorous	Slow, deep, stertorous	Slow, shallow, irregular	Noisy or stertorous	Laboured, irregular, stertorous	
Muscles	Twitching	Hemiplegia	Organic paralysis	Functional paralysis	Relaxed	Relaxed	Recurrent convulsions
Reflexes	Present	Absent	Absent	Present	Increased	Present	
Bladder		Involuntary micturition	False incontinence	Incontinence	May be incontinence	False incontinence	
Rectum		Involuntary passing of fæces	Incontinence of fæces	Incontinence	May be incontinence	No evacuation	
Temperature	Subnormal	Subnormal (high in pontine)	Subnormal, rising later. May be unequal on the two sides	Subnormal	Raised		Subnormal
Special points	Face flushed Absence of alcoholic odour in breath excludes alcoholism	Face cyanosed or grey Conjugate deviation of eyes towards lesion May be albumin in urine			Cyanosis, decreasing Tongue bitten	Odour of breath Face pallid Skin sweating All secretions except sweat diminished	Look for retinitis Albumin in urine Tongue furred Breath foul

The patient is then watched, as should be the routine in all cases of head injury. The only variation in the routine procedure is that the help of a radiograph will be sought at the earliest possible opportunity, whereas in the case of simple concussion the radiograph is taken at any time before the patient leaves hospital.

It is quite another matter when hair or other foreign matter can be seen driven into a fissured fracture—under these circumstances the house surgeon should report for instructions.

Depressed Fracture.—A patient with a depressed fracture which is not compound need not be rushed to the theatre. If the scalp has been shaved, it is good practice to allow the patient time to recover from the shock of his accident. A subperiosteal hæmatoma can simulate the clinical features of a depressed fracture to a nicety; therefore, if the facilities exist, the diagnosis should be confirmed by a portable X-ray apparatus.

If real doubt exists, after shaving and disinfecting the area, there is no objection to inserting a wide-bore needle, or even making a small incision which will enable a recent hæmatoma to be evacuated.

Compound Depressed Fractures.—Compound depressed fractures are quite another matter; no time should be lost in making arrangements for trephining and elevating the depression.

Fractures of the Base.—The routine outlined in the care of the unconscious is followed. If blood or cerebrospinal fluid is issuing from the ear, the discharge is mopped up at intervals with sterile wool. The ears should not be plugged. Conversely, if cerebrospinal fluid and blood are coming down the nose, very light plugging of the nares with sterile cotton-wool soaked in mercurochrome or flavine solution is a good practice. When intrameningeal contents are leaking externally it is obvious that the patient is in imminent danger of ascending meningitis. To attempt to prevent this, urotropine is indicated. Intravenous urotropine, 5 c.c. of a 40 per cent solution, is supplied in ampoules by Schering. This is certainly a good method of getting urotropine into the circulation. It is soon excreted in the cerebrospinal fluid. Alternatively sulphanilamide may be prescribed.

The treatment of fractured base is largely symptomatic. Increased intracranial tension is reduced by one of the methods described below. Magnesium sulphate per rectum is the best, but if this is not tolerated, daily lumbar puncture is extremely effective. About 10 c.c. of cerebrospinal fluid are removed at each puncture. One should bear in mind that persistent bleeding from the ear may be due to middle meningeal hæmorrhage, which decompresses itself by this route.

If the patient is restless, the question will arise as to the best drug to prescribe. Maniacal behaviour can sometimes be controlled by simple drugs, such as a full dose of bromide. Paraldehyde per rectum often produces restful sleep. The consensus of opinion is that morphine and its derivatives are contra-indicated in these cases. Luminal, 3 gr. (in glass ampoules*), given intramuscularly is valuable and can be repeated. When driven to desperation I have, on many occasions, prescribed small repeated doses of hyoscine and have not had occasion to regret it.

ACUTE CEREBRAL COMPRESSION

Cases of middle meningeal hæmorrhage are few and far between, but, like a thief in the night, they come when least expected. It is largely to ensure that

* Luminal ampoules, 3 gr., can be obtained from Evans Medical Supplies Ltd.

we do not allow one of these supremely remediable cases to remain undiagnosed early that we are at pains to organize a system which ensures constant watch on the concussed patient. If a patient is admitted with signs of cerebral compression it is, of course, possible that the hæmorrhage is extradural. In practice we find that many of these patients are suffering from intradural hæmorrhage with laceration of the brain. In every case of cerebral compression a consultation should be arranged with the surgeon. A full account of the physical signs and half-hourly pulse-rate and blood-pressure readings should be available.

All cases of early acute cerebral compression should have the scalp shaved. This allows a thorough examination of the vertex. A tell-tale hæmatoma which has been obscured by hair may be revealed. Should the compression increase and operation become necessary, much time is saved by having the head in a state of preparation for surgical intervention.

CEREBRAL IRRITATION

The patient should be placed in a darkened room with a special attendant to look after him. If magnesium sulphate can be given per rectum and retained, so much the better. Half an ounce of paraldehyde can be added to the first dose and may ensure some much needed rest. If the rectal injection is not retained, magnesium sulphate may be added to the feeds, for the patient will usually take fluid from a feeding cup. If symptoms of cerebral irritation persist for forty-eight hours the house surgeon should consult his chief, for if cerebral irritation persists some surgeons favour dehydrating the brain by means of intravenous sucrose or even performing subtemporal decompression.

INCREASED INTRACRANIAL TENSION

Apart from keeping constant vigil for the signs of intracranial hæmorrhage, the house surgeon is again reminded that his attitude towards a case of head injury should be ultra-conservative. He departs from this path only when he is convinced the patient is suffering from some degree of increased intracranial tension. Commonly this is observed when a severe reaction follows awakening from the concussed state. Persistent headache is a leading symptom. The danger of decreasing intracranial tension is increasing intracranial hæmorrhage; therefore it should never be employed unless this diagnosis has been ruled out. From a practical standpoint this danger has passed forty-eight hours after admission, and it is seldom necessary to resort to any of the following before that time :—

Methods of Reducing Increased Intracranial Tension.—

Posture.—Presuming the patient is now conscious, the blood-pressure, which, by the way, should have been recorded on several previous occasions, is taken once again. If the reading is above normal the patient should be propped up gradually into low Fowler's position. Should the headache persist in spite of other therapeutic measures, after a few hours he can be still further elevated into high Fowler's position.

Magnesium Sulphate per Rectum.—Three ounces of crystals are dissolved in six ounces of warm water. By means of a catheter the resulting solution is run slowly into the rectum. It must gravitate slowly in order to avoid acting as an enema. The intake of fluids is restricted to two pints daily during the dehydration treatment. The injection should be repeated every four hours until the symptoms have abated. No toxic effects have been observed in a large number of administrations of magnesium sulphate by many observers. This

is the best and safest method of reducing increased intracranial pressure and it is the one which should be adopted for general use.

Lumbar Puncture.—The puncture is made with a fine needle, and 5 to 10 c.c. of fluid are evacuated slowly. The puncture may be repeated, if necessary, in twelve or twenty-four hours. Manometric readings (Chapter LII) are desirable. The amount of cerebrospinal fluid to be withdrawn can then be measured with scientific accuracy.

Five-times Concentrated Serum.—This is a much more drastic measure, and in my opinion it should not be employed by the house surgeon unless he has consulted with his chief. Five-times concentrated serum is made by adding 40 c.c. of sterile distilled water to a standard bottle of dried serum. There is some difficulty in getting the serum to dissolve, but if the mixture is shaken well and placed in an incubator for an hour, solution will occur. The concentrated serum must be kept at body temperature, and it is injected intravenously with a syringe. It is too viscid to gravitate. The dose is 40 c.c.

CHAPTER XXIV

THE MANAGEMENT OF HARE-LIP AND CLEFT PALATE CASES

By DENIS BROWNE

HARE-LIP

IT IS necessary for the house surgeon to understand the principles underlying the operative treatment. Complicated flaps and zigzag incisions, so often depicted for joining single clefts, give very poor results. A simple junction of the kind usually known as Rose's operation, with careful joining of the muscles, gives the best result. For the much more difficult problem of joining a double cleft, the formula shown in *Fig.* 222, A, B has been found in practice to work



Fig. 222.—Formula for joining a double-cleft lip. At the points marked X a hole is punched on the mucocutaneous line with a 2-mm. ophthalmic trephine. The cuts are made with a razor-edged chisel, and the trephine hole is stitched to the centre of the side of the middle portion.

exceedingly well. It gives a thick, short, mobile lip with that double curve of the mucocutaneous junction known as a Cupid's bow; and avoids the undue length and tightness which gives that ape-like appearance which was formerly so familiar after these operations.

Most accounts of the operation give no instruction to join the cleft of the floor of the nostril. If the gap extends through this it should be treated precisely as is the gap in the lip itself, by making a raw surface on either side and suturing the two together.

The obstacles to the successful joining of a cleft of the lip are four :—

1. *Tension.*—This is of two kinds. First, the passive tension due to the dragging inwards of the sides of what may have been a very wide gap; and secondly, the active tension caused by the contraction of the facial muscles in

crying or feeding. The counter to this is the use of the 'tension bridge' or modified Logan's bow (*Fig.* 223). This has the advantage over the original model that it can be tightened up to any desired degree while it is in position (*Fig.* 224). It has two important functions apart from making union almost certain. The first is that it greatly diminishes stitch scarring, as it removes that drag which causes stitches to cut through the tissues if they are left unsupported. Secondly, it fulfils the orthopædic principle of leaving a joined muscle in the position of contraction during healing. A hare-lip result is not good unless the patient afterwards has the power of 'pouting' the lips; to ensure this the lips must be left in the 'pouting' position during healing by tight pulling of the sticking-plaster bands. Any slackening of the pull owing to stretching or slipping of the sticking-plaster should be corrected without delay by pulling in the necessary amount on one or

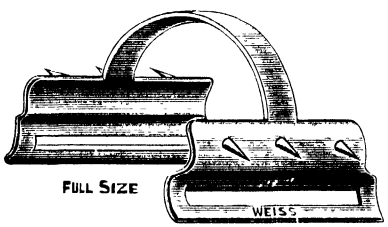


Fig. 223.—The 'tension bridge' modified Logan's bow.

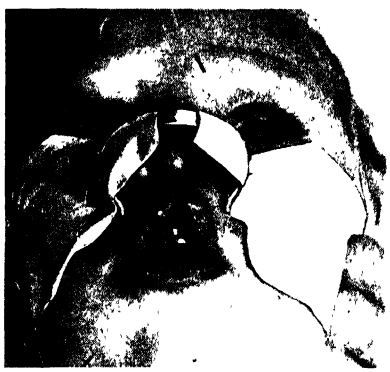


Fig. 224.—The 'tension bridge' in use.

both sides. The bow should be kept on for a fortnight after operation and then removed by pulling each piece of plaster off from the ear towards the lip. Waterproof plaster of the Dry-bak type is much more satisfactory than the ordinary kind.

2. *Irritation and Infection by Nasal Mucus.*—In many cases after operation there is a profuse discharge from the nostril. If this is allowed to flow over the wound it has a very bad effect on healing. The counter to it is to keep a loosely rolled pledget of cotton-wool in the nostril, changing it as soon as it becomes soaked with discharge. When the discharge is profuse this may mean many changes during the day. It must be clearly understood that the cotton-wool is not used as a plug, but should lie loosely in the nostril and soak up the discharge by capillary action.

3. *Infection by Skin Staphylococci and Other Organisms.*—This can be guarded against by keeping the wound lightly smeared with 1–1000 flavine in paraffin. In addition to its antiseptic action, this helps to protect the wound against any chance contact with nasal discharge.

4. *Interference with the Wound by the Child.*—Babies have a natural tendency to clutch and pull at anything that irritates them. To prevent them getting their hands to the operation area the elbows should be kept stiff by cylinders of rolled up cardboard bandaged around the arms.

Feeding.—It is, of course, much the best if the baby can be kept on breast feeding throughout the post-operative period, the milk being drawn off and fed

by spoon for the week after operation. An ordinary teaspoon with the edges tapped together by a hammer so as to deepen and narrow it will be found the best for this. When there is a cleft of the palate as well as the lip the baby will be unable to suck, and must be brought up on the spoon throughout the whole milk feeding period.

Removal of Stitches.—This should be carried out on the sixth day. In the absence of tension, made possible by the correct use of the bow, they will not have caused any noticeable marks by this time, and if they are removed earlier an apparently sound wound may gape open.

Mosquito artery forceps to hold the stitches, scissors with fine but not sharp ends, and a good light are necessary. One assistant should hold the baby, wrapped tightly in a towel, while another grips the head firmly between the palms of the hands. As the baby usually fights and shakes its head vigorously the utmost care and patience is needed; in fact, in order to avoid the risk of damage to the newly-healed wound by an uncontrolled movement, it is often advisable to give a light anæsthetic.

CLEFT PALATE

It should be understood that the object of operation on a case of cleft palate is not to close a gap, but to produce a function. This function is that of the voluntary closing of the nasopharynx, without which correct speech is impossible. Without discussing the vast numbers of procedures that have been recommended, it may be pointed out that success, as defined, turns upon giving a certain action to certain muscles, and that all these recommended procedures contravene the fundamental orthopædic principle that when a muscle is joined it should be left in the position of contraction during healing. In other words, if it is required that the nasopharynx should have the power of closing after operation, it should be left in the closed position while the muscles join.

To obtain this end two things are necessary. First, a drastic and extensive freeing of the sides of the cleft, which will allow it to be joined close up against the posterior wall of the pharynx. The incisions for this extend on either side from the canine teeth backwards along the pterygo-mandibular raphe and through the empty tonsillar fossa left by a previous tonsillectomy. The second is a device which acts exactly as does the 'tension bridge' in treating a cleft of the lip. It is a thick catgut suture passed round the back of the pharynx and through the sutured soft palate tied so tightly as to occlude the nasopharynx temporarily. Apart from fulfilling the orthopædic principle already mentioned, this device takes all tension off the suture line of the cleft and ensures complete healing in some 98 per cent of cases.

The after-treatment of a cleft palate case should be much the same as that of a tonsillectomy. The patient should be encouraged to drink as much as possible and allowed to eat any soft foods that are fancied. Any attempt to syringe or clean the mouth will do more harm than good. The severe pain so often seen after operation is mainly due to tension on the stitches; with the wide freeing recommended there is usually surprisingly little discomfort.

Speech training is unnecessary if the child is intelligent, and is given a palate that will close the nasopharynx before it has acquired bad habits of speech. In less successful cases it can do a considerable amount of good.

CHAPTER XXV

THE MANAGEMENT OF THYROID CASES

By HAMILTON BAILEY

PATIENTS with a toxic goitre require the house surgeon's meticulous attention, both in their preparation for operation and during their early after-treatment.

Preliminary Preparation.—The patient should be admitted at least a fortnight before the operation. In some cases the preparation can be done at home, but this is usually unwise, if not dangerous. There is no need to confine her to bed strictly; on the contrary, it is often advisable for the patient to get up for a short period each day.

Lugol's Solution.—The preliminary medication by Lugol's solution, introduced by Dr. Plummer in 1922, has proved a great advance. In an average case 10 min. three times a day for ten days are ideal. During this time there must be a full intake of easily assimilable carbohydrates and a high fluid intake. The patient should have fruit juice and glucose always available, and be encouraged to drink as much as she can. If Lugol's solution gives rise to nausea or vomiting, it can be given intravenously in doses of 2 c.c. daily, well diluted with saline and glucose.

As we have said, the preliminary treatment with Lugol's solution has revolutionized thyroid surgery. Unhappily, there are cases of toxic goitre which do not respond to iodine therapy. In about 10 per cent of primary thyrotoxicosis, and in about 20 to 30 per cent of toxic adenomata, Lugol's solution has no effect; indeed, it may cause an exacerbation of the symptoms.

There is another group which, unfortunately, is quite commonly encountered: the patient has already been over-iodized. I have met with examples where iodine has been given almost continuously for upwards of three years. Here successful surgery is robbed of one of its greatest assets, and what to do for the best is often a problem.

If the patient is not responding to treatment with Lugol's iodine, it is advisable to consult with a physician. Sometimes it is possible to arrange for two or three months' rest without iodine under medical supervision, and to review the advisability of operation at the end of that period. In others a 'stage operation' such as polar ligation may be considered to be the best course.

Thiouracil.—Promising reports are coming in concerning the control of the symptoms of thyrotoxicosis by thiouracil. This drug acts by preventing the synthesis of excessive thyroxin. While the enlargement of the thyroid gland and the exophthalmos (if present) are unaffected by this form of therapy, a daily dose of 0·5 to 1·0 g. of thiouracil by mouth appears to remove the other symptoms of thyrotoxicosis in about fourteen to twenty-one days.

Iodine antagonizes thiouracil, and therefore these two drugs should never be prescribed at the same time.

Thiouracil therapy which, at the time of writing, is still in the experimental stages, is heralded by some with great enthusiasm. In some cases untoward

effects have been recorded; these include depression, pyrexia, and rashes. More serious is agranulocytosis, which sometimes appears in the early stages of the exhibition of this drug.

Vitamin B.—Three mg. t.d.s. should prove valuable in the pre-operative treatment of thyrotoxicosis. Vitamin B aids in the oxidation of fatigue poisons which are mainly intermediate products in the breakdown of glucose into CO_2 and water. Experiments show that on this account the vitamin B is valuable to tissues subjected to an increased metabolic rate.

On 'Stealing' the Thyroid.—Opinions on this procedure differ. Unless the patient expresses the wish not to know the day of the operation, I never attempt to 'steal' the thyroid. On the contrary, a truthful discussion and an endeavour to inspire the patient with confidence is, I find, better suited to the English temperament. For thyroidectomy performed under local anæsthesia this preliminary talk with the patient a week or ten days before adds considerably to the success of the whole procedure.

Immediate Preparation of the Patient.—Thyroidectomy is best performed in the morning. The exact time of the premedication and the nature of the premedication are written up the night before. This important pre-operative measure varies in detail in accordance with the individual surgeon, and no particulars will be described here. The house surgeon should see the patient two or three hours before the operation, and if there is an exacerbation of symptoms, particularly an undue elevation in pulse-rate, he should telephone to the surgeon and inform him, for it may be considered advisable to postpone the operation.

Immediate Post-operative Treatment.—The patient should be propped up in bed in the sitting position. The pulse must be watched closely; it is a valuable index of the patient's condition. Morphine, $\frac{1}{6}$ gr., is given as often as necessary. If morphine causes vomiting, $\frac{1}{10}$ gr. of heroin can be substituted.

Lugol's solution (60 min.) in glucose solution is given per rectum soon after the operation. Saline and glucose solution is administered either rectally or subcutaneously. It is often of the highest importance that the total fluid intake should be in the neighbourhood of 6 pints or more per day.

While being a strong believer in the value of continuous intravenous saline in many post-operative conditions, I rarely employ it post-operatively in toxic thyroid cases. If it is thought advisable to employ intravenous saline, it must be given sparingly, with the full knowledge that the heart's action is impaired, and to overload the circulation with excessive fluid will certainly tax an impaired heart still further.

If the patient has lost a considerable amount of blood during the operation, it is, of course, a rational procedure to give a corresponding amount of blood or plasma during the first six to eight hours following the operation.

More Remote After-treatment.—If drainage material has been employed it should be removed after twenty-four hours or, at the most, after forty-eight hours, except in the case of a retrosternal goitre. Here there is often a large cavity below the level of the clavicles, and it is much wiser to leave a drainage tube in place for several days, in order to avoid the risk of blood and serum collecting therein. The stole bandage is a very convenient covering to the wound once the patient is over the first forty-eight hours of the post-operative period. Stitches or clips are removed in accordance with the wishes of the surgeon. Lugol's iodine is decreased daily in the same ratio that it was increased during the pre-operative period. Vitamin B can be continued with advantage until the patient leaves hospital.

POST-OPERATIVE COMPLICATIONS

1. Hæmorrhage.—This is more frequent after a general anæsthetic. The wound must be reopened and the bleeding point ligated if possible, otherwise it is packed and left unsutured. A blood transfusion is given if necessary, and secondary closure of the wound can be considered in twenty-four to forty-eight hours. If local œdema and extravasation of blood is extensive, tracheotomy may be indicated.

2. Tracheitis.—Tracheitis frequently follows a thyroidectomy. It is relieved by steam inhalations.

3. Auricular Fibrillation.—This is not always of grave significance, but it is wise to consult a medical colleague. If he considers it advisable, 5 gr. of quinidine sulphate t.d.s. often brings about an improvement.

4. Post-operative Crises.—These are fortunately rare, but they still occur, sometimes most unexpectedly. I have had a fatal case on the third post-operative day in what was apparently a very large, non-toxic goitre. The house surgeon must be prepared for these crises, and act at once, otherwise the patient will hardly ever recover.

It is well to repeat that every house surgeon looking after cases of toxic goitre should have an organization and act at once if signs of a thyroid crisis appear.

SYMPTOMS.—The pulse is rapid, the temperature high, and the general appearance of the patient gives rise to grave anxiety. These symptoms usually commence very suddenly, sometimes as long as four or five days after the operation.

TREATMENT.—Administer intravenously a pint of saline and glucose, to which have been added 50–100 min. of Lugol's solution. If the temperature is in the region of 103°, ice-packs to the limbs are ordered. If the temperature is 104° or more, an ice-pack to the whole body, except the chest wall, sometimes tides the patient over the crisis. The precordial region is a useful situation upon which to apply an ice-pack, but that part of the chest wall overlying the lungs should be avoided.

Reopening the wound and packing it lightly with gauze soaked in glycerol is said to be efficacious, for the toxic serum spilled from the cut surface of the thyroid is absorbed into the gauze. I have not observed any dramatic result from this procedure; indeed, I think it is useless.

If it is available, an oxygen tent or the administration of oxygen in high concentration by means of one of the newer masks is extremely beneficial. Oxygen in some form must be administered without delay; this and Lugol's iodine are the sheet anchors in treatment.

Once the saline is running into a vein, appropriate doses of Lugol's solution can be either injected into the delivery tube or admixed with the saline. As soon as the pulse commences to improve, a suitable dose of morphine is prescribed. It is advisable to get the patient into a room by herself as soon as possible and to provide her with a special nurse.

5. Mechanical Post-operative Dyspnœa.—When hæmorrhage has been discounted as a cause, the house surgeon must consider the possibility of an injury to the recurrent laryngeal nerves. An oxygen tent is of great advantage. Intubation of the larynx is advisable. Be prepared to perform tracheotomy.

As is well known, long-standing adenoparenchymatous goitres are liable to be complicated by a 'scabbard' trachea. Tracheal collapse occurs occasionally soon after thyroidectomy. To relieve it the best method is to pass a laryngeal catheter, if this is feasible. Immediate tracheotomy, of course, may be essential.

PARATHYROID TETANY

This is rare. If it is suspected by reason of tinglings and numbness of the lips, nose, and extremities, the diagnosis should be confirmed by Trousseau's sign.

Trousseau's Sign.—A tourniquet is placed around the arm and the pressure raised to 200 millimetres. If tetany is present, in five minutes typical contractions of the hand are seen—the so-called ' obstetrician's hand '.

The immediate treatment is to administer calcium. One or two heaped teaspoonfuls of calcium lactate should be given every hour until the symptoms are controlled, or calcium gluconate, 10 c.c. of a 10 per cent solution, administered intravenously. Parathormone is not essential, and if given must be accompanied by large doses of calcium.

When the symptoms are controlled, calcium should be continued for months to come. No meat should be allowed, and large quantities of milk are ordered. It is convenient to give the calcium in the milk.

THYROID CRISES

A patient with a toxic goitre may be admitted in a thyroid crisis (i.e., no operation has been performed).

The treatment is much the same as that for a post-operative thyroid crisis. If there is copious vomiting, gastric aspiration is advisable. In any case, it is advisable to place the patient upon continuous intravenous saline and glucose, which should be given with great care. The regulator should be adjusted so that about 30 to 40 drops a minute flow in an average case, and Lugol's solution is given in the saline. Usually 50 min. of Lugol's solution are given once a day, well diluted in the saline.

CHAPTER XXVI

THE MANAGEMENT OF SURGICAL THORACIC CASES

By T. HOLMES SELLORS

OXYGEN THERAPY

THE administration of oxygen is valuable in the treatment of respiratory and circulatory distress. To be effective the alveolar concentration must be high —50 per cent or more. A patient who is desperately in need of oxygen is usually restless and resentful, and a good deal of persuasion is needed to make him submit to oxygen therapy. Masks, catheters, etc., may be swept off the face and an oxygen tent is often actively resisted. When oxygen therapy is likely to be needed the patient should be educated in its use *before* it is necessary.

The variety of methods for administering oxygen shows that the ideal has yet to be found. *The crude arrangement of a tube and funnel blowing a whiff of oxygen across the patient's face is futile.*

OXYGEN TENTS

The main feature of the tent is that the patient can live in an atmosphere of oxygen with an easily adjusted concentration. There is no restraint of the movements of the head by a mask, but patients often complain of stuffiness and

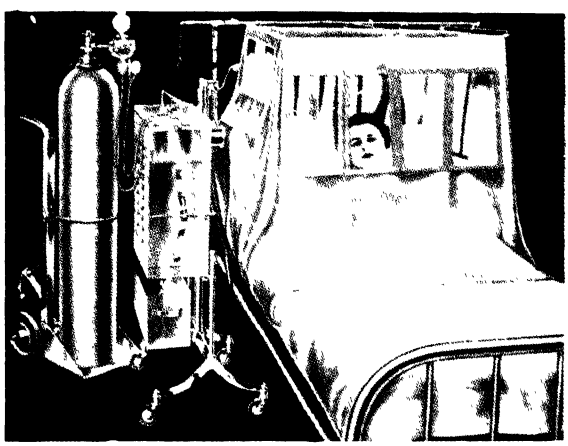


Fig. 225.—An oxygen tent. The loose aprons are tucked in with the bedclothes.

claustrophobia. To overcome this to some extent the temperature of the circulating oxygen can be lowered by running half of it (about 3 litres/min.) through an ice-box. The oxygen flow from large 100-cu.-ft. cylinders is controlled by a reducing valve which leads in some apparatuses to the two outflow

tubes. In addition there is an emergency flushing valve. The average consumption is about 100 cubic feet in six to eight hours to maintain 50 per cent alveolar concentration. Carbon dioxide is absorbed by soda lime.

The tent consists of a bell of light, air-tight material with transparent panels. The loose aprons are tucked in with the bedclothes (*Fig.* 225). Examination of the patient without removing the tent is not easy. Consequently, at any rate for adult surgical cases, a mask is more suitable.

Control and estimation of the oxygen concentration is made from time to time by simple gas-analysis apparatus (Poulton-Shackle). The details of this and precise instructions for managing the tent are supplied with the apparatus or arranged by the valuable hire services that are available in most large towns.

OXYGEN MASKS

Masks have many advantages over tents, and for the majority of cases the modern mask is quite as effective. The mask is much more economical in the matter of oxygen than the tent and the patient is more accessible.



Fig 226.—The B L. B mask Note tubes leading from the nasal mask round the mouth to the reservoir bag The metal ports can also be seen Flowmeter is on the bedside table.

The B. L. B. Mask (Boothby, Lovelace, and Bulbulian) is an effective appliance for oxygen administration. This mask leaves the patient's mouth free for eating and spitting, though clearly, if a high oxygen concentration is to be maintained he should not breathe through the mouth. A mask to cover both nose and mouth is used in the case of habitual mouth-breathers. This apparatus (*Fig.* 226) is provided with three portholes which can be opened to admit air. With all three open and a flow of 4 litres per minute the alveolar concentration reaches 56 per cent, while with 6 litres per minute with all closed the concentration rises to 87 per cent. A flowmeter should be employed, but its absence does not preclude the use of the mask.

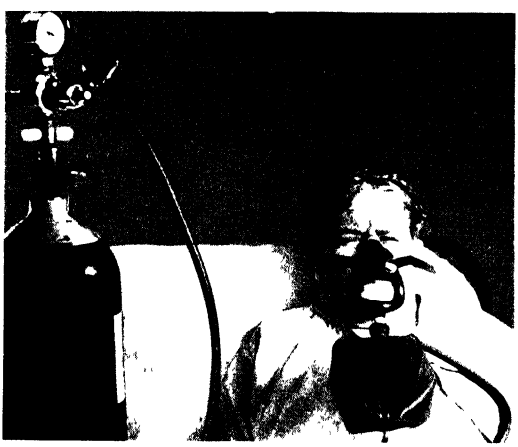


Fig 227.—The injector mask (Barach-Eckman type)

The Injector Mask (Barach-Eckman), *Fig.* 227, is a modification of the above with an expiratory valve placed in the nose-piece. This avoids breathing against pressure at high rates of oxygen flow, and allows the patient to keep the mouth closed more easily. One of the many advantages of this apparatus is that the flowmeter is incorporated in the oxygen cylinder head.

Improvised Masks.—In an emergency an ordinary nitrous-oxide bag and face mask attached to an oxygen cylinder is effective. The expiratory valve can be so adjusted that the patient breathes freely without resistance into the bag.

Rose and Sellors have improvised a mask out of a used X-ray film. The apparatus fits over the chin and is open at the top (*Fig.* 228). The oxygen inlet is at the bottom.

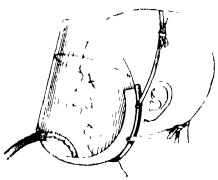


Fig. 228.—Mask improvised out of used X-ray film.

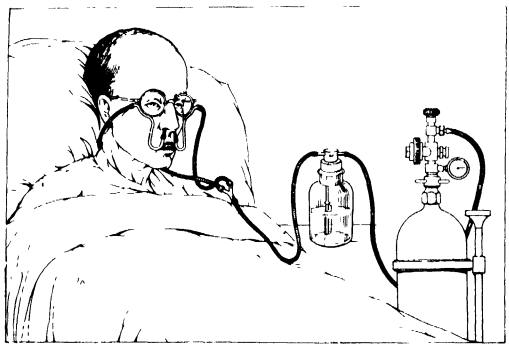


Fig. 229.—Tudor Edwards's spectacle carrier for the intranasal administration of oxygen.

NASAL CATHETERS

Fine catheters introduced into each nostril and supported on a head band or empty spectacle frame (*Fig.* 229) are fairly well tolerated. The oxygen should be bubbled through water so as to maintain adequate humidity. A flow of 3 litres per minute raises the alveolar O_2 to 27 per cent, but a higher rate of flow is not usually tolerated.

Warning.—All oxygen administration is open to the grave risk of explosion and fire; in many of these explosions the patient has perished. All forms of spark, fire, or combustibles must be kept away.

The following are examples of what must be avoided: Smoking, matches, electric light and power switches, night lights, sparking toys, static sparks from combing the hair vigorously, grease on the cylinder head of the oxygen tubes, gas rings, gas lighting.

ASPIRATION OF THE CHEST

Diagnostic Aspiration.—Careful examination suggests the likely spot for exploration.

Injecting Local Anæsthesia.—A preliminary sedative should be given. At the selected point local anæsthetic (1 per cent novocain) is injected. First, with a fine needle, a subcutaneous wheal is raised; then, with a somewhat larger needle, the deeper tissues are infiltrated; in all about 10 c.c. of the solution are injected. Particular attention is paid to the intercostal space, so that by diffusion the nerve in that segment will be anæsthetized. When difficulty in locating purulent fluid is anticipated, a good plan is to make a series of intercostal injections well towards the spine. This will make a wide segmental area insensitive.

Technique.—In performing aspiration there is no necessity to employ a needle of large bore, but it should be at least 2½ in. long. The syringe to which it is connected should contain a few cubic centimetres of air or fluid (the local

anæsthetic solution is handy) so that when the pull on the plunger is released the piston cannot fly against the base of the syringe and break the barrel.

As the needle is advanced towards the pleura it is possible to gauge the thickness of that membrane, which normally offers no more resistance than a sheet of notepaper. A thick pleura gives a rubber-like or even woody sensation, and its thickness can often be judged accurately.

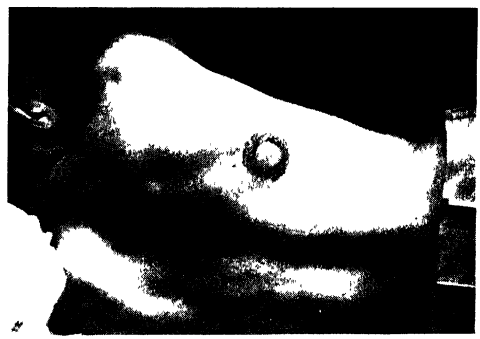


Fig. 230.—The site of a successful puncture is ringed with dye and the depth at which pus was located is recorded in the notes.

Findings.—

Gas is withdrawn: If, instead of fluid, aspirated air appears in the syringe, it must be due to one of the three following: (1) A leak in the needle-syringe outfit; (2) Puncture of the lung; (3) Gas from the empyema cavity—the stink of gas from an empyema leaves no doubt as to its origin.

Blood is withdrawn: Lung puncture is usually accompanied by a little blood, making a froth. The arrival of pure blood into the syringe may be due to several causes. Intercostal vessel injury and entry into a hæmothorax lead to a steady flow of blood into the barrel. These two conditions can be differentiated by assessing where the needle point lies. Liver puncture usually results in some fragments of brownish liver substance being withdrawn; they can be demonstrated by evacuating the contents of the syringe and needle on to dry gauze.

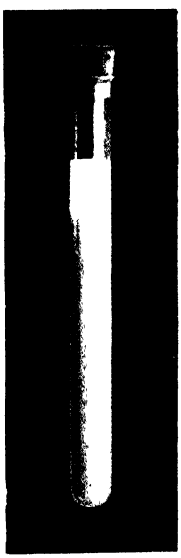


Fig. 231.—Thick pus in aspirated fluid after standing overnight.

Purulent fluid is withdrawn: It is highly important to mark the point of a successful aspiration. The skin about the puncture should be ringed with a small circle of dye (methylene blue) (*Fig.* 230) and the depth of the needle recorded. One specimen should be sent to the laboratory for examination. Another specimen should be retained by the clinician and, unless operation is indicated urgently, left to settle overnight (*Fig.* 231). The amount of deposit will give some indication of the viscosity or density of the pus and help in deciding the course of action.

Pus is suspected, but not located: In a difficult case, in order to cover a wide area it is useful to make the first puncture at right angles to the chest wall and then to work systematically in a radiating fashion until the whole of the suspected area has been explored. If pus is not found the puncture must be repeated elsewhere. Providing the area is properly anæsthetized four to six punctures can be carried out without unduly distressing the patient. Failure to find pus does not imply that it will not be discovered on the next day or a few days later. If clinical findings and radiography point to the

existence of an empyema, the procedure of diagnostic aspiration must be repeated until pus is either found or proved by an exhaustive process of exclusion to be absent.

TREATMENT OF EMPYEMA

Chemotherapy.—The use of sulphonamide preparations should always be considered in the early stages of formation of an empyema. Usually one or more courses of the drug will have been given before the empyema is diagnosed. The agent selected—sulphapyridine, sulphathiazole, sulphadiazine, sulphamethazine—will depend on the bacteriological findings (*see* Chapter XXXVII).

Chemotherapy in the early stages undoubtedly modifies the course of many empyemata, but not to the extent of affecting the surgical principles of treatment.

Deciding upon the Method to be Employed to Remove the Pus.—Thin fluid full of organisms calls for removal less urgently than thick pus, but this same thin fluid may demand immediate removal on account of its pressure effects. In selected cases intercostal drainage is preferable to repeated aspiration.

THERAPEUTIC ASPIRATION

When a large collection of fluid has to be evacuated, it is convenient to attach a T-shaped tap as shown in *Fig.* 232 between the syringe and the needle. The tap avoids disturbing the needle point, a mishap liable to occur when the syringe is repeatedly detached for emptying. Special types of syringe, such as the Dieulafoy, and the Potain aspirator, may be employed.

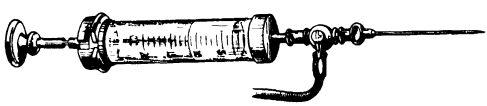


Fig. 232.—A two-way syringe—a valuable instrument when a large collection of fluid has to be evacuated.

After evacuating some ounces of fluid from an empyema it is not unusual for the patient to cough and complain of discomfort, which is due to the sudden removal of fluid. If this occurs the rate of aspiration must be reduced to allow the chest to accommodate for the sudden change in pressure.

Air replacement allows large collections of fluid to be evacuated at one sitting, but this step is inadvisable since any air admitted keeps the pleural layers separated and may enlarge the cavity before adhesions have had time to form.

INTERCOSTAL DRAINAGE

Intercostal drainage is easily performed and can be used in empyemata where thin pus is forming rapidly. It can be employed up to the time that pus becomes thick or fibrin flakes block the lumen of the tube. Intercostal drainage is, therefore, valuable only in the early stages of treatment, and it cannot be regarded as an alternative to rib resection. Very few empyemata are cured without recourse to rib resection.

For intercostal drainage three sizes of cannulæ are commonly used. Catheters of the self-retaining Malecot type must be selected to fit their respective cannulæ. The skin over the anæsthetized area is nicked with a small scalpel or tenotome. Holding the incision steady over the interspace, the trocar and cannula are thrust into the pleural cavity, taking great care to ' guard ' the shaft so that too deep an entry is avoided. The trocar is withdrawn and the opening of the cannula is occluded with a finger until the catheter on its introducer can be inserted. The cannula is then removed, being careful to avoid pulling the catheter out at the same time. The tube is adjusted so that the self-retaining expansion just touches

the parietal aspect of the pleura. A fine stitch is inserted to anchor the tube to the skin. The tube must be clamped immediately it is inserted and the clamp must not be removed until the tube has been connected to an underwater drainage bottle.

If necessary, it is possible for this operation to be performed in the patient's bed without much more difficulty or mess than an ordinary aspiration.

A warning should again be made against too great enthusiasm in persisting with this form of drainage. In adults 5–10 days is the maximum time for intercostal drainage to remain effective; after this period the tube tends to become blocked with flakes of fibrin or thick pus and its value is lost.

RIB RESECTION

Removal of a short length of rib over an empyema cavity has two main advantages—the cavity can be explored and a wide drainage tube can be inserted. There is no constant site for this operation, which is best performed under local anæsthesia. Careful localization with the aspirating needle must determine the lowest and most posterior point of the empyema cavity, so that the contents will be evacuated by the action of gravity and undrained pools avoided. The most usual place in which drainage is required is about the 8th or 9th rib at the posterior angle just outside the erector spinæ mass. A vertical incision (*Fig.* 233) allows access to more than one rib in case the original localization by needle has not been quite accurate. After removing 2 to 2½ in. of rib, the empyema is opened into through the rib bed and pus flows out. The cavity should be explored with the finger to remove any fibrin or 'lymph' mass, and at the same time to assess its outline and check the accuracy of the position of the tube. A large flanged tube is used for drainage, the flange preventing accidental pulling out of the tube and ensuring that it lies close to the inside of the chest wall and does not project into the cavity, where it might injure expanding lung. A flanged tube is not essential and a wide-bore tube with one side eye will serve the purpose well, but its wall must be sufficiently stiff to prevent kinking. Careful suture of muscles and skin round the tube makes an airtight junction, over which a small dressing can be applied. The tube is connected to a 'closed' drainage system as soon as the patient is returned to bed.



Fig 233.—A vertical incision allows access to more than one rib, and is recommended in case the original localization by the needle is inaccurate.

'Closed' Drainage.—One of the factors in the undoubtedly improved results from the treatment of empyema during the past decade is the use of 'closed' drainage in cases where the lung is collapsed. If the skin and soft tissues are sutured closely around the tube and the drainage system is maintained closed by a water-seal (*Fig.* 234), the sub-atmospheric pressure of the pleura is imitated and the lung encouraged to expand.

Maintenance of the 'Closed' System.—In fitting up a closed drainage system it must be remembered that its efficiency is dependent on its narrowest part. A typical apparatus (*Fig.* 235) consists of the drainage tube (A), a glass connexion (B), a long length of rubber tubing (C) leading to the floor, where it enters the collecting bottle via a straight length of glass tubing (D), the end of which dips below the surface of fluid in the bottle. If there is no leakage between the empyema cavity and the bottle, the sub-atmospheric pressure in the pleura

causes the water to rise up the glass tubing (D). With each act of respiration this level oscillates and the violence of a cough will blow the water out of the tube and possibly make bubbles in the bottle before the level ascends again to X. So long as pus descends into the bottle and the fluid level swings freely in the tube, the system is functioning well.

Failures in the System.—On no account should the bottle be raised to the level of the chest during bed making, etc.; if the bottle is elevated fluid can be sucked from the bottle into the empyema cavity, with disastrous results. Blocking

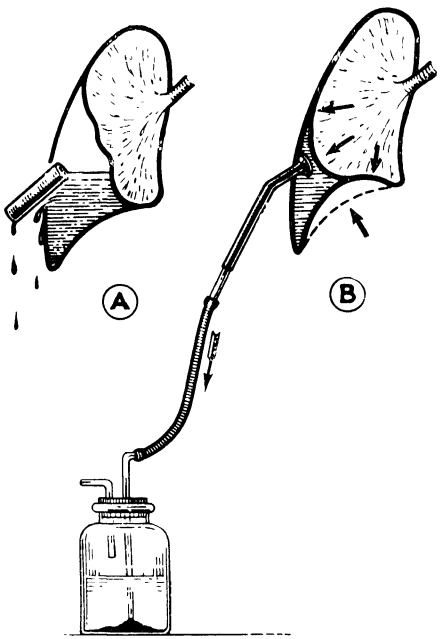


Fig. 234.—Principles of 'open' and 'closed' drainage contrasted A, Open; B, Closed

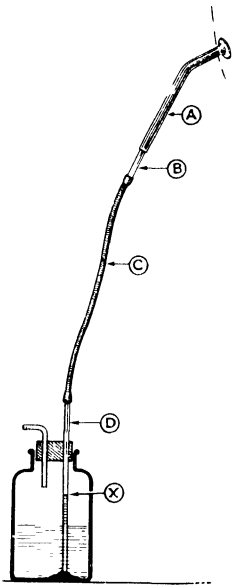


Fig. 235.—Diagram illustrating the maintenance of the 'closed' drainage system (For description *see* text)

at some part or other by pus or fibrin flakes is common and is recognized by absence of swing in the tube (D). The most likely site is at the glass connexion (B), which is invariably the narrowest part of the system. Momentary disconnexion for cleaning or judicious 'milking' downwards of the rubber (C) may affect a clearance. The internal opening of the drainage tube (A) may become occluded by expanding lung or a mass of fibrin, and leakage of pus along the side of the tube will confirm the site of the obstruction. Simple irrigation may suffice to free the drainage, but in obstinate cases it is of help to cut the tube short and explore gently with a soft bougie and pair of forceps. Another cause of error, easily remedied, is a kink or sagging loop in the tubing (C).

Free bubbling into the bottle suggests a leak in one of three places—the apparatus, between the empyema cavity and the outer air, or between the empyema and the bronchi. Leakage at the skin-tube junction is fairly common about the 8th to 10th or 12th day, but as scar tissue forms the tube is gripped more firmly and sealed again.

For the comfort of the patient it is important to see that drag or pull on the tube is avoided. Most tubes lie easily between pillows and pass through the head of the bed, and strapping can be used to take some of the strain of the drainage tube on to the skin of the back. Safety-pins around the long tubing (C) (not through it) into sheets or mattress help further in relieving the pull, and patients when moving their position readily learn to steady the tubing during the process.

Irrigation of an Empyema Cavity.—The value of irrigating an empyema cavity is possibly as much dependent on its mechanical as on its disinfectant merit. The use of a dilute hypochlorite solution is held to dissolve deposits of fibrin. Merthiolate (1–5000) in staphylococcal cases and 1 per cent acetic acid when *B. pyocyaneus* is present are also of use. Azochloramide-T has been found valuable in cases of chronic infections. If irrigations are to be employed there is one definite proviso that must be established before they are attempted—to wit, the absence of a bronchopleural fistula. To pour fluid into a cavity which opens into the air-passages is to invite an uncontrollable fit of coughing and possibly death from drowning.

Test for bronchopleural fistula: A few cubic centimetres of a harmless dye such as dilute methylene blue are injected into the cavity. If the patient coughs up sputum stained blue, it is obvious that a pleurobronchial communication is present. Absence of dye from the sputum for twenty-four hours indicates that it is safe to proceed with irrigation. When irrigation is practised regularly, it can be made to serve another purpose, which is encouraging to both the patient and his nurse—that is, measuring the capacity of the empyema cavity by filling it to overflow every few days and charting the volume.

The Management of an Empyema Drainage Tube.—

Chronic empyema is a most disabling condition which entails months of continuous treatment. In nearly all cases it can be prevented by a proper understanding and careful management of the drainage tube.

Closed drainage is neither necessary nor desirable through all stages of empyema treatment. When the pleural abscess has become localized effectively and the walls of the cavity are relatively firm, the closed system can give place to 'open' tube drainage.

The empyema drainage tube is cut short practically flush with the chest wall; it must not project enough to be pressed upon by dressings. Attention is also directed to the length and position of the tube within the thorax; it must not press upon the lung lest ulceration and hæmorrhage occur. When a large cavity is being drained it suffices to see that the tube is of sufficient dimensions and that lateral openings are so placed that pocketing cannot occur.

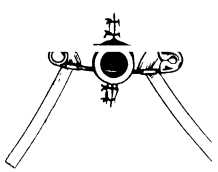


Fig. 236.—Method of anchoring an open empyema drainage tube

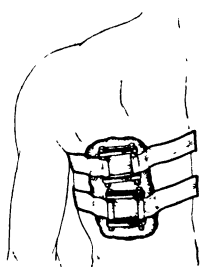


Fig 237. — Learmonth's method of corsettage is particularly suitable for maintaining an empyema dressing in position.

Having attended to these important details, we are in a position to proceed with the routine dressing.

A safety-pin is fastened to the drainage tube in order to prevent it slipping into the chest. It is prevented from coming out of the wound

by anchoring the safety-pin to the chest wall with a narrow adhesive tape (*Fig.* 236). A piece of vaseline gauze can be placed beneath the pin around the tube, and the whole is covered by light dressings. Circumferential binders do not always prevent the dressing from slipping, and they tend to restrict respiratory excursions. Corsettage (*Fig.* 237) is the method which should be employed.

Contrast Radiographs or Pleurograms (*see also* p. 148).—As it is impossible to determine the progress of healing from outward appearances and straight radiographs, and as it is essential to know the size and shape of the cavity, especially during the later stages of treatment, contrast radiographs at regular intervals (every two to three weeks) are indispensable. Having first excluded the presence of a gross communication of the empyema cavity with the bronchial tree, opaque oil (neo-hydriol or lipiodol) is allowed to gravitate into the cavity, the patient lying with the drainage opening uppermost. Radiographs in the antero-posterior and lateral planes are taken, it being particularly important not to ignore the lateral view. In this way a good estimation of the cavity can be gained and compared as successive films are taken at, say, bi-weekly intervals. When a fistula allows the injected oil to run too freely into the bronchi, loose packing of the empyema cavity with gauze soaked in the opaque oil overcomes this difficulty. As a point of economy, it should be realized that to fill a big space with either of the oils mentioned is very expensive, so dilution of the opaque oil with paraffin should be considered, though the radiological result will not be so emphatic. Barium sulphate emulsion as a contrast fluid is more economical than the iodine-containing oils. The former can be used with safety when it has been ascertained that there is not a fistula into the bronchial tree.

When should the Drainage Tube be Removed ?—It is clearly wrong to take out the tube while a large suppurating cavity still requires drainage. Temptation to remove the tube must be firmly resisted when the discharge has almost ceased and the patient's condition is obviously good. Healing cannot be guaranteed until the whole empyema space has been obliterated, and this implies that a tube must remain in place until the capacity of the cavity is less than 5 c.c. As the cavity closes the tube must be shortened appropriately until the empyema is virtually nothing more than a chest-wall sinus. This point cannot be stressed too much ; many chronic empyemata are seen as the result of too early removal of the drainage tube.

It is safe to leave the original tube in situ right up to the end, but it may add to the patient's comfort to substitute a somewhat smaller one when the process of healing is well advanced. *The practice of removing a tube to have it washed and boiled each day is to be deplored.*

If the tube is frequently removed, invariably there comes a time when the contraction of the opening prevents the original tube being re-inserted without pain and a smaller tube is usually placed in the sinus ; at later dates the process is repeated until the external opening is totally inadequate. This error in management is still too frequent, and is often caused by the surgeon leaving the control of the after-treatment to inexperienced junior staff.

Factors Requiring Special Consideration.—As a result of the pleurograms and other data, it will become evident that certain cases require special measures if chronicity is to be avoided.

Mechanically Imperfect Drainage.—When confronted with a case where the external opening has been allowed to contract prematurely, steps must be taken

to stretch it sufficiently to allow the re-insertion of a tube of adequate calibre by : (*a*) The passage of graduated bougies ; or, preferably, (*b*) The insertion of a laminaria or sea-tangle tent for twenty-four hours, but care must be taken to have a string attached to the tent for purposes of withdrawal. When these measures fail the cause of the external narrowing is usually due to osseous regeneration, and operative measures to ensure a sufficiently large opening are required.

With a long, narrow track it is important to be sure that the tube reaches to within ½ in. of the extremity of the cavity. The length of this track can be estimated by soft bougies or, more accurately, by inserting a tube which is radio-opaque (barium-loaded tubing) and screening the patient.

In the case of an hour-glass empyema cavity the constriction must be dilated carefully until a tube of adequate size can be passed into the bulb beyond the stricture.

It is only by contrast radiographs that unsuspected pockets and tracks can be visualized. If the gravity drainage of these is inadequate, further operative treatment is essential, otherwise the infection may be perpetuated and ultimate healing postponed indefinitely. The bacteriology of the discharge should be checked occasionally. If an otherwise straightforward case is becoming unduly tardy, special examinations for tubercle bacilli and actinomyces should be made.

Offensive Discharge or continuing profuse pus are indications for a complete investigation. If the contrast radiographs show that the cavity is not draining at its most dependent point, the patient must either be placed in such a position that the opening is able to drain with the aid of gravity, or, if this is ineffective, operative measures must be considered.

Persistent Pain.—If other factors have been excluded intercostal neuritis may be the cause. This often responds temporarily to injection of novocain, and in more resistant cases to alcohol injection or resection of the intercostal nerve.

Breathing Exercises.—The importance of aiding re-expansion of the lungs by means of breathing exercises cannot be over-estimated. Blowing water from one bottle to another is the traditional procedure. Unfortunately, the indispensable effort in expansion is not expiratory but inspiratory. Exercises must, therefore, be directed towards improving the tone of the inspiratory mechanism, i.e., the musculature of the lower chest and diaphragm (*see* Chapter XVI).

Attention is mainly directed to the ribs over the empyema, but diaphragmatic breathing is also included in every instance.

The exercises should be started within a day or two of the drainage of the empyema and must be persisted with until and even after the empyema has healed.

General Treatment must not be overlooked in the handling of the local condition. A severe degree of anæmia is associated with many empyemata, and this, if untreated, will delay healing. Repeated blood examinations are advisable, and, in addition to iron preparations, blood transfusions may be required.

Another point to remember is that there is a steady drain of body protein in the purulent discharge, and to counter this a high protein diet and even plasma transfusions should be considered.

There is no need to keep the patient bed-ridden once the temperature is steady and signs of toxæmia are abating. A ' closed ' drainage system necessitates some restriction of activity, but at the earliest moment the patient can be allowed out of bed to start the process of physical rehabilitation.

SUCTION DRAINAGE

When breathing exercises fail to produce the lung expansion which is anticipated, the closed water-seal method must be assumed to be inadequate. Direct mechanical suction by electric or water pump is then sometimes helpful. An intervening tap with a manometer and automatic release, such as is found on a Roberts' bottle, prevents too high a degree of suction—2–5 mm. Hg is the maximum for the average case : higher figures may lead to fistula formation. Suction may be maintained for many weeks if necessary.

POSTURAL DRAINAGE

Normally the action of bronchial cilia and coughing remove secretions from the air tubes and maintain them free from obstruction. In certain conditions the infective process causes dilatations and cavities which cannot be properly cleared by coughing.

Postural drainage means the placing of the patient in such a position that the affected part of the bronchial tree can empty under the action of gravity. This is sometimes translated as getting the patient to lean over the edge of the bed for a few moments each day—an almost useless state of affairs.

The actual position to be adopted has to be worked out carefully for each individual case, and the correct position of that case must be maintained for several hours at a time.

A brief description of the anatomy of the bronchi may help towards a proper appreciation of the position to be adopted. In the first place it should be realized that both sides have a similar distribution and that the ' lingula ' process of the left upper lobe is the equivalent of a middle lobe. Both lungs can, therefore, be discussed together.

The *upper lobe* bronchus takes an upward course and gives off branches which describe the areas that they supply, e.g., apical, subapical or posterolateral (which gives off an axillary branch), and pectoral. Drainage will be best with the patient in the *upright* position (*Fig.* 238), leaning slightly away from the diseased side.

The middle lobe bronchus leaves the main stem on the anterior aspect and runs forwards and downwards. There are two main branches, an upper and lower. Drainage is effected by the patient lying *flat on the back* (*Fig.* 239).

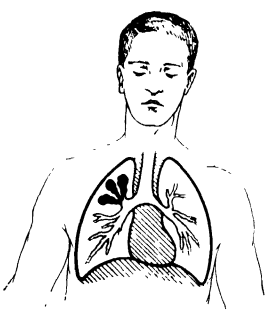


Fig. 238.—The upper lobe is drained when the upright position is adopted.

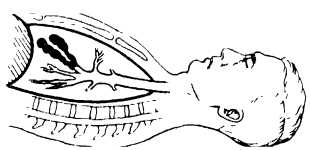


Fig. 239.—The middle lobe is drained effectively when the patient lies on the back.

The lower lobe main bronchus is directed downwards, with a slight outward and backward inclination. It gives off a series of large trunks which supply the base of the lung and are the tubes most commonly affected in bronchiectasis. As these branches lie in front of the main plane of the bronchus, they are referred to as ventral branches, in distinction to less significant dorsal stems, of which the first is the most clearly defined. Drainage is achieved by the patient lying *head downwards*.

The head-down position is the one most commonly required, and the simplest way of doing this is to raise the foot of the bed on high blocks. However,

it is difficult to prevent the patient from sliding downwards by this method. The solution is to lay the patient on his abdomen and to place a wedge of pillows or a chair at the centre of the bed (under the mattress) so that the patient is balanced over the wedge with buttocks in the air (*Fig.* 240).

A specially designed posture bed (Nelson's type) enables a wedge to be raised and lowered at will without moving the patient. An easily constructed apparatus is illustrated in *Fig.* 240 ; a similar frame in wood can be made at a low cost by any carpenter. The centre support must be firm and of a height not less than from 18 to 20 in. If this can be made to detach by a series of bolts and the inclined planes made as hinged flaps, storage is greatly facilitated.

Great emphasis must be laid on the importance of persistence with this form of treatment—it must be a question of hours each day, and with a little practice patients can be induced to sleep upside down. Anything under 6 or 8 hours in the 24 does not give postural drainage a chance of being effective.

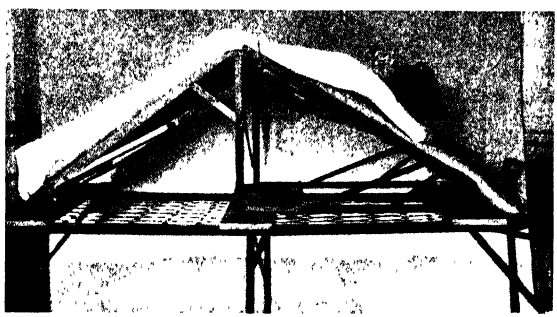


Fig. 240.—Improvised postural wedge for drainage of a lower lobe. The central prop should be 18 to 20 in. high.

TRACHEO-BRONCHIAL 'TOILET'

There are numerous conditions in which the patient is unable to cough effectively. Pain, shock, exhaustion, and excess of secretions may all inhibit the cough reflex. As a result, secretions or blood remain in the air tubes and can occlude some of the bronchi. Massive collapse or atelectasis and even drowning may occur. Take, for instance, a case of pulmonary hæmorrhage ; if the blood is not quickly cleared from the bronchial tree a major disaster is more than probable. Another even better example is the case where vomitus is inspired. Unless tracheo-bronchial toilet is carried out quickly and well, bronchopneumonia, usually fatal, will certainly follow. Post-operatively, excess of mucus or inhaled vomit has the same possible effect. Postural drainage and similar procedures, as described in Chapter XV, succeed in a high proportion of cases, but the patient's condition does not always justify the manipulations, and secretions are sometimes too sticky or viscid to be removed in this way.

Prolonged disability, and even life, may be saved by prompt clearing of the air-tubes. Endotracheal suction can achieve this and is a procedure that need not be regarded as being unduly specialized or unpleasant. Bronchoscopy is the best method, but if experience in handling the necessary instruments is lacking, the passage of a small and long catheter between the cords into the trachea

produces good results when suction is applied. Not many years ago passing a gastric aspiration tube was regarded as a major undertaking; it is now accepted as a matter of routine. In the same way bronchial aspiration may well become a normal procedure in the reduction of post-operative chest complications.

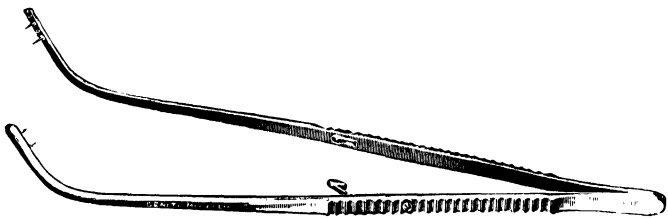


Fig. 241.—Krause's laryngeal forceps.

Anæsthesia.—If the patient is too ill to be moved, the operation can be performed in bed. Extensive spraying and painting of the pharynx and cord are not essential, and the simplest way of producing anæsthesia is as follows: The patient leans forward and holds the tongue well out in a piece of gauze. A Krause laryngeal forceps (*Fig.* 241) holding four to six thicknesses of 1-in. ribbon gauze is lightly soaked in 10 per cent cocaine solution and is passed over the back of the tongue and down the pharynx into one pyriform fossa and held there for about half a minute. The tip of the forceps, if in correct position, can be felt under the skin of the neck, just below and behind the submaxillary gland. The opposite side is similarly treated and the swabbing may be repeated if necessary. Next with the head stretched back, a hypodermic needle is pushed through the cricothyroid membrane and 3 to 5 minims of 10 per cent cocaine* are injected into the trachea. Coughing will occur and, to prevent damage, the needle must be rapidly withdrawn after the injection. Some sputum may be produced during the process of anæsthetization.

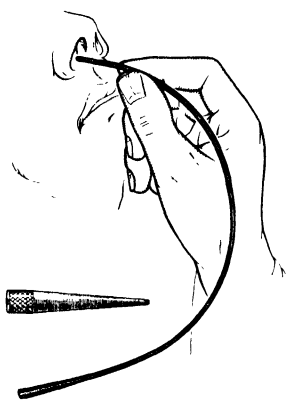


Fig. 242.—Gum-elastic endotracheal tube being passed. *Inset*, Adaptor for fitting to a Record syringe.

Endotracheal Suction.—A long fine tube (gum-elastic) (*Fig.* 242) is passed into one nostril and into the pharynx. The patient is instructed to breathe deeply, and, as the end of the tube approaches the glottis, it is moved up and down until a to-and-fro current of air at the end of the tube suggests that it has entered the trachea (*see also Figs.* 545–549). Difficulties may be overcome by use of a laryngeal mirror and forceps to guide the tube between the cords. As the tube is passed downwards, suction is applied and the patient gently leans to one side or the other to let the tube enter the main bronchi. Considerable quantities of secretions may be removed, and if the tip of the tube

* Two per cent amethocaine (decicaine) or nupercaine (percaine) can be used instead of 10 per cent cocaine.

is moved back and forwards, blocking is avoided. Dramatic relief is common, the patient's breathing becoming less distressed and less 'rattling'. When necessary, the tube can be left in position, and, with a tolerant patient, the suction process repeated as required over a period of many hours.

Suction is not always readily accessible in the wards, and if an electric pump is not available, an ejector worked off an oxygen cylinder has recently been produced. (*See* Chapter XXII.)

Bronchoscopy.—This is a more specialized procedure, but not such a formidable one as generally considered. Knowledge of the instruments and practice should enable it to be more widely used in this type of case. Unless the house surgeon has been trained in the use of the bronchoscope he should rely on the above measures.

CHAPTER XXVII

THE MANAGEMENT OF GASTRIC CASES

By HAMILTON BAILEY

PRE-OPERATIVE TREATMENT

Aspiration of the Stomach.—The stomach must be clean and empty. As a preliminary measure for operations upon the stomach, gastric aspiration and lavage are indicated, particularly in cases of pyloric stenosis. It is a good practice to send the patient to the operating theatre with the tube in position.

If the operation is conducted under local anæsthesia and the patient experiences nausea during the operation, the stomach can be emptied. The tube is left in position after the operation, whether it is partial gastrectomy or gastrojejunostomy.

Hypochlorhydria.—It is extremely valuable from many points of view to have a fractional test-meal to hand before every operation upon the stomach. In cases of hypochlorhydria the pre-operative treatment should include the administration of 10 per cent hydrochloric acid 10 to 60 minims diluted with water three times a day. Lahey makes a great point of this in his pre-operative régime. It will be appreciated that the normal stomach contents are practically sterile, due entirely to the action of hydrochloric acid. How very important this must be in the successful issue of cases of gastrectomy.

Fractional Test-meal.—*See* Chapter L.

Hæmoglobin Estimation.—Many patients with gastric and duodenal ulcers are anæmic, and practically all patients with carcinoma of the stomach are severely anæmic. It should be an unwavering rule for the house surgeon to have a hæmoglobin estimation performed soon after the patient is admitted, and to make adequate preparations for blood transfusion, which is so often indicated in both the pre-operative and post-operative management of the case.

Vitamin Therapy.—The house surgeon should visualize that probably for many months, or even years, the gastric patient has been living on a diet deficient in vitamins. Vitamin C is indicated in both the pre-operative and post-operative régime of gastric patients. The necessity of vitamin therapy, which at one time I thought was being rather exaggerated, was brought home to me in the case of a gastric fistula. The patient developed generalized œdema, the origin of which puzzled me considerably. In the absence of other causes, it was assumed that it was due to vitamin-B starvation. With each dose of nicotinic acid the œdema abated, and it was practically non-existent within three days.

Prevention of Chest Complications.—Patients with gastric lesions are very prone to post-operative chest complications, and it is most desirable that the house surgeon should pay especial attention to an examination of the lungs before a patient undergoes an operation upon the stomach.

POST-OPERATIVE TREATMENT

Feeding after Gastric Operations.—The post-operative régime varies somewhat in different hospitals. The following scheme will be found to be satisfactory.

First Twenty-four Hours.—Nil by mouth. Intravenous saline with glucose continuously. Oral hygiene. Frequent mouth-washes.

Second Day.—Stop the intravenous saline and glucose unless there is a definite indication for its continuance. Sterile water by mouth 1 fl. oz. hourly.* Rectal saline with glucose six-hourly.

Third Day.—Sterile water 2 fl. oz., alternating with Benger's or Allenburys' Food 2 fl. oz. two-hourly. Rectal saline eight-hourly.

Fourth Day.—Sterile water 3 fl. oz., alternating with Benger's Food 3 fl. oz. three-hourly. Glycerol enema.

Fifth Day.—Sterile water 4 fl. oz., alternating with Benger's Food 4 fl. oz. four-hourly.

Sixth Day.—Very weak tea (strained). Custard, jelly, water *ad lib.*

Seventh Day.—Pounded fish. Wafer of bread and butter—no crust.

Eighth Day.—Minced chicken.

The diet is then gradually increased.

Vomiting after Gastric Operations.—During the first forty-eight hours after operations upon the stomach, a proportion of patients bring up bile in varying quantities. In order that we may be in a position to judge whether the stoma is functioning, orders are given that the vomitus is to be measured and recorded on a separate slip—a vomit chart.

A better practice is to pass a gastric aspiration tube via the nose as a routine. Instead of a patient vomiting, gentle aspiration is carried out if he even feels sick. Feeds must be stopped forthwith and fluid supplied by another route. After twenty-four hours, feeding is commenced with the tube still in situ. If at the end of this period there has been no tendency to vomiting, the tube is removed.

It is after forty-eight hours, if vomiting commences or large quantities of bile are recovered by gastric aspiration, that a serious view of the case must be taken. Obviously the stoma is not functioning—it is very suspicious of a vicious circle.

In health the liver secretes about 50 fl. oz. of bile in twenty-four hours, and by the chart one can work out approximately how much is passing through the stoma. In order to make these calculations the method of charting described above is absolutely essential. If by the vomit chart you are not satisfied that at least half the bile is passing through the stoma, request an urgent consultation with the surgeon.

Post-operative Hæmatemesis.—

1. Pass a gastric aspiration tube and wash out the stomach gently with 2 per cent bicarbonate of soda in normal saline at 120° F., and into the last portion of the wash add a drachm of 1–1000 adrenaline.

2. Have the pulse recorded hourly on a separate piece of paper pinned on the chart.

3. Give morphia ¼ gr. subcutaneously.

4. Get the blood grouped and arrange for a suitable donor to hold himself in readiness.

It should be needless to add that the surgeon must be summoned at the earliest possible moment.

Remote Severe Post-operative Melæna.—Severe melæna sometimes occurs a week to ten days or more after gastro-enterostomy. The particular type of case this uncommon complication seems to favour is duodenal ulcer with stenosis. When hæmorrhage

* Feeds must be stopped for a time if the patient vomits.

occurs so remotely, it is unlikely that the bleeding is coming from the anastomosis—it is the ulcer which is bleeding. This type of hæmorrhage is liable to be overlooked, especially as the patient has been doing well up to the time of its onset.

Blood transfusion, and arrangements for re-transfusion if necessary, is the treatment recommended.

Drainage through the Abdominal Wall after Gastrectomy.—Experience has taught me that it is advisable to leave a corrugated rubber drain through a convenient part of the laparotomy incision after partial gastrectomy. Particularly after difficult operations which have involved the pancreas, it is wise to retain a shortened piece of corrugated rubber through the abdominal wall for ten or even twelve days. The reason for this is that late leaks occur, and if there is a drain in place (it does no harm in this situation) gastric or duodenal contents find their way to the surface, and the patient usually survives.

Duodenal Fistula following Gastric Operations.—*See* p. 272. In addition to this reference, if the discharge from a gastric or duodenal fistula is copious the surgeon should be informed, for early jejunostomy under local anæsthesia will enable the patient to be fed below the leak.

Acute Dilatation of the Stomach.—*See* p. 270.

Perforated Peptic Ulcer.—For years I have advocated the passage of a gastric aspiration tube to empty the stomach as a first-aid measure in cases of perforated peptic ulcer. I envisaged the general practitioner carrying a gastric aspiration tube in his bag and utilizing it in this and other emergencies before sending the patient to hospital. As far as I know the suggestion has never been put into practice.

It is only after he has had experience of a few cases that the house surgeon begins to appreciate fully the rationale of preventing further extravasation of gastric contents into the peritoneal cavity in this catastrophe. Once a gastric aspiration tube is in place and the stomach has been emptied and is kept empty, the clock is metaphorically made to stand still. A six-hour perforation remains virtually a six-hour perforation, at least long enough to allow the patient to be got into the best condition possible for the operation. In my opinion, the house surgeon should not be over-anxious to rush the patient to the operating theatre; his chief anxiety should be to prevent waste of time in removing stomach contents which otherwise would escape into the peritoneal cavity.

HÆMATEMESIS (NON-POST-OPERATIVE)

Cases of hæmatemesis are usually, but not invariably, admitted to the medical side. It is a good practice to have the blood grouped at the first available opportunity, for blood transfusion may become necessary urgently. It is for cases of hæmatemesis that drip blood transfusion is indicated.

During recent years the conservative treatment of hæmatemesis has undergone a radical change. The patient is made to sit up in the low Fowler's position, and is fed instead of being starved. The following is a résumé of the modern treatment :—

DIET.—

1st day.—Three pints of milk with three beaten eggs added are allowed. Eight ounces of this mixture is given three-hourly. If the patient is thirsty the mixture may be given even immediately after the hæmatemesis. On the other hand, if the patient does not wish to have the milk it is not forced upon him. Water may be given instead.

2nd day.—As on the first day.

3rd day.—If no further hæmatemesis, allow jelly, eggs, and custard.

Subsequently.—The usual medical treatment for peptic ulcer.

DRUGS.—A restless, anxious patient is given ¼ gr. morphine. A teaspoonful of alkaline powder is given four times a day, and a mixture containing 20 gr. of iron and ammonium citrate t.d.s.



Fig. 243.—Drip-feed being employed through a gastrostomy tube.

GASTROSTOMY AND JEJUNOSTOMY FOR FEEDING

For the first few days after the tube has been introduced a drip feed (*Fig.* 243) of peptonized milk and glucose is often admirable. In the case of a gastrostomy, before the patient leaves hospital he and a relative must be instructed concerning his feeding (*Fig.* 244), the cleansing of the tube (*Fig.* 245), and the management of the artificial opening. A gastrostomy belt should be supplied, together with a special spigot (*Fig.* 246) for use at night. Emphasis must be laid upon the fact that the gastrostomy opening must never be left unoccupied by one or other of these pieces of apparatus.



Fig. 244.—Patient about to feed himself through a gastrostomy tube



Fig. 245.—A gastrostomy tube.

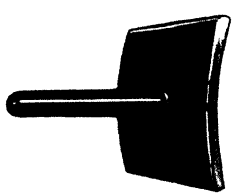


Fig. 246.—Solid rubber gastrostomy spigot.

THE MANAGEMENT OF INFANTS UNDERGOING RAMMSTEDT'S OPERATION

By ELLIOTT EMANUEL

The medical treatment of pyloric stenosis with eumydrin is practised widely, but there are still a number of cases where Rammstedt's operation is indicated.

Pre-operative Treatment.—Probably the infant will be dehydrated, and certainly the mucosa of the stomach will be in an unhealthy condition. Life may be saved and hospitalization will be reduced if these two factors receive energetic attention. Gastric lavage should be carried out twice daily with normal saline,* and should be performed just before the operation.

If the baby is still on the breast, breast-feeding must be maintained. Ideally, the mother should live in the hospital. The fluid intake must be supplemented in accordance with the degree of dehydration, which in severe cases is best combated by intravenous glucose-saline.

Immediate Pre-operative Treatment.—Gr. $\frac{1}{100}$ atropine is given one hour before operation. If local anæsthesia is used, sugar 'comforters' should be provided during the operation. The patient should come to the theatre with the

6-HOUR PERIOD	INTERVAL BETWEEN FEEDS	NO. OF FEEDS IN 6 HOURS	AMOUNT	FLUID IN 6 HOURS	NATURE
	Hours			Ounces	
1	1	6	120 minims	1½	5 per cent glucose or cane sugar
2	1	6	180 ,,	2¼	Ditto
3	1	6	240 ,,	3	¼ milk
4	2	3	360 ,,	2¼	Ditto
1st 24 hr.				9	
5	2	3	1 fl. oz.	3	¼ milk
6	2	3	1 ,,	3	½ ,,
7	2	3	1½ ,,	4½	Ditto
8	2	3	1½ ,,	4½	Ditto
2nd 24 hr.				15	
9	2	3	2 fl. oz.	6	½ milk
10	2	3	2 ,,	6	¾ ,,
11	2	3	2 ,,	6	Ditto
12	2	3	2 ,,	6	Whole milk
3rd 24 hr.				24	
13	3	2	3 fl. oz.	6	Whole milk
4th 24 hr.				24	
Later	3	2	3½ fl. oz.	Omit night feed 24½	

The infant should be put to the breast as soon as he is sucking strongly; probably on the second or third day.

* Sodium bicarbonate solution should not be used because of the danger of alkalosis.

gastric aspiration tube in place ; this ensures that the stomach is empty—a factor which facilitates delivery of the hypertrophied pylorus.

Post-operative.—Care must be taken to regulate the temperature. Hyperpyrexia is not uncommon. Feeding is commenced four hours after the operation ; many schemes are in use, they all aim to provide a gradual increase in the strength and quantity of the feed. The table on the previous page is only a guide : the appetite of the infant may allow faster, or compel slower, progress. The milk given is preferably the infant's own mother's milk expressed three- or four-hourly. Next best is other human milk, and next a half-cream dried milk used in $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$ of its usual strength (60 g. to the oz.) as the feeding progresses.

It will be noted that in the first two days the oral fluid intake is insufficient : it must be supplemented by subcutaneous or intravenous fluid administration.

Sutures are removed on the seventh day, and if all has gone well the infant may then be discharged.

CHAPTER XXVIII

THE MANAGEMENT OF GALL-BLADDER AND PANCREATIC CASES

By HAMILTON BAILEY

Gall-stone Colic.—Morphine as the standard treatment of gall-stone colic is so ingrained in medical practice that it will take years to alter it; yet every experienced clinician agrees that morphine or its derivatives, in moderate doses, do not relieve the pain as often as might be expected. On the other hand, doses large enough to render the patient stuporous are liable to increase damage to a liver already damaged. During the spasms of pain the aim should be to give a drug which will relax involuntary musculature (morphine causes such musculature to contract). The following have been recommended, and the general practitioner and the house surgeon have more opportunities of observing which is the best, than the surgeon.

1. An ampoule of nitro-glycerin 1–1000 is broken in a handkerchief and inhaled. This should be followed by an injection of atropine, gr. $\frac{1}{100}$.

2. As an alternative to atropine, an injection of the contents of an ampoule of 10 per cent gluconogalactogluconate.

3. 2 to 5 c.c. of Novalgin (Bayer) or Novaldin (U.S.P.) intravenously. A second dose can be administered some hours later for a new attack.

4. Pethidine (Roche) 2 c.c. (100 mg.) intravenously. In severe cases the dose can be repeated in one hour.

As soon as the acute pain has passed off is the time to apply heat in some form to the right upper abdomen. It is often impracticable to expect the patient to tolerate hot applications while she is rolling in agony.

When NOT to Order a Cholecystogram.—Cholecystography, which is now so safe and usually so satisfactory, depends upon the liver being able to excrete a chemically complex dye. It is in keeping with common sense not to tax liver cells within three days of their having weathered the storm of an attack of gall-stone colic. Another fundamental principle is that cholecystography must never be attempted in the presence of jaundice. The reason for this should be obvious. I have been summoned to the X-ray department to find a jaundiced patient collapsed and almost comatose. Apart from the risk it entails, the futility of expecting a deeply jaundiced patient to excrete the dye in sufficient concentration to visualize the gall-bladder should in itself deter the house surgeon from ordering a cholecystogram.

Acute Cholecystitis.—

Delayed Treatment.—The delayed treatment of acute cholecystitis stipulates an accurate and confident diagnosis, but there is no question regarding the extremely good results accruing from this treatment. When the attack has subsided, cholecystectomy is performed.

The details of treatment are very similar to those of the Ochsner-Sherren treatment of acute appendicitis (*see* p. 222). The patient is placed in Fowler's

position. Water only is given by mouth for two or three days. After this time a fluid diet is substituted until all the symptoms have subsided. For so long as the condition of the patient gives rise to anxiety, the temperature and pulse are recorded every two hours. Hot fomentations or a hot bottle placed on the upper abdomen helps to relieve the pain. No morphine or its substitutes are given for the first twenty-four hours unless the diagnosis is absolutely undeniable.

Gall-stones and Chronic Cholecystitis.—

Pre-operative Treatment.—Provided the patient has not been jaundiced recently, and has not had an attack of biliary colic for a week or more, there is rarely need for more than ordinary pre-operative care. It is a good practice, however, to insist on a high intake of carbohydrates twenty-four or forty-eight hours before the operation. Glucose may be prescribed conveniently in the form of barley sugar.

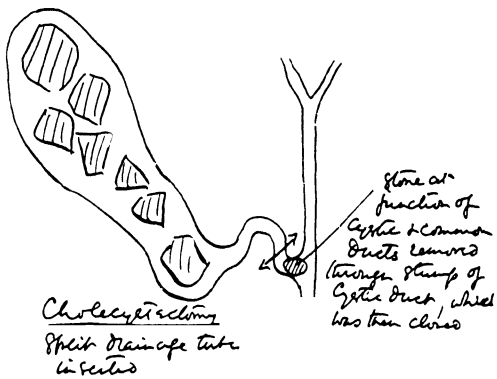


Fig 247.—Facsimile of a record of the operation of cholecystectomy.

Post-operative Treatment.—If, as is not infrequently the case, the patient is obese, special consideration should be given to the prevention of pulmonary complications (*see* Chapter XV).

Drainage Tubes.—In standard cholecystectomy a drainage tube is inserted. For the first forty-eight hours there is a blood-stained exudate, usually dark-coloured portal blood from the bed of the gall-bladder in the liver. Bright red blood suggests the possibility that the ligature on the cystic artery has slipped and requires the house surgeon's watchful attention.

After forty-eight hours, and sometimes before, a varying amount of bile escapes.

There should be no hurry in removing the tube; unlike tubes situated in the lower abdomen, the danger of coils of intestine becoming adherent to the tract is almost negligible. If bile is escaping from the wound, it is better to leave the tube in too long than not long enough, although of course the tube should be shortened. Occasionally the flow of bile is so profuse that doubt is entertained as to the integrity of the common bile-duct. In such cases the stools are examined daily. If the stool is putty coloured, a specimen is sent to the laboratory for examination for the presence of bile.

In all cases of biliary fistula the skin in the immediate vicinity of the wound should be protected by an oily dressing.

Thorek's Operation.—After cholecystectomy by Thorek's method a strip of the gall-bladder is left attached to the liver. The mucosa of the strip is coagulated with the diathermy. After suitably enfolding the area with stitches and patching it with a piece of detached omentum, the abdomen is closed without drainage.

After all operations on the biliary tract, during early convalescence it is a rational procedure to prescribe a biliary antiseptic such as felamine, which contains cholic acid and urotropine; the dose is one tablet t.d.s., p.c., with a copious draught of water.

Records.—A simple diagram indicating the position of stones and other pathological features of the gall-bladder and bile-ducts is more valuable as a permanent record than a long description (*Fig.* 247).

Obstruction to the Common Bile-duct.—

Pre-operative Treatment.—Jaundiced patients require extremely careful pre-operative preparation. The well-known tendency for jaundiced patients to bleed should be sufficient warning for a thoughtful house surgeon to get the patient grouped for a possible transfusion without being told to do so. If facilities exist, the coagulation time should be tested daily during the period of preparation for operation. There is much to be said for prescribing teaspoonful doses of powdered calcium lactate dissolved in hot water, or calcium gluconate in similar doses, t.d.s., for several days before the operation. The ingestion of vitamin K, with the addition of bile-salts, has proved a most valuable advance in allaying the tendency to hæmorrhage in jaundiced patients. It should be noted that vitamin K is fat soluble, and it therefore cannot be absorbed from the intestine in the absence of bile-salts. Vitamin K should be given several days before, and continued for several days after, the operation. It is also an excellent practice to give the patient a small blood transfusion, i.e., half a pint, about twelve hours before the operation. The object in view is to supply him with prothrombin, and it should be remembered that fresh blood is much richer in this constituent than is preserved blood.

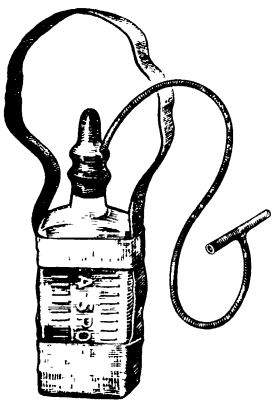


Fig. 248.—A medicine bottle, a rubber teat, and adhesive plaster make a convenient sterile receptacle for bile. (*After H V. Cameron.*)

The remarks concerning the administration of glucose pre-operatively for operations on the biliary tract are doubly important in this instance, for the liver cells are choked with bile. Glucose should be given by mouth and also by rectum. Unless the obstruction has been relieved, it is unwise to give intravenous saline or a large blood transfusion to a patient suffering from obstructive jaundice. Intravenous saline sweeps the bile-pigments to the kidneys and the uriniferous tubules become choked. Anuria is liable to develop. It is therefore necessary among other things to observe and record the urinary output of the deeply jaundiced patient.

Post-operative Treatment : the Management of a Cholecystostomy Tube.—The tube is led into a sterile bottle (*Fig.* 248). In profoundly jaundiced patients the liver function is at a low ebb and the flow of bile during the first forty-eight hours is often discouraging. If the bile is very thick the house surgeon can very gently irrigate the interior of the gall-bladder through the tube, using not more than an ounce or two of saline. To encourage a flow of bile intravenous saline can be given very cautiously. A cholecystostomy tube should never be removed early ; indeed, in almost every instance it is best to cut the retaining stitch on the tenth day and allow the tube to be extruded spontaneously.

Management of a Tube in the Common Bile-duct.—A tube in the common bile-duct should be the house surgeon's special care. He should give instructions that it is to be left in and that he himself will remove it when the time comes. A tube often employed is a T-shaped one (*Figs.* 249, 250), and it is necessary to

realize that a track around the tube shutting it off from the peritoneum must form before any thought of removing the tube is entertained. If a tube in the common duct is removed too early, of necessity bile leaks into the general peritoneal cavity.

When a T-tube has been used to drain the common duct, after a week it may be clamped for an hour or two, in order to ascertain if the bile will flow into the duodenum. If pain follows or bile drains around the tube, it is certain that the time for removal of the tube is not at hand. Before removing a tube in the common bile-duct it is very desirable to know if the path for the bile from the liver to the duodenum is free. This can be demonstrated by injecting lipiodol down the tube and having a radiograph taken (*see* p. 156). After fourteen days have elapsed, one can be sure that protective adhesions have formed. If in addition it has been demonstrated radiologically that the path to the duodenum is patent, the T-shaped tube can be removed by a steady pull with every confidence.

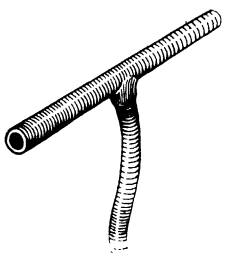


Fig. 249.—T-tube for draining the common bile-duct

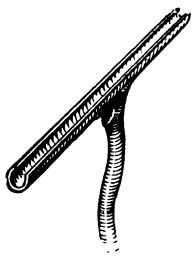


Fig. 250.—Maingot's T-tube for draining the common bile-duct.

Feeding of Bile.—In patients with a total biliary fistula the advisability of collecting the bile and returning at least some of it to the patient should be considered. In patients whose general condition is good two or three ounces of bile can be mixed with fruit juice and given at frequent intervals. Another method is to dilute the bile with saline and to administer it per rectum. A third method, which is especially indicated in very ill patients, is to pass a gastric aspiration tube and to administer the bile at intervals during the day into the stomach.

Stone Impacted in the Common Bile-duct: Pribram's Method of Treatment.—Ether dissolves cholesterol; many gall-stones are composed of this substance. At the operation a rubber drainage tube without lateral fenestrations is insinuated through an opening in the common bile-duct down to the calculus. About six days later lipiodol is injected down the tube and a radiograph taken. The first treatment with ether is undertaken a few hours later. The amount of ether used varies with the diameter of the common duct. When the duct is small only a few drops are used. First the bile is sucked out with a syringe. The syringe is then filled with ether, which is injected drop by drop. Directly the patient feels pressure, suction is applied. The injection is repeated several times in this way. Finally, 1 c.c. of liquid paraffin is injected and the tube is clamped with a hæmostat. The clamp remains until the patient feels pressure. The procedure is repeated several times a day. After a week's treatment a second cholangiograph is obtained. The treatment is continued until it is proved that bile is passing freely from the common duct into the duodenum.

THE PANCREAS

Post-operative Treatment.—Escaping pancreatic juices tend to digest the abdominal wall and the sutures contained therein. It is advisable to forestall the possibility of a burst abdomen by applying an abdominal corset forty-eight hours after the operation. Digestion of the skin around the wound can be prevented to a large extent by smearing it with paraffin ointment containing 0·2 per cent of hydrochloric acid, which renders the ferments impotent.

In the early stages feeds should be pancreatized, and fats should be withheld as far as possible.

CHAPTER XXIX

THE MANAGEMENT OF LOWER ABDOMINAL CASES

By HAMILTON BAILEY

FOWLER'S POSITION

IN order that purulent exudate shall collect in the pelvis rather than in the upper or middle abdomen, the aid of gravity is invoked. It is not sufficient to order that a patient be placed in Fowler's position; it is necessary to see that the position is maintained effectively. The house surgeon should imagine purulent fluid within the peritoneal cavity and then go to the bedside to satisfy himself that the angle at which the abdomen is set is sufficiently acute for fluid to trickle downwards. If this is not done, George Ryerson Fowler's priceless gift to abdominal surgery—so simple, and yet so important—may be set at nought. (*Fig.* 251.)

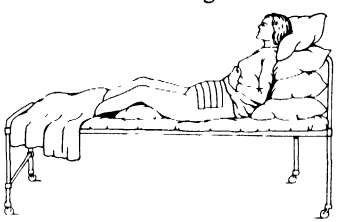


Fig. 251.—Incorrect Fowler's position.

In well-equipped hospitals there are special beds for maintaining Fowler's position. Among a number of excellent specially constructed bedsteads of British manufacture may be mentioned the Lawson Tait (*Fig.* 252) and the Melbourne Thomas bedsteads; such a bed makes the maintenance of Fowler's position a simple matter. In less lavishly equipped institutions special supports known as the Sister Doris (*Fig.* 253) and

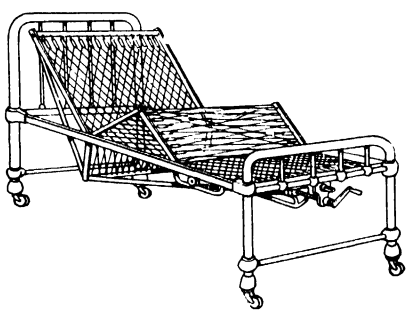


Fig. 252.—The Lawson Tait bed for maintaining Fowler's position.

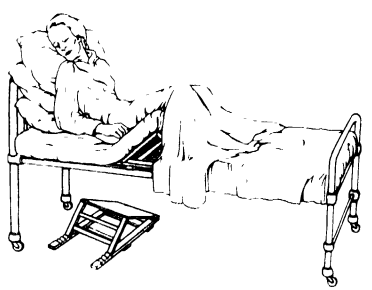


Fig 253.—The Sister Doris bed support.

the Burton 'donkey' (*Fig.* 255) are in use. Both these latter operate beneath the mattress. Fowler's position can be improvised on an ordinary bed by a bolster beneath the thighs. A better substitute for the bolster beneath the thighs is one of the 'knee rests' such as the Dunlopillo (*Fig.* 256) or the Stay-Put (John Bell & Croydon) (*Fig.* 257). A better substitute for a mass of pillows at the patient's back is one pillow resting on a back-rest. An additional advantage of the back-rest is that it does not take so much room at the head of

the bed, and thus does not push a tall patient's feet out of the end of the bed. Such back-rests can be purchased, but Holmes Sellors' back-rest (*Fig.* 254) can be made by any carpenter for a few shillings. These appliances are advantageous when Fowler's position has to be maintained in a private house. All of them can be efficient, but the more rudimentary the apparatus the more strict must be the supervision.

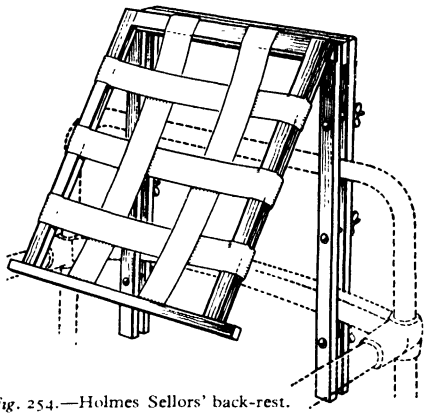


Fig. 254.—Holmes Sellors' back-rest.

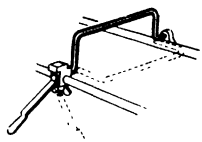


Fig. 255.—The Burton 'donkey'.

High Fowler's Position.—This is employed in cases of peritonitis. The head of the bed is raised eighteen inches on wooden blocks (*Fig.* 258). Better than blocks is a fitting supplied by Hoskins & Sewell, of Birmingham (*Fig.* 259); this bed-lifter can be attached to any bedstead, and permits the bed to be wheeled about without any alteration of the patient's position.

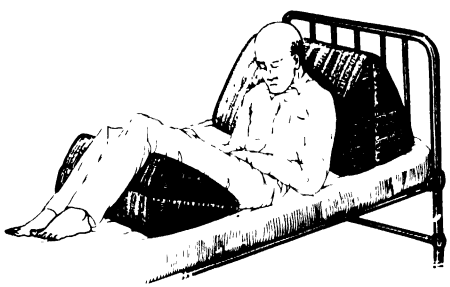


Fig 256.—Maintaining Fowler's position with two Dunlopillo pillows.

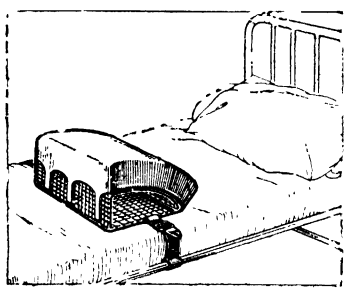


Fig. 257.—The Stay-Put knee support.

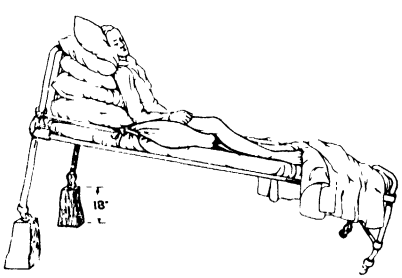


Fig. 258.—High Fowler's position maintained by wooden blocks, a bolster, and pillows.

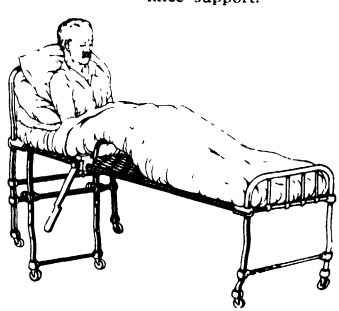


Fig. 259.—High Fowler's position, using the Hoskins bed-elevator and the Burton 'donkey'

Special Note.—Pressure on the under surface of the thighs occasioned by the bolster, and, to a somewhat lesser extent, by the other pieces of apparatus, favours venostasis and thrombosis in the veins of the calf. Here is the starting-place of many pulmonary emboli. By ordering the legs to be exercised from the very first day of a patient being nursed in Fowler's position, and also prescribing pulmonary gymnastics, and by seeing that these measures are carried out faithfully, I think it no exaggeration to say that during his term of office the house surgeon will prevent at least one patient from getting a pulmonary embolus.

DRAINAGE TUBES

A drainage tube in the lower abdomen, while often a life-saving measure, becomes, if unattended, a menace. After forty-eight hours the tube must be turned and it should be shortened. It is only by attention to these points that a fæcal fistula and intestinal obstruction can be avoided. Picture a tube in the lower abdomen with the patient in Fowler's position ; coils of intestine must be in juxtaposition to the tube. If the tube is left undisturbed, pressure necrosis of an adjacent coil of intestine is almost bound to occur ; that such neglect favours intestinal obstruction is equally evident. The tube must be turned at the end of forty-eight hours. The retaining stitch should be cut and a safety-pin inserted through the tube. Usually on the third day the tube should be shortened considerably. Personally, I generally remove the tube on the third day and substitute a piece of corrugated rubber, but there is no fundamental objection to leaving a *short* tube through the abdominal wall.

To use gauze for the purpose of drainage is, I consider, unsound The heat of the body dries the absorbed pus and instead of the gauze functioning as a drain, it acts as a bung. Vaseline gauze is not open to this objection.

PRONE POSTURAL DRAINAGE

The prone position of draining the peritoneal cavity should be used more often. Obviously it is mechanically sound. As is seen in *Fig.* 260, the left arm is flexed and the right arm is by the side. The left leg is flexed slightly, and the right leg is straight. The patient lies in this position for from half to three hours, and in many cases of pelvic peritonitis pus literally pours out through the suprapubic drainage tube. I have been astonished at the effectiveness of this procedure when it has been carried out by a skilful sister. Another great advantage of the prone position is that it admits of considerable variation in posture without impairing dependent drainage. These changes do much to relieve the weariness of any fixed position, and obviate the ever-present menace—venostasis and thrombosis.

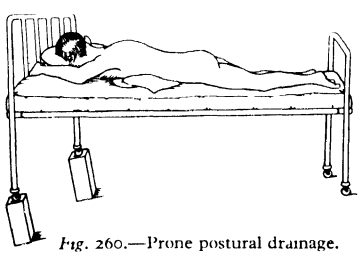


Fig. 260.—Prone postural drainage.

THE MANAGEMENT OF CASES OF APPENDICITIS BY THE OCHSNER-SHERREN RÉGIME

The house surgeon will soon find out whether or not the surgeons to whom he is attached advocate this method. If they do, he will have some interesting and responsible work. I might add that many of my house surgeons have been brought up in schools opposed to the method, but not one, after his term of office, has left unconvinced of the efficacy of the Ochsner-Sherren régime.

In any case, it is extremely useful to understand the correct details of the method, for the same principles are invoked by many in the treatment of certain cases of acute cholecystitis, pancreatitis, salpingitis, and pneumococcal peritonitis, as well as 'late' cases of appendicitis.

The surgeon will select the case which is to be treated by the delayed method. It will be a case of appendicitis of over 48 hours' duration, and particularly one where a localized mass is palpable.

Taking the History.—A careful history is essential. Particular note is made of the number of hours since the onset. The history begins " 10, 26, 55 hours ago ", not " last Thursday ", or " three days ago ". A careful inquiry is made as to whether the patient has ingested a purgative. The exact amount and nature of the purgative, and the time it was taken, and whether it was vomited, are recorded. The recent ingestion of a powerful purgative may be a justifiable indication for performing an operation which would otherwise be delayed.

Recording Physical Signs.—The physical signs are recorded in diagrammatic form (*Fig.* 261). The extent of the rigidity is marked by shading. The presence of a lump is drawn as near as possible to scale on the diagram, and also outlined in indelible pencil upon the patient's abdomen. The presence or absence of hyperæsthesia is always recorded, and the findings of the rectal examination are not omitted.

Leucocyte Count.—When facilities exist it is a good practice to order a leucocyte count and to have it repeated daily or every other day.

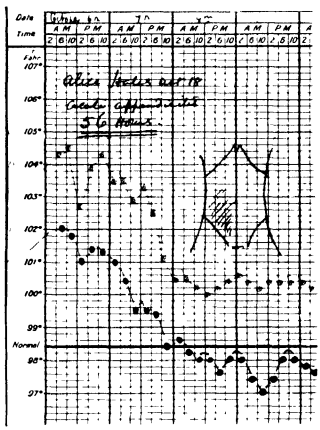


Fig. 261.—Chart of a case of acute appendicitis, first seen 52 hours after the onset of the attack, treated by the Ochsner-Sherren method.

Position.—The patient is placed in high Fowler's position (*see* p. 221).

Charts.—As a routine the pulse is recorded every two hours in graphic form on a special chart. In cases where anxiety is felt as to the advisability of continuing the treatment, an hourly or even half-hourly chart is employed. The temperature is relatively unimportant and is recorded every four hours.

Vomiting is recorded on a separate piece of paper known as a *vomit chart.* On this is entered the time at which the vomitus was ejected, together with the quantity and character of the fluid.

Drugs.—It should be noted particularly that no morphine or its derivatives are given, and under no circumstances is a purgative administered. A sulphonamide can be prescribed with advantage by the rectal or intravenous routes (*see* p. 276). When the rectal route is chosen the dosage is as follows :—

Sulphonamide tablets	
Rectal saline	ad 4 fl. oz.
(Every four hours.)	
Average dose in adults	16 g. (32 tablets) in forty-eight hours.

Continuous Intravenous Saline.—As everything by mouth is withheld for the first 24 to 48 hours, continuous intravenous saline and glucose must be

commenced at once. As a rule, there is no need to continue this form of therapy for more than 48 hours.

Diet.—After 48 hours the continuous intravenous saline is usually discontinued. For 12 hours after this the patient may have cold plain water to drink, but he is not encouraged to drink more than is necessary to satisfy his thirst. If by this time everything is not quite satisfactory, the plain water only by mouth is continued until the end of the fourth day. If, however, the pulse, temperature, and local signs are satisfactory, flavoured glucose drinks and an occasional cup of commercial beef extract (which makes the patient think he is having something very nourishing when actually he is being given little more than flavoured water) are substituted.

On the fifth day feeding is usually commenced. Small quantities of Benger's food, alternating with cups of beef extract, are given. On the sixth day custard, jelly, strained gruels, and strained soups are allowed. Thereafter the diet is increased intelligently.

Bowels.—The bowels are left confined if they are not opened naturally. On the fourth or fifth day a small glycerol enema is given. No purgatives of any kind are given until resolution is complete—that is, until the temperature and pulse have been normal for a week and pain and physical signs are absent—then liquid paraffin, 120 m. thrice daily, is prescribed.

Co-operation with the Nursing Staff.—The house surgeon should emphasize to the nurse in charge that he is to be called at any time she is not perfectly satisfied with her patient's progress. Particularly she should report to him: (1) A rise in the pulse-rate; (2) Vomiting; (3) Pain; (4) In the later stages of treatment, diarrhœa or the passage of mucus in the stools (pelvic abscess).

If the nurse is not conversant with the Ochsner-Sherren régime, it is as well to put a notice over the patient's bed, "Nothing by mouth; frequent mouth-washes only. No purgatives."

Explanation to the Patient and His Friends.—It is most necessary to explain in simple language to the patient and his friends what is being done and why he is to be starved. "To try to prevent the appendix bursting", is what I tell them. It is equally important to make everyone understand that an operation may become necessary during the course of the treatment. In favourable cases, during the first few days of treatment, the necessity of eventual appendicectomy must be broached in no uncertain tones and permission for it obtained. If this important detail is omitted, once the symptoms have abated the patient may take the risk of getting a further attack. I always try to emphasize how lucky is the patient who has been tided over, and give the impression that such luck cannot be expected twice—that another attack is probable within three or four months—and I rarely fail to get written permission for appendicectomy on a given date—usually two months after leaving hospital.

Special Points which Foretell Possible Failure of the Treatment.—*A Rise in the Pulse-rate.*—An increased pulse-rate is the most reliable single sign that it is dangerous to proceed with the delayed method. If the pulse-rate has increased even 10 points in the first four hours, operation is often indicated.

Temperature.—A moderate rise in temperature is quite often indicative that the patient is exhibiting a good reaction to the inflammatory process; it does not necessarily mean that a local abscess is developing, though this, of course, may be the case, and will be revealed by the physical examination. A moderate rise of temperature with a pulse-rate of 80–90 does not foretell failure of the delayed treatment.

Vomiting.—After the first few hours, vomiting should always be regarded seriously, and this by itself may be a sufficient indication to abandon delayed treatment.

Pain.—A patient undergoing delayed treatment should not complain of pain, as opposed to tenderness, after the first six hours of treatment. If he does there is usually something wrong, and this is a strong indication for operation.

Development of a Pelvic Abscess.—The passage of mucus and relaxed stools is very suspicious that a pelvic abscess is developing. In all cases undergoing the Ochsner-Sherren treatment a rectal examination should be made periodically. If a mass can be felt, a daily rectal examination is necessary.

It should be needless to add that the Ochsner-Sherren treatment of appendicitis is only to be undertaken in a properly equipped institution where operation can be carried out (if necessary) at once.

In order that there should be no misunderstanding, the house surgeon is advised to get into immediate touch with his chief if: (1) The pulse is rising; (2) The patient vomits; (3) The patient complains of pain; (4) The mark on the abdominal wall shows that the localized swelling is increasing in size; (5) Signs of a pelvic abscess are in evidence.

UNEXPLAINED POST-OPERATIVE PYREXIA WITH REFERENCE TO ABDOMINAL SURGERY

Proceed as follows: Investigate:—

1. The wound, for infection.
2. The lungs, especially bearing in mind atelectasis.
3. The urine, for renal infection.
4. The pelvis per rectum, for a pelvic abscess. A repeated daily examination is often advisable.
5. The subphrenic area, for subphrenic abscess.
6. The abdomen generally, for a possible walled-off accumulation of pus.

To Examine a Laparotomy Wound for Infection.—Put on sterile gloves. Paint the skin with antiseptic and palpate the subcutaneous tissues along the length of the incision between the finger and thumb. If there is an area of induration, and especially if this area is more tender than the remainder of the environs of the incision, prise open the relevant part of the incision with a sterile probe. Should this result in evacuation of blood or pus, it will prevent further spread of the infection. (F. H. Lahey.)

CHAPTER XXX

RENAL FUNCTION TESTS

By E. G. B. CALVERT

THE decision to carry out special tests of kidney function should always be based on the results of a thorough general clinical investigation, including, of course, an examination of the urine. The diagnosis and prognosis of a case of renal damage can only be made after a careful summing-up of all the findings, of which that for kidney function is but one.

Of the characteristics of the normal kidney the most striking and the most important is its capacity to adapt itself to the requirements of the body. When little fluid is taken, or when there is excessive loss of fluid by sweating, diarrhœa, or vomiting, a small volume of highly concentrated urine is passed; on the other hand, if the amount of fluid presented to the kidney is large a profuse flow of dilute urine results. In advanced chronic renal disease the ability of the kidneys to form a concentrated or dilute urine, as the occasion demands, may be so reduced that little of the normal elasticity of function is left—eventually there may be fixation of the specific gravity of the urine at about 1010 (which is approximately the specific gravity of deproteinized blood-plasma).

The process of concentrating waste products, which are being transferred from the blood to the urine, is the most important function of the kidney, and impairment of this function by disease is generally evident earlier than a defect in dilution. Concentrating power is regarded as directly proportional to the number of functioning nephrons (i.e., glomerulo-tubular units), of which there are about a million in each kidney. Ordinarily only a small percentage of the nephrons are at work at any one time, but when the load on the kidneys is steadily increased then more and more nephrons are brought into action until finally all may be engaged. Therefore the *reserve power* is very large. Indeed, it has been found that as much as two-thirds of the total kidney substance may be destroyed before failure of function occurs. With less damage of the kidneys there would be normal or adequate function, though the structural and functional reserves are reduced. Under conditions of stress, however, the lower the reserve power the more likely are the kidneys to show impairment or failure of function. Defective concentration may for a time be balanced by an increased volume of urine so that the total quantity of waste products excreted is sufficient to prevent their accumulation, above the normal level, in the blood. Such a condition is described as a *compensated impairment of renal function.* When polyuria fails to prevent the accumulation in the blood there is a *decompensated impairment of renal function—i.e., renal insufficiency or failure.* The decompensation of a compensated impairment of function may therefore be caused by a prerenal deviation of fluid—for example, by cardiac failure or by excessive vomiting or diarrhœa. Decompensation may also be brought about by increased protein katabolism, either endogenous or exogenous.

It is the aim of function tests to discover the existence, and if possible the extent, of impairment of renal function by imposing extra work on the kidneys

and noting their response, but when these organs are already overloaded by an accumulation of excretory products in the blood, as in failure of function, the further increase of such products should be avoided.

Function tests may be employed to assess: (*a*) The total renal capacity; (*b*) The capacity of either kidney separately.

TOTAL RENAL CAPACITY

The tests may be grouped as follows: (1) Examination of the urine; (2) Examination of the blood; (3) Estimation of the concentration and dilution powers of the kidneys; (4) The ability of the kidneys to excrete foreign substances; (5) The blood-urea clearance test.

1. EXAMINATION OF THE URINE

A systematic examination of the urine is of fundamental importance in every case of renal disease. The volume and specific gravity of all specimens passed during the day and night should be noted, tests for albumin, blood, and other suspected abnormalities carried out, and an analysis made of the centrifuged deposit.

The methods of examination and the significance of the results which may be obtained are described in Chapter VIII.

2. EXAMINATION OF THE BLOOD

In renal failure, whether permanent or transitory, there is in the blood an excess accumulation of certain urinary constituents, the chief of these being the non-protein nitrogenous compounds. This group includes urea, uric acid, and creatinine. The concentration of inorganic phosphate, calcium, cholesterol, and plasma proteins is also altered in one or other type of renal failure.

Urea.—An estimation of the urea content of the blood is now regarded by most authorities as the best measure of nitrogen-retention; its determination is easier, more accurate, and more informative than that of uric acid, creatinine, or the total non-protein nitrogen.

From what has been said on the subject of renal reserve power (*see* p. 226) it will be clear that a normal concentration of urea, or of any of the other non-protein nitrogenous compounds, in the blood does not necessarily denote normal kidneys; on the contrary, the normal level may not be exceeded until there is destruction of about two-thirds of the total kidney tissue.

If the samples of blood for urea estimation are obtained before breakfast the possibility of error from large amounts of protein in the diet is eliminated.

The normal concentration of urea in the blood is from 20 to 40 mg. per 100 c.c., but after middle age an upper limit of 45 mg. per 100 c.c. may be allowed.

The blood-urea is generally normal in chronic nephrosis, certain stages of the nephrotic forms of nephritis, focal nephritis, benign nephrosclerosis (benign ' chronic interstitial nephritis '), and in the kidney of pregnancy. It is raised in acute diffuse glomerulo-nephritis, secondary contracted kidney, malignant nephrosclerosis (malignant ' chronic interstitial nephritis '), acute renal failure of the ' crush syndrome ' and of mismatched blood transfusions, obstruction of urinary excretion by the crystallization occasionally of sulphapyridine, sulphathiazole, or similar sulphonamide (mainly their acetyl derivatives—from hepatic acetylation) in the renal tubules, pelves, and ureters (when dosage is full or high, urine output low, reaction acid), severe ureteric obstruction from other causes, urethral (prostatic) obstruction, cases of marked congestion of the kidneys in heart failure, and in a group of cases known as extra-renal azotæmia.

By *extra-renal azotæmia* is meant nitrogen-retention which is not attributable to disease of the kidneys or to back-pressure on them. It occurs in pyloric or high intestinal obstruction, in the alkalosis induced by the excessive use of alkali in the treatment of peptic ulcer, and in prolonged vomiting from other causes; also in severe diarrhœa, continuous gastric lavage, diabetic coma, Addison's disease, and after much loss of blood as in severe gastric or duodenal hæmorrhage. Dehydration and hypochloræmia are important features of these cases. An extra-renal azotæmia may, as not infrequently happens, be superimposed on a primary renal impairment or failure, and may, by aggravation of the latter, precipitate a fatal issue. It is useful here to make the following distinction: the azotæmia of renal origin is characterized by a blood of about normal chloride concentration (but often low in very advanced chronic nephritis) and normal or low alkali reserve (acidosis) and by a urine of low maximum specific gravity and urea concentration (*see* pp. 229, 230) and of normal chloride content, whereas in extra-renal azotæmia there is a blood of low chloride concentration and, except in diabetic coma, often high alkali reserve (alkalosis) and a urine of normal maximum specific gravity and urea concentration and of low chloride content.

In acute diffuse glomerulo-nephritis the blood-urea may rise to very high figures—250 mg., or more, per 100 c.c.—and yet complete recovery occur. Equally high concentrations in chronic nephritis may indicate a temporary exacerbation of the disease, or, more likely, a terminal phase of short duration. In ureteric or urethral (prostatic) obstruction the blood-urea is often brought from exceptionally high levels to normal, or nearly so, by operation.

The above findings, including those in extra-renal azotæmia, go to show that nitrogen-retention is often not directly proportional to the amount of renal damage.

In deciding the value of any blood-urea result the amount of protein in the diet and the state of the circulation must be borne in mind—for example, in some cases of renal failure the blood-urea may be greatly reduced, perhaps even to normal, by protein starvation; on the other hand, a rise in concentration may be partly or entirely due to congestive heart disease.

There is no definite level of blood-urea at which uræmia appears. In chronic nephritis one patient may become uræmic at 140 mg. per 100 c.c., while another at the same figure, or even higher, may live in fair comfort for a year or more. Uræmia, however, seldom occurs with a blood-urea below 100 mg. per 100 c.c.

On the surgical side blood-urea estimations are of special value in cases of prostatic obstruction. If the urea figures are above normal it is much safer to do a preliminary drainage, by suprapubic cystotomy or by means of an indwelling catheter, and postpone prostatectomy until a normal or almost normal blood-urea has been reached.

Uric Acid and Creatinine.—The normal concentration of uric acid in the blood is 2·0 to 3·5 mg. per 100 c.c. and that of creatinine 1·0 to 1·5 mg. They are both found in increased amounts in renal failure. Rather than estimate uric acid and creatinine separately it is preferable to include them, along with urea and other non-protein nitrogen, in a determination of total non-protein nitrogen, the normal for this being 20 to 40 mg. per 100 c.c. These figures should not be confused with the normal blood-urea figures of 20 to 40 mg. of urea per 100 c.c., which expressed as urea-nitrogen equal approximately 10 to 20 mg. per 100 c.c. The estimations of uric acid and creatinine are given in terms of the substances themselves.

Inorganic Phosphate and Calcium.—The normal amount of inorganic phosphate is 2 to 4 mg. per 100 c.c., and of calcium 9 to 11 mg. An increase of inorganic phosphate to 8 mg. or over, or a reduction of calcium to 6 mg. or under, is of very grave significance and generally means that uræmia is imminent, if not already present.

Cholesterol.—The normal is 150 to 225 mg. per 100 c.c. In chronic nephrosis and in the nephrotic type of nephritis, where there is a plasma-protein deficit due to profuse albuminuria, the blood-cholesterol is raised—perhaps to double or treble the normal amount.

Plasma Proteins.—As stated in the last paragraph, there is, in cases with marked loss of albumin in the urine, a lowering of the protein content of the plasma. The fall is almost entirely in the albumin fraction, which may be reduced to less than 1 g. per 100 c.c. The normal protein content of the plasma is: albumin, 5·5 g. per 100 c.c.; globulin, 2·0 g. per 100 c.c.; and fibrinogen, 0·2 g. per 100 c.c.

For the technique of the various kinds of blood analysis mentioned reference should be made to a manual on blood chemistry.

3. ESTIMATION OF THE CONCENTRATION AND DILUTION POWERS OF THE KIDNEYS

Many tests have been devised for this purpose. Among those which put the kidneys to extra effort the following may be selected as being effective and easy to carry out:—

a. **Urea Concentration Test** (MacLean and de Wesselow).—This is a test of the concentrating power of the kidneys.

The patient, after emptying the bladder, takes 15 g. of urea dissolved in 100 c.c. of water, flavoured with tincture of orange. At one hour and two hours later the urine is collected for urea estimation. According to MacLean and de Wesselow, if either specimen gives a percentage of urea above 2 the kidneys are held to be fairly efficient, and the higher the concentration the better the function. On the other hand, in severe renal damage the concentration may not reach 1 per cent. As there may be some diuresis during the first hour of the test it is generally better to rely on the second-hour specimen. If the volume of this specimen should exceed 120 c.c. a collection at the end of the third hour may be used, or the test repeated. In patients with persistent diuresis the excess of volume must be allowed for in arriving at a result.

A limitation of the test is that normal results are obtained in the œdematous forms of nephritis, even when severe in degree; apart from this the method has, as a rule, proved itself a valuable one in the examination of kidney function. The test has been found to be more sensitive than a blood-urea estimation, but very occasionally, however, the results fall within the normal in cases of azotæmia of renal origin.

b. **Range of Concentration Tests.**—The range of urea concentration test and the range of specific gravity test (Calvert) arose out of work on the methods of Strauss and Graunwald, Volhard, and MacLean and de Wesselow. Both tests investigate the range and 'flexibility' of renal function by estimating not only the power of concentration but also that of dilution, and over hours when these measures yield most information.

i. *Range of Urea Concentration Test.*—

The taking of fluid between noon and 7 o'clock the next morning is forbidden, except for 3–4 fl. oz. at lunch and 2–3 fl. oz. at tea-time (4 to 5 o'clock); none is allowed with the evening meal at 8 o'clock. At 10 p.m. the patient (an adult) is given the following 3-fl. oz. dose: urea gr. 240 (= 16 g.), tr. aurant., m. 30, and aq. ad 3 fl. oz. If the

patient's age is between 3 and 12 years a half dose is given; if over 12 years a full dose. An hour later (i.e., at 11 p.m.), when any diuretic effect of urea will have passed off, the bladder is emptied and the urine discarded. The patient is then kept warm in bed and encouraged to sleep. All the urine is collected from 11 p m. to 7 a.m., the bladder being completely emptied at the latter hour; a specimen of this total collection is labelled 'A' and kept for estimation of its urea content. Starting at 7 a.m., immediately after micturition, the patient drinks, between 7 a.m. and 7.45 a.m., a pint of water and a pint of weak tea containing little or no sugar; if thought advisable another half to one pint of water may be given at 8 a.m., especially in hot weather—i.e., 40 to 60 fl. oz. in all. Cooling of the skin, by exposure, will aid diuresis. The urine is collected from 7 a.m. to 8 a.m., from 8 a.m. to 9 a.m., and from 9 a.m to 10 a.m.; the three specimens, each labelled 'B', are kept for urea analysis.

In cases where the percentage of urea in the blood has been found to be well above the normal (e.g., 80 mg. or more) the dose of urea may be reduced or omitted (*see* p 227). Further, as regards specimens 'B', it is inadvisable to give to waterlogged patients more than a small amount of fluid—for example, only 15 to 30 fl. oz. The extent to which fluid is withheld or pushed in any particular case is governed by the general clinical condition.

The range of urea concentration is represented by the 'maximum' concentration, as given in specimen 'A', and by the 'minimum' concentration, as found in the most dilute of the specimens 'B'. The value of the maximum concentration as an index of function is greatly increased by comparing it with the minimum concentration—for example, maximum and minimum percentages of 2·0/0·2, respectively, indicate better function than a range of 2·0/1·2.

As with other tests of renal function a considerable variation is displayed in normal results. The distinction, however, from abnormal findings is readily made. As a rule, the normal maximum concentration is 2·5 per cent or over (mostly 3 per cent or over) and the minimum 0·5 per cent or under. In hot weather the minimum figure may sometimes be as high as 1·0 per cent, but the maximum will also be raised.

A range of 4·8/0·3 means a greater degree of adaptability or efficiency than one of 2·8/0·5, though the latter is within the normal. Occasionally in apparently normal persons who ordinarily pass a large volume of urine a range such as 1·8/0·1 may be found. This, however, is in sharp contrast to the restricted range of severe renal impairment with the same maximum—for example, 1·8/1·1. In the terminal stages of chronic nephritis, without œdema, a very limited range of low concentration is obtained—for example, 1·3/1·2. In the dropsical forms of renal disease a restricted range of fairly good concentration is found, such as 2·4/2·1.

The influence of failure of the circulation must be taken into account. With slow glomerular filtration the 'A' and 'B' concentrations are raised and their approximation varies directly as the degree of vascular-renal stasis.

ii. *Range of Specific Gravity Test.*—This method is a simplification of the previous one and gives results of practically equal value. A reliable urinometer is the only apparatus required. The test is carried out in a similar way but no dose of urea is given and the specific gravity of the specimens is determined instead of the percentage of urea.

In order to provide the kidneys with sufficient work (*see* p. 226) the patient should be put on as full a diet as possible with a high proportion of protein in the evening meal at 8 o'clock. As in the range of urea concentration test no fluid is allowed with this meal—the only fluid permitted between noon and 7 o'clock the next morning being 3–4 fl. oz. at lunch and 2–3 fl. oz. at tea-time (4 to 5 o'clock). It is advisable to collect the urine, as an additional 'maximum' concentration specimen, from just before the 8 p.m. meal to 11 p.m. The 'maximum' concentration specimens (specimens 'A') are therefore from 8 p.m. to 11 p.m., and from 11 p.m. to 7 a.m., and the dilution specimens (specimens 'B'—*see* fluid intake of 40–60 fl. oz., etc., described above) from 7 a.m. to 8 a.m., 8 a.m. to 9 a.m., and 9 a.m. to 10 a.m.

The 8 p.m. to 11 p.m. specimen should be examined for sugar. Owing to the rise in specific gravity due to sugar the range of specific gravity test should not be applied to any patient with glycosuria, unless all the specimens of urine for the test can be obtained sugar-free by means of dietetic or other treatment.

Albuminuria, even in marked degree, does not invalidate the test. As ordinary urinometers are graduated for 15° C. (or approximately a room temperature up to 20° C.) the specimens ought to be allowed to cool before their specific gravity is taken. The cooling of urine increases its specific gravity—for example, if 1015 when passed it may become 1018 on standing.

In normal persons the maximum specific gravity (the more concentrated of the specimens ' A ') is nearly always 1025 or over (1030 or over if deprivation of fluid strict) and the minimum (the most dilute of the specimens ' B ') 1005 or under. Results like 1035/1003 indicate a high renal efficiency. Maximum concentration readings between 1020 and 1015 must be viewed with suspicion unless the dilution figure is exceptionally low—1002 to 1001. A marked restriction of range below 1020 means renal inefficiency—for example, 1014/1006. The findings in the dropsical forms of kidney trouble are those of limitation at a moderate level, such as 1022/1019 or 1019/1017. The effect of circulatory failure on range of concentration results is referred to in the account of the previous test.

Of chronic renal disease (considered apart from complications) it may, in general, be said that the lower the maximum concentration and the more restricted the range the worse is the prognosis ; in the most advanced cases the specific gravity becomes practically fixed at about 1010 (*see* p. 226).

Both the range of urea concentration test and the range of specific gravity test will detect impairment of renal function before, frequently long before, failure is represented by a rise of the blood-urea.

4. THE ABILITY OF THE KIDNEYS TO EXCRETE FOREIGN SUBSTANCES

The foreign substance employed is phenol-sulphone-phthalein (Rowntree and Geraghty).

The dye is injected intravenously or intramuscularly and the amount excreted in the urine over the course of two hours ascertained.

A glass of water is given to ensure a good flow of urine. About fifteen minutes later the bladder is emptied and 6 mg. (1-c.c. ampoule) of the dye is injected as above. After allowing five minutes for the beginning of the excretion of the dye all the urine is collected one hour and two hours later and the volumes measured. In certain cases a catheter must be used.

The specimens are made strongly alkaline with a solution of 25 per cent caustic soda, and from the red colour developed the amount of the dye excreted is estimated colorimetrically. The standard colour, for comparison, may be made by diluting the contents of a 1-c.c. ampoule of the dye (i.e., 6 mg.) with water, or a mixture of water and normal urine, adding 25 per cent caustic soda solution as for the test-specimens of urine, and making the volume up to a total of, say, 1000 c.c.

Normally, 40 to 60 per cent of the amount of dye injected should be obtained in the first hour, and 20 to 25 per cent in the second hour—that is, a total of 60 to 85 per cent in the two hours. An excretion of under 40 per cent in two hours generally indicates serious renal damage. In uræmia no dye may be excreted. Very occasionally, however, a normal output is found in cases in which a considerable degree of renal impairment or failure is present. The test is claimed to be of particular value prior to prostatectomy.

The presence of interfering colours in the urine makes estimations difficult, while with obvious blood the method becomes impracticable.

5. THE BLOOD-UREA CLEARANCE TEST (MÖLLER, McINTOSH, AND VAN SLYKE)

In estimating the urea-excreting capacity of the kidneys it is important to compare the concentration of urea in the blood and the excretion of urea in the urine. Investigation has shown that the relationship of these two values (representing respectively the task on which the kidneys are engaged and the response thereto) is best expressed by means of the blood-urea clearance test. This test determines the volume of blood which, if it were completely 'cleared' of urea by the kidneys, would yield the amount of urea excreted in the urine in one minute.

It has been proved (Addis and Watanabe) that when sufficient urea and water are taken to produce a fairly large volume of urine the ratio of the amount of urea excreted per unit of time to the concentration of urea in the blood is constant for the individual. The ratio may be written as $\frac{UV}{B}$, where U = the percentage of urea in the urine, V = the number of c.c. of urine excreted per minute, and B = the percentage of urea in the blood.

It is obvious that if the amount of urea (UV) excreted in one minute is divided, as in the above ratio, by the percentage of urea in the blood (B), the number of c.c. of blood from which UV could be derived (by complete 'clearance') is obtained. In the normal adult this volume of blood is, on an average, 75 c.c.

Austin, Stillman, and Van Slyke have demonstrated that the ratio only holds when the volume of urine is 2 c.c. (termed the 'augmentation limit'), or more, per minute. With the volume of urine less than 2 c.c. per minute the urea excretion is diminished and is approximately proportional to $\sqrt{V}$. The ratio then becomes $\frac{U\sqrt{V}}{B}$. In the normal adult the volume of blood calculated in this way is, on an average, 54 c.c.

Möller, McIntosh, and Van Slyke have applied the term '*standard clearance*' to the blood volume obtained by this latter ratio, and the term '*maximum clearance*' to the blood volume obtained by the former ratio.

In the modern *blood-urea clearance test*, first described by these authors, both modes of clearance are recognized. To repeat, the formulæ are:

a. Maximum clearance $(C_m) = \frac{UV}{B}$. In the normal adult the average is 75 c.c.

b. Standard clearance $(C_s) = \frac{U\sqrt{V}}{B}$. In the normal adult the average is 54 c.c.

In the case of children, and of others whose size is considerably different from that of the average adult, the observed V should be multiplied by 1·73 and divided by the number of square metres of body surface (obtained from tables—by du Bois—for height, weight, and age).

The C_m formula is employed when the urine volume is 2 c.c., or more, per minute (as observed in the average adult or as corrected in children or others for body size), and the C_s formula when the urine volume (as observed or corrected) is less than 2 c.c. per minute. Both clearances are expressed as percentages of the average normal values (C_m = 75 c.c., and C_s = 54 c.c., as above)—that is, as percentages of the average normal renal efficiency.

Technique of the Test.—As originally described, the procedure is to give the patient a glass of water and then collect the urine in two portions during

consecutive periods of one hour each; a sample of blood is taken about the end of the first hour. From the urea contents of the blood and urine and from the volumes of urine the blood-urea clearance is calculated in the way just explained. It has been shown (Fowweather and others) that more accurate results are obtained if a dose of urea is given about an hour before the beginning of the test. In cases, however, where the preliminary blood-urea figure has been found to be considerably above the normal (e.g., 80 mg. or more) the giving of urea is unnecessary (*see* p. 227). The amount of water allowed in the blood-urea clearance test should only be such as to produce a moderate excretion of urine. A large excretion, while lessening the liability to error from incomplete collection of urine, has the drawback that the estimation of a very low concentration of urea is not so exact.

The following technique is recommended :—

To avoid any complications due to food and exercise the test is done with the patient fasting and at rest, though a light breakfast without coffee may be allowed two hours previously.

At 9 a.m. the bladder is emptied, and immediately afterwards 15 g. of urea and a glass of water (8–12 fl. oz.) are taken. At 10 a.m., after another glass of water, the bladder is again emptied and the exact time recorded. An hour later the first specimen of urine is collected, the time noted, and a third glass of water taken. The second specimen of urine is collected at 12 noon. The sample of blood for urea estimation is obtained just before or after the collection of the first specimen of urine.

Two points require emphasis: The bladder must be completely emptied from 10 a.m. onwards—by catheter in all women and in any man who has difficulty with micturition; also the exact number of minutes over which each specimen is collected must be known.

Although no urea was given in the following case of renal disease it is selected as an example because it illustrates the use of both formulæ (C_m and C_s) :—

A normal-sized man, aged 38.

First specimen of urine.—

Collected over 58 minutes; volume 128 c.c.; urea 0·800 per cent.

Blood-urea at the end of the first hour = 40 mg. per 100 c.c. (= 0·040 per cent).

As the volume per minute $= \frac{128}{58} = 2{\cdot}21$ c.c., the C_m formula is used:

$$\frac{UV}{B} = \frac{0{\cdot}800 \times 2{\cdot}21}{0{\cdot}040} = 44{\cdot}20 \text{ c.c.}$$

The average normal for $C_m = 75$ c.c. Therefore, expressing 44·2 c.c. as a percentage of 75 c.c., the patient's $C_m = \frac{44{\cdot}2}{75} \times 100 = 58{\cdot}9$ per cent of the average normal.

Second specimen of urine.—

Collected over 63 minutes; volume 113 c.c.; urea 0·900 per cent.

Blood-urea as above.

As the volume per minute $= \frac{113}{63} = 1{\cdot}79$ c.c., the C_s formula is used:

$$\frac{U\sqrt{V}}{B} = \frac{0{\cdot}900 \times \sqrt{1{\cdot}79}}{0{\cdot}040} = \frac{0{\cdot}900 \times 1{\cdot}34}{0{\cdot}040} = 30{\cdot}15 \text{ c.c.}$$

The average normal for $C_s = 54$ c.c. Therefore, expressing 30·15 c.c. as a percentage of 54 c.c., the patient's $C_s = \frac{30{\cdot}15}{54} \times 100 = 55{\cdot}8$ per cent of the average normal.

The mean of the two estimations (58·9 per cent and 55·8 per cent), which should agree within 10 per cent of each other, is 57·3 per cent. Therefore the blood-urea clearance test shows that the patient's renal efficiency is 57·3 per cent of the average normal renal efficiency.

The average normal renal efficiency is 100 per cent, with a range of 70 to 130 per cent. Therefore any value of 70 per cent and over is counted as normal. For ages over 60 years, however, the lower limit of the normal may be extended to 65 per cent.

The superiority of the blood-urea clearance test over the blood-urea alone has been demonstrated by Van Slyke, who showed in a long series of cases of renal disease that renal function, as measured by the clearance method, was always reduced to 50 per cent of the average normal (and in half the cases to between 40 and 20 per cent) before there was any rise of the blood-urea above normal.

In acute diffuse glomerulo-nephritis the urea clearance may fall as low as 10 per cent (according to Van Slyke) and yet complete recovery occur. Prognosis cannot be based on the test results during the first two months of the disease, but if no steady improvement is noticed by the end of the fourth month then progress downwards to the active chronic or terminal stage is almost inevitable. As long as the clearance value remains above 10 per cent uræmia is unlikely to be present, but by the time the clearance has fallen below 5 per cent the patient is almost certain to be uræmic. In secondary contracted kidney and in malignant nephrosclerosis the course of the disease may be followed fairly accurately by means of the test, while in chronic nephrosis a gradual lowering of clearance is not infrequently noticed and suggests glomerular destruction and a termination in uræmia.

As regards operation in cases of prostatic obstruction, it is claimed that the blood-urea clearance test is a reliable guide; preliminary drainage should be carried out if the figure is below 60 per cent, as prostatectomy at this stage would be hazardous.

Although the blood-urea clearance test is generally considered to be the most sensitive method of examining renal function it should not be relied on alone; indeed it should not be employed unless the strictest accuracy in technique can be assured, as slight faults may produce serious errors in results. A simple blood-urea estimation ought always to be done and, in addition, a concentration test or one of the concentration and dilution tests. Of the latter, the range of specific gravity test is not only reliable but also easy to perform.

CAPACITY OF EITHER KIDNEY SEPARATELY

Before any decision can be reached concerning nephrectomy it is necessary to estimate the capacity of each kidney. This is done by determining the total renal capacity, in the way already described, and then comparing the function of the two kidneys by means of chromocystoscopy and by excretory urography (*see* Chapter XIX). In the chromocystoscopy test 10 c.c. of a 0·4 per cent solution of indigo-carmine is injected intravenously and the interval of time before the blue-coloured urine appears at each ureteric orifice is noted by cystoscopy. Normally, the dye is seen in 5–20 minutes; delay is usually of pathological significance. The comparison of excretion on the two sides provides an index of the relative function of the kidneys. Thus, if the dye should not appear on one side until some time after it has appeared on the other, then the side of the delay (or greater delay, if both sides defective) may be regarded as the affected (or more affected) one; the time-figures obtained and the amounts being excreted serve to apportion the total renal capacity.

CHAPTER XXXI

THE MANAGEMENT OF RENAL CASES

By HAMILTON BAILEY

Intake and Output of Fluid.—A special chart is kept of the amount of fluid the patient imbibes during twenty-four hours, and of the output of urine voided. This must be kept with great care and accuracy.

The Control of the Reaction of the Urine.—Maintaining, and, if necessary, altering, acidity or alkalinity of the urine is of the highest importance in the management of bladder, prostatic, and urethral, as well as renal, cases. Keeping the urine at a given reaction is largely in the hands of the nursing staff. Unless the nurse understands the reason for producing and sustaining acidity or alkalinity of the patient's urine, she cannot be expected to be really vigilant in achieving the desired result. Sometimes the house surgeon is unable to impart the necessary knowledge to the nurse. Possibly, in some instances, this is because he is not clear about these matters himself. The following may be helpful :—

Render the Urine Acid, and keep it Acid.—

a. When you wish to prevent infection, e.g., after prostatectomy.

b. When urinary antiseptics which act only in an acid medium have been prescribed.

It should be noted particularly that several urinary antiseptics, e.g., hexamine, are valueless unless the urine is kept acid constantly, and that it is positively dangerous to give sulphonamide preparations to a patient with a urinary infection unless the urine is alkaline.

Render the Urine Alkaline.—

a. When you wish to soothe a painful bladder.

b. When a patient with a urinary infection has pyrexia sufficient to cause concern.

c. When the urinary output is unsatisfactory and you wish to coax the kidneys to excrete more.

d. When urinary antiseptics which act best in an alkaline medium have been prescribed.



Fig. 262.—A spiked paper file used as a test-tube stand. A drop of neutral-red shows that the urine is acid in this case.

Verification of the Reaction of the Urine.—As it is employed so universally, many must be satisfied with the litmus paper test. With comparatively fresh litmus paper and a well-trained nursing staff, the record can be relied upon. Even so, I submit that the method I employ in urinary cases is more reliable. On the patient's locker stands a test-tube supported in a home-made holder, which is fashioned in a few moments from a spiked paper file. In the test-tube is 1 in. of the patient's morning urine, to which has been added, from a proper drop bottle, one drop of neutral-red.*

If the urine is acid, it is unmistakably red (*Fig.* 262).

If the urine is neutral, it is pink.

If the urine is alkaline, it is yellow.

*N.B.—Neutral-red *not* methyl red.

What could be simpler! There the test-tube remains throughout the twenty-four hours, reminding all concerned of some objective in the treatment of the case. To my eyes this is far from unsightly. At any rate, I am sure that its presence adds to the interest and efficiency of urinary therapeutics.

ACIDIFICATION OF THE URINE

For many years sodium acid phosphate has been the standard urinary acidifier, but there are ever-recurring cases where prolonged and liberal doses of this drug fail to alter the reaction of the urine.

For acidifying the urine the following mixture can be recommended :—

℞	Ammonium Benzoate	gr. 15
	Glycerol	m. 30
	Chloroform Water	m. 240

T.d.s., p.c.

Alternatively, ammonium chloride is a splendid urinary acidifier, and it can be given in conjunction with hexamine in the following prescription :—

℞	Ammon. Chlorid.	gr. 20
	Hexaminæ	gr. 10
	Ext. Glycyrrhiz. Liq.	m. 25
	Aquam	ad m. 240

* T.d.s., p.c.

Not only is ammonium chloride a better acidifier than sodium acid phosphate, but it possesses another great advantage. A mixture containing ammonium chloride and hexamine remains stable for two weeks, whereas, as is well known, when sodium acid phosphate is used the hexamine must be prescribed separately.

If neither of the above drugs produces acidification of the urine, the following mixture can be tried :—

℞	Acid. Nitrohydrochloric. Fort.	m. 45
	Aquam Dest.	fl. oz. 4

T.d.s., p.c.

It should be noted that it is nitrohydrochloric acid *fort.* (U.S.P.) which is used. This can be obtained from Martindale's.

Mandelic Acid Preparations.—Ammonium and phosphorus salts have superseded earlier preparations of mandelic acid. Amongst the most popular are Mandelix (British Drug Houses), 120 minims four times a day in water; Ammoket (Boots Pure Drug Co.), the dose of which is 240 minims four times a day. Collosol Phospho-Mandelate (Crookes' Laboratories) appears to upset the stomach less than other preparations. Full directions for administration, together with test papers and comparison tints of different *p*H levels, are provided by the manufacturers.

It should be noted that the cost of a fortnight's treatment with mandelic acid preparations is about 25s.

Acidogenic Diet.—An acidogenic diet is often of as much importance as drugs in maintaining an acid urine. From the following items menus can be selected of which no patient could complain.

* The problem of the patient who cannot take sufficient acidifying medicine because of nausea or vomiting is often solved by prescribing keratin-coated capsules of ammonium chloride. (May & Baker; Eli Lilly.)

Breakfast.—Cereal or porridge, sugar, cream. Eggs boiled, poached, or fried. Bacon, kidney, cold ham, fish. Bread and butter.

Lunch.—Beef, mutton, chicken, ham, liver, lean pork, veal, omelette, rice, macaroni, lentils, spaghetti. Stewed plums, stewed prunes, cream. Cheese and biscuits.

Tea.—Weak tea, sugar, milk or cream. Toast with butter. Egg sandwiches, sardine sandwiches.

Supper.—Meat as for lunch. Fish (salmon, mackerel, herring, haddock, halibut), bread and butter, weak tea or small amount of coffee.

If the urine continues to remain alkaline in spite of determined efforts to render it acid, almost invariably it will be found that on bacteriological examination a proteus infection will be revealed. When this is the case it is useless to continue with acidifying drugs, diet, and bladder washes. The correct treatment is a direct attack on the proteus bacillus (*see* p. 238).

ALKALINIZATION OF THE URINE

It is better to employ *sodium* citrate than the popular potassium salt. There is no fixed dosage. From 40 gr. to 80 gr. can be given every two hours ; if necessary up to a total of 300 gr. to 400 gr. in twenty-four hours. Each specimen of urine must be tested soon after it has been passed, and only when the urine becomes alkaline is the dose of citrate reduced ; then, and then only, is a maintenance dose of 30 gr. four times a day sufficient.

A Method of Alkalinizing the Urine Very Rapidly.—In those conditions where it is of paramount importance to render the urine alkaline forthwith (e.g., after incompatible blood transfusion), there is no better method than to inject intravenously 10 c.c. each of an isotonic solution of sodium lactate and a saturated solution of sodium bicarbonate. Ampoules containing the appropriate dosage of these drugs can be obtained ready for use from Crookes' Laboratories.

URINARY ANTISEPTICS

There are a host of urinary antiseptics, and their choice is largely one of individual preference. It is certain that many of them are of value in preventing urinary infection, and the house surgeon should not forget to prescribe one of the popular antiseptics in cases where it is of paramount importance to *prevent* infection, i.e., after operation upon the urinary tract and in cases where catheterization has been employed.

Sulphathiazole.—The urine should always be rendered alkaline and maintained alkaline while giving a course of sulphonamide to a patient with a urinary infection. Sulphathiazole seems to be the most effective of this group of drugs as far as the urinary system is concerned. In most cases a high concentration in the urine is necessary ; a dose of 2 g. a day with copious fluids often produces a favourable result. The drug should be continued for a period of five to eight days. At the end of that time it is usually advisable to stop the drug whether the urine has been sterilized or not. After an interval of two weeks a second course can be given.

Hexamine (syn. Urotropine).—Given by mouth, this has stood the test of time. It has been in clinical use for over forty years. In itself, hexamine has no bactericidal action, but in an acid medium it decomposes with the liberation of free formaldehyde. *Therefore the urine must be well acidified.*

Methylene Blue.—This is an old-fashioned remedy (1–4 gr. in pill or cachet). Recent work has shown that this dye is as good as, if not considerably better than, many of the newer remedies in inhibiting bacterial growth in the urine.

Neotropin.—The usual dose is two dragees by mouth three times a day, with copious draughts of bland fluids. It turns the urine a brilliant orange colour. After four days' treatment there should be three days' rest.

Acriflavine.—Provided the urine is alkaline, and in an alkaline medium only, acriflavine exerts an antiseptic action against the colon bacillus and staphylococcus. Acriflavine is administered in doses of 2 gr. three times a day.

All the above drugs are useful. It is a good practice to change the antiseptic after ten days or so.

Urinary Antiseptics in Relation to Bacteriology.—Except when facilities are lacking (usually the house surgeon is extremely well placed in this respect) the prelude to the treatment of a urinary infection is a bacteriological examination of the urine. With this cardinal information before one, instead of prescribing empirically, it is possible to design a direct attack upon the offending organism.

Streptococcus fæcalis: Contrary to what might be expected, sulphonamide preparations are without value, at any rate in an alkaline medium. As it is a fundamental rule that sulphonamides should not be prescribed in urinary cases unless the urine is alkaline, a course of sodium or calcium mandelate should be given, and it is often successful in eradicating this organism.

Bacillus coli: Render the urine alkaline and then give a six-day course of sulphathiazole. The concentration of sulphonamide in the urine need not be high, and 2 g. per day for an individual weighing 150 lb. is usually sufficient. At the conclusion of the course, render the urine strongly acid for a week. When the infection persists in spite of this régime, try a course of one of the mandelic acid preparations.

Bacillus proteus: Pay great attention to cases with this infection; the longer it has persisted the more difficult is it to eradicate. The urine will be strongly alkaline because the *B. proteus* splits urea, so it is safe to proceed at once to give a six-day course of sulphathiazole. Following this course, no effort should be spared to get the urine acid. Commence with liberal doses of the ammonium chloride mixture (*see* p. 236). It is for these cases that acid. nitrohydrochloric. fort. is sometimes of value. Acid bladder washes are indicated in appropriate cases. It is often necessary to revert, after a week's rest, to a second or a third course of sulphathiazole, but if it is appreciated that the reason for persistent alkalinity is splitting of urea, it is seldom that, with perseverance, the infection cannot be eradicated.

Staphylococcus: All the staphylococci are notorious stone-makers, and their presence in the urine is a serious matter. Again, the urine is often persistently alkaline, due to the splitting of urea. The same routine as outlined for the *B. proteus* should be followed. In cases where this fails, neoarsphenamine is often effective. It is administered intravenously in doses of 0·3 to 0·44 gr., and repeated in a few days, if necessary. Not more than four doses should be given.

Bacillus pyocyaneus (*Pseudomonas pyocyanea*).—During the past few years I have encountered a number of cases of pure *B. pyocyaneus* infection of the urinary tract. Usually this is a 'hospital' infection due to catheters, etc., but several of my patients were what might be termed virgin cases. There was no question of a urethral instrument of any kind having been passed. I have found that the *B. pyocyaneus* is the most difficult organism of all to eradicate from the urinary tract. Sulphanilamide and sulphathiazole have had not the slightest effect in several cases. It should be borne in mind that this organism can be eliminated from wounds by 1 per cent acetic acid. Local and general acid therapy is therefore indicated. Locally, I have found the buffered saline solution of azochloramid of some value.

ACUTE PYELITIS

Alkaline Treatment.—Fluid must be given in large quantities, the aim being a minimum intake of 5 pints in 24 hours. The output of urine should not be allowed to fall below 90 to 100 oz. Enough sodium citrate is given to render the urine alkaline (*see* p. 237).

Dramatic results can sometimes be achieved, especially in early cases, by rapidly alkalinizing the urine by the method described on p. 237. I have observed a very ill patient with a temperature of over 103° so change half an hour after the injection that he was sitting up smiling and asking for his tea—an unexpected improvement which was maintained.

Intravenous urotropine (Schering) occasionally produces similar results in ultra-acute cases, but I am inclined to think that the above will be of more general value.

MANAGEMENT OF AN INDWELLING URETERIC CATHETER

In some cases of acute pyelitis which do not respond quickly to alkaline therapy, an indwelling ureteric catheter is extremely good treatment. A ureteral catheter is also retained in cases of leaks from the ureter, and in some cases of unilateral chronic pyelitis rebellious to other forms of treatment. It is the house surgeon's duty to see that an indwelling ureteral catheter is functioning. Obviously, if the catheter is not providing free drainage it is obstructing the ureter, and is much worse than useless. With a pyelography syringe the interior should be irrigated gently every few hours in order to prevent the catheter from becoming blocked. The urine is allowed to drip into a sterile bottle (*Fig.* 263), and urinary antiseptics must be given. I have had several cases where a catheter has been kept in place satisfactorily for a week, but usually it should not be retained for more than twenty-four hours. Promising results have been obtained in selected cases of chronic pyelitis by irrigating the interior of the kidney with sulphonamide preparations; 0·5 g. is instilled at each injection.

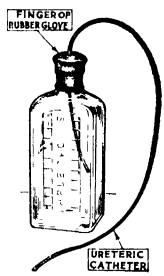


Fig. 263.—A sterile collecting bottle improvised with the finger of a rubber glove and a medicine bottle

MANAGEMENT OF A NEPHROSTOMY

Temporary nephrostomy is performed in many operations upon the kidney, particularly after nephrolithotomy. The catheter in the renal pelvis allows irrigation of the renal pelvis. Saline solution is employed for the irrigation during the first twenty-four hours. It is best to instruct the nursing staff to use only a drachm or two of fluid, i.e., just enough to make certain that the catheter is not blocked. When it is assured that there is no hæmorrhage, a weak antiseptic solution such as 1–1000 mercurochrome can be used for irrigation with advantage. If the mercurochrome solution is used earlier, it is difficult to be certain whether hæmorrhage is proceeding or not.

As a general rule, a nephrostomy tube is retained for ten days. At the end of this time the retaining stitch is cut, and by the twelfth day the tube is usually extruded. If spontaneous extrusion does not occur within three days, the house surgeon should remove the tube.

MANAGEMENT OF DRAINAGE TUBES IN THE PERINEPHRIC SPACE

The house surgeon should be vigilant that a drainage tube designed to drain the perinephric space is not removed too early. A drainage tube in this situation cannot possibly do any harm, and it should be left in place (although it can be turned, and, in certain cases, shortened) for several days after apparently it has ceased to function. Especially after conservative operations upon the kidney and ureter, e.g., removal of calculi, late leaks of urine are liable to occur.

Following conservative operations upon the kidney and ureter the watch-word should be 'it is better to leave a tube in the perinephric tissues a week too long than remove it a day too early'.

HÆMATURIA

Severe hæmaturia from any cause, whether pre-operative or post-operative, should be the signal:—

1. For a special chart to be kept of the pulse-rate every hour.
2. For instructions to be given to the nursing staff that all specimens of urine must be saved and labelled with the time of voiding. It is then possible to compare one specimen with a previous one, and to form a rough idea as to whether bleeding is progressive or not.
3. For blood grouping of the patient and tentative arrangements for a blood transfusion.
4. For a careful watch that clotting is not occurring in the bladder. Timely bladder irrigation will prevent massive clot formation in the bladder and its attendant evils of sepsis and retention of urine.

Is there blood in the urine?—It is sometimes of great diagnostic value to know if there is blood in the urine which looks clear. The house surgeon and practitioner will do well to employ the following reliable test for minute traces of blood.

"*Scotland Yard*" *Test:* To half a test-tube of urine add one drop of caustic soda 40 per cent, one or two drops of the reagent and one drop of hydrogen peroxide.

If blood is present, a pale purple diffuse phosphorescent glow is produced. The luminosity is best seen in a dark room or cupboard.

Formula for the reagent:—

Aminophthalic cyclic hydrazide	1 g.
Na_2CO_3	50 g.
H_2O_2 (10 vol.)	50 c.c.
Aq. dest.	ad 1000 c.c.

ANURIA AND OLIGURIA (SUPPRESSION OF URINE)

Oliguria implies an excretion of 20 *oz. or less in twenty-four hours; anuria is an absence of excretion for twenty-four hours.*

Often the patient looks and feels comparatively well until the condition is irremediable. This is not the time to wait and see, nor one in which to strike a reassuring note. It is a time for action, and the house surgeon should not relax his efforts until a satisfactory flow of urine has been re-established. It should be noted particularly that diaphoretics are perfectly useless as a means of ridding the patient of urea and other constituents of urine. Sweating merely depletes the patient of much needed water and salts.

OLIGURIA

Have a blood-urea estimation performed. Order copious intake of fluids and/or rectal drip of tap water. Arrange to see the patient again in a few hours.

ANURIA

Obstructive (*syn. post-renal*) *Anuria.*—Necessarily the obstruction (e.g., a stone or stones) must be bilateral, or involve a sole functioning kidney.

Renal Anuria is consequent upon failure of renal epithelium to excrete urine.

Pre-renal Anuria results when the blood-pressure falls below that point where excretion of urine is possible.

If obstructive anuria is suspected a radiograph should be taken, but gaseous distension of the intestine accounts for a very large percentage of failures to visualize calculi. *On no account should excretory pyelography be attempted.*

General Principles of Treatment.—A catheter is passed. In a case of anuria the bladder will be found to be empty, or practically so. Distend the bladder with warm lotion before removing the catheter. Especially in reflex cases, this measure sometimes initiates a resumption of renal activity.

When **not** *to give a Diuretic.*—Manifestly it is absolutely contra-indicated to give a diuretic in unrelieved obstructive anuria; indeed, the dangers of the misuse of intravenous therapy reach their zenith in such cases. To allow several pints of any fluid to gravitate into a vein without a correspondingly adequate output of urine is to increase renal œdema and thereby sound the death-knell.

When to give a Diuretic.—In cases of proven non-obstructive anuria, and in obstructive anuria when the obstruction has been remedied.

The best diuretic is an isotonic solution of sodium sulphate given intravenously by the continuous drip method. An isotonic solution of sodium sulphate is made up by dissolving 42·85 g. of Glauber's salts in one litre of water.

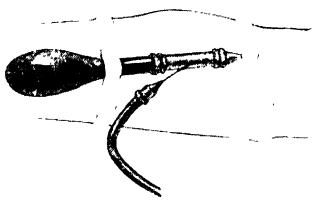


Fig. 264.—With Edwards's vein seeker in position intravenous fluid therapy can be stopped and restarted without disturbing the hollow needle in the vein.

The house surgeon must stay with the patient, or at any rate visit him at very frequent intervals, not forgetting that the night is as important as the day. There is no excuse for allowing an excess of fluid to enter the circulation. With Edwards's vein seeker in place fluid therapy can be stopped and restarted at will (*Fig.* 264) Until a corresponding output of urine has been recovered, not more than one half to three-quarters of a pint of sodium sulphate solution should be given.

Reducing the Circulating Urea when it is Very High (200 *mg. or more*).—Insert a cannula into the median basilic vein and allow two pints of venous blood to escape steadily. While this is going on gravitate one to one and a half pints of plasma into a vein on the opposite side of the body. I have found this to be a splendid procedure.

Kindling Renal Activity.—Once at least a little urine has been excreted :—

a. Intravenous therapy can be recommenced very cautiously; usually 5 per cent dextrose is given at this time. It is important to note that salt (NaCl) solution should be eschewed, for chlorides tend to damage still further damaged renal epithelium.

b. An enema is given and this can be followed by a warm high colonic douche, which is often helpful in stimulating the left kidney. Pulv. jalap. co., 40–60 gr., which produces a large, watery stool, should be prescribed. Heat is applied to the loins, the best form for this purpose being an electric heating pad. In necessary cases the force of the heart-beat should be increased by suitable drugs.

When the above measures fail to produce any result within nine to twelve hours (it should be noted that slumbering renal epithelium awakens very slowly) there is one last resort: Half a pint of five times concentrated serum can be injected intravenously.

Anuria due to Sulphonamide Crystalluria.—The ureters must be catheterized without delay. While preparations for this procedure are going forward, a urethral

catheter should be inserted and the bladder irrigated with warm saline. If ureteric catheters can be passed the pelves of the kidneys must be irrigated at repeated intervals with small quantities of warm isotonic dextrose solution at 110° F. Continuous intravenous fluid should be administered cautiously.

Anuria due to the Crush Syndrome.—Assume that every patient who has had a considerable part of his body crushed and trapped for several hours will develop anuria (probably fatal) unless precautions are taken to prevent it as soon as he enters hospital. A crushed limb should be encircled firmly with an Esmarch's bandage, as high as possible. The bandage is released gradually by the house surgeon himself over a period of six to eight hours. From the very start sodium citrate is given and fluids are forced by mouth. If oliguria and anuria develop, the same measures advocated in this chapter should be carried out.

COLLECTING SPECIMENS OF URINE IN INFANTS

By ELLIOTT EMANUEL

The Male Infant.—A piece of adhesive plaster 1 in. wide and 7 in. long is procured. The middle is wrapped half-way round the circumference of a test-tube, in such a way that half the width of the plaster projects beyond the top of the tube (*Fig.* 265). The penis is cleansed and placed into the tube, with the adhesive plaster against its under surface. The overlapping ½ in. of plaster is made to adhere to the under surface of the root of the penis. The free ends of the plaster are crossed over the dorsal surface of the penis and stuck to the skin of the groins (*Fig.* 265). The infant lies on his back. The head of the cot is raised 6 in. He is visited every half hour until sufficient urine has been obtained. When it is necessary to collect the urine over several hours, a large collecting vessel is employed. For prolonged collections a preservative, e.g., a few drops of toluol, should be placed in the bottle. For ascorbic acid estimations, glacial acetic acid to give a final concentration of 5 per cent, is employed.

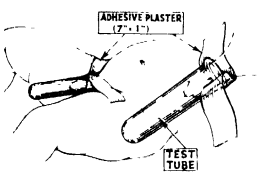


Fig. 265.—A method of collecting a specimen of urine in a male infant.

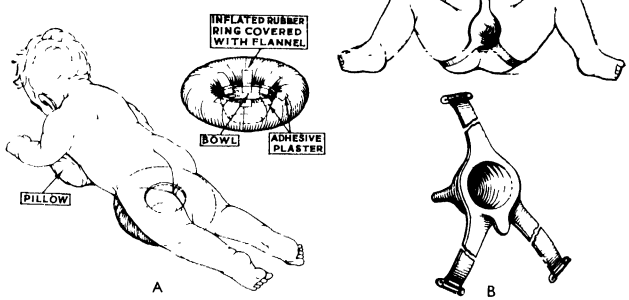


Fig. 266.—Methods of collecting a specimen of urine in a female infant. A, With improvised apparatus; B, With Cohen and Blatt's apparatus.

The Female Infant.—Considerable difficulties have to be overcome. *Method* 1: A bowl about 5 in. in diameter is fitted accurately into the hollow of an inflated rubber ring, which has been covered with flannel. Strips of adhesive plaster are made to hold the two together. The infant lies face downwards with the chest on a pillow and the perineum over the bowl (*Fig.* 266, A). Employing this method but little urine is lost, and the collection of the urinary output over several hours can be made. *Method* 2: A test-tube is pushed through a slit in a 2-in. square of adhesive plaster which is made to adhere to the opened-out vulva. *Method* 3: Much the best method, when the apparatus is available, is Cohen and Blatt's rubber collector (*Fig.* 266, B).

CHAPTER XXXII

CATHETERS AND CATHETERIZATION

By HAMILTON BAILEY

CATHETERIZATION should be regarded with great circumspection—it is one of the house surgeon's most responsible duties. Even if the patient requires relief at an inconvenient time, laxity in taking every precaution to ensure asepsis is unforgivable.

STERILIZATION OF CATHETERS

All modern catheters can be sterilized by boiling. It should be appreciated that the modern gum-elastic catheter with due care will stand repeated boiling provided that it is carried out in the following way :—

The catheter is plunged for two minutes into water already boiling. It must be removed carefully by its wide end and dropped into sterile cold water or cold antiseptic solution.

TECHNIQUE OF CATHETERIZATION

Sterile towels must cover a wide area in order that the operator's hands and the shaft of the catheter may be protected from contamination. The penis is grasped in a gauze swab moist with weak antiseptic. The prepuce is retracted and the glans cleansed thoroughly with another moist swab. Even this is insufficient. The anterior urethra should be washed out in every case. This is easily performed with a syringe (*Fig.* 267) filled with weak antiseptic. The tip of the chosen catheter is lubricated with sterile lubricant (*Fig.* 268). The penis is kept stretched vertically while the instrument is passed, and the watchword for urethral instrumentation is, as always, *arte non vi.*



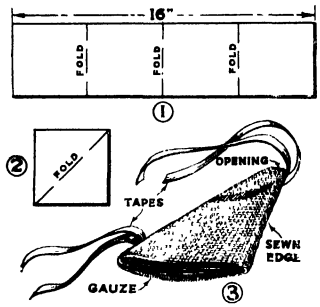
Fig. 267.—A good type of urethral syringe which is very inexpensive. In its absence a Record syringe can be used.

Fig. 268.—The minimum requirements for catheterization. A, Bowl containing weak antiseptic, e.g., acriflavine 1–10,000 ; B, Sterile lubricant, e.g., liquid paraffin ; C, Sterile swabs. The urethral syringe is not shown. An ordinary hypodermic syringe without the needle will suffice.

TYING IN A CATHETER

Provided a catheter has been inserted under absolutely sterile conditions, and means are taken to prevent infection, a skilfully tied-in catheter is, in certain

circumstances, an extremely satisfactory procedure. A badly tied-in catheter, and/or one retained without every precaution to prevent ascending infection, is a menace to life. There are many methods of tying in a catheter. I consider that the worst method, which unfortunately is very popular, is the use of flexible adhesive plaster applied directly over the peno-catheter junction. Over and over again I have been called to see a patient with a catheter tied in by this method and on removing the adhesive plaster purulent urethritis is only too obvious.



269.—An antiseptic penile jacket made from gauze and tape

We will assume that the catheter has been introduced as it should be—perfectly aseptically. The next thing to consider is how to protect the meatus from bacterial infection.

The best method of preventing urethritis is to smear the glans liberally with sulphanilamide ointment and then to apply a penile jacket. The latter can be made easily (*Fig.* 269). It is boiled before use and wrung out in surgical spirit. A penile jacket with sulphanilamide ointment around the meatus effectively prevents infection alongside the catheter. Therefore a method of retaining the catheter in position which allows the application of a penile jacket should be chosen.

Foley's Bag Method (*Fig.* 270).—If the bag can be introduced—and, of course, in many cases of urethral obstruction this is impossible—Foley's bag (*see Fig.* 296, p. 256) is a good method. The patient is very comfortable with this apparatus in position, and no mechanism for retaining it is necessary.

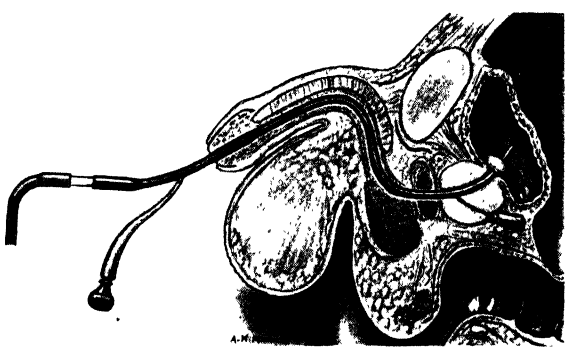


Fig. 270.—The balloon-ended self-retaining catheter made by Bard & Co., of New York but a Foley's bag is equally good.

The Pipe-cleaner Method.—The pipe cleaners are sterilized by immersing them in spirit, and before use the excess of spirit is removed with a dry swab. After the catheter has been passed, four pipe-cleaners are strapped with 1-in. adhesive tape round the circumference of the penis as near the base as possible. The four ends of the pipe-cleaners are brought to the catheter and fixed there with a very narrow strip of adhesive plaster in such a way that each pipe-cleaner

has a definite bow and stands away from the glans penis (*Fig.* 271). The ends at the base of the penis are then bent back, and any excess cut off with scissors. Pipe-cleaners have the necessary rigidity to stand away from the penis and do not press upon the corona.

Instead of employing adhesive plaster at the base of the penis, the lead strap of my design (*Fig.* 272) which holds three pipe-cleaners, will be found most practical and comfortable for the patient. These can be easily cut out from a piece of the sheet-tin used in the massage department for the indifferent diathermy electrodes, but they can be obtained ready-made from Donald Rose.

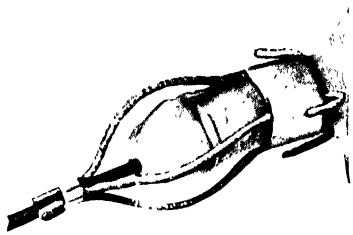


Fig. 271.—A method of tying in a urethral catheter, using pipe-cleaners. The penile jacket is not shown. (*After G. B. Davis.*)

Management.—It is, of course, futile to tie in a catheter aseptically, and then to let it discharge its contents into a bed-bottle; infection will follow as surely

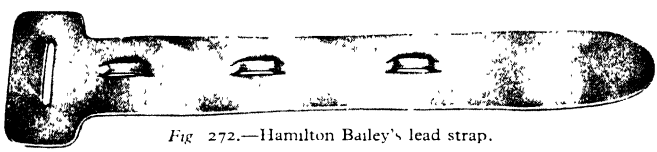


Fig. 272.—Hamilton Bailey's lead strap.

as night follows day. The catheter must be connected to sterile rubber tubing by a sterile glass connexion and led into a sterile bottle. In order that the weight

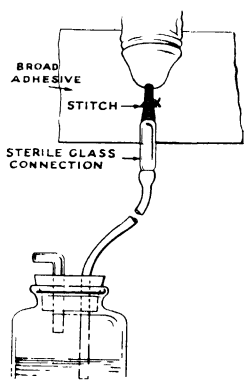


Fig. 273.—Method of supporting a tied-in catheter with a strip of adhesive plaster. If the catheter is stitched to the adhesive plaster, angulation and meatal pressure ulceration are prevented.

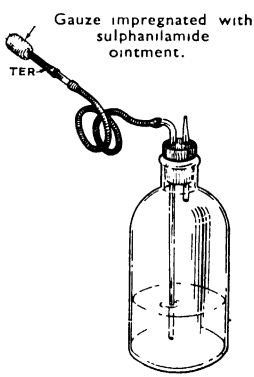


Fig. 274.—Method of managing an indwelling catheter in the female.

of the tubing shall not cause angulation of the catheter and meatal pressure ulceration, a strip of broad adhesive plaster across the thighs supports the penis and the catheter. A stitch passed through the centre of the adhesive plaster and tied round the catheter will maintain it in the correct position (*Fig.* 273). A

better alternative to the bottle beside the bed is to connect the rubber tubing to a St. Mark's apparatus for intermittent bladder irrigation. (*See* p. 252.)

Indwelling Catheter in the Female.—The problem of the indwelling catheter is relatively simple in the case of a female. By employing the refinements shown in *Fig.* 274 a catheter may be kept in position for a considerable period without inviting urethritis or ascending infection.

TREATMENT OF ACUTE RETENTION OF URINE

On no account should a patient with acute retention be catheterized in the casualty department and sent home. He must be admitted.

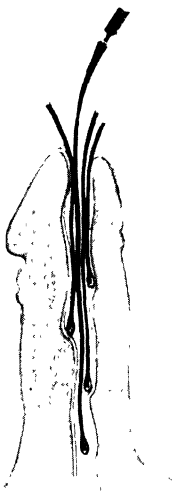


Fig. 275.—Finding the lumen of a strictured urethra with multiple filiform guides (*After I. S. Koll*)

Provided the general condition is satisfactory, the time-honoured ¼ gr. of morphine and a hot bath should be tried; in a very small proportion of cases urine is passed into the bath.

Acute Retention due to Stricture of the Urethra.—To catheterize a strictured urethra is often exceedingly difficult, if not impossible. Only too often the patient arrives in hospital with his urethra bleeding and his retention unrelieved. I am convinced that the best method to try in these cases is not a catheter, but a small gum-elastic bougie, passed, if necessary, by the faggot method. The correct way of passing a filiform guide is by a gentle probing movement combined with rotation caused by rolling the guide between the finger and thumb (*Fig.* 275). Little, if any, damage can be done with this instrument, and if one can be insinuated through the strictures (they are often multiple), the retention is relieved in the best possible manner, viz., slowly, by the urine trickling alongside the instrument.

Especially in tropical countries (where gum-elastic instruments perish rapidly and strictures of the urethra are very common) the employment of Allen's cannulized metal bougie (*Fig.* 276) has been found an admirable means of relieving many cases of acute retention of urine due to stricture. If the bougie can be passed (and great gentleness and some skill is always necessary) the bladder can be decompressed by affixing a dripper to the spigot in the same way as is illustrated in *Fig.* 276.



Fig. 276.—Allen's bougie

Urinary antiseptics should be prescribed from the commencement of treatment in these and all other cases where acute retention of urine is being relieved.

Retention due to Enlargement of the Prostate.—This is the commonest variety and the one which requires the most careful handling. The patient

is elderly, the kidney function is probably impaired, and at all costs we must endeavour to avoid infection. After the usual preliminaries, culminating in washing out the urethra, it is a good practice to instil some 4 per cent novocain into the urethra and wait four or five minutes. It is improbable that a soft rubber catheter will pass the obstruction; it is better to employ a large-sized gum-elastic bi-coudé catheter at the commencement. The difficult point to pass is where the middle lobe begins. Occasionally the left index finger in the rectum may help to lever the tip of the catheter into the bladder (*Fig.* 277). Once the catheter is in place only a few ounces of urine should be allowed to escape. The bladder is then decompressed slowly.

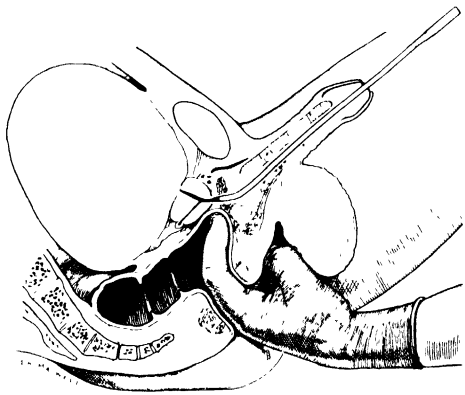


Fig. 277.—A finger inserted in the rectum aiding the passage of the catheter in a difficult case of prostatic obstruction.

DECOMPRESSION OF THE OVERFULL BLADDER

Of all the methods of decompressing the bladder, I think the one of using an intravenous saline dripper is the method of choice. Into the mouth of the catheter is inserted a nozzle—an ordinary glass nozzle serves the purpose, but the silver, right-angled connexion (*Fig.* 278) which I designed has many advantages. The free end of the nozzle is connected to the tubing of the intravenous saline dripper.

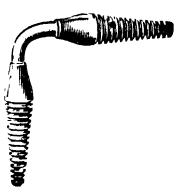


Fig. 278.—Silver connecting link for use between catheter and tubing. Made by Kipling, 7, Meredith Street, E.C.1, it prevents kinking and ensures a watertight junction.

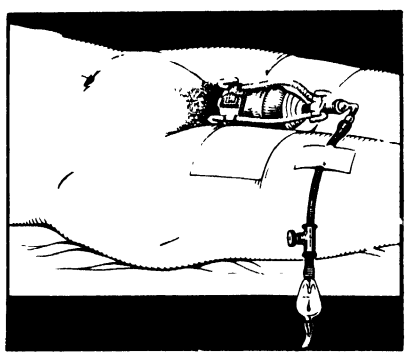


Fig. 279.—Decompression of the bladder using the dripper of an intravenous saline apparatus. The penile jacket is not shown.

The tap of the dripper is set to allow forty to sixty drops per minute to escape (*Fig.* 279). If the retention is of long standing the rate of emptying is somewhat slower.

ACUTE RETENTION WHERE ATTEMPTS AT CATHETERIZATION HAVE FAILED

If, after a reasonable attempt with catheters, the bladder has not been entered, one of two courses must be adopted: (1) Suprapubic puncture; (2) Suprapubic catheterization.

Suprapubic Puncture with a Hollow Needle.—When acute retention of urine cannot be relieved by catheterization, and the circumstances are extenuating, suprapubic puncture with a hollow needle is a method which can be recommended. If the circumstances remain extenuating, and a catheter still cannot be passed, suprapubic puncture can be repeated. Repeated puncture is only permissible in exceptional circumstances, for to allow the bladder to refill after it has been punctured is dangerous; leakage is liable to occur into the cave of Retzius.

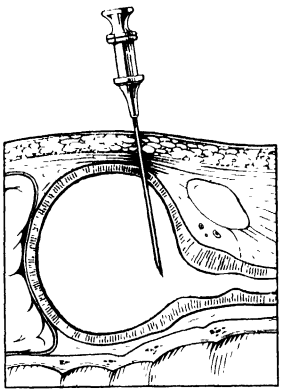


Fig. 280.—Suprapubic puncture of the full bladder, using a lumbar-puncture needle.

The pubes are shaved and the skin of the lower abdomen sterilized. A lumbar-puncture needle is a convenient instrument to employ. Exactly in the middle line, one finger-breadth above the symphysis pubis, a wheal of local anæsthesia is raised in the skin. Through this the lumbar-puncture needle is directed backwards and slightly downwards until the bladder is entered (*Fig.* 280). The needle is carefully held in position until the bladder is empty. Relief of the retention lessens œdema and congestion around the seat of the obstruction. Armed with this knowledge, four or five hours after the puncture, catheterization can be attempted again with renewed hope.

Suprapubic Catheterization.—When urethral catheterization has failed, an alternative to suprapubic puncture, which at the best is but a makeshift, is suprapubic catheterization. In acute retention of urine, ordinary suprapubic cystostomy, which allows the urine to gush forth, must be avoided rigorously. The aim is to introduce a mushroom-ended catheter into the bladder without spilling more than a few drops of urine. There are several ways of achieving this, but here is a description of the one which I have found to be the safest and most satisfactory.

The essential apparatus is a No. 28 reinforced Malecot catheter (*Fig.* 281). The type of perforator shown in *Fig.* 282 is inexpensive, never gets out of order, and consequently is a most useful instrument to possess. The front of the distended bladder is exposed through a short suprapubic incision, and the bladder wall, with tortuous veins coursing over it, is clearly seen. Local anæsthesia can be used most satisfactorily, but care must be taken not to prick the distended bladder. The bladder perforator is armed with the Malecot catheter, which is stretched over the perforator as shown in *Fig.* 282. The end of the Malecot having been dipped in liquid paraffin, all is in readiness for its insertion into the bladder. This is done with a short, sharp stab. The introducer is disengaged while the end of the catheter is pinched prior to clipping it with a hæmostat. The catheter is pushed well into the bladder; otherwise, as the bladder empties, the mushroom end is likely to be pulled up against the bladder wall. Only a few drops of urine escape around the puncture. Half a teaspoonful of sulphanilamide powder is placed in the prevesical space. Drainage of the prevesical space is



Fig. 281.—A Malecot catheter. The special reinforced model No. 28 is essential for successful use with the bladder perforator.

provided, using a strip of corrugated rubber. The abdominal wall is approximated with silkworm-gut sutures, not forgetting to anchor the catheter with one of these.

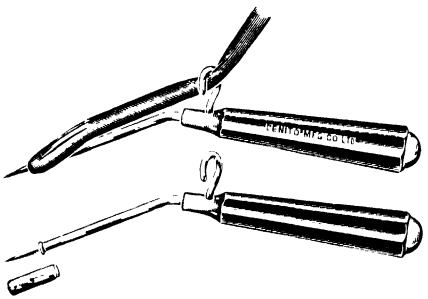


Fig. 282.—Hamilton Bailey's bladder perforator to be used with a No. 28 Malecot catheter.

If the special perforator is not obtainable, the Malecot catheter can be stretched over a narrow-bladed scalpel (*Fig.* 283). This is not so satisfactory and requires some deftness, but in cases of necessity it serves the purpose.



Fig. 283.—A narrow-bladed scalpel can be used as a bladder perforator in the absence of a special instrument.

The catheter is connected with a dripper decompression apparatus precisely as described on p. 247.

Retention with Overflow. — However carefully treated by the usual methods, the mortality in these cases is appalling unless special precautions are taken. After trying many methods, I am convinced that the following procedure is second to none. *No attempt is made to pass a urethral catheter.* A No. 28 Malecot catheter is introduced suprapubically, as just described; it must be pushed well into the over-distended bladder. Decompression is commenced with the dripper running at 30 to 40 drops a minute. When the bladder is half empty, continuous intravenous sodium sulphate is administered, 1½ pints only being instilled at the rate of 30 to 40 drops a minute. As soon as the intravenous drip is started the rate of escaping urine is increased to 50 to 60 drops a minute until the bladder is empty. The suprapubic Malecot catheter is then disconnected from the dripper and connected with a St. Mark's apparatus (*see* p. 252). A high fluid intake and suitable urinary antiseptics are prescribed.

Retention as an Accompaniment of Acute Urethritis.—Every means should be taken to relieve the retention without passing a catheter. The patient should be placed in a hot bath, or made to sit in a hot sitz bath, and directed to pass his water in it. If this is unsuccessful, an injection of hot water into the rectum may be tried. If this fails also, the choice lies between passing a catheter under an anæsthetic and introducing a Malecot catheter suprapubically. My own view is that the latter procedure is much the better.

Retention Complicating Acute Prostatitis or a Prostatic Abscess.—Again, when possible, catheterization should be avoided. To drain the bladder with a suprapubic catheter is correct treatment. If an abscess is present in the prostate, the abscess should be drained through the perineum.

Clot Retention.—Blood-clot in the bladder sometimes causes acute retention. The passage of a catheter relieves the retention, and repeated washings through a catheter of wide bore sometimes evacuate all the clot. Blood-clot in the bladder is certain to become infected. If the source of the bleeding is known, and it is estimated that there is a considerable amount of clot in the bladder, it is best to evacuate the clots by suprapubic cystostomy. The measure avoids decomposition of blood and the attendant dangers of purulent cystitis.

Retention due to Impacted Urethral Calculus.—Usually retention is only partial, but the pain of a stone in this situation is intense. Systematic palpation of the course of the urethra usually reveals the site of the impaction, which is not infrequently behind a stricture or a narrow external urinary meatus. Meatotomy (*see* p. 319) will at once relieve matters if the stone is impacted just behind the meatus. In other situations,

if a catheter cannot be passed, the retention can be relieved by suprapubic puncture. Before the bladder refills, the stone should be extracted through an incision in the floor of the urethra.

Post-operative Retention.—Acute retention of urine after operations never occurs before puberty, and is more common in private than in hospital patients. Proctoclysis definitely favours such retention. In dealing with this troublesome condition one should follow some logical therapeutic crescendo: (1) The rectal tube, if present, should be removed. (2) Potassium acetate, which is both a parasympathetic stimulant and a diuretic, is prescribed: ½ oz. of 1–15 solution of liquor potassii acetatis by mouth. This is repeated every half hour for eight doses if required. Alternatively subcutaneous injections of 1–2000 prostigmine methyl-sulphate (Roche) can be tried. (3) Psychological methods are invoked. Assure the patient that there is no danger of organic obstruction, and suggest to him that if he cannot void urine in a given time a painful catheter may have to be used. (4) Hot stupes to the hypogastrium, combined with supporting the lower abdomen with the flat of the hands, and in certain cases allowing the patient to put his knees over the side of the bed, is the next step to be tried. (5) Catheterization: naturally, discrimination must be used as to how long to persevere before the catheter is employed. In the gynæcological department of the Johns Hopkins Hospital the need for catheterization after pelvic operations has been reduced from 51 per cent to 6·5 per cent by instilling into the bladder 1 oz. of 0 5 per cent solution of mercurochrome at the close of every pelvic operation before the patient leaves the theatre. The method is entirely empirical.

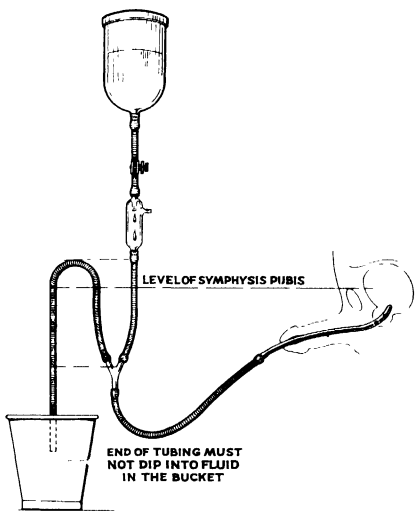


Fig. 284.—Rationale of tidal drainage of the bladder. (*After Lawrie and Nathan.*)

Retention from Paralysis (Lesion of the Spinal Cord).—The consensus of opinion is that catheterization should be avoided, for if it is used serious infection supervenes eventually. Automatic emptying of the bladder can sometimes be established. In the absence of facilities for tidal drainage, the best way of treating difficult cases is to perform suprapubic catheterization.

Tidal Drainage.—There are many modifications of the apparatus, of varying complexity. The one shown in *Fig.* 284 is the simplest. The bladder is filled at a rate of 60 drops per minute. *In cases of paralysis the height of the* ∩*-shaped tube leading from the* Y*-connexion should be* 2 *in. only above the patient's symphysis pubis.* When the bladder has become filled the level of the fluid rises in the system to this height, and then overflows the loop and runs down the tube into the receptacle, thus emptying both the bladder and the tubing by siphonage. The process then restarts automatically. The glass dripper must have a side tube which is left open. The end of the outflow tubing must not dip into the fluid in the receptacle, and there must be no air in the catheter or the tube leading to it. The tube leading from the Y-shaped glass connexion to the bucket should be of a larger bore than the other tubes. When the automatic drainage has been proved to be working satisfactorily it can be allowed to function continuously. The lotion used may be any bland bladder wash, and it can be used cold.

CHAPTER XXXIII

THE MANAGEMENT OF BLADDER AND PROSTATIC CASES

By HAMILTON BAILEY

BLADDER WASHES

HOUSE surgeons have been divided into two classes—those who stand at the foot of the bed and prescribe, and those who take off their coats and wash out the bladder ! I have found that the ones who take off their coats are more likely to adopt, and succeed in, the practice of surgery.

Bladder washes should be made up to a temperature of 110° F. They cool considerably on passing through the tube of the irrigator. Usually a receptacle holding 2 pints of the solution is suspended 3 ft. above the level of the patient. The following washes will be found of use :—



1. Acriflavine 1–10,000.
2. Mercurochrome 1 per cent or weaker.
3. Potassium permanganate 1–2000.
4. Silver nitrate 1–10,000 may be employed as an alternative to one of the above.
5. Sulphanilamide 0·8 per cent in normal saline.
6. A saturated solution of boric acid diluted with an equal volume of sterile water.
7. Phosphoric acid 1 per cent is often indicated in cases of persistent alkaline cystitis.
8. Acetic acid 0·25 per cent is a most satisfactory bladder wash. This acid solution inhibits the growth of many organisms which give rise to cystitis, notably the colon bacillus, staphylococcus, streptococcus, and proteus. It is therefore an ideal medium to *prevent* infection of the bladder.

Technique.—There are a number of ways of washing out the bladder, each with a field of usefulness :—

1. *Through a Urethral Catheter* (*Fig.* 285).—Some 3 or 4 ounces of the solution are run into the bladder. The nozzle is withdrawn and the bladder allowed to empty.

Fig. 285.—Washing out the bladder through a urethral catheter. (*After Sir William Wheeler.*)

2. *Janet's Method.*—This is carried out via the urethra without a catheter. It is indicated almost exclusively when there is a suprapubic cystostomy and it is desired to irrigate the prostatic bed. A nozzle is applied to the sterilized meatus. After the anterior urethra has been washed out the nozzle is passed in more deeply, and sufficient hydrostatic pressure is used to overcome the contraction of the compressor urethræ. The warm lotion flows up the urethra, irrigates the prostatic bed, and can be seen issuing from the suprapubic wound.

3. *Through an Open Suprapubic Wound.*—When the house surgeon carries out the bladder washes himself (the routine washes are carried out by the nurse or dresser) it is often advisable to remove the suprapubic box, if one is present. This allows thorough inspection of the wound and the surrounding skin. A means of collecting the overflow is to employ a Thomson-Walker tray (*Fig.* 286). After passing a large rubber catheter into the suprapubic wound, irrigation is continued until the wash is returned clear. The house surgeon re-applies the box and gives any necessary instructions for its management.

4. *Automatic Bladder Irrigation.*—The simple apparatus illustrated in *Fig.* 287, and first used at St. Mark's Hospital, revolutionized routine bladder irrigation. It can be employed when a catheter has been tied into the urethra or when a mushroom-ended catheter has been sutured into the suprapubic wound. It is not applicable in cases of open suprapubic cystostomy, nor is it advisable after Harris's operation with complete closure of the bladder.

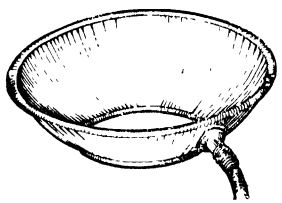


Fig. 286.—Sir John Thomson-Walker's tray.

5. *Bladder Washes after Harris's Operation of Prostatectomy, with Closure of the Bladder.*—Through the indwelling catheter 1 oz. of silver nitrate 1–10,000 or acriflavine 1–10,000 is instilled. Irrigation beyond the amount necessary to ensure that the catheter is not blocked is to be deprecated, as it throws pressure on the suture lines and tends to cause leakage into the

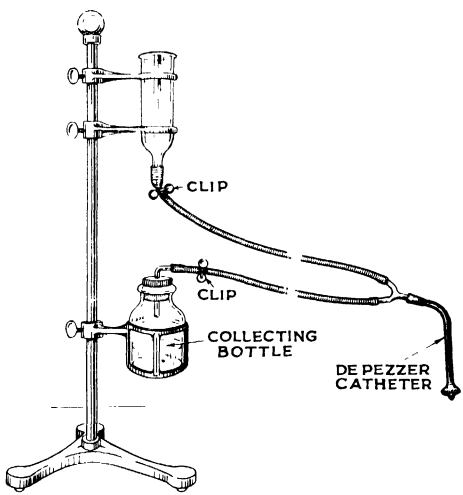


Fig. 287.—St. Mark's Hospital apparatus for bladder irrigation. By merely releasing the appropriate clips on the tubing the bladder is filled with the wash. In the interval between the washes the urine drains into the bottle.

cave of Retzius. Particularly during the first forty-eight hours, the house surgeon must pay frequent visits to satisfy himself that the catheter has not become blocked. If there is bleeding steps should be taken to inform the surgeon at once. It is highly important that the connexion of the catheter

to the tubing and the urine-collection bottle should be strictly aseptic, and maintained so.

* * *

If the house surgeon is called to see a patient of whom the nurse reports that the bladder wash, instead of coming through the suprapubic de Pezzer (or Malecot)

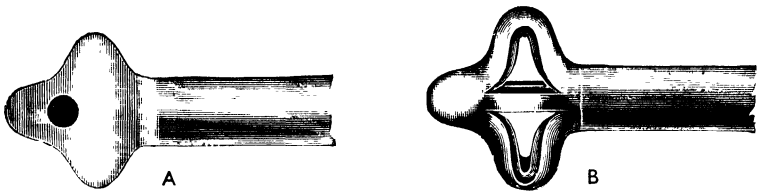


Fig. 288 —A, de Pezzer catheter, B, Malecot catheter

catheter (*Fig.* 288), is issuing from the drain in the cave of Retzius, it is possible that the eye of the catheter is blocked with blood-clot; but what is more probable is that the de Pezzer has come out of the bladder and is lying in the extravesical space. This is liable to occur after suprapubic catheterization of a full bladder where allowance has not been made for the decrease in the size of the organ (*Fig.* 289). A skin stitch holds the catheter rigidly in place. Under these circumstances it is best to pass a urethral catheter if possible, and tie it in, and to remove the suprapubic de Pezzer, allowing ample drainage for the cave of Retzius. If this course is not possible, the surgeon who performed the operation should be consulted at once.

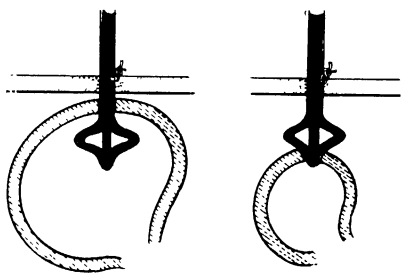


Fig. 289 —Unless the expanded end of the catheter is pushed well into the bladder, it will be dragged out as the bladder contracts, for the catheter is fixed to the skin by a stitch.

BLADDER DRAINAGE

Changing a de Pezzer Catheter.—It is unnecessary and unwise to change a de Pezzer catheter before fourteen days. It is not until the lapse of three or

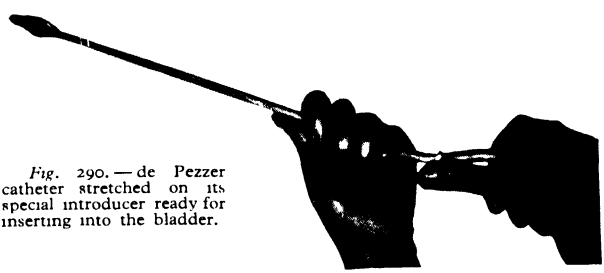


Fig. 290. — de Pezzer catheter stretched on its special introducer ready for inserting into the bladder.

four weeks, when the track is lined with granulation tissue, that the old catheter can be removed by a sudden sharp pull, and a new one, stretched on its special introducer (*Fig.* 290), pushed down the track. Before there is a well-formed

track the introduction of the catheter is a difficult and uncertain proposition. It is best undertaken in the operating theatre by the person who performed the original operation. While it is most imprudent, and even disastrous, to change a de Pezzer (or Malecot) catheter too early, it should be considered negligent to leave it unchanged for weeks on end. "No wonder the bladder infection has failed to respond to the remedies prescribed" I have been compelled to remark more often than I care to record, on pulling out a de Pezzer catheter, the head of which could be likened to the bottom of a ship which had sailed the Sargasso sea.

Suprapubic 'Boxes'.—There are numerous pieces of apparatus for collecting urine from a suprapubic fistula. They are all modifications of the Hamilton Irving box. Macdonald's box, which is illustrated in *Fig.* 291, is light and easily adjusted.

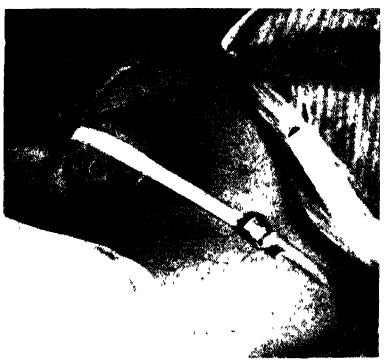


Fig. 291.—Macdonald's box.

'Wick Drainage' is based on an entirely different principle. A piece of gauze 1 yard square is taken, rolled, and drawn through a 34-in. length of Paul's soft tubing. The whole is then sterilized in the autoclave or by boiling. With the wick thoroughly wet with sterile water or boracic lotion, the protruding end of the gauze is tucked into the sinus and spread about it. The other end of the drain passes into the neck of a sterile bottle (*Fig.* 292). The drain is held in place with safety-pins to the bed, and a ring of kaolin and vaseline around the wound edges completes the dressing. A bed-cage prevents displacement of the dressing. Capillary traction carries away the urine as fast as it is excreted, in the same way as a lamp wick delivers oil to the flame. Of course, the patient must remain reasonably quiet on his back in order to keep dry. A fresh drain must be applied every four to eight hours, but the drain can be re-sterilized and used repeatedly. By modifying the outlet of Macdonald's box to accommodate the wick, I have combined the advantages of both principles.

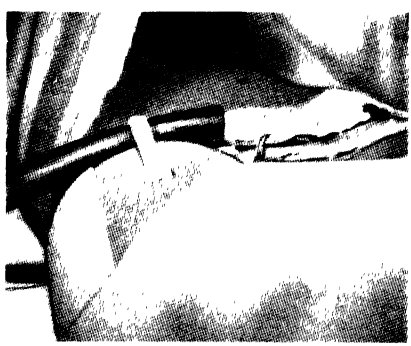


Fig. 292.—Thompson and Wright's lamp-wick method of collecting urine from a suprapubic fistula. (*By kind permission of the 'Journal of Urology'.*)

Suction Drainage.—Another method of maintaining drainage of a suprapubic cystostomy wound is by suction. This is a splendid principle; urine is aspirated as soon as it enters the bladder—the antithesis of suprapubic boxes, where there must be always a stagnant pool which invites infection. Stedman's tube consists of a Marion's

tube with an ingenious fitting to hold a rubber catheter within it (*Fig.* 293). The catheter is connected to a suction apparatus. A most important nursing detail is that the wound is left completely uncovered by making a 'divided bed'. A sterile towel above and below protect the hypogastrium from the bedclothes (*Fig.* 294).

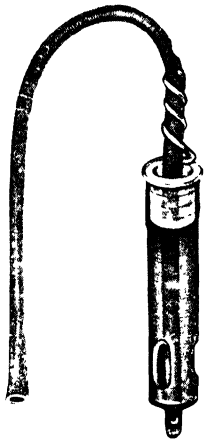


Fig. 293.—Stedman's tube. The Stedman fitting enables a rubber catheter to be retained within Marion's tube.

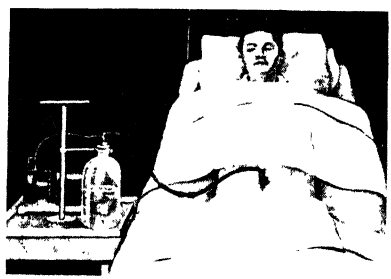


Fig. 294.—Suction drainage, using a Stedman's tube. Note the division in the bedclothes, which are protected by sterile towels. The pump is placed on the floor.

THE TREATMENT OF ACUTE CYSTITIS

Cystostomy in acute cystitis is absolutely contra-indicated. I think it wise to refrain from even passing a catheter during the early acute stage and to rely entirely upon conservative treatment. Sulphonamide preparations should not be used until (*a*) the urine has been rendered alkaline, and (*b*) the house surgeon has satisfied himself that the urinary output is adequate. Commence by rendering the urine alkaline by sodium citrate (*see* p. 237). Thirty minims of tinct. hyoscyami every three hours helps to relieve pain. In a matter of thirty-six hours it is permissible to pass a catheter. This serves as an opportunity:—

a. To obtain a specimen of bladder urine for bacteriological examination.

b. To ascertain if there is any residual urine (in acute cystitis the bladder is usually tonically contracted, hence the futility of suprapubic cystostomy).

c. To irrigate the bladder very gently with warm saline solution under low pressure.

d. To leave in the bladder 4 oz. of sterile liquid paraffin.

The last measure is particularly valuable; some of the paraffin is retained in the bladder for upwards of three days, and there is no contra-indication to further instillations.

A good alternative instillation is as follows:—

℞ Methylene Blue 2·0 per cent Distilled Water 94·0 per cent
Novocain 4·0 „

HÆMORRHAGE AFTER PROSTATECTOMY

Harris's operation and transurethral resection have considerably minimized the incidence of this alarming complication. Hot bladder washes are useful, and it should be noted very carefully that the temperature of the wash-out must not

exceed 110° F. when it is poured into the receptacle. Preparations for a blood transfusion should be initiated at once.

Packing the Prostatic Cavity is a reliable method of controlling hæmorrhage. A gauze roll, one or two inches in diameter, is used, and as much of this as necessary is packed firmly into the cavity at the bladder neck. To impregnate the gauze with plenty of sulphonamide powder is a sound expedient. A stout piece of silk tied to the end of the pack will enable it to be withdrawn easily. As a rule the pack should remain in situ for not longer than four days. A large suprapubic drainage tube should occupy the suprapubic wound while the pack is in place.

Pilcher's Bag.—

Method of Use.—If Pilcher's bag (*Fig.* 295) has been inserted, the tube A should have the ligature imprisoning its contents released, and after pulling on the tube B to ensure that the bag is lying well within the prostatic cavity, a Higginson's syringe is fixed to the tube A, and two, or at the most three, syringefuls of water should be forced into the bag, but no more. The end of the tube A is then occluded with a hæmostat or a ligature. A piece of tape or silk, long enough to pass over the bed rail at the foot of the bed, is attached to the tube B. A bed-cradle prevents the tape becoming displaced by the bedclothes. By this means extension is applied, ensuring retention of the bag within the cavity. Irrigation of the bladder is then continued.

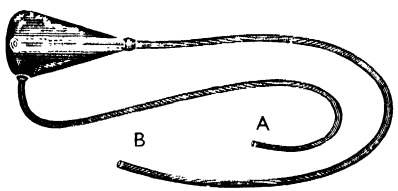


Fig. 295.—Pilcher's bag for controlling hæmorrhage from the prostatic cave after the prostate has been removed.

To Remove the Bag.—The bag is usually removed forty-eight hours after the operation. The contents of the bag are allowed to escape. After the extension has been removed, it is highly important to sterilize thoroughly and to lubricate the tube B, for it is to be drawn through the urethra and the prostatic cavity. The suprapubic drainage tube is removed after cutting the appropriate stitch, and probably one other stitch in the neighbourhood will have to be removed also. By pulling on the tube A steadily the bag will be delivered into the wound and can be removed. A rubber drainage tube is then passed into the cavity of the bladder and retained either by a stitch or a safety-pin.

Foley's Bag.—This apparatus is designed for use after transurethral resection of the prostate. The principles involved in its use can be seen in *Fig.* 296.

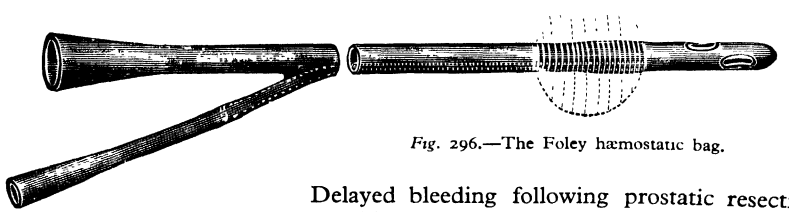


Fig. 296.—The Foley hæmostatic bag.

Delayed bleeding following prostatic resection provides obvious indication for the use of this instrument. It is essential that the bladder be free from clots when the catheter is installed, for its walls are not sufficiently rigid to attempt evacuation of clots by forcible aspiration.

The Management of the 'Permanent' Suprapubic.—In elderly men with prostatic obstruction it is often necessary to delay prostatectomy for a matter of weeks or months after the bladder has been drained. Such patients are often sent to a convalescent home, or their own home under the care of their doctor and a district nurse. It is not justifiable to order a 'permanent' suprapubic apparatus for such patients who can be kept dry and comfortable with an easily-made belt to keep the de Pezzer catheter snugly in place. The belt is made from flexible adhesive plaster reinforced at the back with non-elastic plaster (*Fig.* 297). Only the lateral parts are allowed to adhere to the skin. The free extremities of the belt are laced together around a dressing through which the catheter passes.

For longer cases, i.e., those in which several months must elapse before prostatectomy can be considered and in cases of carcinoma where the belt will be truly permanent, the house surgeon will be expected to instruct the patient on the management of his belt. The essentials of a good apparatus are that the belt must lie snugly with closely fitting groin straps. A straight catheter of the Jacques type with an open end is usually the best. This must fit the pad tightly, but be detachable so that it can be removed and cleansed daily. Two catheters are an advantage so that one can be boiled and replaced as soon as the other is removed. The catheter should lie within the bladder but not deeply enough to irritate the trigone. When the correct depth has been ascertained a shallow groove can be cut in the catheter at the top of the pad and the groove stained with Indian ink. If this precaution is neglected trouble will arise from ill adjustment (Baines). In a few obese patients a Jacques catheter is not efficient, and a de Pezzer catheter, which fits the belt, is substituted. The latter is changed every five or six weeks. At the Queen Elizabeth's Hospital, Birmingham, patients' wives are taught to make barley water, which the men find easier to imbibe than an adequate amount of plain water. So often the reason for an unsatisfactory permanent suprapubic apparatus is that the patient has not been properly instructed before he leaves hospital.

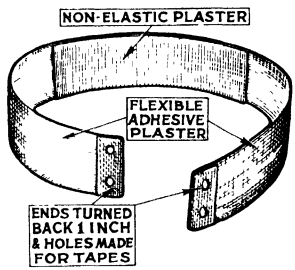


Fig. 297.—O. P. Clark's home-made belt for keeping a de Pezzer catheter snugly in position

RECORDS

It has repeatedly been pointed out in this work that diagrammatic representations of pathological findings and operative procedures are always of the highest value in the house surgeon's notes. In the case of new growths of the bladder under intermittent treatment by cysto-diathermy, a diagrammatic representation of what is seen through the cystoscope is almost a necessity if the case is to be treated, as it should be, by a thorough follow-up (*Fig.* 298).

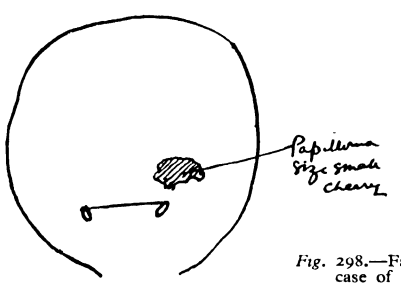


Fig. 298.—Facsimile from the record of case of papilloma of the bladder.

CHAPTER XXXIV

MANAGEMENT OF RECTAL CASES

By W. B. GABRIEL

PREPARATION FOR OPERATION

In some cases no preparation is required: for instance, before opening an acute anorectal abscess the administration of an enema causes unnecessary suffering. The skin preparation in such a case is postponed until the anæsthetic has been given.

Routine Operation.—In the case of a routine rectal operation the following schedule is suitable :—

Evening but one before Operation.—An aperient, graded according to the patient's habits, is ordered.

Day before Operation.—

Morning: A small dose of salts.

Evening: A soap and water enema; perineum to be shaved; bath.

Diet: Light lunch and dinner.

Day of Operation.—Two hours before the operation the rectum is washed out with half a pint of plain water. Suitable premedication is ordered.

Radical Operation.—A longer period, i.e., five to ten days, should be allowed for the preparation of a patient for a radical excision of the rectum. The diet should be of a light, low-residue character, and the free intake of fluids should be encouraged.

The general preliminary examination will include a survey of the heart, lungs, blood-pressure, and urine analysis. Pathological investigation will include estimation of the blood-urea, blood group, often also the red-cell count and hæmoglobin. Suitable relatives should be grouped with a view to having an available donor tested and cross-matched prior to the operation.

Aperients.—An aperient such as ½ oz. of liquid paraffin and ½ oz. of milk of magnesia is given orally each evening, and a soap and water enema is administered on alternate nights, the last enema being timed for the evening before operation. A rectal tube is passed a few hours before the operation with the object of ensuring that the patient comes to the operation with a rectum which is free from fluid.

Skin Preparation.—In all cases in which an excision of the rectum may be a possibility, it is the house surgeon's duty to see that both the abdomen and perineum are prepared for operation, and in male cases he should tie in a gum-elastic coudé catheter immediately before the patient is brought to the operating theatre.

POST-OPERATIVE TREATMENT

Immediate.—The patient is returned to bed and is placed on his back, at any rate for three or four hours or longer, in order to assist the firm support of the anal dressings. Retention of urine is often a difficulty after rectal operations, but the number of cases which require catheterization has been greatly reduced by the hypodermic injection of 1 c.c. of doryl or esmodil to stimulate contraction of the bladder musculature.

First Day.—Remove the tube from the rectum by gentle traction twenty-four hours after operation. Cut off the excess of gauze but leave in situ the corners of gauze that have been tucked into the anal canal. Change the outer dressing and dress with gauze soaked in eusol lotion. Apply dressing firmly with a pad of wool and T-bandage. This should be done morning and evening. Fluid or very light low-residue diet.

Second Day.—Dress as above morning and evening. 7.30 p.m.: Liquid paraffin ½ oz. Cascara evacuant 30 m. (or equivalent aperient). 9.0 p.m.: Milk of magnesia ½ oz. in an equal part of water.

Third Day.—An olive oil and gruel enema (*see* p. 145) is given into the rectum before the bowels move: this is given before or after breakfast according to whether the patient feels the bowel action imminent. The patient should retain the enema for five to ten minutes, and then pass it *without straining*. A bed-pan should be used for this first action: if there is no hæmorrhage in the stool a commode or a neighbouring W.C. can be used for subsequent actions. Light or ordinary diet.

It should be noted that in certain cases—for instance, after amputation of a rectal prolapse—it may be desirable to postpone the first bowel action till the fifth to the seventh day after operation. *In such cases clear instructions must be given to the nursing staff.*

Daily Dressings.—The routine for subsequent dressings is as follows: The patient is placed on his or her left side with the buttocks lifted out over the edge of the bed; a mackintosh sheet is placed underneath and is led over the side of the bed into a bucket. The anus is gently irrigated from a douche-can which is fitted with a yard of rubber tubing and a single nozzle (*Fig.* 299), carefully sterilized before use, with 2 pints of dilute peroxide solution, or dettol ½ oz. to a pint. A firm gauze dressing is then applied, the gauze being soaked in eusol; a corner of the gauze should be tucked into the anal canal with sinus forceps and the excess arranged firmly outside. The patient is allowed to take a bath on the evening of the third day, and thereafter morning and evening before the dressings. The bowel actions are regulated with liquid paraffin and cascara or magnesia, according to individual needs; care should be taken not to over-purge the patient. When a clean healing surface is present the dressing may be changed to lotio rubra, cod-liver oil and vaseline, or a scarlet red ointment. In the final stages of healing, the anus should be kept dry by the application of a zinc, starch, and boric dusting powder.



Fig. 299.—Rectal dressing. An anal wound is being irrigated. The sheet upon which the patient lies is led into one bucket, the other being used for dirty dressings

Management of the Sphincter.—In practically all operations on the anal canal and lower rectum, open wounds must be left to heal by granulation. It is the house surgeon's duty to supervise the healing of these wounds and ensure that premature healing and bridging do not occur. A successful result, particularly after operations for cure of fissures and fistulæ, largely depends on careful dressings, and on the management of the sphincter.

Painful dressings may be eased by smearing the gauze which is to be tucked into the anal canal with a zinc and castor-oil cream, to which 3 per cent anæsthesin or decicain (Bayer) may be added. In most cases it is found advisable, in addition, to perform a routine dilatation of the anal canal after operation; this may be done digitally, or by passage of St. Mark's Hospital dilator (*Fig.* 300); the best pattern of this dilator has a maximum diameter of 1 inch.

In the management of fistula cases after operation the passage of this dilator once a day from the fifth or sixth day after operation is advocated. The passage of a dilator does not exclude the necessity for periodically examining the granulating wound with a finger and probe, by which means any roughness or pocketing, or the presence of unopened tracks, may be detected and suitably dealt with.

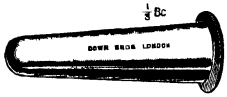


Fig. 300.—St. Mark's Hospital dilator.

Undue exuberance of granulations should be an indication for paring them down with scissors and cauterizing them with a stick of silver nitrate.

In cases of fissure the dilator may with advantage be passed twice daily from the evening of the fourth post-operative day. In these cases, even after the fissure has healed, it is advantageous for the patient to have a dilator for passage at increasing intervals, to make certain that the calibre of the anus is maintained at its proper size.

MANAGEMENT OF REACTIONARY OR SECONDARY HÆMORRHAGE FROM THE RECTUM

Untoward hæmorrhage occasionally occurs after a rectal operation.

Reactionary hæmorrhage from an exposed vessel calls for no special comment. The house surgeon must secure and ligate the vessel promptly.

Reactionary or secondary hæmorrhage *from inside the rectum* is a more serious complication. Secondary hæmorrhage occurs between the seventh and tenth day after hæmorrhoidectomy in about 1 case in 200 cases. The method of dealing with this by plugging the rectum should be clearly understood.

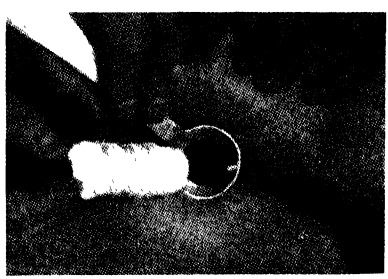


Fig. 301.—Post-operative hæmorrhage from the rectum. Method of introducing a tube surrounded by gauze into the rectum through a proctoscope. (*From the author's 'Principles and Practice of Rectal Surgery', H. K. Lewis, London.*)

Method of Plugging the Rectum.—After giving an injection of morphine the patient is placed on his left side with buttocks well over the edge of the bed. A tubular proctoscope is passed, and a large amount of blood and clot will be evacuated. The rectum is irrigated with warm saline or hazeline lotion. With the protoscope still in position, a stout-walled rubber tube of ½-in. outside diameter, with a gauze 'surround' wrapped around it and smeared with vaseline, is pushed into the rectum through the proctoscope (*Fig.* 301). As soon as the tube and 'surround' are felt to slip into the rectum, the proctoscope is withdrawn over the outer free end of the tube. Traction on the tube now brings the gauze up against the anal canal, and in this position efficient pressure is exerted against a bleeding point in the internal hæmorrhoidal region.

A stout safety-pin is passed through the tube just external to the anus, and a gauze strip, several feet in length, is wound round the tube, between the anus and the safety-pin. A firm pad of gauze and wool is applied. The foot of the bed is raised on blocks, and the usual general treatment of hæmorrhage is adopted.

The external dressing is inspected at regular intervals to see if further hæmorrhage is taking place. This very seldom happens, and the tube and 'surround' are removed by traction forty-eight hours later: a preliminary rectal injection of olive oil should be given, and a plain tube (without gauze) should be left in the rectum for another day to reveal any further bleeding.

MANAGEMENT OF A COLOSTOMY

A Terminal Colostomy.—In dealing with cancer of the rectum the high operability rate of over 70 per cent is now being achieved by the extended use of combined excision of the rectum. This means that a terminal left iliac colostomy is the commonest type. The patient is sometimes returned to bed with the colostomy open after removing the Parker-Kerr clamp, or another routine method is to insert a No. 15 rubber catheter into the colon at the conclusion of the operation and to secure it with a purse-string suture. A few ounces of warm olive oil are then run in to lubricate the colon and prepare the way for the passage of flatus and fæces. This catheter is removed on the day after operation and a finger is inserted to ensure that the lumen of the colon is opened up properly.

Trimming.—A terminal colostomy is purposely left at the time of operation with about 2 in. of bowel projecting outside the abdominal wall. This is longer than is ultimately required and the colostomy orifice soon becomes somewhat fibrosed. About two weeks after the original operation the colostomy should be trimmed under local anæsthesia. After injecting 10 c.c. of 1 per cent novocain round the colon, it is slit down with straight scissors on its upper and outer aspect to within $\frac{1}{2}$ in. of the skin; each flap of colon is held up in Allis forceps and the bowel is then trimmed off horizontally, leaving at least $\frac{3}{4}$ in. projecting. Hæmorrhage is usually somewhat free and is controlled by a continuous suture of atraumatic catgut passed round the cut edge and securing the mucous membrane at each bite. When finished it should be possible to pass a forefinger easily into the colostomy (*Fig.* 302, A, B). A contracted orifice is to be avoided since it predisposes to the formation of a subcutaneous colostomy bulge.

A Loop Colostomy.—A loop colostomy whether in the left iliac region or a transverse colostomy is usually opened with a cautery at the conclusion of the operation; the wound is first carefully packed off with dry gauze which is tucked snugly up to the bowel beneath the rod and further protected with a dry towel or pack on each side.

A loop colostomy is sometimes left unopened at the time of operation, and it is the house surgeon's duty to open it twenty-four to forty-eight hours later. The indications for doing this are the complaint of attacks of colicky abdominal pain and the development of abdominal distension. A cautery should be used rather than scissors, because less hæmorrhage will result. No anæsthetic is required: the patient can be assured that the opening will be made painlessly. A crucial incision should be made in order to provide a wide opening into the colon. Only the overlying gauze should be lifted; the deep gauze previously placed beneath the rod should not be disturbed at this stage.

After-treatment—The skin sutures should be removed from the colostomy wound not later than the sixth or seventh post-operative day: if left in longer than this, stitch sepsis is likely to develop. The glass rod is left in for at least two weeks, and at the end of that time may be removed, or if it appears advisable



Fig 302.—A, A terminal left iliac colostomy before trimming. B, After trimming the colostomy now admits a forefinger easily.

on account of incomplete healing to hold up the colon for a longer period, a rubber tube with overturned ends (*Fig.* 303) may be substituted for the glass rod: it is softer and can be worn comfortably even when the patient is sitting up out of bed.



Fig 303.—Left iliac colostomy. Rubber tube substituted for glass rod. (*From the 'British Journal of Surgery'.*)

Other Types of Colostomy.—A 'Devine' disconnecting transverse colostomy and the double-barrelled colostomy left after a Paul-Mikulicz operation are usually sent from the operating theatre with a Paul's tube tied into the proximal colon and a de Martel clamp on the distal colon. The subsequent management is to remove the Paul's tube about 24 hours after operation and the de Martel clamp is left in situ until it becomes loose on about the fourth or fifth post-operative day.

Care of an Artificial Anus.—The first bowel action from a colostomy often takes place spontaneously on the second or third day after operation. A gentle aperient such as liquid paraffin (½ fl. oz.) and milk of magnesia (½ oz.) may be given on the second or third evening after operation, and if difficulty is experienced in promoting an action, an injection of 1 fl. oz. each of glycerin and olive oil may be run into the proximal opening or a glycerin suppository may be inserted. Subsequently the aim should be for the patient to have a motion from the colostomy each morning after breakfast, and sometimes a smaller one about tea time.

Alternative Routine.—In some cases the advisability of giving a daily wash-out into the colostomy may be considered. It has the disadvantage that a state of catarrh may be induced in the colon by this routine, particularly if soapy water is used for the injection. Normal saline is preferable, but even so the bowel is likely in time to become irritable and contracted. More serious drawbacks are that occasionally, if a colostomy wash-out is given too forcibly, some of the fluid may be forced back into the ileum and produce abdominal pain, and rarely the colon has been perforated by a rectal tube being thrust through the bowel wall, or through a diverticulum, with the rapid onset of peritonitis.

Late Management.—Some technical points are involved in the late management of a colostomy :—

1. If the colostomy is a loop type made prior to a perineal excision of the rectum, it will be advisable to render the distal colon and rectum as clean as possible in preparation for the second-stage operation. About a week after the colostomy operation 3–4 fl. oz. of olive oil should be run into the distal colostomy opening each night through a tube and funnel, and in the morning the patient is placed on a bed-pan and a wash-through is given in a similar way : the solution may be warm water, saline, or saline and bicarbonate.

2. If the colostomy is a palliative one, it may be helpful to give a saline wash-through in a similar way two or three times a week, in order to keep the distal bowel as clean as possible and remove irritating blood and mucus from the rectum.

3. The late complications of colostomy are skin stenosis, spur retraction, prolapse, and formation of a ventral hernia. For some of these a secondary operation for reconstruction of the colostomy may be needed.

Diet of a Patient with a Colostomy.—The intake of ' roughage ' must be regulated according to the individual patient : usually it is advisable to allow no green vegetables at first : later fruit, then salads, are given, and as the patient's convalescence proceeds, a full diet can be worked up. If the bowel is sluggish a small portion of stewed apples or prunes in the evening often proves more efficacious than laxatives such as senna or magnesia.

MANAGEMENT AFTER EXCISION OF THE RECTUM

When the patient is returned to bed after an excision of the rectum, whether perineal or combined, he should be placed on his back, the sacrum and perineal dressing resting on a partially inflated air-ring. The dorsal position assists the falling backwards of the pelvic organs, and for the first few days after operation the patient should not be allowed to lie on his side.

The foot of the bed is raised on 9-in. or 12-in. blocks, and for the first twenty-four hours after operation the chief care is in regard to the cardiovascular system.

The blood-pressure should be taken on the patient's return to bed, and a half-hourly record kept of the pulse-rate. If a drip-blood transfusion is given this will need watching, and when the blood has finished running, a continuous saline and glucose drip (at the rate of 40 to 50 drops per minute) may be continued. Officer's pattern of transfusion apparatus is particularly suitable for these cases (*see* p. 258). M & B 693 soluble, at the rate of 1 g. per pint of intravenous fluid, may be added as a routine prophylactic against chest complications.

The state of the lungs will need careful consideration ; if there should be any sign of a moist bronchitis, the blocks must be removed, and the patient inclined up at a gentle slope. It should be observed that a high Fowler position is most undesirable after excision of the rectum, as pressure sloughing of the sacral end of the wound is prone to develop. Injections of transpulmin (2 c.c. six-hourly intramuscularly for 4 to 6 doses) often quickly relieve the pulmonary condition. Inhalation of CO_2 and oxygen is also indicated.

The abdomen should be examined to see that no distension is developing. After excision of the rectum, intestinal movements should be heard on auscultation, and even if no colostomy action has started, the knowledge that the small bowel is contracting normally is encouraging. Liquid paraffin may be given orally on the third or fourth post-operative day, supplemented by milk of magnesia if thought advisable.

Vomiting after twenty-four hours should especially be noted, and the upper abdomen palpated for evidence of a dilated stomach (p. 270). The mortality from small-intestinal ileus has been greatly decreased by the *early* passage of a gastric aspiration tube : this should be done in the earliest stages of a rising pulse-rate before vomiting commences (*see* p. 271).

Management of the Urine.—In male cases the indwelling catheter is connected to a St. Mark's Hospital apparatus (p. 252).

In women a catheter is passed every six to eight hours after operation, and a bladder wash-out given once or twice daily until normal micturition is resumed.

Management of the Wound.—The patient is usually returned to bed with some form of perineal packing.

One excellent method which has been in routine use for a number of years is to place a sterilized rubber bag (made by the Dunlop Rubber Co.) in the perineal wound and pack it with one or two 6-yard rolls of gauze. This packing, together with the bag, may be removed in forty-eight hours after a perineal excision, and in sixty hours after a combined excision ; the method is to place the patient on his left side on a mackintosh sheet and remove the packing and bag under a stream of dettol lotion ($\frac{1}{2}$ fl. oz. to 1 pint). Thereafter the wound is irrigated twice daily with dettol, eusol, or peroxide, and a light packing of gauze moistened in eusol is tucked into the aperture left for drainage. The sutures should be removed on the sixth or seventh post-operative day, or earlier if redness or tension is observed.

Later, as the wound closes in and becomes clean, a change may be made to red lotion or ichthyol in glycerin (5 per cent). Throughout this time the wound needs careful and regular inspection to guard against premature healing and pocketing in its depth. An evening pyrexia for no apparent reason is likely to be due to a deep abscess in the wound or urinary infection.

In aged subjects a form of deep bed-sore may develop at the posterior end of the perineal incision, with sloughing of the posterior sacral ligaments. In this case the posterior part of the incision must be laid open under local anæsthesia to permit eusol gauze dressings to be applied directly to the sloughing area. Slow but complete healing can be anticipated.

CHAPTER XXXV

THE MANAGEMENT OF GYNÆCOLOGICAL CASES

By STANLEY W. WRIGHT

MAJOR gynæcological operations fall into two categories: (*a*) *Vaginal operations*, which include vaginal hysterectomy and various procedures for remedying urethral, vaginal, and uterine prolapse. (*b*) *Abdominal sections*. Only those special points connected with the purely gynæcological aspects of laparotomy are dealt with in this chapter.

Consent for Operation.—It is of paramount importance to obtain consent for hysterectomy for *every* gynæcological laparotomy and vaginal operation on the uterus. The reason for this is that it sometimes happens that removal of the uterus is necessary in cases where prior to operation this step was not considered needful. Failure to obtain such consent may result in the patient having to undergo another operation. In addition, it is most desirable to obtain consent of the patient's husband or nearest relative. When sterilization of the patient is contemplated, written consent must be obtained, not only from the patient, but from her husband or nearest relative as well.

Operation during Menstruation.—The chief disadvantage of performing an operation during menstruation is the hyperæmia of the pelvic organs. This is of little consequence in abdominal operations, which need not be postponed. In vaginal plastic cases, however, the increased bleeding is a source of difficulty and it is advisable to defer operation, preferably until the mid-cycle.

MORE REMOTE PRE-OPERATIVE TREATMENT

The patient requiring a major operation should be admitted into hospital several days beforehand. The waiting period can be utilized most profitably in making those investigations and preparations which add to her safety. By observing this rule, the total time the patient has to spend in hospital is often actually reduced.

Anæmia.—Because unsuspected degrees of anæmia exist so often, it is an excellent practice to make the examination of the blood practically a routine procedure. An operation, unless urgent, should not be performed until the hæmoglobin content has been raised to a safe level, i.e., at least 70 per cent. Urgent cases should receive a blood transfusion just before or during operation.

Vaginal Discharges.—A specimen should be collected (for technique, *see* Chapter XLIV) and sent for microscopical examination. While the presence of non-pathogenic organisms is of little consequence, and even after treatment in the ward one cannot expect a negative bacteriological report in cases with chronic cervicitis, a 'set' major gynæcological operation should not be undertaken until a purulent vaginal discharge has been treated and controlled.

The treatment of gonorrhœa is discussed in Chapter LX. Vaginitis due to the *Trichomonas vaginalis* can be treated by the nightly insertion of two tablets of acetarsol or stovarsol vaginal compound, with an acid douche every third

day. Such treatment may have to be prolonged in order to eradicate the organism.

An alternative method is, after drying the vagina, to insufflate it with picragol. Cases have been reported of air embolism by the use of this method in pregnancy.

Monilial discharge, which is common during gestation, is readily cured by the use of aniline dye compounds, such as Bonney's blue paint or triple dye. The vagina should be wiped clean of the caseous discharge with swabs soaked in sodium bicarbonate solution, dried, and then painted thoroughly throughout with the dye. Daily treatment usually clears up this discharge within a week.

Non-specific discharges often improve after treatment by daily acid douches (lactic acid, 90 m. to the pint, or vinegar, $\frac{1}{2}$ fl. oz. to the pint). When chronic cervicitis is present treatment must be directed to removing the cause.

Urinary Infections.—Particularly in cases of prolapse, it is essential that a catheter specimen of urine be examined bacteriologically. Should the urine prove to be infected, measures must be taken to render it sterile before the operation is undertaken. Residual urine must be removed regularly immediately after micturition by sterile catheterization.

In cases of prolapse, the cystocele should be pushed up by two fingers in the vagina and maintained in that position until the catheter has ceased to drain.

The treatment of urinary infections *per se* follows the principles set down in Chapter XXXI.

Bowels.—Habitual constipation is so common among gynæcological patients that it is often necessary to employ daily enemata several days before operation. Routine preparation should include an aperient on the evening but one before the operation. On the day before operation the midday and evening meals should be light. An enema of soap and water is given in the evening. On the morning of operation the lower bowel is washed out with plain warm water. Some surgeons also favour a constipating mixture such as Mist. Catechu c. Opio or Mist. Kaolin. Sed. to be given the evening prior to operation.

COMPARATIVELY IMMEDIATE PRE-OPERATIVE TREATMENT

Skin Preparation.—Except for minor operations limited to the vulva or vagina, e.g., excision of a Bartholin cyst, the area of prepared skin should extend from the costal margins to the mid-thighs. The pubic and vulvar hair must be removed. In the presence of inflammatory lesions (e.g., furunculosis), operation should be deferred. The pudendal regions are cleansed with soap and water, but on no account should antiseptics, spirit, or ether be applied to these areas in a conscious patient. Vaginal douching is rarely necessary.

Pre-operative Catheterization.—The patient should be catheterized before her journey to the theatre, and the catheter, closed by a spigot, left in situ, so that the bladder may again be emptied on the operating table immediately prior to operation. This is a very important detail.

Pre-operative Pelvic Examination under Anæsthesia.—In most instances gynæcological cases are examined under anæsthesia in the lithotomy position before commencing the operation in order to check the clinical diagnosis.

Cleansing and Packing the Vagina.—Particularly if hysterectomy is contemplated, the vagina should be cleansed by swabbing with a non-irritating antiseptic. Iodine, flavine, or aniline dye compounds are commonly used for

this purpose. A length of gauze soaked in an aqueous solution of a weak antiseptic may be packed into the vagina, taking care that a length of it is left outside the vulva to facilitate its removal during operation. Such a pack, if not removed in the course of the operation, must be removed at the end of the operation.

In cases of complete procidentia the vagina requires special pre-operative attention, for usually ulceration of its walls has occurred. The procidentia should be completely reduced; this is seldom difficult, provided (1) the bladder is empty, and (2) pressure is made in the line of the axis of the pelvic brim. Occasionally œdema of the prolapsed parts renders reposition temporarily impossible. In such cases the bladder must be kept empty by a self-retaining catheter and hot packs soaked in a saturated sodium sulphate solution applied to the prolapsed parts. Under such management reduction usually becomes possible in about twelve hours.

Once the procidentia has been replaced, a diaper and firm 'T' bandage will prevent recurrence provided the patient is kept in bed. The nurse should be instructed how to put back the prolapsed parts should they come down during defæcation.

Provided the procidentia is kept within the vagina, healing of the ulcerated areas occurs comparatively rapidly (14–21 days), especially if an acid douche of 1 fl. oz. vinegar in 1 quart of warm water is given twice daily. Antiseptics are not necessary and may retard healing. In women past the menopause, tab. stilboestrol, 1·0 mg. twice daily, by increasing the vascularity of the vagina, helps to accelerate healing.

POST-OPERATIVE CARE

Posture.—After recovering from the anæsthetic, patients who have undergone a gynæcological operation other than one involving the pelvic floor should be nursed in Fowler's position. When repair of the pelvic floor has been effected the patient should be nursed recumbent for the first ten days, but in order to avoid hypostasis she should be alternately turned on to her right and left sides at reasonably frequent intervals.

Vaginal and Uterine Packs.—The importance of removing a *vaginal pack* has been stressed already; its retention may cause serious infection and excoriation of the vaginal epithelium. A vaginal pack, which is inserted at the close of a plastic operation for the purpose of furthering hæmostasis, may be left in for a period not exceeding twenty-four hours.

A *uterine pack*, such as is sometimes used after abortions, is best removed in twelve hours. As extraction of the gauze is often painful, morphine should be given half an hour previously. The fact that the pack has been removed must be recorded on the patient's chart.

Retention of Urine.—Very frequently, gynæcological patients suffer from post-operative retention of urine. In general, the principles of management of post-operative retention follow those set out in Chapter XXXII. In cases of established retention during the post-operative period most gynæcological surgeons favour intermittent catheterization. Twice daily, or more often if the amount of residual urine is large, the patient is catheterized after micturition. This is continued until the tone of the bladder has become re-established.

In the rare event of urinary retention persisting longer than the first week after operation, an intramuscular injection of carbachol (carbaminoyl choline), 0·5 mg., sometimes results in restoration of natural function.

Urinary infections are the commonest complication of major gynæcological operations, and if pyrexia, not readily explained, occurs during convalescence, microscopical and cultural examination of the urine should always be among the first investigations.

Care of the Vulva.—Cleanliness of the vulva is important, particularly when sutures have been inserted in the perineum. The area should be swabbed

every four hours during the day and after defæcation. This precaution is continued until the wound has healed. A mild antiseptic, such as aqueous flavine solution 1–8000, or weak dettol or other xylene antiseptic may be used; if the latter irritates the skin the former is recommended. Should the perineum become œdematous, hot packs of saturated sodium sulphate solution often ease the pain and may obviate the necessity for removing the sutures before union has occurred. If the wound breaks down, the same dressing may be used. Later, dressings with an electrolytic sodium hypochlorite solution, 1–100, are useful in encouraging the formation of granulation tissue.

The Prevention of Pulmonary Embolus.—Those subjects of major gynæcological operations likely to be confined to bed for more than a week should have post-operative exercises. The exercises are started on the second day following operation with foot movements, and are gradually increased in scope until the patient is performing active flexion of the knees and thighs. The co-operation of the massage department should be sought in this matter (*see* Chapter XVI). In addition to materially lessening the complication of peripheral thrombosis and its dreaded sequelæ, these exercises help to shorten the convalescence of the patient after she is allowed out of bed. Sodium citrate is held by some authorities to reduce the possibility of venous thrombosis. The dosage recommended is 30 gr. four-hourly.

When to Allow the Patient out of Bed.—The convalescent period varies with different operations and with different surgeons, but in general it may be said that patients who have had operations upon the pelvic floor or who have undergone panhysterectomy should be kept in bed for at least eighteen to twenty-one days.

All gynæcological patients should be examined vaginally before leaving hospital, preferably, at least in major cases, before the patient is allowed up. This not only enables the examiner to form an estimate of the result of the operation, but also precludes the possibility of a patient being sent home with a swab left by mischance in the vagina.

Post-operative Hæmorrhage.—Hæmorrhage may occur from the cervix or vagina following plastic operations. Slight bleeding should be controlled by packing, but if the loss is severe it will be necessary to seek and secure the bleeding point under anæsthesia. A rare form of reactionary hæmorrhage may take place in the tissues between the vagina and bladder. The loose pelvic cellular tissue is involved, and a tender mass appears above the pubes. The risk of infection of the hæmatoma is so great that it is advisable to cut the vaginal sutures and evacuate the clot. In favourable cases, after the bleeding point has been secured, the vagina can be resutured.

Secondary hæmorrhage usually comes on eight to ten days following operation. The bleeding point is most often situated in the posterior vaginal wall about 1½ in. within the introitus, but it may occur from other areas of the suture line when sepsis ensues. Often such bleeding will cease with morphine and a hot vaginal douche, but packing of the vagina with antiseptic gauze may be required. This packing can usually be done in the patient's bed, using a small Sims' speculum and with the patient lying in the Sims' position. Rarely is it necessary to suture the bleeding point. The packing should not be left in for more than twenty-four hours.

Secondary hæmorrhage sometimes arises from the cervix, particularly after cauterization. This form of hæmorrhage may be mistaken for a menstrual

period, but the blood is usually brighter in colour. Hot douches, morphine, and, maybe, packing of the vaginal vault are required, for the bleeding, though not heavy, is sometimes most persistent.

Internal hæmorrhage due to a slipped ligature, usually of the uterine artery, is a very dangerous and alarming complication of hysterectomy. A slipped ligature on the pedicle of an ovarian cyst comes under the same category. Signs are sometimes delayed for some hours after operation. A sudden rise in pulse-rate, pain in the abdomen, increasing restlessness, and shock should warn the attendant of the catastrophe. Immediate laparotomy is indicated; blood transfusion should be given at the same time.

Damage to a Ureter or Ureters.—Although fortunately rare, the house surgeon should be alive to the possibility of operative damage to the ureter or ureters, especially in cases where total hysterectomy was difficult. Anuria or serious oliguria following a pelvic operation should be an occasion to notify one's chief immediately, for the possibility of inclusion of one or both ureters in ligatures arises. In the case of a unilateral accident whereby the ureter is either ligated, or partially or completely severed, the most usual sequel is the development of a uretero-vaginal fistula. Such a fistula can be recognized by the onset, usually after the first fortnight, of urinary incontinence. Examination in a good light with a speculum may reveal the source of the fistula in the vaginal vault, for there is often a slough in the lateral fornix on the side of the injury.

The serious operation necessary for the cure of the fistula should be delayed until the patient's general condition has been restored, the local sepsis eradicated, and the urine sterilized.

THE TREATMENT OF ACUTE PELVIC INFLAMMATION

Acute pelvic inflammation includes acute salpingitis, parametritis, and pelvic peritonitis of gynæcological origin. All three, especially in puerperal cases, may coexist. The commonest causal organisms are the gonococcus, often associated with secondary invaders, and the *Streptococcus hæmolyticus*, particularly after childbirth or abortion. Both of these organisms are sulphonamide-sensitive. (A cervical swab should be taken, as it may reveal the organism responsible.) In any case a full course of sulphanilamide therapy should be given as early in the disease as possible, for it may prevent extension of the inflammation.

In addition to the full Ochsner-Sherren regime (*see* Chapter XXIX), which is eminently suited to the majority of these cases, hot douches of 5 per cent saline solution may be given twice daily at low pressure. They are better avoided in puerperal cases if the cervix has not completely closed. Glycerin tampons or gelato-glycerin pessaries may also be inserted into the posterior fornix once or twice daily.

The patient must be kept in bed until the acute inflammation has resolved completely and the temperature has been normal for at least two weeks. Chronic inflammatory masses usually slowly resolve. Sometimes resolution can be hastened by short-wave pelvic diathermy. In the early stages of the illness the inflammation may be found to be spreading, when the advisability of operation will arise, and it is at such times that the house surgeon should seek a second opinion, if necessary at frequent intervals. Later development of a pelvic abscess may call for operation. In this instance there is usually no great urgency, but the abscess should not be allowed to attain considerable dimensions for want of clinical investigations.

CHAPTER XXXVI

THE MANAGEMENT OF SOME COMPLICATIONS AFTER ABDOMINAL OPERATIONS

By HAMILTON BAILEY

SEVERAL important complications are described elsewhere in the book, e.g., POST-OPERATIVE RETENTION OF URINE (p. 250); POST-OPERATIVE PULMONARY COMPLICATIONS (Chapter XV).

FLATULENCE

Flatulence causes much post-operative discomfort. It occurs in some measure after most abdominal operations. The following simple carminative may be prescribed :—

℞	Aspirin	gr. 15
	Sod. Bicarb.	m. 30
	Sal. Volat.	m 30
	Aq. Menth. Pip.	ad m. 240

Oil of cajuput, 3 m. on a lump of sugar, is of definite value in helping the patient to pass flatus. A rectal tube can be passed and left in situ for an hour. The best type of rectal tube has a terminal eye, and not one at the side like a catheter. If there is no contra-indication, a turpentine enema gives much relief. In more severe cases acetylcholine 0·1 g. every two or three hours for three doses, or a dose of pitressin, preferably given intramuscularly into the deltoid, may be prescribed. It is inadvisable to order these drugs unless the wishes of the surgeon in charge of the case have been consulted.

Where severe post-operative flatulence ends and paralytic ileus begins, no one knows. The treatment of the latter is difficult, and various views are held as to the best course to adopt. If the patient is not responding to simple remedies, the girth of the abdomen at the umbilicus should be measured and recorded, and instructions given for a two- or four-hourly pulse-rate reading to be taken and the surgeon to be informed.

ACUTE DILATATION OF THE STOMACH

Acute dilatation of the stomach is not excessively rare. By the aid of the gastric aspiration tube acute dilatation can be diagnosed and treated efficiently even *before the patient vomits*. One vomit of the characteristic fluid should always be sufficient indication for the passage of the tube. If we keep the condition in mind and pass an aspiration tube when the patient feels nausea and has a rising pulse-rate, milder degrees of acute dilatation, which may or may not be associated with paralytic ileus, can be treated successfully.

No possible harm can accrue from what may be called ' sounding the stomach ' in suspicious cases. I used to be afraid of distressing the patient, especially when the diagnosis was in reasonable doubt; but so often has the benefit from the passage of a gastric aspiration tube outweighed the misdirected compassion of withholding it that I feel most strongly that to procrastinate even for a few

hours is the antithesis of good judgement. Over and over again a quantity of dark fluid is aspirated, and the diagnosis of at least some degree of acute dilatation is established. Even if the stomach is found to be empty, extremely important diagnostic data have been obtained.

Treatment of Established Cases.—The principles are: (1) Empty the stomach and keep it empty; (2) Administer continuous intravenous saline; (3) Invoke the aid of gravity. Posture, which until recently was given prior place in treatment, is, I consider, relatively unimportant. This is fortunate, for to be compelled to turn a patient with a laparotomy or suprapubic wound on to his face, and to raise the foot of the bed, is not desirable if it can be avoided. If the patient is responding to the first two measures—and usually the response is undeniable—the application of the third is unnecessary.

In late cases the aid of gravity cannot be neglected. The German method of placing the patient in high Trendelenburg's position is more generally applicable than the prone position with elevation of the foot of the bed.

PARALYTIC ILEUS

The condition is very worrying, and there are two schools of surgical opinion regarding its treatment.

The school of stimulation prescribes drugs to stimulate peristalsis.

The school of rest believes that to try to stimulate the gut in this condition is like whipping a tired horse (*Fig.* 304).

Apart from all other considerations, gastric aspiration should certainly be instituted by the house surgeon as early as possible, for not infrequently the condition is associated with at least some degree of acute dilatation of the stomach.

I am strongly of the opinion that once distension has occurred any drugs designed to stimulate peristalsis further jeopardize more lives than they save. Even the newer preparations such as acetylcholine, doryl, and esmodil come under this category. Followers of the school of rest prescribe morphine, to be followed, after the patient has had a good rest, by a turpentine or ox-bile enema. Anti-gas-gangrene serum is also prescribed. If these measures are not effective and the patient is experiencing nausea or vomiting, gastric aspiration is essential. Continuous intravenous saline and glucose is administered. Cajuput oil, 1 min., may be ordered to help the patient to pass flatus, and this can be repeated after six or eight hours. Another turpentine enema is given; even if this should produce no result, providing the diagnosis is assured and the patient's condition is not deteriorating, a further twenty-four hours' rest is ordered. Intestinal aspiration (*see* p. 139), as yet in its infancy, may well prove the solution to the treatment of this most difficult problem.

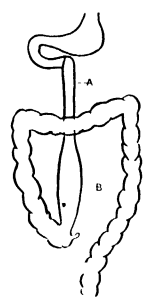


Fig 304. — Diagram showing why purgatives often fail in the treatment of paralytic ileus. A, Comparatively healthy small intestine readily excitable by purgatives; B, Paralysed intestine, unexcitable by purgatives.

A spinal anæsthetic is sometimes effective when other measures have failed. In a desperate case I have had success by giving a spinal anæsthetic and then passing a sigmoidoscope. A rectal tube was insinuated high in the colon through the sigmoidoscope. Whether the good result was due to the spinal anæsthetic or the intubation I do not know.

Preventive Treatment of Paralytic Ileus.—It should be noted carefully that this is preventive treatment, i.e., the treatment is started *before* distension occurs.

1. Pitressin, ½ c.c., is given, preferably intramuscularly. If given subcutaneously it is often absorbed too slowly to produce the desired effect. Alternatively an ampoule of 0·5 mg. of prostigmine (Roche) may be given.

2. The initial dose must be given in the presence of non-distended intestine. Hence, the first dose is given at the beginning or immediately after the operation, and it is repeated twice a day until the bowels are open. Usually an enema is administered to assist the treatment forty-eight hours after the operation.

My experience is that pitressin, prostigmine, and acetylcholine, indeed, all drugs belonging to this group, can prove to be most dangerous. To my certain knowledge acetylcholine sometimes has exactly the opposite effect to the therapeutic action for which it is intended. With a view to preventing paralytic ileus I have tried the administration of prostigmine in cases where the onset of paralytic ileus seemed probable. Some of the results have been disastrous. As the result of a mass action of repeated doses of the drugs in question a coil of small intestine became entrapped by being forced through the peritoneal layer of the incision. If the so-called preventive treatment is employed the house surgeon must supervise it with the utmost care. He should examine the patient shortly after each injection. He must stop the injections if the patient vomits or if he is not satisfied that the whole length of the small intestine (*see Fig.* 304) is being energized by the drugs. On no account should the patient be simply ordered "six-hourly injections until the bowels are open".

FÆCAL FISTULA

The first thing to do is to be quite certain that there is really a fæcal leak. Many times a fæcal fistula is reported when in reality a foul, fæcal-smelling pus has been discharged from the wound. The passage of flatus with the discharge is proof positive of a communication with the bowel.

The house surgeon will institute the following measures:—

1. Place the patient in Fowler's position.

2. Provide free exit for the fæcal matter through the abdominal wall by the insertion of a soft corrugated rubber drain.

3. Provide efficient corsettage to the wound (*see* p. 301). After the corsets have been applied he should make certain that they are sufficiently tight to prevent the wound bursting open, but still allow free drainage of the wound.

4. Make arrangements for the prevention of skin excoriation.

The Prevention and Treatment of Skin Excoriation.—This is a difficult problem. The number of local applications which have been recommended for the purpose are so numerous that this, in itself, is good evidence that none is universally satisfactory. I have tried them nearly all, and have found that aluminium paint, if applied early, is the most satisfactory. Illingworth-Law's formula is as follows:—

℞	Aluminium powder	30
	* H. E. B. base	5
	Water	ad 100

It is best applied with a brush, and renewed as necessary. An alternative is kaolin paste.

* Liquid paraffin, 3, Soft paraffin wax, 2, Lanette Wax S. X., 2.

A sufficient quantity of sterilized powdered kaolin is mixed with glycerin to make a thin paste. It is applied to the skin surface, and over it is spread a generous quantity of powdered kaolin. The application is renewed every six hours.

Suction.—The higher the fistula in the alimentary canal the more skin excoriation must be expected. This reaches its zenith in cases of duodenal fistula. Undoubtedly, some form of suction apparatus to remove the enzyme-laden discharge is a fundamental procedure. In cases of duodenal fistula suction is imperative.

Potter has found that a glass-tipped rubber tube connected to the suction apparatus operated by the patient himself is a satisfactory method of applying the suction in appropriate cases.

Drugs and Diet.—Pulv. cret. aromat., given in teaspoonful doses every four hours, helps to thicken the discharge and so prevents an unbridled outpouring; it also has the effect of lessening the offensiveness of the fæcal discharge. After a few days the patient seems to develop a tolerance to pulv. cret. aromat. and the dose has to be increased. I have found that a better practice is to substitute isogel for the chalk powder for four or five days, and then to return to the powder.

Diet should consist of milk preparations at frequent intervals, and three times a day the white of an egg should be given.

Watch must be kept that the patient is receiving an adequate fluid intake. Timely administration of intravenous saline and glucose will prevent dehydration. In the case of high fistulæ a jejunostomy for feeding purposes may have to be considered, for the higher the location of the fistula the greater the menace to life.

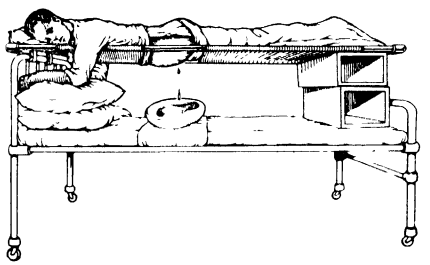


Fig. 305.—Nursing a patient in the prone position on a Bradford frame. The fistula leaks directly into the receptacle. (*After Potter.*)

Prone Postural Treatment.—In selected cases, and especially during the night, the patient can be placed in an anterior Bradford frame with a slit in the region of the fistula (*Fig.* 305). A bed-pan beneath the opening serves as a receptacle for the discharge. Within a very short time the patient accustoms himself to sleeping on the frame.

BURST ABDOMEN

Prevention.—Certain conditions are known to predispose to burst abdomen. Amongst the more important are the following: (1) Violent or persistent cough; (2) Infection of the laparotomy wound; (3) Intestinal obstruction with distension; (4) Escaping ferments, notably in acute pancreatitis; (5) Hasty closure of the wound; (6) Ascites; (7) Extreme debility of the patient—tissues fail to heal.

There are many occasions where the accident can be prevented by supporting the abdominal wall with laparotomy corsets (*see* p. 301).

Immediate Treatment.—From the clinical standpoint, burst abdomens are of two varieties. The house surgeon may be summoned hastily because the wound has given way and coils of intestine are prolapsed on to the abdominal wall. This is the common variety. Less frequently the wound breaks open

more quietly, revealing a mass of reddish tissue beneath. One hopes that this mass is the rectus muscle, but it nearly always turns out to be a coil of small intestine covered with granulation tissue. In other words, the abdominal wall has given way a few days before, and the prolapsed coil has been covered only by skin. Thus it comes about that if there is uncertainty as to the nature of the reddish tissue it is safer to ascertain this point in the operating theatre.

The immediate treatment is to cover the wound and the prolapsed contents with hot moist gauze. The patient is told not to cough if this can possibly be avoided. Pain and shock are singularly absent, but in order to quiet the patient and to aid relaxation under the anæsthetic, morphine, ¼ gr., is administered at once, and arrangements for operation are made forthwith.

STITCH ABSCESS

It is improbable that stitch abscesses are often due to suture material. If numbers of cases occur in a short space of time, there is probably something amiss in the sterile ritual of the theatre. On one occasion, after a prolonged search, an epidemic of stitch abscesses was traced to infected powder used with the rubber gloves.

Stitch abscess is treated in the same way as any other abscess, but it should be noted that a little redness around the wound is not always the signal that a fomentation should be applied, and the surgeon's wish should be consulted in such cases. If the whole wound is inflamed, precautions against a burst abdomen should be taken forthwith.

PERSISTENT HICCUP

Persistent hiccup is a distressing complication, sometimes seen after abdominal operations, although it is by no means rare in uræmic subjects. It is a serious complication, distressing for the wretched patient, upsetting to the other patients,

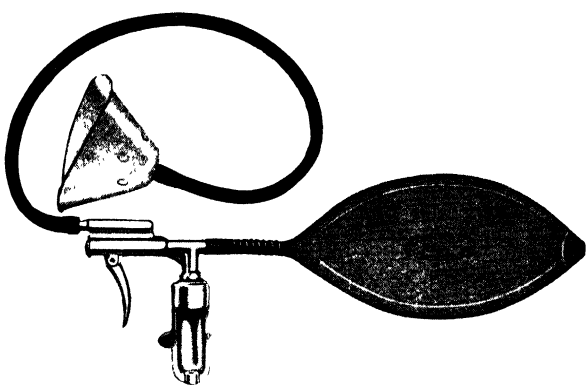


Fig. 306.—'Sparklet resuscitator' with mask.

and distracting to the staff. Morphine sometimes controls it for a time, but persistent hiccup is almost untouched by this drug.

The numerous remedies which have been recommended are divergent in principle. We will assume that carminatives and holding the breath have been tried without avail. The first thing to do is to make certain there is no dilatation

of the stomach, by passing a gastric aspiration tube. In relevant cases it is a good practice to take a sample of blood for a blood-urea estimation. A reliable method of treatment is to get the patient to inhale air containing an excess of CO_2. A homely method is to get him to breathe in and out of a thin paper bag for half a minute or so at a stretch. The inhalation of 5 per cent CO_2 is often effective. It is quite useless to blow the CO_2 in front of the patient's nose; it must be given properly with an anæsthetic mask. Inhalation should be given from 3 to 15 minutes and charted thus :—

Time	*CO_2 Inhaled for*	*Freedom from Hiccup*
3.30 a.m.	10 minutes	20 minutes
4 a.m.	5 minutes	30 minutes

I have used the method in a number of cases with favourable results. A State-registered nurse is quite capable of using the method once it has been demonstrated to her. The sparklet " resuscitator " with a mask attached (*Fig.* 306) was designed by me so that objections to a nurse giving CO_2 were overcome.

Some speak well of an inhalation of amyl nitrite, and among the newer remedies benzedrine sulphate in doses from 10 to 30 mg. must be mentioned. Several reports have been published where a dose of 10 mg. (two tablets of benzedrine) has controlled the hiccuping for twenty minutes, when the dose can be repeated, if necessary, for two or three doses. I have tried this remedy but have had no success with it.

Finally, exposure of the left phrenic nerve and injecting it with local anæsthetic is a comparatively trivial procedure. On several occasions I am sure that this measure has proved life-saving.

ACIDOSIS

(*Ketosis*)

Acidosis is a well-known complication after general anæsthesia in children. For Rothera's test, *see* p. 74.

Prevention.—After emergency operations on little children it is a good practice to order saline and glucose per rectum.

Acidosis should be suspected when vomiting for which there is no apparent reason continues for more than forty-eight hours after operation and the patient is a little child. A characteristic odour of new-mown hay in the child's breath helps to confirm a suspicion of acidosis.

Treatment.—

Glucose.—It is of the utmost importance to get glucose promptly into the circulation. Six to eight ounces of a 10 per cent solution of glucose in saline are given slowly per rectum. This is repeated every four hours. The nurse should be told to report if the solution is not retained. If this is the case, a 5 per cent solution may be given subcutaneously. In urgent cases a 5 per cent solution may be given intravenously. The stomach should be washed out if vomiting continues, using a small stomach tube.

Other Forms of Treatment.—Sodium bicarbonate in large doses is useful, and insulin is stated to be of value. Regarding the administration of the latter, it is advisable to seek the help of a medical colleague.

CHAPTER XXXVII

SULPHONAMIDE THERAPY

By C. ALLAN BIRCH

PREPARATIONS AND INDICATIONS

THE term ' sulphonamide ' embraces the whole of this important group of drugs. It is unfortunate that the nomenclature of its subdivisions is so complex, largely owing to proprietary preparations.

Sulphanilamide is available as such, and has over 50 synonyms which are best avoided since they indicate identical substances. Sulphanilamide is employed for streptococcal and *B. coli* infections. It is especially inimical to the hæmolytic streptococcus.

Sulphanilamide Preparations for Parenteral Administration.— There are a number of proprietary solutions of sulphanilamide in organic solvents, but in many of these the doses recommended are inadequate. If they are used their sulphanilamide content must be known.

It is not difficult to prepare a sterile solution of sulphanilamide. The solubility of sulphanilamide in water or saline is 1 per cent at body temperature and a solution of 1 g. of powder in 100 c.c. of 0·5 per cent sodium chloride should be autoclaved at 115° for 30 minutes and cooled to body temperature before injection.

Sulphapyridine (syn. Dagenan ; M & B 693) may be used for meningococcal, gonococcal, pneumococcal, and gas-gangrene infections. The soluble form is M & B 693 soluble (syn. Dagenan Sodium) and is supplied in 3-c.c. ampoules containing 1 g.

Sulphathiazole (syn. M & B 760 ; Thiazamide) is a very active sulphonamide and so is useful against resistant organisms like staphylococci, as well as those mentioned under sulphapyridine. It can be obtained in ampoules containing 1 g. for intravenous use. Owing to its relatively strong alkalinity it should never be given intramuscularly.

Sulphadiazine has all the activity of sulphapyridine, and because of better absorption, smaller doses may be required. In addition to the group of organisms listed under sulphanilamide, sulphadiazine is effective against infections with Friedländer's bacillus.

Sulphamezathine resembles sulphapyridine in action, but is less toxic.

Sulphacetamide (syn. Albucid ; Sulphacetamide Sodium M & B) is a sulphonamide which has been used chiefly in gonorrhœa and urinary infections. It can be obtained in 5-c.c. ampoules of a 30 per cent solution which, not being strongly alkaline, is suitable for intramuscular injection. A 30 per cent solution may be used on the conjunctiva.

Sulphaguanidine. Only 25 to 50 per cent of this sulphonamide is absorbed from the gut, and so it is of great value in dysenteric infections.

Succinyl sulphathiazole (syn. Sulphasuxidine) has similar uses to sulphaguanidine. Only 5 per cent of it is absorbed.

RATIONALE

Sulphonamides interfere with the enzyme system of bacteria by substituting for the *p*-aminobenzoic acid which they need. They are bacteriostatic rather than bactericidal. Of most value against organisms causing acute generalized infections, they are less useful in chronic localized infections. They do not neutralize toxins.

Because most sulphonamides are soon excreted, a high blood concentration should be attained rapidly. It is often advisable to estimate the concentration of sulphonamide in the blood.

For blood estimation 2 c.c. of oxalated blood is used. A fairly accurate micro-method using 0·2 c.c. is now available also. For severe infections the effective blood concentration of most sulphonamides is from 7 to 10 per cent. A higher concentration of sulphadiazine is desirable

Sulphonamides rapidly find their way into all body tissues, secretions and excretions, including discharges from wounds. Of the substances hindering sulphonamide activity the most important is pus,* and once this forms it must be let out and its presence not masked by sulphonamides. Procaine and eusol also antagonize sulphonamides.

The concentration in the cerebrospinal fluid varies from 20 to 90 per cent of that of the blood, being highest with sulphanilamide and lowest with sulphathiazole. Sulphonamides are not secreted in the milk in an amount sufficient to harm the breast-fed infant. Because sulphonamide concentration in the urine is as much as fifty times that of the blood, a high urinary concentration is easily attained

DOSAGE AND METHODS OF ADMINISTRATION

Small, infrequent doses given on chance without clear indication are useless and dangerous. The initial loading dose should be twice the subsequent four-hourly dose. The dosage table applies to sulphanilamide, sulphapyridine, sulphathiazole, and sulphadiazine, except that effective blood levels of sulphadiazine can be attained by six-hourly dosage. Oral administration is preferable in most cases. Tablets of all the preparations contain 0·5 g. If sulphonamides are going to be effective they soon show evidence of this, and a course of treatment should seldom exceed seven days. Sulphanilamide may be given per rectum in 0·8 per cent solution, but high blood concentration is not usually attained.

In order to avoid accidental excess therapy it is wise to prescribe from day to day, or for seventy-two or ninety-six hours only. At the end of each twenty-four-hour period the amount administered should be recorded. It is usual to keep on with a small dose for several days after the desired effect is observed. When using sulphapyridine and sulphathiazole a high fluid intake should be maintained in order to avoid excessive deposition of crystals in the urine. After absorption about 20 per cent of most sulphonamides combines with an acetyl group in the liver and becomes therapeutically inactive. Acetyl derivatives tend to crystallize out in the urinary tract.

In all cases, if a second course of sulphonamide therapy is deemed necessary agranulocytosis must be excluded before a second course is commenced.

Dosage for Children.—Children, weight for weight, tolerate sulphonamides well. If the weight is known, a simple rule is to give 1 grain per pound per

* Marfanil—a new sulphonamide for local application—is active in the presence of pus.

twenty-four hours. This is a comparatively small dose for a baby. The weight is difficult to obtain during illness, and then the dosage table will be found convenient.

In the absence of a table, it is useful to remember the upper limit of dosage in twenty-four hours for severe infections, i.e., 3 g. for the smallest child and 12 g. for an adult.

DOSAGE OF SULPHONAMIDES*

	ADULTS	CHILDREN		
		0–3 *years*	4–10 *years*	11–15 *years*
Severe Infections (endangering life) :—				
Initial	2–4 g. i.v. 1·5 g. by mouth	0·5 g. i.v. 0·5 g. by mouth	1 g. i.v 0·75 g. by mouth	1–2 g. i.v. 1 g. by mouth
Followed by :— 1st period, 2–3 days	1·5 g. 4-hrly.	0·5 g. 4-hrly.	0·75 g. 4-hrly.	1 g. 4-hrly.
2nd period, 2 days (approximately two-thirds of dose of 1st period)	1 g. 4-hrly.	0·5 g. 6-hrly.	0·75 g. 6-hrly.	1 g. 6-hrly.
3rd period, 2 days (approximately one-third of dose of 1st period)	1 g. 6-hrly	0·25 g. 6-hrly	0·5 g. 6-hrly.	0·5 g. 6-hrly.
Milder or 'Moderate' Infections :				
Initial dose	2 g.	0·5 g.	0·75 g.	1 g.
Followed by :— 1st period, 2 days (unless otherwise stated)	1 g. 4-hrly.	0·5 g. 4-hrly, for 12–24 hr.	0·5 g. 4-hrly.	0·75 g. 4-hrly.
2nd period, 2 days (unless otherwise stated)	1 g. 6-hrly.	0·5 g. 6-hrly. for 3–4 dy.	0·5 g. 6-hrly.	0·75 g. 6-hrly.
3rd period, 2 days	1 g. 8-hrly.	0·25 g. 6-hrly.	0·25 g. 6-hrly.	0·5 g 6-hrly.

* From *M R C. War Memorandum No* 10 ("The Medical Use of Sulphonamides"), by kind permission of the Controller of H M Stationery Office

The duration of a course is normally 6–7 days, and it should rarely be prolonged beyond the seventh day.

Parenteral Administration.—As indicated above, several preparations are suitable for parenteral use, but this method should not be undertaken lightly. It is often preferable to give sulphonamides by œsophageal tube to patients who cannot swallow.

Sulphanilamide, because of its low solubility, is not very suitable for parenteral injection, and solutions in special solvents are also relatively weak.

M & B 693 soluble is best given intravenously. Being very alkaline it is irritant, and intramuscular injection should be avoided. If it must be so given, it is wise to inject a very small quantity of procaine before and after the drug.

Thiazamide sodium should only be given intravenously.

Local application of sulphonamide powder is now widely employed after excision of potentially infected wounds and, indeed, as a prophylactic measure in operative incisions. A dose of 10 g. should rarely be exceeded. If the powder is blown into the wound with an insufflator, this amount will be found more than enough for even the largest wound. For 1 g. applied 0·5 mg. per cent appears in the blood-stream.

TOXIC REACTIONS

Early Reactions, Not Necessarily requiring Cessation of Treatment.—

Cyanosis (with sulphanilamide) is usually due to methæmoglobin formation. This usually can be ignored, but it must not be confused with cyanosis due to disease. If the cyanosis is intense and progressive, sulphæmoglobin formation should be suspected, and can be confirmed by spectroscopy. Sulphur-containing foods and drugs need not be avoided. Methæmoglobin cyanosis may be mitigated by methylene blue, 0·5 g. orally three times a day, or 0·1 g. intravenously.

Vomiting (with sulphapyridine) is likely to prevent adequate absorption of the drug. Often it can be avoided by fractional dosage, suspension of the drug in mucilage, large doses of potassium citrate, and the avoidance of smoking and constipation. Nicotinic acid in 50-mg. doses is recommended, though there is some evidence that it makes the drug less effective. Early vomiting due to disease is an indication for parenteral therapy. In later vomiting other sulphonamides may be tried.

Later Reactions, coming on after Five to Seven Days and requiring Cessation of Treatment.—

Sulphonamide Rashes are common and are usually associated with drug fever. In children they may cause difficulties in the differential diagnosis of the exanthemata.

Sulphathiazole is more prone than other sulphonamides to produce rashes. One of the lesions it produces is indistinguishable from erythema nodosum, and is often associated with conjunctival injection. These cases may show photosensitivity, porphyrinuria, stomatitis, and mental changes—the ' pellagroid syndrome '.

Withdrawal of the drug, forcing of fluids, and giving nicotinic acid are the methods of dealing with the rash. Should the primary condition demand the continuance of chemotherapy, the sensitization to subsequent doses may disappear.

Hæmaturia.—Deposition of crystals in the urinary tract occurs chiefly with sulphapyridine and sulphathiazole, and may lead to lumbar pain followed by microscopic and macroscopic hæmaturia, oliguria, anuria, or renal colic, and occasionally to urolithiasis medicamentosa. Dehydration due to vomiting, sweating, diarrhœa, and inadequate fluid intake all favour the condition, as also does poor renal function.

Prophylactic measures are copious fluids and administration of alkalis. It is wise to look early for crystals in the urinary deposit. Treatment of renal complications is by heat to the loins, fluids in excess, ureteric catheterization, and irrigation of the renal pelves with 2·5 per cent sodium bicarbonate. 50 c.c. of 10 per cent dextrose intravenously promotes diuresis.

Mental Symptoms.—Slight disorientation is common. Other symptoms resemble those of bromide intoxication—apathy, delusions, and hallucinations—and they rapidly disappear when the drug is stopped.

Drug Fever is usually accompanied by rashes and is most often encountered in cases of gonorrhœa after seven days' treatment. The fever disappears when the drug is stopped.

Uncommon, Serious Reactions coming on after Fourteen Days' Treatment.—These are granulocytopenia, hæmolytic anæmia, peripheral neuritis, and jaundice. Leucopenia is not important unless rapidly progressive to 4000 per c.mm. Since agranulocytosis is almost unknown before the fourteenth day of treatment, the fear of producing it by high initial dosage is unfounded. Prolonged suboptimal dosage, however, increases the risk of this complication.

Hæmolytic anæmia, with jaundice and hæmoglobinuria, has occurred with sulphanilamide. Treatment should be stopped, fluids administered, and blood transfused. Subsequent use of sulphonamides must be avoided.

SOME INDIVIDUAL INFECTIONS IN RELATION TO SULPHONAMIDE THERAPY

Gas Gangrene.—Sulphonamides and antitoxin, if given early, may prevent gas gangrene. In established infection sulphathiazole or sulphadiazine should be used in full doses.

Urinary Infections.—Sulphanilamide and sulphacetamide are effective against *B. coli* and similar organisms. Sulphathiazole should be used for staphylococcal, *B. proteus*, and *B. pyocyaneus* infections and for resistant cases. Sulphonamides are useless against *Str. fæcalis* and resistant organisms.

A urinary output of at least 1500 c.c. per day must be maintained and an alkaline urine (*p*H 7·7) is an advantage. When culturing urine containing sulphonamides, the medium should contain *p*-amino-benzoic acid 2 mg. per cent in solid media and 0·5 mg. per cent in liquid media. Dosage as for moderate infections (*see* Table).

Gonococcal Infections.—(*See* Chapter LX.)

Meningococcal Infections.—Sulphathiazole is the drug of choice, but sulphadiazine and sulphapyridine are also effective. After the first intravenous dose treatment may be continued in unconscious patients by nasal tube. Estimation of cerebrospinal fluid or blood concentration is very desirable. Dosage as for severe infections (*see* Table).

Lumbar puncture is only necessary for diagnosis and as a test of cure. Daily puncture should be avoided since it removes the drug from the theca.

Pneumococcal Infections.—All types of pneumococci are susceptible to sulphonamides, sulphathiazole and sulphadiazine being the most effective. In pneumonia in doses as for severe infections (*see* Table) the temperature falls to normal in thirty-six hours. The rate of resolution is not altered, but the mortality has been reduced from 20 per cent to 5 to 8 per cent. Nicotinic acid in 50-mg. doses is said to aid the resolution of sulphonamide-treated pneumonia. Friedländer's bacillus pneumonia is best treated with sulphadiazine. Staphylococcal pneumonia responds to sulphathiazole in an uncertain way, and the organism should be tested for sensitivity.

Pneumococcal meningitis should be treated as meningococcal meningitis and any local focus, e.g., otitis media, drained.

Staphylococcal Infections.—Because of rapid and irregular absorption and elimination, big doses, as for severe infections (*see* Table), of sulphathiazole are necessary to maintain the recommended blood concentration of 15 mg. per 100 c.c. Intravenous administration in a continuous drip transfusion is often

necessary. One gramme in 100 c.c. saline at the rate of 25 drops per minute gives 1 g. in 4 hours. In staphylococcal septicæmia reliance should not be put on sulphathiazole alone, and 20,000 units of staphylococcal antitoxin of high anti-leucocidin content should be given together with penicillin if the organism is sensitive to it. Impetigo responds well to 5 per cent sulphathiazole ointment.

Intestinal Infections.—Sulphaguanidine, 3 g. four times a day for three days, followed by 3 g. twice a day for four days, has cured bacillary dysentery and has been of benefit in gastro-enteritis of the newborn. Succinyl sulphathiazole may be used in smaller doses (10 g. daily). Typhoid, paratyphoid, and bacterial food poisoning do not respond to sulphonamide therapy. Ulcerative colitis may be improved by retention enemata of 10 g. sulphaguanidine in 7 fl. oz. of mucilage.

Other Infections.—Sulphanilamide has been used in many streptococcal diseases, but it is chiefly effective against those due to hæmolytic streptococci. It has been used with success in puerperal sepsis and it should be given to all cases in which there is risk of puerperal infection, though mass prophylaxis is not advised. It has no action in the toxic phase of scarlatina, though it may be useful for the septic and invasive complications. It is of no value in diphtheria. Virus infections generally are not influenced except lymphogranuloma inguinale, and possibly other manifestations of lymphopathia venereum. Brucella infections, actinomycosis, and erysipelas are favourably influenced. Sulphonamides have been used with some success also in tetanus and anthrax.

CHAPTER XXXVIII

PENICILLIN THERAPY

By I. ILLINGWORTH-LAW

PENICILLIN is an unstable organic acid produced by a mould *Penicillium notatum*. Its calcium and sodium salts are used clinically and are relatively stable when dried *in vacuo* between 4° C. and 10° C. Solutions are stable for twenty-four hours if kept below body temperature.

INDICATIONS

Generally speaking, Gram-positive bacilli and Gram-negative cocci are susceptible. Gram-negative bacilli are insensitive. A bacteriological diagnosis should, therefore, be made before treatment begins. Penicillin is effective against the following organisms :—

- Gonococcus
- Meningococcus
- Staphylococcus aureus
- Streptococcus viridans (most pathogenic strains)
- Pneumococcus
- Bacillus diphtheriæ
- Clostridia of gas gangrene
- Actinomyces (some strains)
- Spirochætes of syphilis, Vincent's infection, and relapsing fever and possibly of Weil's disease.

It is therefore used in :—

- Septicæmia
- Puerperal sepsis
- Cellulitis, acute abscesses and carbuncles
- Sinus thrombosis
- Infections of urinary tract by sensitive organisms
- Pneumonia
- Anthrax
- Actinomycosis
- Gonorrhœa
- Gas gangrene
- Vincent's stomatitis
- Sulphonamide-resistant acute infections

It may be of benefit in :—

- Syphilis
- Otitis media and mastoiditis
- Chronic osteomyelitis
- Diphtheria
- Bacterial endocarditis (as a prolonged course).

Surface applications are used in burns, impetigo, sycosis barbæ, conjunctivitis, infected wounds (in the absence of inactivating contaminants).

Penicillin is of doubtful value or no value in tuberculosis, rheumatic fever, ulcerative colitis, virus infections, typhoid, and other Gram-negative bacillary infections, glandular fever, and malaria.

MODE OF ACTION

Penicillin is bacteriostatic rather than bactericidal. Maximum blood concentration is attained 15 minutes after intramuscular injection. The meninges are

relatively, and the pleura and serous linings of joints almost completely, impermeable to penicillin. Fifty per cent of the drug is recoverable from the urine in five hours. It appears in the saliva and bile, but not in the pancreatic juices and tears. It acts in a medium between *p*H5 and 7, and thus alimentary tract infections cannot be treated by penicillin by mouth. Adequate surgical treatment is always necessary. Penicillin is rapidly inactivated by heat above body temperature, oxidizing agents, alcohol, heavy metals, synthetic rubber, and penicillinase produced by organisms like *B. coli* and *B. pyocyaneus*.

METHODS OF ADMINISTRATION

Systemic.—Intravenous administration is unnecessary and liable to cause thrombosis. Intramuscular administration given three-hourly or by continuous drip produces a satisfactory blood concentration. The intermittent method is preferable during transport, but apt to be wasteful over a period. Impurities give rise to pain which prior injection of procaine may mitigate.

Local.—Penicillin may be used locally in solutions, as a cream, as pastilles, and as a powder when it is mixed with sulphathiazole which has been sterilized by heating to 140° C. for two hours.

The formula for cream is —

Lanette wax Sx	12 parts
Arachis oil	25 parts
Water	55 parts
Phenoxytol*	1½ per cent
Calcium penicillin	250 units g

or,

Lanette wax Sx, in water	30 per cent
Phenoxytol*	1½ per cent
Calcium penicillin	250 units g

Autoclave at 20 lb. for 20 minutes. Cool to 40° C. Add penicillin and allow to set

The formula for pastilles is —

Gelatin	440 gr.
Nipagin M	2½ gr.
Simple syrup	2 fl. oz.
Water dist.	2 fl. oz
Penicillin	25,000 units

Each pastille should contain 250 units.

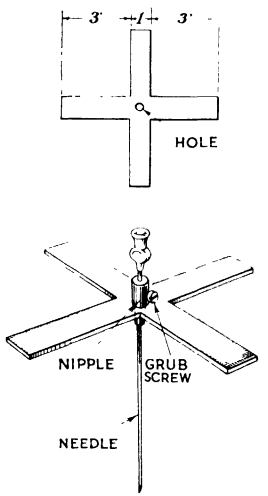


Fig. 307.—An easily constructed device for maintaining an intramuscular hollow needle in situ for prolonged periods

GENERAL TECHNIQUE

All apparatus must be sterile, but spirit must not be used in it or on the skin. A 17 s.w.g. needle 2½ in. to 3 in. long is used and may be fixed at the required depth by the following device. From a piece of sheet metal a cross is cut whose limbs are 3 in. × 1 in. At the intersections a hole is bored and a cycle brake nipple soldered into it. The nipple has a grub screw in its side which retains the needle at the correct depth (*Fig.* 307). The limbs of the cross are moulded to the leg and secured by strapping. A seal of tulle gras is placed under the centre of the cross.

Continuous Therapy by the Drip Method.—Apparatus for administering penicillin continuously has not yet been standardized. The equipment here

* Phenoxytol inhibits *B. pyocyaneus*.

described has given satisfactory results. The upper container (*Fig.* 308) holds the dose for twenty-four hours' treatment (say 100,000 units). The tubing is filled, and also the lower container, which holds 12,500 units in 12 c.c. This ensures that not more than one-eighth of the total dose is given in each three-hourly period. A special intramuscular needle is required. The Ranfac needle* has proved satisfactory in practice.



Fig. 308. — Apparatus for continuous intramuscular drip penicillin therapy.

Continuous Injection.—Last's apparatus (*Fig.* 309) consists of a Record syringe, the plunger of which is very slowly depressed by a screw mechanism controlled by a small electric motor. Thus, the plunger is depressed $1\frac{1}{2}$ in. in 24 hours.

Spraying.—For spraying penicillin on the surface, Mackenna's atomizer (*Fig.* 310) ensures accuracy combined with economy.

Penicillin Cream.—For introduction of penicillin cream into small abscesses, e.g., a whitlow, R. E. O. Williams recommends putting up a small tube of the cream, together with a swab stick, in a sterile capped bottle, ready for use (*Fig.* 311).

DOSAGE

The Oxford Unit.—The dosage of penicillin is expressed in what is known as the Oxford unit, which is purely arbitrary. This unit is the amount of penicillin that, when dissolved in one millilitre of water, gives a uniform inhibition to a strain of staphylococci that is retained at Oxford.

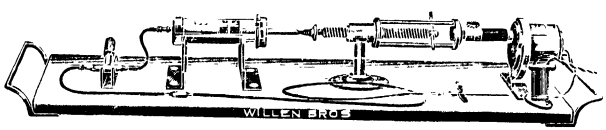


Fig. 309 —Last's apparatus for continuous intramuscular injection of penicillin. The plunger is so slowly depressed that it takes twenty-four hours to empty the syringe

Systemic.—The usual adult dose is 100,000 units in 24 hours for 5 to 7 days subject to bacteriological control. Infants need only 10 per cent of the

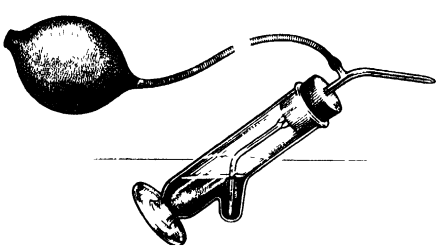


Fig. 310.—Mackenna's spray.

Fig. 311.—Williams's method of storing penicillin cream for use in small abscess cavities.

* Made by George Carsberg Ltd., 79, Meredith Street, E.C.1.

adult dose. Pyrexia and leucocytosis continue after cultures are sterile. In syphilis a daily dose of 240,000 units for 10 days is needed. An extended course is advisable in bacterial endocarditis. In acute gonorrhœa 100,000 units in 24 hours is usually sufficient. In actinomycosis wide variation in dosage is called for according to the susceptibility of the organism.

Local.—The calcium salt, being more stable, is used. Powders contain 2000 to 5000 units per gramme of sulphathiazole ; solutions contain 250 units per c.c.

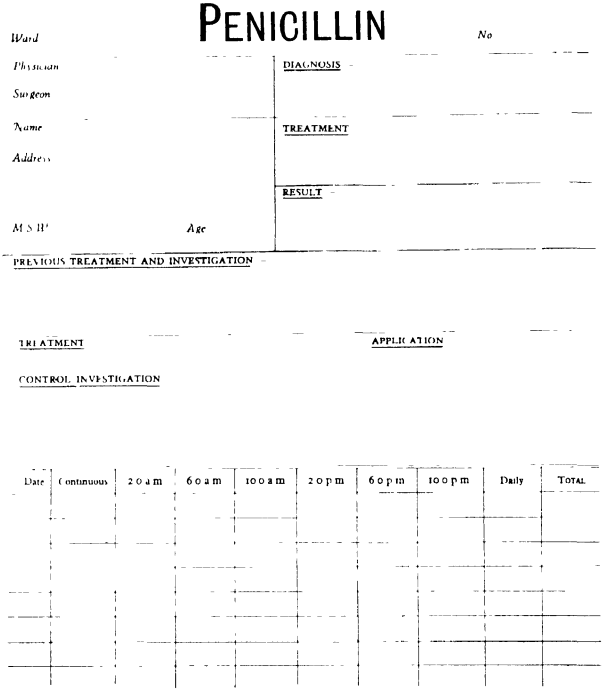


Fig. 312.—Chart for recording penicillin therapy.

For empyema daily injections of 25,000 to 75,000 units are used. In meningitis daily intrathecal injections of 500 to 1000 units are given.

It is an advantage to have a special chart (*Fig.* 312) for recording penicillin treatment.

TOXIC EFFECTS

It is probable that pure penicillin would have no toxic properties, but impurities in present preparations may cause pyrexia, rigors, urticaria, meningeal irritation, and, if given intravenously, thrombosis.

Failure of treatment is due to penicillin-resistant organisms or mixed infections, inadequate dosage, inactivation by contamination, etc., and omission of necessary surgical treatment, i.e., drainage.

CHAPTER XXXIX

BANDAGES AND BANDAGING

By HAMILTON BAILEY and SISTER BECKETT

BANDAGING, it is said, is a lost art; with this we agree if it implies that some of the older convolutions are no longer to be witnessed in the wards and operating theatres. Nevertheless, modern methods of bandaging are efficient and less time-consuming.



Fig. 313.—The sling.



Fig. 314.—Application of the reversed spiral

THE TRIANGULAR BANDAGE

The triangular bandage is the half of a square of 36 in., and is usually made of unbleached calico or some strong material.

Slinging the Forearm.—The sling should be made just short enough to elevate the shoulder slightly, or the patient will not care to trust the full weight of the limb to it. The hand should be held so that it is a little higher than the elbow. (*Fig.* 313.)

THE ROLLER BANDAGE

The art of applying a roller bandage requires practice. The first thing to learn is how to distribute the pressure evenly. The bandage must be kept rolled up—dropping it is a sure sign of a bungler—and held (as in *Fig.* 314) three or four inches away while the finger and thumb are used to retain that part of the bandage which is already in position.

General Rules.—Bandage from within outwards and from below upwards, and always have the upper part of the bandage looser than the lower. Bandage smoothly without irregularities or creases and cover all the dressings.



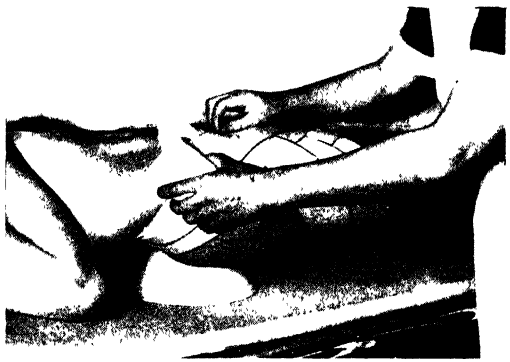
Fig. 315.—Application of the figure-of-8.



Fig. 316.—Figure-of-8 for the elbow.

The Reversed Spiral.—The manipulation of 'reversing' is shown in *Fig.* 314. The reversed spiral may be applied to the trunk or limbs. It is liable to slip, is not elastic, and is not suited for the neighbourhood of joints.

The Figure-of-8.—Being not less firm, and yet more elastic, this bandage is useful in the neighbourhood of joints. *Figs.* 315, 316 will give a better idea of its application than words can express. The great point to bear in mind is to make the loops of the '8' as open as possible by going boldly up the limb and coming down again as far as the bandage will allow.



317.—Applying a spica bandage to the groin. Note the inverted bowl

The Spica (*Spike* or *spathe*, a botanical term applied to heads of seeds arranged as in an ear of wheat).—It is extremely useful for applying firm pressure to the shoulder, groin, thumb, or great toe.

The Spica of the Groin.—The patient lies with the pelvis supported on a pelvic rest. An inverted dressing bowl can be conveniently used for this purpose (*Fig.* 317). The hip should be slightly flexed. The bandage begins by two or three reversed turns from within outwards around the top of the thigh. It is then carried outwards over the groin to just above the anterior iliac spine, and round the back just below the iliac crest. It is then brought obliquely across the symphysis pubis, crossing over the starting-point. Each successive turn overlaps two-thirds of the previous one, and four or five such turns complete the bandage (*Fig.* 318.) It may be doubled and applied to both groins.

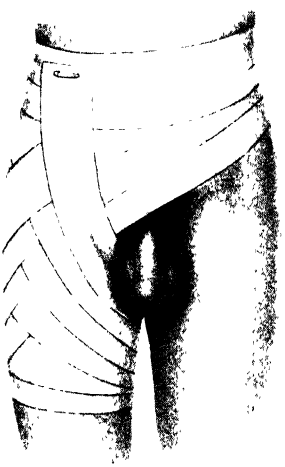


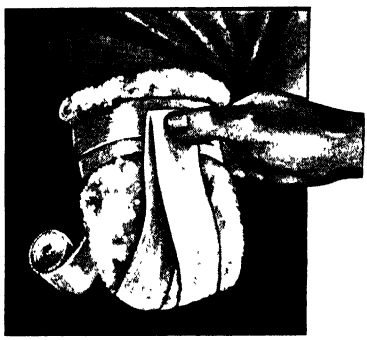


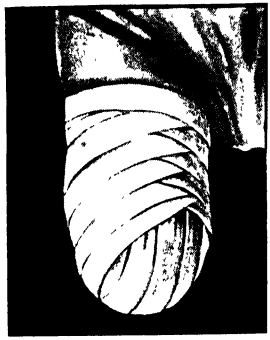


Fig. 318.—Spica of the groin. *Fig.* 319.—Spica of the shoulder. *Fig.* 320.—Spica of the thumb.

The Spica of the Shoulder.—This is an extremely firm bandage. The starting-point is taken from the upper arm, the turns being rolled round as high as the axillary folds will allow (*Fig.* 319). The bandage is then brought through the axilla, over the shoulder, and round the chest, passing under the opposite axilla. The crossing of the first turn should go as high upon the shoulder as the bandage will lie. This pattern requires a long bandage, and if required, it may be doubled for both shoulders as in the case of the groin spica.

The Spica of the Thumb.—The roller should be not more than ¾-in. wide. The spica is started with a few turns around the wrist from above downwards (*Fig.* 320).

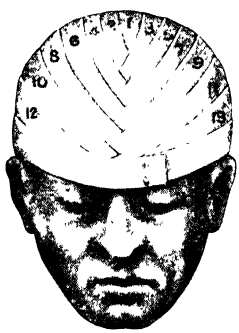




Figs. 321, 322.—The recurrent bandage for covering a stump.

The Recurrent Bandage.—This is used for covering a stump. The roller should not be more than 2 in. wide for an amputation of the arm. The application of this bandage in the case of an amputation through the thigh is shown in *Figs.* 321 and 322.





Figs. 323, 324.—The application of a capeline bandage

The Head.—The capeline bandage is the classical method However, we consider that Norman Dott's method of dressing the head is far better in most instances.

The Capeline.—Two bandages not more than 2 in. wide are



Fig. 325.

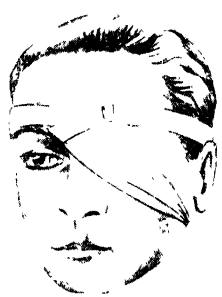


Fig. 326.

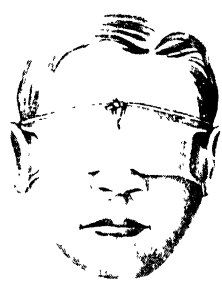




Fig. 327.

Fig. 325.—Eye bandage. The first two turns are taken round the forehead above the ears. A strip about three inches long is left hanging over the nose.

Fig. 326.—Eye bandage. Further turns are brought forward under the ear on the side of the eye to be covered usually over a pad (not shown in Fig). The last turn is taken round the forehead again and secured to the loose end, thus preventing the bandage slipping down over the uncovered eye.

Fig. 327.—Moorfields binocular bandage. The small button-hole allows the tapes, after tying, to be passed through and tied again, thus securing the bandage against slipping. A small pad of cotton-wool is usually introduced between the knot and the forehead. (For cardboard shield *see* Chapter LVIII.)

joined together by tacking. Standing behind the patient, holding one bandage in each hand, the join is placed in the centre of the forehead. The two rollers are then brought round the head and cross below the occiput. One roller is continued round the head and the other is carried to and fro across the calvarium, each span being locked in the manner shown in *Figs.* 323 and 324 until the cap is completed.

Norman Dott's Method is shown in *Fig.* 328. In a number of cases a flexible adhesive plaster dressing (*see Fig.* 344, p. 297) is efficient in comparatively minor wounds.

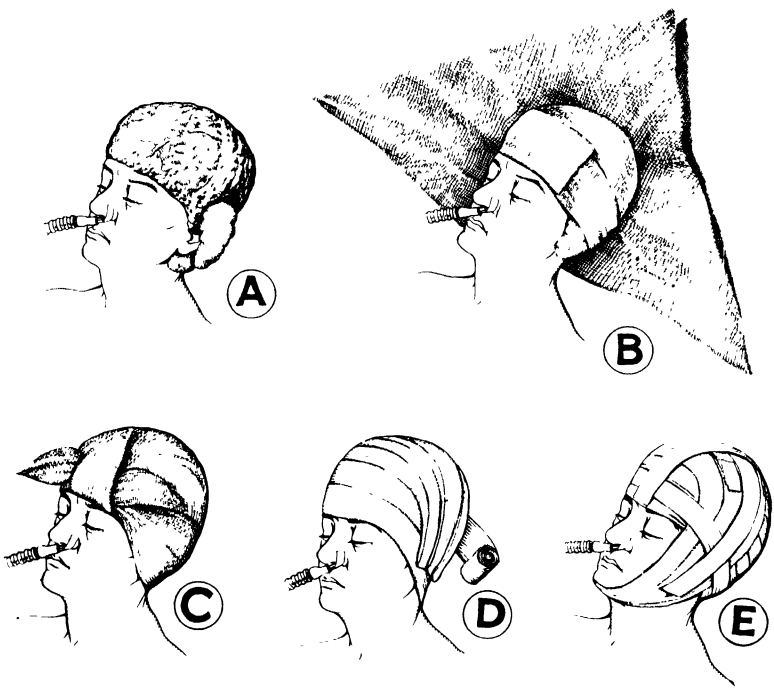


Fig. 328.—Norman Dott's method of dressing the head.

A, The scalp in the region of the operative area is smeared liberally with vaseline. The ears having been smeared also, pads of cotton-wool are placed behind and in front of them as shown

B, Large gauze pads soaked in 1–2000 perchloride, or other mild antiseptic lotion, cover the area of operation. A triangular bandage made of suitably folded dry gauze is placed beneath the head.

C, This is folded about the head forming a closely fitting cap.

D, The cap is kept in place by gauze roller bandages applied as a capeline.

E, Finally, the gauze roller bandage is carried beneath the chin. When the bandaging is completed it is fixed with 2½-in. adhesive plaster.

The Eye.—A simple and efficient method of bandaging one eye is illustrated in *Figs.* 325 and 326.

The Moorfields Bandage covers both eyes. It is made of firm material, such as calico or domette, with tape loops at both ends. These loops pass behind the patient's ears, and are secured by a single tape attached to each loop, and tied in front (*Fig.* 327).

The Mastoid Bandage.—Standing in front of the patient, the roller is passed completely round the head. The second turn is brought obliquely across the mastoid back to the starting place, and so continued. On completion, the free end of the roller is secured with a safety-pin (*Fig.* 329).



Fig. 329.—The mastoid bandage.

The Jaw.—*The Barrel Bandage* is now usurping the classical four-tailed bandage, and is proving more efficient. Six feet of 2-in. or 2½-in. unbleached calico is required. The middle of the bandage is placed under the jaw, well back just in front of the angle, and the two ends are brought to the top of the patient's head and tied in a simple knot (*Fig.* 330, A). Using two hands, the loops of the knot are opened (*Fig.* 330, B) so that one loop is brought down in front of the forehead and the back loop under the occiput. The two ends of the bandage are now brought upwards, exerting traction at the same time (*Fig.* 330, C). The two hitches (one on either side) are brought into position, slightly above and in front of the ears. The ends of the bandage are secured by a reef knot over the vertex (*Fig.* 330, D).

An excellent method of immobilizing the lower jaw is shown in *Fig.* 331. The only materials necessary are a surgeon's cap, a suitable piece of corrugated rubber, and four safety-pins.

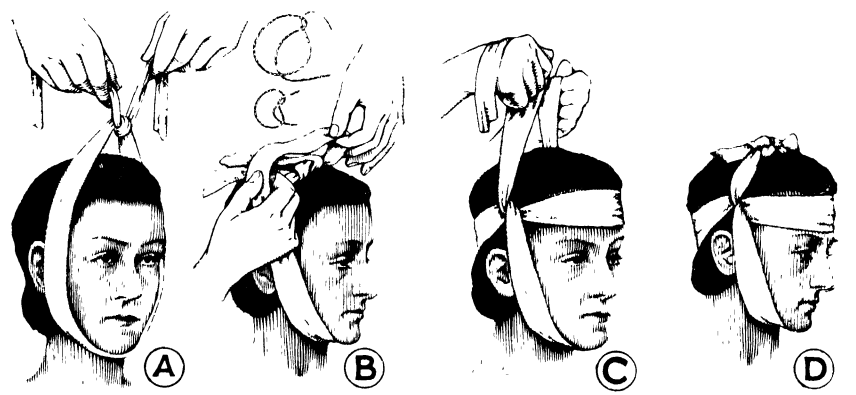


Fig. 330.—Application of the barrel bandage. (*After Sir Harold Gillies.*)

The Neck (with special reference to thyroid operations).—In order to apply an efficient bandage after thyroidectomy three assistants are necessary, one to support the head and one for each arm. It is now easy to ensure firm bandaging without disturbing the patient unduly. The first two turns encircle the neck. The roller is then passed down across one side of the chest under the axilla, across the back and up over the other side of the chest, passing round the neck again. This manœuvre is repeated until the whole of the dressing is covered

(*Fig.* 332). It is especially necessary to see that the dressing beneath the chin is supported by the bandage—a turn or two around the head may be necessary.

If the patient is inclined to vomit, the whole of the dressing is covered with a layer of jaconet fitted to the neck and stitched into position.

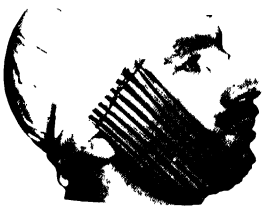


Fig. 331.—An alternative method of immobilizing the lower jaw.



Fig. 332.—Bandage applied to the neck after thyroidectomy.

THE MANY-TAILED BANDAGE

When a dressing requires changing frequently, the many-tailed bandage is particularly valuable. It can be used for the abdomen, thorax, breast, or for a limb.

For the Abdomen.—The abdominal many-tailed bandage is used in the majority of clinics. It is a method of bandaging the abdomen which has stood

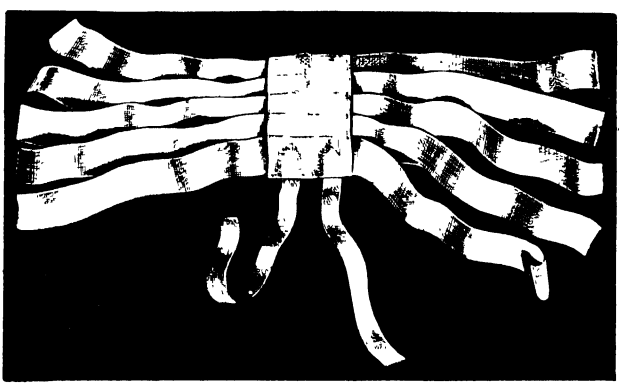


Fig. 333.—A many-tailed bandage

the test of time, and on the whole it is satisfactory. If the perineal stirrups are omitted the bandage tends to ride upwards; it is the omission of these essential stirrups, rather than the bandage itself, which has led to undeserved adverse criticism.

The bandage (*Fig.* 333) is made as follows: To a square of flannelette measuring 12 × 12 in., five strips 5 in. wide and from 36 to 48 in. long are stitched at right angles in such a way that they overlap one another for two-thirds of their width.

In order to apply the bandage properly, two persons are necessary. A rolls the patient towards himself, while B insinuates the bandage under the back just beyond the middle line. B now rolls the patient towards himself, while A retrieves the bandage. Commencing from below upwards A and B alternate in bringing the strips of the many-tail across the abdomen with firm pressure ; the final strip is secured with a safety-pin.



Fig. 334. — Bandage after amputation of the breast. A many-tailed bandage has been supplemented by a spica to the shoulder. The arm is kept abducted on pillows as shown.

The lower part of the bandage may be applied firmly with advantage, but the upper part must not be tight.

Special Precaution.—The groins should be well padded with cotton wool, or the stirrups will cause friction.

For the Breast.—After amputation of the breast a many-tailed bandage can be applied, not forgetting stirrups for the shoulders. A spica to the shoulder is a valuable addition, for it provides adequate support and pressure where it is most needed (*Fig.* 334).

In those cases of abscess of the breast which are being treated by the closed method (*see* Chapter XLVI), the many-tailed bandage is absolutely necessary.

For the Thorax.—After an empyema has been drained, a many-tailed bandage with shoulder stirrups is unsurpassed. The tube can be brought out between the tails of the bandage.

THE T-BANDAGE

The T-bandage consists of a double fold of firm material such as calico or flannelette, 48 × 4 in., for the waist-piece, in the middle of which a single piece of material, about 36 × 7 in., is firmly sewn (*Fig.* 335). The waist-piece is passed round the patient, with the sewn portion at the centre of the back. The wider

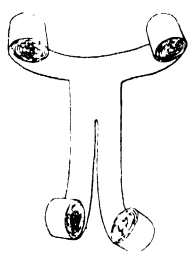


Fig. 335.—The T-bandage for the male.

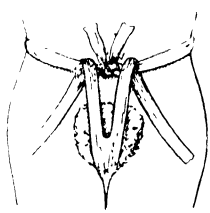


Fig. 336.—Method of securing a T-bandage. The loose ends are knotted. (*After Gabriel.*)

strip is brought from the back, upwards, between the patient's thighs, and secured to the waist-piece in front. This bandage is convenient for use in the case of either female or male patients by making the wide strip into one or two tails.

The T-bandage is very efficient. It is important to maintain firm pressure on the dressing with the hand until the T-bandage has been tied securely (*Fig.* 336).

NITSCHKE'S SCROTAL BANDAGE

We have found this a most excellent scrotal support, and apply it as a routine after operations upon the testicle or the inguinal canal. It is particularly valuable after operations for hernia, and by its regular use the complication of post-operative scrotal hæmatoma can be prevented. It should be noted carefully that the bandage is made of butter muslin, which in Canada is known as 'cheese cloth'.

A square of butter muslin, measuring 18 18 in., is folded diagonally (*Fig.* 337). A 3-in. gauze roller bandage is placed in the centre, between the layers of the preceding fold. Just above the roller bandage a small hole is made with a pair of blunt-ended scissors. A piece of $2\frac{1}{2}$-in. bandage, 16 in. long, is folded in the middle; the folded end is pushed through the opening made in the gauze and looped through. Another piece of bandage is tied round the patient's waist and the scrotal bandage is applied firmly, so as to elevate the scrotum. The ends are fixed as shown in the last two figures. The two ends of the muslin are tied to the waistband, after which a hole is made in the muslin to accommodate the penis.

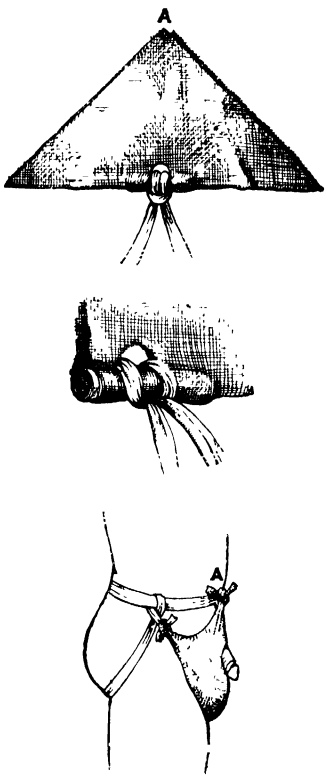




Fig. 337.—An easily constructed scrotal support.

VISCOPASTE BANDAGE

Viscopaste consists of a white gauze bandage impregnated with a paste of gelatin and zinc oxide. When applied it forms a light, firm plaster which can be left in position for several weeks if so desired. The bandage should not be applied in an overlapping spiral, but in the form of a reversed spiral, the aim being to obtain a uniform thickness of the paste over the affected area.

In the case of open wounds the wound itself is first covered with a few folds of the bandage; take, for instance, an open wound of the neck (*Fig.* 338).

After the Viscopaste bandage is in place an ordinary roller bandage should be superimposed (*Fig.* 339) to protect the Viscopaste until it has 'set'. Viscopaste is an excellent bandage after skin-grafting and for any other open wound



Fig. 338.—Before the bandage encircles the neck two folds have been employed to cover the wound



Fig. 339.—A roller bandage has been applied over the Viscopaste. This is left in place for several hours until the Viscopaste has set firmly

where the dressing must remain intact for a comparatively long period. It is extremely useful in the ambulatory treatment of varicose ulcers, and in many other conditions where a firm, long-lasting bandage is required.

If a Viscopaste bandage has been in stock for a considerable time, it may require to be softened by putting it in warm water.

CHAPTER XL

BANDAGES AND BANDAGING, *continued*: ADHESIVE PLASTER TECHNIQUE

By HAMILTON BAILEY AND SISTER PAULINE

UNDER the term 'adhesive plaster' we include flexible adhesive plaster, which is issued under a variety of somewhat perplexing proprietary names such as Elastoplast, Flexoplast, Leukoplast, and Pressoplast. Unless otherwise stated, it is *flexible* adhesive plaster which is to be employed in the bandages to be described.

Advantages.—Bandaging with adhesive plaster has certain advantages. Adhesive plaster does not become loose, nor can it become displaced; it provides excellent firm support which immobilizes the part; it prevents the patient from surreptitiously inspecting his wound.

Disadvantages.—In some patients the plaster causes skin irritation, and its removal is not painless. These disadvantages can be minimized considerably by paying attention to the following points:—

1. Adhesive plaster should never be applied unless the skin is hairless, or has been shaved adequately.

2. The skin should be dry and free from antiseptic paints, e.g., iodine.



Fig. 340.—Removing flexible adhesive plaster, little by little, after applying a solvent on a swab, as shown. This renders the process almost painless.

3. Painting the skin with compound tincture of benzoin before applying adhesive plaster helps considerably in preventing the formation of vesicles and pustules. We have found this extremely efficient. It is important to allow the coating to dry before applying the adhesive plaster.

4. Regarding removal of the plaster. Working from one free end, and then the other, little by little it should be pulled off towards the centre. As this procedure is in progress it is extremely helpful to dab on methylated ether, or, better still, one of the proprietary preparations called Zoff (T. J. Smith & Nephew) or Antihæsin (Allen & Hanburys), paying particular attention to the under surface of the adhesive plaster (*Fig.* 340). These solvents allow the plaster to be peeled off much more easily.

GENERAL PRINCIPLES OF APPLICATION

Like everything else, to get the best results a correct technique is necessary. Unless adhesive plaster is properly applied many of its advantages, such as the maintenance of even pressure, are lost; indeed, badly applied adhesive plaster is a menace. We have only to mention the plaster which becomes unstuck while

the patient is coming round from the anæsthetic, the rucked plaster, and the too-tight encircling limb plaster.

The plaster bandage adheres much better if it is bifurcated for a suitable distance at each extremity, and we recommend the following general principle.



Fig. 341.—Bifurcate—press—stretch—press—bifurcate, is the guiding principle in applying flexible adhesive plaster in most situations

The end of the plaster is bifurcated for a suitable distance. The plaster is applied well away from the dressing, and is held in place with the flat of the hand until the bifurcated portion, and that immediately adjacent, has adhered firmly. With the flat of the hand still keeping the end of the plaster in place, the roll of adhesive plaster is drawn very firmly over the dressing. An assistant places the flat of her hand on the contralateral side, and keeps it there while cutting and bifurcating her end. She does not remove her hand until the plaster has adhered (*Fig.* 341). Further strips of plaster are applied similarly, overlapping one another.

We will describe some typical examples of the use of adhesive plaster for bandaging, indicating where necessary its advantages or disadvantages as opposed to the corresponding methods in the preceding chapter. Actually, we are using



Fig. 342.—A pilonidal sinus has been excised and the wound sutured. The rubber pad is placed upon the gauze, and pressure exerted by flexible adhesive plaster.



Fig. 343.—The compression dressing completed

adhesive plaster relatively more frequently than hitherto, and the reports from the patients and the ward sisters appear to justify the preference.

The Compression Dressing.—In many situations elastic pressure applied to a sutured wound will enhance healing by preventing hæmatoma formation. We have found the following type of dressing very valuable. Formerly we employed sorbo sponge, but as this is not now obtainable, the pad is made from

rubber tubing, No. 12, bent backwards and forwards, and then stitched together (*Fig.* 342). Such pads may be used over and over again and are sterilized by boiling. The rubber pad is placed on the gauze which covers the wound. No wool is used. Strips of flexible adhesive plaster are then applied (*Fig* 343) and, what is extremely important, they are applied according to the principle illustrated in *Fig.* 341.



Fig. 344.—Adhesive plaster dressing for the head

THE HEAD

Instead of a bulky and conspicuous capeline bandage, a useful dressing for scalp wounds is shown in *Fig.* 344. A strip of flexible adhesive plaster, 2½ in. wide, is employed. The plaster is prepared by placing one layer of plain gauze to all that part of the sticky surface which will come in contact with the hair. The ends are slit for a length of 3 in., and the bifurcations are stuck to the skin on either side of the ears.

THE FACE

Pickerill's method of applying adhesive plaster in cases of Bell's palsy, and after operations upon the parotid gland, where the facial nerve may have been implicated, is one which should receive attention. Ordinary adhesive strapping, as opposed to flexible adhesive strapping, must be employed. The strips are applied as shown in *Fig.* 345.

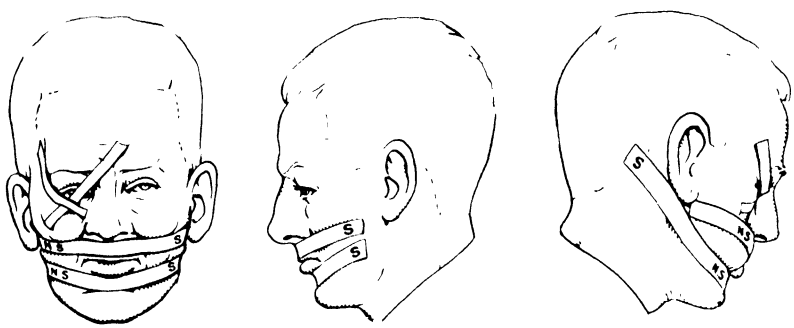


Fig. 345.—Pickerill's method of supporting the musculature in cases of paralysis of the seventh nerve. S, Strapping stuck to the skin. N S, Strapping not stuck to the skin.

THE NECK

After operations upon the neck adhesive plaster applied as shown in *Fig.* 346 provides a quick and efficient method of keeping the dressings in position. In many cases it can be used with advantage combined with a compression dressing.

The Thyroid.—Immediately after subtotal thyroidectomy for toxic goitre, we still prefer the firm support afforded by the roller bandage, but in the later stages of convalescence of these cases, and as a primary bandage after enucleation of thyroid adenomata, the 'stole' bandage is excellent. When the time comes for removal of the drainage tube or the stitches, the flexible plaster bandage can be cut, either in front, as shown in *Fig.* 347, or at the back. The

'stole' can then be reconstituted once again by approximating the cut edges with safety-pins or lacing.



Fig. 346.—A flexible adhesive plaster dressing applied after dissection of glands of the neck



Fig. 347.—The 'stole'. If it is cut along the line A–B, the dressing may be changed, and the severed portions re-joined with safety-pins

THE BREAST

After operations for removal of simple tumours of the breast a flexible adhesive plaster dressing is ideal. A hole should be cut for the nipple (*Fig.* 348). In this case the patient had a fibro-adenoma removed under local anæsthesia as an out-patient, and the bandage ensures that the wound will not be interfered with until she attends for the removal of the stitches.



Fig. 348.—A fibro-adenoma has been removed under local anæsthesia. A hole has been cut to accommodate the nipple.



Fig. 349.—A method of strapping the breast.

Strapping the Breast.—An extremely efficient method is illustrated in *Fig.* 349. The strips of plaster are made to adhere inferiorly and then carried over the shoulder. In this way the breast is elevated and supported.

THE THORAX

Strapping the Ribs.—Ordinary flexible plaster must be avoided in this instance. The old-fashioned rigid adhesive plaster is excellent for the purpose, or there is a variety of Elastoplast which is elastic only in its width, and not in its length. The strips should be 4 in. wide. The patient sits, if possible, with his arm raised and his hand resting upon his head or supported by an assistant. The first strip is applied inferiorly. It is made to adhere over the spine at the level of the 12th rib. The patient is then told to expire to the fullest degree, and the strip is carried round and made to adhere evenly as far as the sternum. With the curves of the ribs serving as a guide, further strips are applied during expiration in such a way that each strip overlaps the preceding strip by a third of its width (*Fig.* 350).



Fig. 350.—Strapping the ribs.

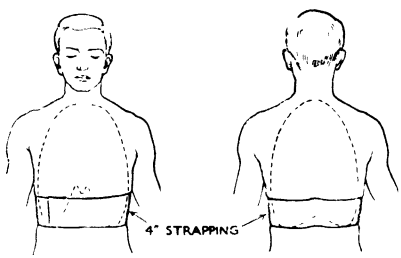


Fig. 351.—Blades' method of strapping the thorax

While the foregoing is the standard method of strapping the thorax, we are very impressed with Blades' method. Blades is emphatic that the proper method to immobilize the chest wall is to encircle the costal margin with 4-in. wide adhesive plaster as shown in *Fig.* 351. If this encircling plaster is put on during full expiration it is immaterial whether the upper or lower ribs are fractured, for the whole thoracic cage is immobilized.

After Empyema Operations.—When the 'closed' operation with rib resection has been performed for empyema, flexible adhesive plaster applied over the wound and the outer flanges of the Tudor Edwards tube helps considerably in making the drainage truly 'closed', i.e., water-tight.

THE ABDOMEN

We find that adhesive plaster dressings are particularly satisfactory after many abdominal operations. Take, for instance, gridiron appendicectomy. A gauze dressing is applied, and this is covered with flexible adhesive plaster in the manner shown in *Fig.* 352. Another typical example can be seen in *Fig.* 353. The patient has had Mayo's operation performed for an umbilical hernia. Strips of adhesive plaster are applied, which cover the wound completely and provide excellent support.

After hernia operations well-applied flexible plaster is second to none. In *Fig.* 354 is shown a patient who has had a large inguinal hernia repaired by



Fig. 352.—Gridiron appendicectomy. Over the gauze dressing strips of flexible plaster have been applied



Fig. 353.—Mayo's elliptical incision dressed with overlapping strips of flexible adhesive plaster

Gallie's fascial graft. The site of the operation has been covered by strips of flexible adhesive plaster, and a long strip covers the sutured wound of the thigh. It should also be noted that Nitschke's scrotal bandage (*see* p. 293) has been applied in this case.



Fig. 354.—Operation for inguinal hernia. Repair by Gallie's graft. The inguinal region has been bandaged by strips of adhesive plaster. The sutured wound of the thigh has been covered by a single strip of the same material.

After herniotomy in an infant flexible adhesive plaster is applied as shown in *Fig.* 355. To cover the area with oiled silk, kept in place by more flexible adhesive plaster as shown in *Fig.* 356, is an excellent practice. The penis is brought out through a suitable hole. If, in addition, a splint which reaches from the axilla to the ankle is



Fig. 355.—Herniotomy has just been performed. A single layer of gauze is covered by flexible adhesive plaster.



Fig. 356.—Note the oiled silk protective covering and the splint which will be applied from the axilla to the ankle.

strapped to the lateral side of the patient by further adhesive plaster, the operative area is immobilized so well that many of these patients can be sent home as soon as they have recovered from the anæsthetic.

CORSETTAGE

By the early and intelligent use of corsettage in appropriate cases the final closing of a wound is often expedited by many weeks and the number of wounds requiring secondary suture is reduced considerably (*Fig.* 357). In the case of abdominal incisions corsettage is particularly valuable. When the wound is threatening to break down and or the patient has a persistent cough, the timely use of corsettage will prevent many 'burst abdomens'.

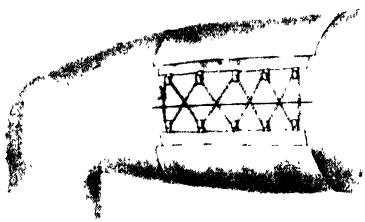


Fig. 357.—Showing the principle of corsettage

Sir Robert Kelly's Method.—A piece of strapping is folded longitudinally, not quite in the midline, its sticky side outwards. Nicks are made with scissors (*Fig.* 358, A) in the fold, just large enough to allow a dressmaker's hook, but not its flattened arch, to be

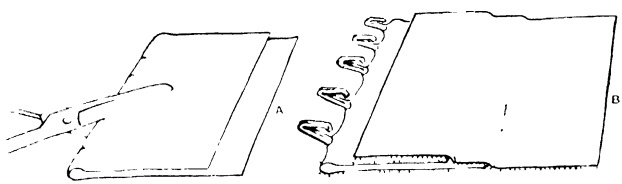


Fig. 358.—Kelly's method of fixing dressmaker's hooks to adhesive strapping

pulled through. When enough hooks have been inserted a second piece of strapping is placed over the first, sticky side down (*Fig.* 358, B).

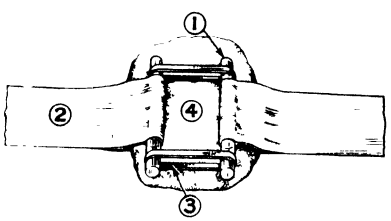


Fig. 359.—Method of fixing a dressing which requires frequent changing. (1) Glass rods; (2) Strips of flexible plaster folded round the glass rods so that the adhesive surface does not come into contact with the dressing; (3) Rubber bands; (4). Dressing (*After Learmonth.*)

The strapping is fixed to the skin parallel with and about one and a half inches from the edges of the wound. The hooks are then laced with a length of stout silk.

Learmonth's Method.—Two strips of adhesive plaster are folded round glass rods in such a way that the adhesive surface does not come in contact with the dressing. When the adhesive plaster has adhered to the skin, strong rubber bands are applied as shown in *Fig.* 359.

Laparotomy Corsets.—Good as is corsettage of abdominal incisions by one of the above methods, we find the ready-made abdominal laparotomy corsets manufactured by Biersdorf & Co., of Welwyn, exceedingly valuable.

In certain cases—for instance, in a very stout patient or when the wound is transverse—it will be found that the corsets fit much better and are more comfortable if they are cut every three or four inches. Cutting the corsets

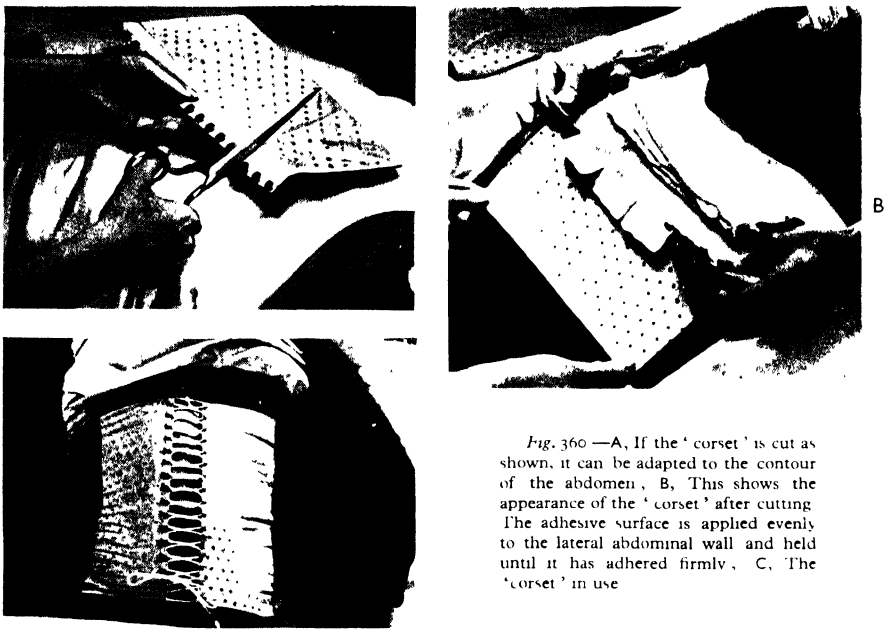


Fig. 360.—A, If the 'corset' is cut as shown, it can be adapted to the contour of the abdomen; B, This shows the appearance of the 'corset' after cutting. The adhesive surface is applied evenly to the lateral abdominal wall and held until it has adhered firmly; C, The 'corset' in use.

makes them more pliable and enables them to be fitted to an uneven contour. In order to avoid explanation of the method of cutting, a reference to *Fig.* 360, A, B, C, will make the procedure quite clear.

THE 'WATERSHED' DRESSING

The 'watershed' dressing is used to separate two wounds, notably a laparotomy incision from a colostomy or a cæcostomy. It ensures that the former

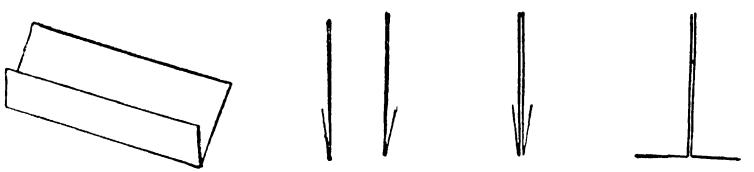


Fig. 361.—Making a 'watershed'. A, Method in which the strips of adhesive plaster are folded; B, Approximation of the strips held by the surgeon and assistant; C, The strips approximated; D, The 'watershed' applied to the abdomen.

is not contaminated by the discharge from the latter. Non-flexible adhesive plaster is used.

A strip of broad adhesive plaster about 6 in. long is taken by the surgeon, and a similar piece of exactly the same length by the working assistant. Facing

one another, and independently but simultaneously, both the surgeon and the assistant fold their piece of plaster longitudinally (*Fig.* 361, A). The surgeon now approaches the assistant, and the strips of plaster are placed back to back (B and C). The surgeon then takes the two pieces, the backs of which have adhered to one another and applies the 'watershed' to the abdominal wall between the two wounds (D). *Fig.* 362 shows the 'watershed' in action.



Fig. 362.—'Watershed' in action

In addition to preventing fæcal contamination of the laparotomy wound, it serves to remind the nurse that the two dressings must be performed separately.

THE SCROTUM

As a post-operative bandage the Nitschke scrotal bandage (*see* p. 293) is unsurpassed, but the Bellevue bandage has its uses, and it is valuable in cases of mild epididymo-orchitis where the patient has to be treated ambulatorily.

The Bellevue Bandage.—Instructions for making the bandage are epitomized in *Fig.* 363. Either ordinary adhesive plaster or flexible plaster can be used. The top of the bandage is divided into two equal parts by tearing it down for 12 in. An inverted V is cut in the other end of the plaster 16 in. deep, to make two perineal strips. A piece of gauze 4 in. wide and a roller bandage 2½ by 1 in. are placed as shown; the latter is best stitched to the adhesive.

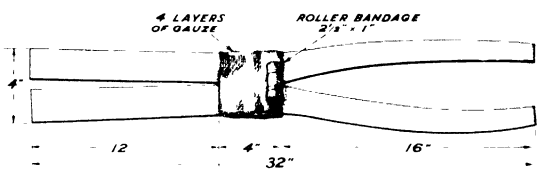


Fig. 363.—The Bellevue bandage



Fig. 364.—The Bellevue bandage applied.

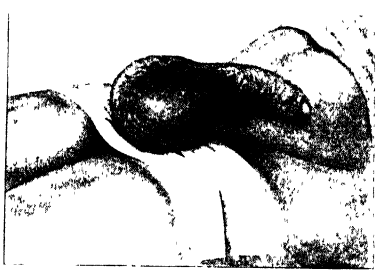


Fig. 365.—A scrotal sling.

The bandage is applied in the following manner. The scrotum is elevated and the gauze pad is applied to the perineum, the roller bandage being tucked behind the root of the scrotum. The other hand places the broad strips over

the inguinal regions, and they are held until they stick firmly (*Fig.* 364). The perineal strips are then brought round the thighs in the gluteal folds, over the anterior superior spines. To make the suspensory bandage stick to the skin better, another piece of adhesive plaster is made to adhere over the hypogastrium from one great trochanter to the other.

A Scrotal Sling is made by applying broad adhesive (non-flexible) plaster to the thighs in the manner shown in *Fig.* 365. With the legs in apposition and the scrotum elevated, the strip of adhesive plaster is applied tightly across the thighs, well up towards the perineum. A little pad of cotton-wool, upon which is sprinkled dusting powder, makes a good nest upon which the testicles can lie. A bed-cage is used to prevent pressure from the bedclothes. The main use of the scrotal sling is in cases of acute epididymo-orchitis.

STRAPPING THE BUTTOCKS TOGETHER

This is an important procedure in cases of prolapsed rectum (*Fig.* 366), in order to keep the prolapse in place after it has been reduced. We employ it regularly in the out-patient department after the injection of internal hæmorrhoids.



Fig 366.—Strapping the buttocks together. Unless the principles set out on page 295 are followed, this extremely efficient measure is rendered useless

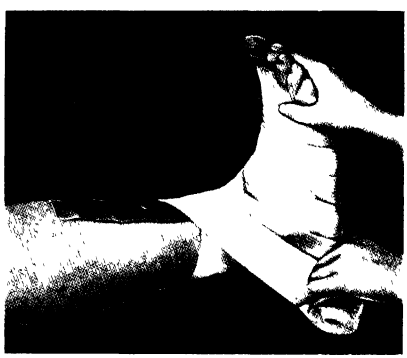


Fig 367.—Applying a flexible adhesive plaster bandage to a sprained ankle.

JOINTS

For many joint conditions, particularly sprains, the adhesive plaster bandage is indispensable. As a typical example will be taken the case of a torn external lateral ligament of the ankle-joint.

A strip of adhesive plaster is applied to the dorsum of the foot and continued half-way up the leg. An adhesive plaster bandage is then applied in wide figure-of-8 turns, care being taken to keep the foot flexed and everted (*Fig.* 367).

THE LIVERPOOL METHOD OF PREPARING AND APPLYING STRAPPING EXTENSION

There are many occasions where strapping extension can be applied with advantage. We will take the case of an inflamed hip-joint. Straps must be

prepared to suit the individual case. Measurement from fold of the groin to just below the malleoli is taken. This represents the length of the strapping required. The girth of the thigh is measured—two-thirds of this measurement is taken as the width of the strapping required. A piece of Flexoplast orthopædic strapping or Leslie's Holland strapping is cut according to these measurements. Because the diameter of the lower limb becomes increasingly less from the thigh to the ankle and the strapping must fit the limb as accurately as possible, the strapping is bisected in the manner shown in *Fig.* 368, after which each strip is nicked all along the edges with cuts about $\frac{1}{4}$ in. in depth (*Fig.* 369). The next

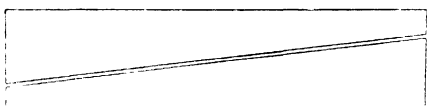


Fig. 368.—Showing the method of cutting strapping so that two tapering strips can be obtained from one length of material



Fig. 369.—The strapping is nicked, as shown, the better to mould it to the contour of the limb

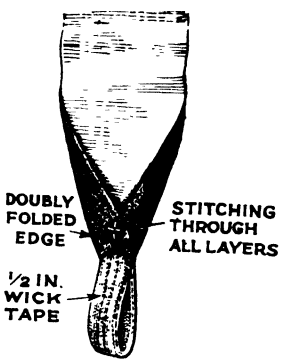


Fig. 370.—The method of stitching a lamp-wick loop to the end of the strap.

step is to fix a loop of $\frac{1}{2}$-in. lamp-wick to the narrow end of the strapping. This is carried out as shown in *Fig.* 370, and the stitching must be done securely. The straps are now ready for application.

The limb should not be shaved. The strapping is heated sufficiently and each strap is applied evenly to the limb. The inner strap should be slightly anterior to the outer. The straps are held in position by a *loosely applied gauze bandage* (*Fig.* 371). Just above the ankle the gauze bandage ceases to be applied over the strapping; it is passed beneath the non-adherent attachments of the wick tapes. Two or three turns of bandage over the malleoli will prevent pressure on these bony points. If the fractured limb is to be treated on a Thomas splint, a piece of flannel bandage is threaded through each of the wick loops and twisted so as to form a cord. One cord is passed in front of the outer

bar and the other is passed behind the inner bar. Sufficient extension is maintained by tying the two cords tightly over the end of the Thomas splint, *Fig.* 372. When the limb is not being treated on a Thomas splint, a wooden spreader can be used. The wooden spreader should be incorporated in the strapping before its application (*Fig.* 373), or if the pattern shown in *Fig.* 374 is available, it can be buckled on to the standard straps.

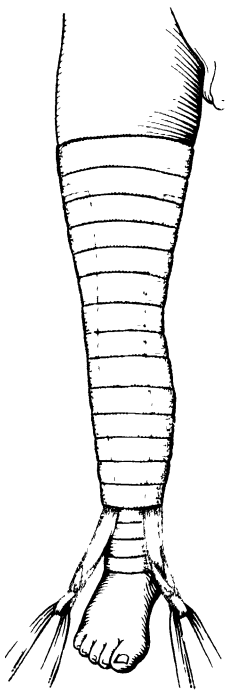


Fig 371.—Note carefully that a gauze bandage is applied over the straps, then under the straps, in the region of the malleoli. The method of threading a piece of flannel bandage through each loop of lamp-wick tape is also depicted



Fig. 372.—Showing the method of passing the extensions around the bars of a Thomas splint and tying them.

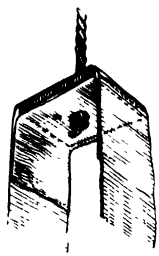


Fig 373.—A wooden spreader for incorporation in strapping plaster ready for application

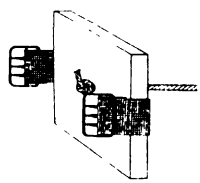


Fig 374.—A wooden spreader for buckling to extension straps already attached to the limb

APPLYING STRAPPING EXTENSION TO AN AMPUTATION STUMP

Four suitable pieces of strapping extension are prepared according to the instructions given above. It is, however, unnecessary for them to be cut so that

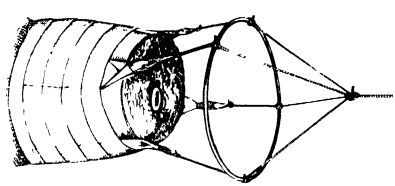


Fig 375.—Strapping extension applied to an amputation stump

they taper. With blind cord, the straps are connected to a hoop (*Fig.* 375). When a hoop cannot be procured, a substitute can be constructed easily from Cramer wire.

THE FINGER

A strip twice the length of the finger is cut from a 2½-roll of flexible plaster. It is applied on the flexor surface as shown in *Fig.* 376. Using one half for the front, the other half is turned over the top to cover the back. The two sides

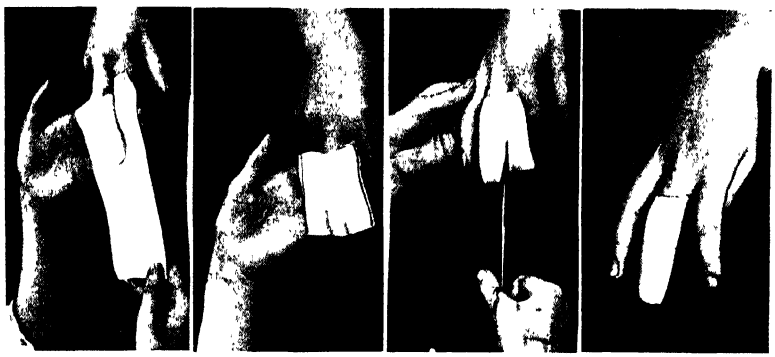


Fig. 376.—A, A strip of flexible adhesive plaster is applied to the finger, as shown; B, The excess at each side is pressed together; C, The excess is cut away, D, The dressing completed.

of the bandage will adhere to each other. They are pressed together carefully, the excess being cut away with scissors. Care must be taken not to apply this dressing tightly, and to be sure that a small part of the adhesive plaster below the dressing is in contact with the skin.

CHAPTER XLI

SOME GENERAL PRINCIPLES IN MINOR OPERATIONS

By HAMILTON BAILEY

LOCAL ANÆSTHESIA

THE remarks concerning the provision of unquestionably sterile local anæsthetic —a cardinal requisite for many minor operations—are addressed particularly to the general practitioner who may require to use it only at comparatively long intervals. Ampoules solve this problem.

For small infiltrations, the P.M. syringe (*Fig.* 377), which is loaded with cartridges of 2 c.c. of local anæsthetic (costing about 2s. 6d. a dozen), is extremely handy and efficient. For larger infiltrations capsules of powdered novocain are recommended. The contents of one capsule in ¼ pint of boiled water dissolve immediately and form a 1 per cent solution which is infiltrated by means of a Record syringe. The syringe must, of course, be efficiently sterilized (*see* p. 233), and it should not be one which has served general purposes, for instance, aspirating pus from the chest. I labour the necessity for constant vigil regarding sterility; sterility of the overlying skin, of the anæsthetic solution, of the syringe and needles, only because I have seen disasters. True, they have been few—probably constituting not more than one-fifth of 1 per cent of cases. But then, I have spent my surgical lifetime working under much more favourable conditions than the average practitioner.

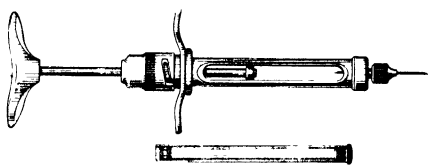


Fig. 377.—The P.M. syringe and a cartridge of local anæsthetic. (Pharmaceutical Manufacturing Co. Ltd., Cheltenham.)

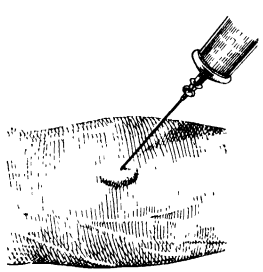


Fig. 378.—The first puncture is made with a fine needle, and a wheal is raised

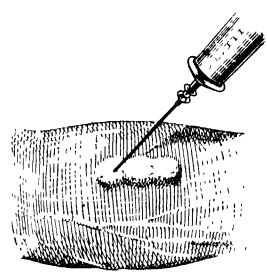


Fig. 379.—Subsequent punctures are made into the edge of a wheal

Technique of Infiltration.—The first puncture should be made with a very fine needle, and a wheal is raised (*Fig.* 378). As succeeding punctures can be

made through anæsthetized skin (*Fig.* 379), a larger needle, which makes infiltration less laborious, can be employed. Infiltration of the deeper planes must be thorough, but having introduced the needle it is an excellent practice to make a routine of having the syringe not quite full of local anæsthetic solution, and before discharging the contents of the barrel, to try aspiration. This ensures



Fig. 380.—Points of puncture for anæsthetizing a digit

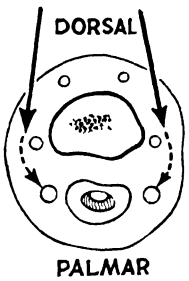


Fig. 381.—Anæsthetic solution should always be introduced from the dorsal surface

that the point of the needle is not in a blood-vessel. I feel sure that novocain convulsions and other untoward symptoms which from time to time have been encountered are due, not to an idiosyncrasy, but to injecting local anæsthetic directly into the venous system.

Special Infiltrations.—It is quite impossible to detail precise technique for the legion of individual minor operations which can be performed. A few common instances requiring somewhat more than straightforward methods will be detailed.

Anæsthetizing a Digit.—By correctly infiltrating the base of a finger or toe, the whole digit can be rendered anæsthetic. The needle is introduced from the dorsum (*Fig.* 380) and infiltration carried round to the palmar aspect, as depicted in *Fig.* 381.

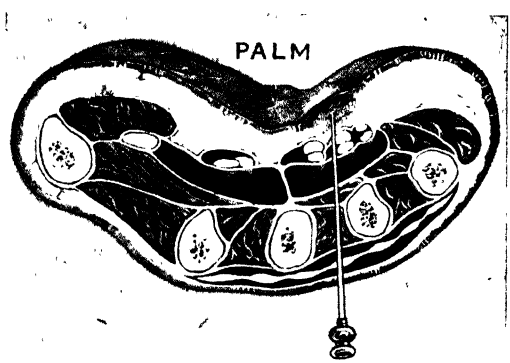


Fig. 382.—Local anæsthetic being introduced from the dorsum to anæsthetize the palm.

Anæsthetizing the Palm of the Hand.—Again, the anæsthetic solution must be introduced from the dorsum. Infiltration should be widespread; it is an easy matter to infiltrate the subcutaneous tissues of the palm from the dorsum (*Fig.* 382).

Anæsthetizing the Inferior Dental Nerve.—This is an extremely useful procedure to master, for it renders anæsthetic one-half of the lower jaw and its overlying mucous membrane. It is a very good method to employ when opening an alveolar abscess.

The syringe depicted in *Fig.* 383 is used by dental surgeons, and thus is admirably suited for this purpose. The objective is to infiltrate the inferior dental nerve as it enters the inferior dental foramen at the outer side of the lingula (the spine of Spix). This point lies about half an inch above the posterior extremity of the last molar tooth. Often the lingual nerve is infiltrated at the same time. Thus it is possible effectively to anæsthetize one-half of the floor of the mouth and the tongue by this manœuvre.

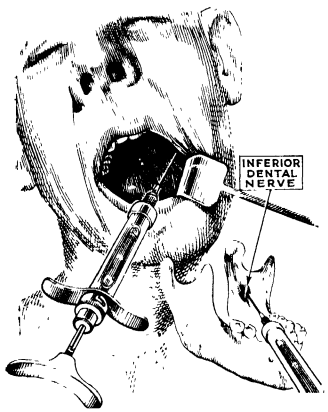


Fig 383.—Blocking the inferior dental nerve.

TECHNIQUE OF SOME MINOR OPERATIONS

In this chapter I will detail the technique of some minor operations which can be carried out by the practitioner and are not included in the chapters on minor surgery which follow this introduction.

Excision of a Wart.—Inject local anæsthetic into the skin at the base. Pick up the wart near its base lightly with a hæmostat, and apply traction. With a scalpel, make a narrow elliptical incision around the wart, removing the pedicle with a piece of normal skin. Do not attempt to substitute the foregoing by cutting the pedicle with scissors, as not only is recurrence likely, but the resulting wound will heal less kindly.

Excision of a Subcutaneous Lipoma. — Infiltration is made at four points (*Fig.* 384). At each a skin wheal is raised, and through this (*a*) the whole of the subcutaneous surface of the lipoma, and (*b*) the whole of the deep surface can be anæsthetized. It will be realized that if a subcutaneous tumour is removed through a straight incision, too much overlying skin will remain, and if the skin edges are approximated there will be bagginess, which predisposes to hæmatoma formation beneath. Therefore, commence the operation by making an elliptical incision (*Fig.* 384), the breadth of the ellipse being proportional to the size of the tumour. Leave the island of skin attached to the lipoma and dissect laterally, until the tumour is free. In some cases a subcutaneous lipoma can be easily enucleated with the finger, but unless the neoplasm literally "pops out" do not try to force it; rely upon dissection.

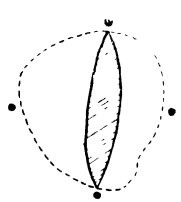


Fig. 384 — Excision of a lipoma Showing the points at which local anæsthetic is injected and the ellipse of skin to be removed The size of the latter depends upon the size of the tumour.

Excision of a Sebaceous Cyst.—It is a mistake to endeavour to dissect out the cyst *in toto*. Cut the cyst clean in two (*Fig.* 385). Remove the sebaceous matter by squeezing with a swab. When all the contents of the cyst

have been removed it will be found that some of the lining membrane has been left behind. With a hæmostat, pull out this lining; it is friable, but with two or three manœuvres every piece of it can be stripped off. In the case of larger cysts there will be an excess of skin; excise a suitable crescent from each skin margin before approximating the skin edges with sutures. A compression dressing (*see* p. 296) completes the operation.

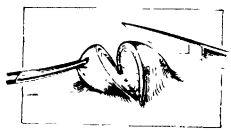


Fig. 385.—Excision of a sebaceous cyst. Step 1, the cyst has been bisected

Excision of a Pigmented Mole.—Many disastrous melanomata are the result of cauterization and other similar treatment of pigmented moles; incomplete excision is another common cause of the occurrence of a malignant change. If a pigmented mole is to be removed, and this is a wise precaution, clean surgical excision, including an adequate margin of healthy tissue, is the sole permissible procedure. Inject the local anæsthetic at a distance from the tumour. Insert two sutures some distance from the mole (*Fig.* 386). Excise widely and deeply down to the fascia, using the sutures, not forceps, for traction (Lee).

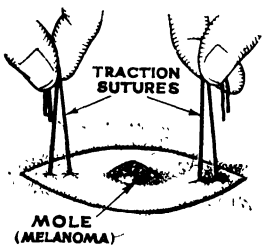


Fig. 386.—Technique of excision of a pigmented mole (*after Lee*)

Excision of a Fibro-adenoma or a Cyst of the Breast.—Comparatively small, innocent lumps in the breast are particularly well suited to removal under local anæsthetic. The very small lump is often more difficult to remove than one, say, the size of a pigeon's egg. The reason for this is that when the tissues have been infiltrated, the localized swelling which previously could be palpated with ease, becomes obscured by the œdema. It is therefore advisable to spend a little time in being absolutely sure of the exact location of the lump before infiltration, and to disperse the local anæsthetic by massage before commencing to operate. Having regard to the subsequent scar, a suitable incision is made over the lump.* After ligating bleeding vessels in the subcutaneous fat, the breast tissue is exposed. The tumour may lie on the surface, or, what is more usual, some of the breast tissue must be incised before the lump is revealed. The opportunity of palpating the lump through the wound is taken before infiltrating the deeper planes around the lump. In the case of a fibro-adenoma a definite plane of cleavage will be found and the tumour can be shelled out easily. In cases of a cyst (usually found in conjunction with chronic interstitial mastitis) it is not often possible to perform a clean dissection. The cyst is usually opened before the operation has progressed very far, and it is often advisable to include a portion of the breast tissue in the immediate vicinity of the cyst wall in the excision. Once a lump has been removed and bleeding points have been arrested—undersewing them with a ligature on a needle is often an excellent practice—a few deep, buried sutures are necessary to bring together the cleft in the breast tissue before closing the skin. If hæmostasis is good and a compression dressing is applied, drainage is unnecessary.

* In the case of a fibro-adenoma of the breast, Greene's technique of anchoring the tumour with a straight cutting needle before infiltrating the local anæsthetic is an excellent practice. Greene recommends this to be done before any local anæsthetic is introduced, but a preliminary minute intradermic injection does not interfere with the procedure.

If the operator has any doubt whatsoever on the nature of the tumour removed, it should be submitted to histological examination and the patient told that the result of the examination must be awaited.

Evacuation of a Subungual Hæmatoma.—There are many reasons why a hæmatoma under the nail should be decompressed and the blood evacuated. Pain is relieved almost immediately, the danger of infection is very considerably minimized, an unsightly black nail, which will be with the patient for many months, is prevented. The operation should be undertaken much more frequently than is the case. Of several methods, the following is very simple and effective. In many cases it can be undertaken without anæsthesia, but if the finger is very tender it is wise to infiltrate the base of the digit as described on page 309. A sharp, rather pointed scalpel is taken and with a drilling motion, employing very little pressure, a hole is drilled in the nail just above the quick (*Fig.* 387). This permits the blood to escape and by gently squeezing, if the case is a recent one, all the blood can be evacuated. A little sulphonamide powder is pushed into the trephine hole with the blunt end of a needle, and flexible adhesive plaster is applied so as to exert moderate pressure.



Fig 387 — Trephining the nail in order to evacuate a subungual hæmatoma.

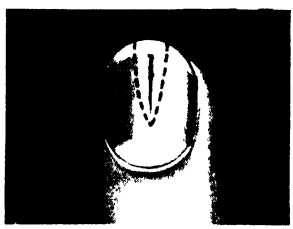


Fig 388 —A wedge-shaped piece of nail should be removed to give access to a foreign body beneath the nail

Removal of a Splinter beneath the Nail.—So often failure to remove the foreign body, or all of it, results in infection. The following simple and regularly effective measure should be adopted in all cases. The base of the finger is infiltrated with local anæsthetic. A wedge of the nail overlying the splinter is excised (*Fig.* 388). This permits indisputable access; not only can the foreign body be removed easily, but the wound can be cleansed and dressed.

Skin-grafting by Thiersch's Method has a great field of usefulness, and comparatively small granulating areas can be covered with satisfactory grafts without hospitalization. I have carried out the technique shown pictorially in *Figs.* 389–394 many times, and I think the practitioner will find it useful. A really sharp razor (not hollow-ground), a pair of ordinary wooden butter pats and a probe are the only instruments required.

Removal of a Salivary Calculus from Wharton's Duct.—The stone must be palpable. The patient should be lying down and a good light is necessary. A mouth-gag is placed in position on the opposite side. An assistant gets a firm hold with one hand on the tip of the tongue in a swab, and draws the tongue outwards, upwards, and towards the opposite side. With the other hand, the corner of the mouth is drawn backwards with any curved retractor. Having dried the area, the operator again palpates the stone and injects local

Skin-grafting by Thiersch's Method

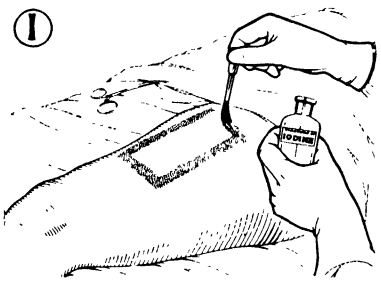


Fig. 389.—The first step is to map out the area from which the graft is to be taken. The edges are outlined with iodine

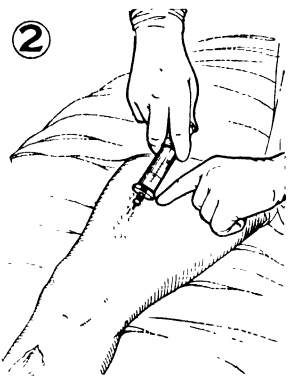


Fig. 390.—The marked area is infiltrated with local anæsthetic. Had it not been mapped out, it would be difficult to tell which part was anæsthetized and which was not

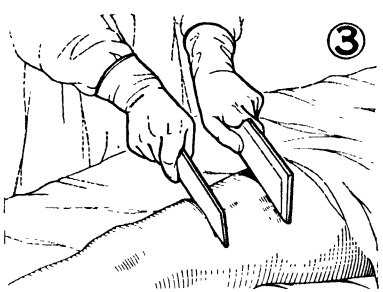


Fig. 391.—The anæsthetized area of skin is stretched forcibly. A pair of ordinary butter pats, which have been sterilized by boiling, are drawn apart steadily and then held firmly in place.

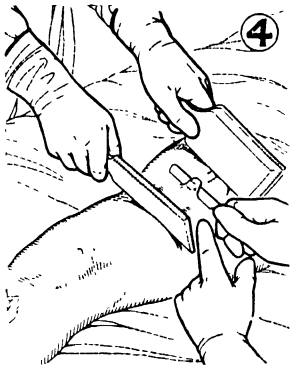


Fig. 392.—With the skin stretched to the fullest degree, the graft is cut with a very sharp razor, moist with saline solution. A sawing movement is used and care is taken that only skin is removed

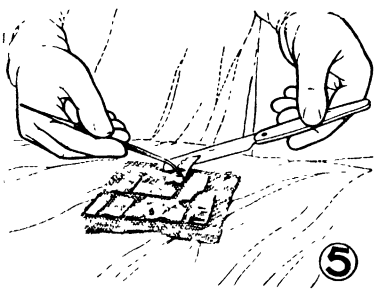


Fig. 393.—Each graft is about 1 in. square, and one by one they are transferred to the surface of a piece of tulle gras, which has been cut to the shape of the area to be grafted. The grafts, as they lie on the tulle gras, must have their raw surfaces uppermost

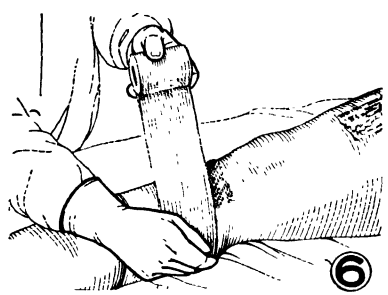


Fig. 394.—The piece of tulle gras covered with the grafts is laid skilfully on the area to be grafted. A few layers of dry gauze are placed over the tulle gras, which in turn is covered firmly with flexible adhesive plaster. The area from which the graft was taken is covered with a dry dressing. The dressings are not disturbed for a week.

anæsthetic beneath it. One puncture is sufficient. With a small curved needle on a holder, a deep stitch is inserted into the floor of the mouth behind the stone. With this in place the floor of the mouth can be steadied and the stitch prevents the stone from slipping backwards into the hilum of the gland. An incision in the long axis of the duct is made over the stone. Often the point of the scalpel can be felt to grate upon the calculus. It is now a simple matter to lever the stone from its bed. A hæmostat can be used for this purpose, but the stone should not be grasped and pulled (or it will break). It should be rendered free and picked out of its bed. The temporary suture is removed. Bleeding is slight. A mouthwash is the only after-treatment necessary.

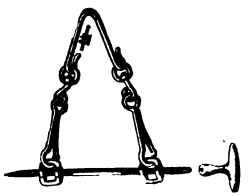


Fig. 395.—Whitchurch Howell's nail.

Skeletal Traction.—As this important subject is not dealt with elsewhere in the book, it will be included here. My own preference is for a nail, and of the nails I prefer Whitchurch Howell's (*Fig.* 395); but this suggestion is for the practitioner; it is beside the point for the house surgeon, who will follow the instructions of his chief.

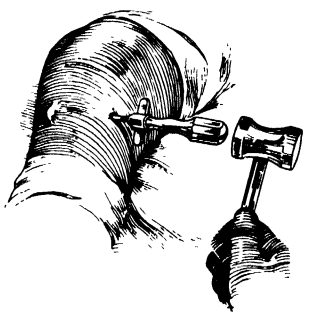


Fig. 396.—Inserting a nail through the upper end of the tibia.

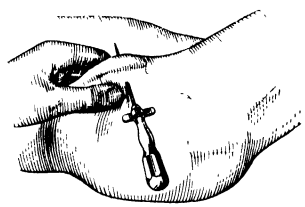


Fig. 397.—Steinmann's nail has been inserted through the iliac crest (*after Kirschner*)

Insertion of Steinmann's Nail.—

a. Through the upper end of the tibia: The point chosen should be ½ in. behind the crest, just below the level of the tubercle of the tibia (*Fig.* 396).

b. Through the lower end of the tibia: Here the bone is penetrated about 2 in. above the ankle.

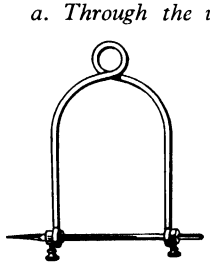


Fig. 398.—Bohler's swivel stirrup affixed to a Steinmann nail.



Fig. 399.—Max Page's nail holder.

c. Through the os calcis: The nail is driven through the bone at a point 1 in. below and behind the external malleolus. Do not use this site for continuous traction.

d. Through the iliac crest: The iliac crest is grasped with the left hand and the soft tissues are pressed back vigorously from the bone. The bone is bored through in the manner shown in *Fig.* 397. *See also* p. 361.

In all cases the skin should be sterilized with great care. A nick is made with a scalpel and the nail is driven through with a hammer in the case of Steinmann's nail (*Figs.* 398, 399); by boring with the attached handle in the case of Whitchurch Howell's instrument. When the point of the nail appears on the contralateral side, the skin is again nicked and the nail advanced appropriately. Pentothal anæsthesia is suitable for these operations.

The Removal of a Nail.—The stirrup is detached and the entrance and exit wounds, together with the nail itself, meticulously cleansed with spirit. The nail can be pulled out with pliers, and as it is loose, an anæsthetic is unnecessary. The entrance and exit wounds are swabbed, this time with iodine or some other skin antiseptic, covered with a small piece of sterile gauze, and sealed with flexible adhesive plaster. Healing should take place within a fortnight.

Kirschner's wire has the advantage over nails that it can be inserted under local anæsthesia. The apparatus is liable to get out of order, the wire sometimes snaps, but above all, the wire may cut out if heavy extension is employed without orthopædic understanding. If the last happens, serious damage may result. I know that Kirschner's wire can be most successfully employed, but I feel that the house surgeon should receive practical instructions from his chief in its use, and without that advantage it should not be employed.

When a nail or wire has been inserted, it is highly important to make a watertight junction on each side by painting collodion over wool or gauze at the point where the nail or wire protrudes from the skin.

CHAPTER XLII

MINOR OPERATIONS ON THE MALE GENITAL ORGANS

By HAMILTON BAILEY

CIRCUMCISION

In a very Young Infant.—For a number of years house surgeons at the Royal Northern Hospital, London, who had had their training in Australasia, advocated, and performed very successfully, circumcision by means of a pair of bone forceps (*Fig.* 400). This method has long been used in Australia for circumcision in young infants. The penis is cleansed with soap and water. The tip of the foreskin is grasped laterally by small Spencer Wells forceps, and enough traction is made upon it to allow a thorough breaking up of adhesions under the prepuce with a probe. This part of the procedure must be done very thoroughly. Exercising suitable traction on the now freed prepuce, the bone forceps are applied just distal to the glans with their V-shaped surface towards the baby. There is momentary pain experienced, but it lasts only a few seconds. After three minutes the superfluous tissue is severed with a sharp scalpel just distal to the instrument. It will be found that there is no hæmorrhage and that the skin and the mucous membrane are sealed together throughout the circumference sufficiently to allow what remains of the foreskin to be placed gently behind the corona. A dressing of tinct. benzoini co. is all that is required. Healing occurs very quickly.

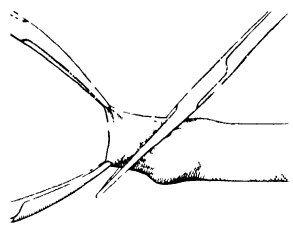


Fig. 401.—Circumcision. Applying sinus forceps preparatory to excising the redundant skin.

Fig. 400.—Type of bone forceps used in circumcision.

In Older Children.—A general anæsthetic is given. The prepuce is grasped in sinus forceps, which are inclined somewhat downwards (*Fig.* 401). Redundant skin in front of the forceps is amputated with scissors. The forceps are removed, and the skin retracts, displaying the preputial mucosa covering the glans. A dorsal slit is made in this mucosal shroud, whereupon it can be peeled off the glans, smegma being brushed away with a swab. The mucosa is now trimmed to within a quarter of an inch of the corona. It remains to unite the cut edges of skin and mucosa to one another by fine, interrupted catgut sutures. The first of these stitches includes the severed frænal artery, which it is usually necessary to clamp early in the operation. The three-in-one frænal stitch (*Fig.* 402)

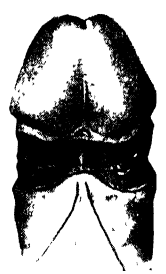


Fig. 402.—The three-in-one frænal stitch.

is a neat method of securing this artery and approximating the skin and mucosa at this point. The dressing is preferably tinct. benzoini co., applied on a narrow strip of gauze or wool.

In the Adult.—It is far best performed under local anæsthesia, which is highly satisfactory.



Fig. 403.—Method of anæsthetizing the prepuce when it cannot be retracted.

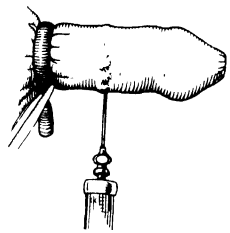


Fig 404 —Method of anæsthetizing the prepuce when it can be retracted.

When the Prepuce cannot be Retracted.—After cleansing the area thoroughly, 1 per cent novocain is infiltrated into the foreskin as far back as a quarter of an inch behind the corona. The patient only experiences pain on the first prick of the needle, which is driven in by a sharp stab, at the point shown in *Fig.* 403. Via this puncture the whole of the prepuce is ballooned with the local anæsthetic. It is sometimes advisable to make a second puncture to infiltrate the frænum.

When the Prepuce can be Retracted.—The alternative method of introducing the anæsthetic, shown in *Fig.* 404, can be employed.

Operation.—Grasping the edges of the prepuce in hæmostats, a dorsal slit is made to within a quarter of an inch of the corona. A hæmostat is then placed on the frænum and the requisite amount of prepuce is excised. In this connexion it is well to note carefully that it is preferable to excise too little than too much. The ideal circumcision should provide just enough skin to surmount the corona. Suturing the mucous membrane to the skin is accomplished in exactly the same way as in the child.

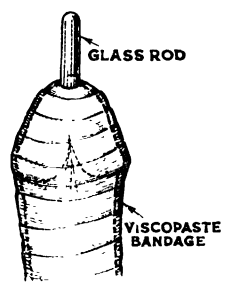


Fig. 405.—Technique of the dressing.

Post-operative Dressing.—Priapism is minimized, as also is the likelihood of post-operative hæmorrhage and infection, if the following dressing is applied carefully. Sulphanilamide powder is dusted upon the suture line, which is wrapped with a strap of vaseline gauze. A well-lubricated glass rod is introduced into the mouth of the urethra while a narrow viscopaste bandage is applied. The entire penis is bound up (*Fig.* 405), after which the glass rod is removed. At the end of a week the dressing can be removed easily by splitting it with scissors.

The operation is quite painless, but priapism may follow. A full dose of bromide (30 gr.) should be prescribed.

Hæmorrhage after circumcision usually occurs from the region of the frænum. The three-in-one frænal stitch minimizes this untoward occurrence. Further,

it can be used with advantage to stop bleeding in the area. When bleeding is coming from any part of the cut surface, an interrupted stitch or two will usually control the hæmorrhage, especially when ribbon gauze soaked in tinct. benzoin. co. is wrapped around the region of the corona. When persistent bleeding occurs after circumcision, hæmophilia should be suspected, and measures taken forthwith to supply an adequate amount of prothrombin.

INCISION OF THE FORESKIN FOR BALANITIS AND CHANCROID

It is most unwise to perform circumcision in cases of balanitis and soft sores, but if the patient has phimosis it is necessary to expose the glans.

Intravenous anæsthesia is advised, and instead of the usual dorsal slit, it is better to make two incisions, one on either side of the penis, so as to expose the pockets on each side of the frænum. A grooved director is inserted under the foreskin, and upon this the mucous membrane and skin are slit with scissors from the free margin to the back of the corona.

PARAPHIMOSIS

In early cases the following can be tried: the end of the penis, including the strangulating band, is wrapped in a bed of cotton-wool soaked in a mixture of 1·0 per cent adrenaline and 10 per cent cocaine. The compress is kept in position for ten to fifteen minutes. On removal of the compress the œdema will be found



Fig. 406.—Method of attempting to reduce a paraphimosis.

to have abated considerably, and by the manœuvre shown in *Fig.* 406 the prepuce can often be restored to its normal position.

It should be noted that it is usually only possible to effect reduction by simple manipulation when the condition has been present for not more than six hours.

The classical method of treating cases which do not respond to the above measures is to give a general anæsthetic, nick the constricting band in several places, and then apply forcible pressure. In my experience not only does forcible reduction often fail, but it causes much bruising, and after nicking and battering the penis, infection commonly supervenes. Even when successful, circumcision must be performed later, otherwise the condition will recur.

For these reasons I strongly recommend the following operation: Local anæsthetic is injected in the circular form about ¼ in. proximal to the constricting band. The œdematous area distal to the constricting band is also lightly infiltrated, paying particular attention to the frænal region. The constricting band can then be excised painlessly (*Fig.* 407). This leaves an œdematous collar attached to the corona. When the œdema has been reduced by compression, it will be seen that most of this is composed of mucous membrane behind the corona. This is trimmed according to circumstances, and on the other side of the gap left by excision of the band a further cuff is excised, according to judgement, before uniting the skin to mucous membrane, as in circumcision. This simple operation is always effective and cures the patient permanently.

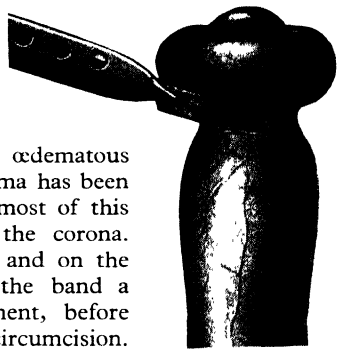


Fig. 407.—Paraphimosis. Excising the constricting band.

MEATOTOMY

Meatotomy is a minor operation which, if correctly performed, gives much satisfaction. It is indicated when the meatus is too small to allow the passage of instruments, and in cases of pin-hole meatus giving rise to symptoms. The frænum of the glans penis is infiltrated with novocain (*Fig.* 408, A). The cut is then made with a scalpel introduced into the

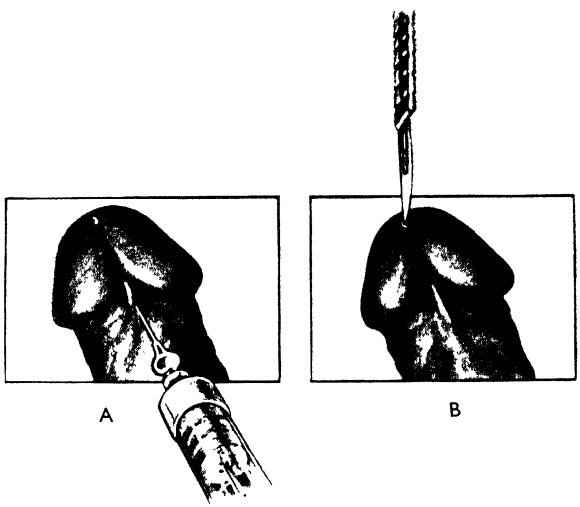


Fig. 408.—Meatotomy. A, Infiltration of the frænum, B, Introduction of the scalpel. Note that the blade is directed downwards and slightly to one side of the middle line.

meatus for a distance of about one centimetre, directing the blade slightly to one side of the middle line, the better to avoid the frænal artery (*Fig.* 408, B). If the condition is not to recur, it is essential that arrangements are made for dilatation of the meatus twice in the first week and once a week for the three following weeks.

ANÆSTHETIZING THE URETHRA

To be able to anæsthetize the urethra effectively is a very valuable acquisition. The urethra is irrigated and 120 minims of 4 per cent novocain are introduced by means of a urethral syringe (*Fig.* 409). The syringe is removed and the solution is prevented from running out by pinching the lips of the meatus together (*Fig.* 410). The penis is then grasped with the left hand so as to force the solution

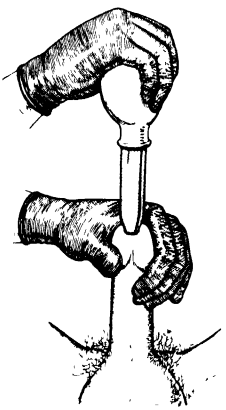


Fig. 409.—Injecting local anæsthetic into the urethra.

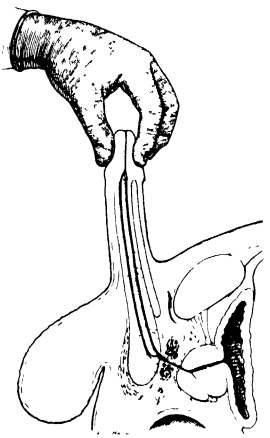


Fig. 410.—Anterior urethra distended with local anæsthetic solution.

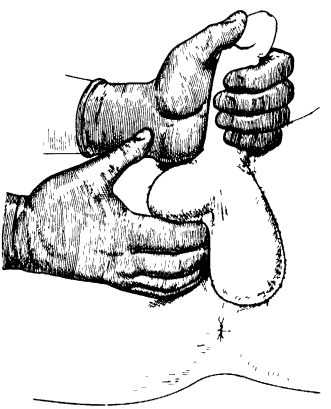


Fig. 411.—Massaging the local anæsthetic solution into the posterior urethra. (*Figs.* 409–411 *after Sir William Wheeler.*)

backwards. The right hand massages the solution into the posterior urethra (*Fig.* 411). When the meatus and penis are released no fluid should escape. Another 60 minims of novocain are injected into the anterior urethra, and a penile clamp applied. After a lapse of five minutes the penis is again grasped, the clamp removed, and the fluid once again massaged into the posterior urethra. A further 60 minims are introduced.

The whole process takes from ten to fifteen minutes. If good results are to be expected one must be patient.

DILATATION OF A URETHRAL STRICTURE

Efficient lubrication of urethral instruments is of great importance. A good method is to fill a tall, narrow beaker with biniodide solution 1–4000, and pour into it several teaspoonfuls of liquid paraffin, which will float on the top. The instrument is lubricated by the floating oil as it is withdrawn.

Before any urethral instrument is passed, the glans should be cleansed carefully and the urethra irrigated with weak antiseptic solution.

Metal Bougies.—The passage of metal bougies requires a little experience and a very light hand. The *tour de maître* is shown in *Fig.* 412. No force should be used.

Gum-elastic Bougies.—If the house surgeon is inexperienced in urethral instrumentation he will be well advised to confine his activities to the gum-elastic bougies. The penis is grasped behind the glans, and is kept on the stretch.

The bougie is introduced. If the point is arrested it is withdrawn a little, and again pushed onwards. If the attempt fails, a smaller instrument is selected, and so on, until the size which will pass is reached. In attempting to pass a bougie through a fine stricture filiform bougies are employed. They should not be resorted to until the operator is satisfied that he is really dealing with a fine stricture. The ' faggot ' method (*see Fig.* 275, p. 246) is often useful.



Fig. 412.—Passage of a urethral sound. The *tour de maître.*

Two, three, or four guides are introduced until one finds the opening. The correct way of passing a filiform guide is by a gentle probing movement combined with rotation.

It is very important to *record* the size of bougie passed ; it is insufficient to tell the patient ; he so often forgets it by the time of his next visit. Metal bougies are generally calibrated in the English scale and gum-elastic bougies in the French scale. This is unnecessarily confusing, but we cannot alter it.

English	*French*	*English*	*French*
00	1	7	14
	2		
0	3		15
	4		16
1	5	9	17
2	6	10	18
	7		19
3	8	11	20
4	9	12	21
	10		22
5	11	13	23
6	12	14	24
	13		25

THE INJECTION TREATMENT OF HYDROCELE

The patient is recumbent. After transilluminating the hydrocele, the skin of the scrotum is sterilized with picric acid. Grasping the neck of the scrotum with the left hand, the skin is made tense over the swelling. Using 1 per cent novocain, a wheal is raised in the skin at a convenient point. A large lumbar puncture needle (Barker's) is passed into the sac as far as possible without striking the testicle. The hydrocele fluid is allowed to run out into a bowl (*Fig.* 413), or it is aspirated by fitting a syringe to the base of the needle. When the

sac is empty, the testicle is palpated to obviate the possibility of overlooking the primary cause of the hydrocele. Using an aspirating syringe, the sac is washed out with saline in order to rid the interior of any albuminous material. Some 2 to 3 c.c. of quinine urethane are injected into the sac, the needle is withdrawn, and the scrotum is gently massaged, so that all parts of the sac come into contact with the solution. The puncture is sealed with collodion, and the patient is given a suspensory bandage.

He is instructed to report in a week's time. Usually, on the second visit the hydrocele appears as large as ever, and the patient should be warned of this probability. The process is repeated, using 3 to 4 c.c. of quinine urethane. In the case of a large hydrocele a third injection is usually necessary.



Fig. 413.—The injection treatment of hydrocele. Evacuating hydrocele fluid.

The patient then reports at weekly intervals, and it is found in most cases that although the fluid reaccumulates it is gradually absorbed, and that the hydrocele has disappeared by the end of three weeks after the last injection.

I have treated a large number of cases by this method, and have had favourable results in over 80 per cent of cases. There seem no definite criteria as to which case is going to respond to injection treatment and which is not, but on the whole one may say that very large hydroceles are better treated by operation.

Unilocular cysts of the epididymis also respond to injection therapy, but they must be unilocular. If, as is often the case, they are multilocular—i.e., they do not completely empty on being aspirated—injection treatment should not be employed.

THE INJECTION TREATMENT OF VARICOCELE

The injection treatment of varicocele is sometimes effective in small or moderate-sized varicoceles. One treatment is all that is necessary.

TECHNIQUE.—The neck of the left side of the scrotum is shaved and the skin is prepared with picric acid. A wheal of local anæsthetic is produced in the skin.

The patient stands, and a small bunch of veins is taken up between the finger and thumb. Using 2 c.c. of a 5 per cent solution of sodium morrhuate or 1–2 c.c. of ethamoline in a syringe armed with a particularly sharp needle, the injection is made from above downwards, just below the external abdominal ring (*Fig.* 414). The pampiniform plexus is entered at several points by a few short jabs of the needle. The patient lies down, and the puncture is sealed with collodion. The pain occasioned by this treatment is often quite severe, and there is sometimes a considerable reaction. It is well to keep the patient lying on a couch for an hour, and then advise him to go home and rest for twenty-four hours. A suspensory bandage should be worn for a month.

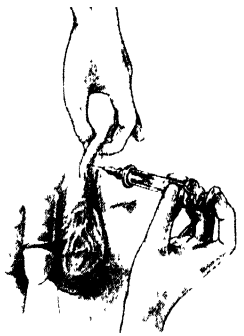


Fig. 414.—The treatment of varicocele by injection.



Fig. 415.—Diagram to illustrate prostatic massage.

MASSAGING THE PROSTATE

To be able to massage the prostate effectively is useful for both diagnosis and treatment. After the patient has passed urine he assumes the knee-elbow position. The gloved finger is inserted into the rectum, and gently the prostate and vesicles are massaged in the direction shown in *Fig.* 415. After a minute several drops of fluid will drip from the meatus. These are collected on a slide for microscopical examination.

CHAPTER XLIII

MINOR ANO-RECTAL OPERATIONS

By W. B. GABRIEL

PROCTOSCOPY

THE rectum should preferably be empty, but a little formed fæcal material is no great handicap, for it can be removed by swabbing. The tubular proctoscope (*Fig.* 416) has proved efficient both for diagnosis and proctoscopic treatment. Brilliant illumination is essential. The anglepoise standard light has proved most satisfactory for a rectal examination. Proctoscopes are now on the market with a built-in electric light attachment. The proctoscope is sterilized by boiling, and is laid on a sterile towel to cool. Fitted with its obturator, and lubricated, the proctoscope is passed by gentle pressure into the anal canal.

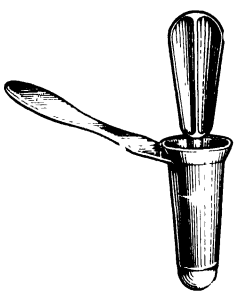


Fig. 416.—Tubular proctoscope.

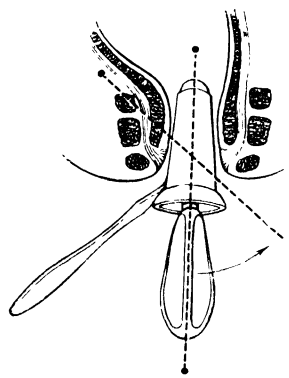


Fig. 417.—Proctoscopy diagram to show change of direction required after passing instrument through the anal canal.

If the patient is lying in the left lateral position, with his knees drawn up, the direction of the anal canal is upwards and forwards. The proctoscope should accordingly be passed at first towards the patient's umbilicus; when the instrument is felt to pass through the anorectal ring into the rectum its direction is altered (*Fig.* 417), the tubular part now being directed more posteriorly.

The proctoscope is inserted up to the full distance allowed by the flange; the obturator is withdrawn and the light directed in. If the patient relaxes properly, the lumen of the rectum will be seen to open as air enters.

The normal mucous membrane is pale. Capillaries and sometimes tributaries of the superior hæmorrhoidal vein are visible. Any change, e.g., inflammation, ulceration, or neoplastic formation, will be observed.

As the proctoscope is withdrawn, the mucous membrane begins to close in; prolapsing internal hæmorrhoids will become apparent as they bulge into the lumen of the instrument. As it is withdrawn farther, lesions in the anal canal, e.g., a fissure, will become apparent.

If the problem is that of bleeding at defæcation, it is often advisable to introduce the proctoscope a second time, and ask the patient to strain down as it is withdrawn: in this way the internal piles become congested and a bleeding point may be revealed. The frequency with which bleeding comes from a superficial fissure in the anal canal deserves mention.

Records.—The results of a rectal examination are conveniently recorded by the use of a rubber stamp (*Fig.* 418). The outer circle represents the anal margin, the inner circle represents the upper end of the anal canal. Local lesions such as piles, fissures, fistulæ, etc., can be shown in a graphic manner.

The same system is used for recording operative procedures in this region.

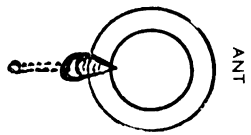


Fig. 418.—Facsimile record of the findings in a case of a chronic dorsal fissure with a short direct fistula.

SIGMOIDOSCOPY

The passage of a sigmoidoscope is commonly required as part of a rectal examination, and is readily performed immediately following digital and proctoscopic examination without anæsthesia or further preparation. A proximally-lit sigmoidoscope such as Yeomans' (*Fig.* 419) (with 8-in. or 10-in. tubes) or Morgan and Officer's pattern (25 cm.) has many advantages.

Sigmoidoscopy is carried out with the patient in Sims' position. The instrument, warmed and lubricated, is passed through the anal canal into the ampulla of the rectum. The obturator is removed and the eyepiece, light, and bellows are attached. The rest of the examination is done under direct vision and no attempt should be made to pass the instrument blindly into the upper part of the rectum.

After carefully examining the rectal ampulla the sigmoidoscope is passed in farther, and at this stage, while following the sacral curve, the outer (eyepiece) end of the instrument must be held rather far forwards; if this is not done sufficiently the inner end of

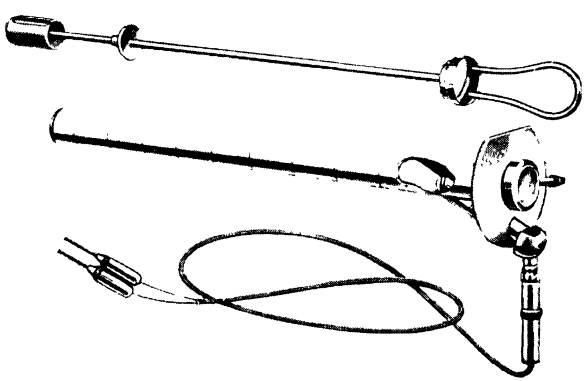


Fig. 419.—Yeomans' sigmoidoscope.

the tube will impinge on the anterior rectal wall and in consequence the lumen of the rectum will not be apparent. When the upper rectum has been reached at about 6 inches from the anus the direction of the bowel forwards and to the left must be followed; the uppermost, left, valve of Houston must be passed and the instrument will then proceed through the recto-sigmoid region into the lower pelvic colon. Spasm or an organic stricture may, however, prevent this. During the examination air should be gently blown in with the bellows to keep the bowel lumen opened out; forcible air distension should be avoided as it may cause pain and spasm.

The presence of blood and mucus should be noted and any organic lesion such as inflammation or ulceration of the mucosa, polypi, or a carcinoma must be recognized. The total distance visualized should be recorded, also the distance from the anus of a polyp, etc., and the quadrant affected. If a carcinoma is seen a portion of the edge of the ulcer should be removed with Brunings' or a punch forceps for biopsy ; this is a safe and routine procedure.

EXTERNAL HÆMORRHOIDS

Thrombotic External Pile (syn. *Anal Hæmatoma*).—This should be excised. The patient is placed on his left or right side so that the hæmatoma will lie on the *under* aspect of the anus. Local anæsthetic is injected ; the initial puncture must be at least half an inch external to the swelling. Enough skin is excised to leave a racket-shaped wound which will remain flat and heal by granulation (*Fig.* 420).

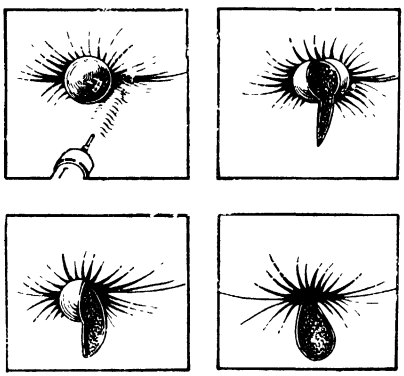


Fig. 420.—Excision of an anal hæmatoma The drawings show the successive stages from the superficial injection of procaine to the splitting of the swelling into two portions and their excision Adequate external drainage by a pear-shaped wound is effected. (*From the author's 'Principles and Practice of Rectal Surgery', H. K. Lewis, London.*)

AFTER-TREATMENT.—The wound is dressed twice daily with gauze soaked in eusol lotion, a corner of the gauze being tucked into the anus in order to keep the skin margins flat. The wound will as a rule be healed in ten to twelve days. This operation is most suitable if the hæmatoma is a solitary one, situated on one or other side of the anus.

A hæmatoma in the middle line anteriorly or posteriorly should be treated with lead lotion compresses unless it is very large, in which case a triangular wound (as for a fissure) will be necessary to minimize the risk of a fissure developing. The conglomerate type of hæmatoma, in which multiple clots and much related œdema are present, should also be treated palliatively, as excision of this would denude too large an area of anal margin.

Anal Skin Tags.—These constitute another type of external hæmorrhoids and may require local excision. Before doing this, however, the rectum should be carefully examined to make sure that a prolapsing internal hæmorrhoid is not present. Skin tags situated laterally can readily be snipped off with scissors after injecting a few drops of novocain at the base : if placed anteriorly or posteriorly much care must be taken to leave a triangular wound of adequate size, or a fissure is liable to result ; if sphincter spasm is present the deep posterior injection of proctocaine or nupercaine in oil is indicated (*see* p. 330).

INTERNAL HÆMORRHOIDS

Palliative Treatment.—If a patient is seen in an acute attack of prolapse, with thrombosis, ulceration, or sloughing, an attempt should be made to return the piles inside the rectum ; pressure is applied digitally, with gauze or cotton-wool, and a short anæsthetic may be necessary. If, however, the sphincter is relaxed and stretched by the prolapsing piles, they will probably prolapse again immediately after reduction. In any case, whether reduction is successful or not, the patient should be kept in bed until all infection and œdema have subsided. Four-hourly compresses of eusol, perchloride lotion 1–2000, or lead lotion should be applied. Liquid paraffin is given orally, and olive oil enemata are indicated if constipated fæces are present in the rectum.

Injection Treatment.—The injection treatment of internal hæmorrhoids is indicated in the early stages, particularly when bleeding rather than prolapse is the chief symptom. After a preliminary proctoscopy to define the piles and, if possible, identify the one which is responsible for the bleeding, the speculum is reinserted to its full length, and a submucous injection of 5 per cent phenol in almond oil is given. A suitable syringe and needle for this technique is shown

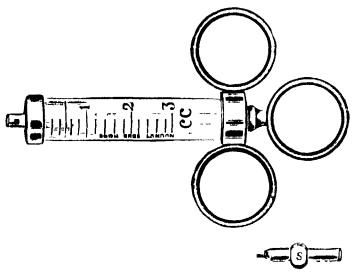


Fig. 421.—The author's syringe for use in the injection treatment of hæmorrhoids

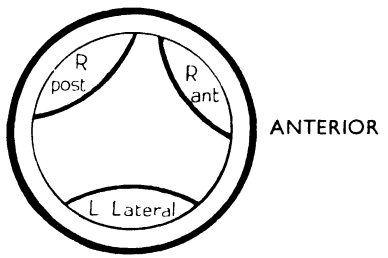


Fig. 422.—The three primary internal hæmorrhoidal areas. (The patient is in the left lateral position.)

in *Fig.* 421. Two important points in technique should be stressed: (1) the injection must be given at the upper end of the pile, at or slightly above the ano-rectal ring; and (2) the bevel of the needle should be directed towards the mucosa on the side which is being injected, rather than towards the lumen of the rectum—in this way it is easier to insert the needle correctly into the submucous layer. The phenol in oil solution is injected slowly. The amount injected into any quadrant is usually 2 to 3 c.c.; the injection is stopped before the tissues become tense. Some blanching is usually seen, with the capillaries standing out on the oil wheal: this 'striation sign' is an indication that sufficient solution has been injected. Occasionally a larger amount, 5 to 6 c.c., may be required if the mucosa is extremely lax.

The three primary internal hæmorrhoidal areas to be injected are shown in *Fig.* 422. As a general rule it is advisable to inject one of these at each session, but there is no set rule, and two or three piles may be injected at one session if thought advisable. The injections are repeated at weekly intervals, and the aim should be to complete the treatment in three or four sessions. The site of injection, the amounts injected, and results of treatment can be recorded by using the two-circle diagram shown in *Fig.* 418.

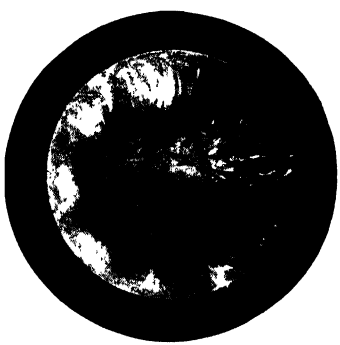


Fig. 423.—Correct site for injecting a hæmorrhoid. (*From the author's 'Principles and Practice of Rectal Surgery', H. K. Lewis, London.*)

Occasionally a stronger solution of phenol, 20 per cent, in glycerin and water, may be injected into the lower pole of a vascular pile, either in combination with a submucous injection higher up, or at a subsequent treatment. The dose is from 5 to 8 min.

Bearing in mind that the object of the treatment is to produce a chemical sclerosis, the following practical hints should be observed :—

1. Inject high up (*Fig.* 423). When the injection is made too low, i.e., beneath the epithelium of the anal canal, severe pain is produced and furthermore the formation of a fissure or abscess is likely to result.

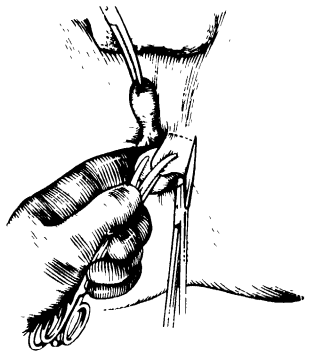


Fig. 424.—Ligature operation for hæmorrhoids. Making the V-shaped cut with scissors for the left lateral pile.

2. The needle must be gently and correctly inserted into the submucous layer. If the needle is too superficial a white spot will be observed as soon as the injection is begun ; in this case the needle should be passed in deeper or else removed and inserted at a different place. Again, if the needle is thrust in too deeply, so that it reaches the muscle of the rectal wall, pain will result.

3. Injection of too large amounts must be avoided or there will be a risk of necrosis and sloughing. At the other extreme, injection of inadequate amounts will produce unsatisfactory results.

4. Care must be taken when re-injecting a pile previously treated to avoid overdosage. When some fibrosis has developed the tissues are less tolerant and superficial necrosis is more liable to take place.

Complications after Injection.—Massive thrombosis in the internal hæmorrhoidal plexus occurs rarely and is usually due to overdosage ; with rest in bed and hot applications to the anus the thrombosis gradually subsides. Superficial necrosis will heal slowly ; the ulcer should be painted through a proctoscope with 2 per cent aqueous mercurochrome solution. Abscess formation and fissure are due to errors in technique.

Operative Treatment.—Although numerous methods of removing hæmorrhoids have been described, the ligature operation has always been the most popular. The method of ligature and excision described by Milligan et al. in 1937 is correct anatomically and gives consistently better results than older methods.

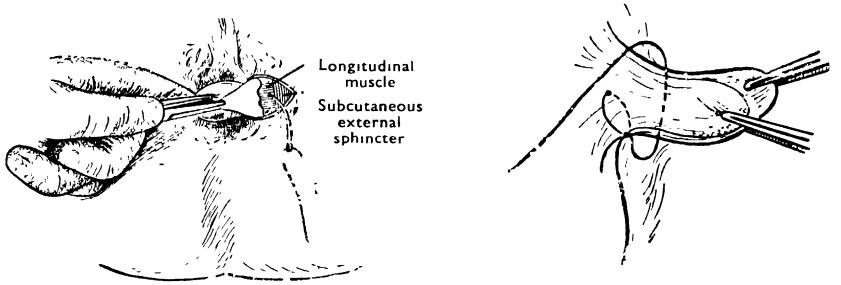


Fig. 425.—Ligature of the pedicle of the pile.

A ligature operation is required for the cure of intero-external hæmorrhoids, and for internal piles which have reached such a large size that prolapse and discharge are a constant source of misery and discomfort.

The patient is placed in the lithotomy position after being anæsthetized with a general anæsthetic (inhalation or intravenous), or the operation may preferably be done under local or low spinal anæsthesia. The three primary hæmorrhoids are taken in artery forceps, and when the external sphincter is properly relaxed, a little traction on each in its proper axis will enable a firm grasp of each pile pedicle to be obtained. The incision to free each pile and prepare it for a ligature is made with straight scissors by the technique described by Milligan and co-workers: a second pair of artery forceps is placed on the skin at the anal margin or on the skin tag related to each pile, and applying traction to both forceps with one hand a V-shaped cut is made with scissors as shown in *Fig.* 424: a little blunt dissection now exposes the inner border of the subcutaneous external sphincter, and a ligature is applied to the pedicle of the pile at this level; the ligature may be an encircling one of stout silk, or a No. 3 chromic catgut ligature may be passed on a round-bodied needle, and the pedicle ligated by transfixion (*Fig.* 425). By this technique

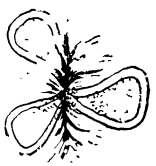


Fig. 426.—Appearance of the anus at conclusion of the operation.

the ligature is made to embrace the expansion of the longitudinal muscle, so that when the excess of ligated pile tissue is excised the ligature is prevented from retracting. A ligature applied in this way not only secures the main branch of the superior hæmorrhoidal artery and vein in the pedicle of each pile, but removes the dilated veins of the external hæmorrhoidal plexus which are related to each pile, together with venous channels connecting the internal and external hæmorrhoidal plexuses.

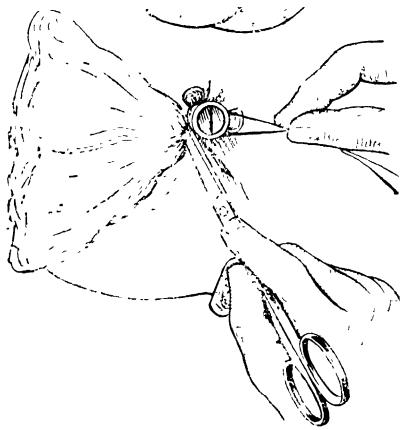


Fig. 427.—Gauze being tucked in at the side of the anal tube.

Proceeding in this way the operator deals first with the left lateral pile, then the right anterior, and lastly the right posterior, in which case the forceps are held in the right hand and the cut is made with the left hand. If secondary piles are present (usually on the left anterior and posterior, or right posterior aspects) a small scissors cut is made at the muco-cutaneous junction, and a catgut ligature applied separately. As the final step of the operation, a little more loose or overhanging skin may need to be excised in relation to the external skin wounds, in order to leave flat surfaces which will heal by granulation (*Fig.* 426). Sterile vaseline is injected from a collapsible tube, a short piece of rubber tubing of $\frac{1}{2}$-in. outside diameter is inserted, and then a flat piece of gauze, moistened in eusol or diluted Milton lotion, is tucked into the anal canal on the lateral aspects of the tube (*Fig.* 427). A pad of gauze and wool and a firmly applied T-bandage complete the operation.

OPERATIVE CURE OF ANAL FISSURE

This is one of the most important minor operations in this region. A fissure which has become chronic and palpable, being usually associated with a sentinel skin tag, and often with infection at its base, cannot be cured except by operation. The operation itself requires a careful and considered technique, and the after-treatment is of great importance.

Technique.—With the patient in the lithotomy position, a triangular incision is made with a scalpel, as shown in *Fig.* 428. The sides of this incision are about

1¼ in. in length from the anal margin. The flap of skin enclosed by the incisions is lifted up with toothed dissecting forceps, and is dissected up towards the apex of the triangle: in this way the sentinel tag, together with the fissure, is excised. If a forefinger is passed into the anal canal at this stage a fibrous bar or ridge is felt traversing the anal extremity of the wound: this is the contracted subcutaneous portion of the external sphincter, which should now be incised in the middle line with scissors; after doing this a portion of the divided sphincter may need cutting off on each side, and then a gentle digital stretching is often helpful in restoring a normal calibre to the anus. The result should be a smooth wound along which a finger can be passed into the rectum without feeling any ridge or hindrance to drainage.

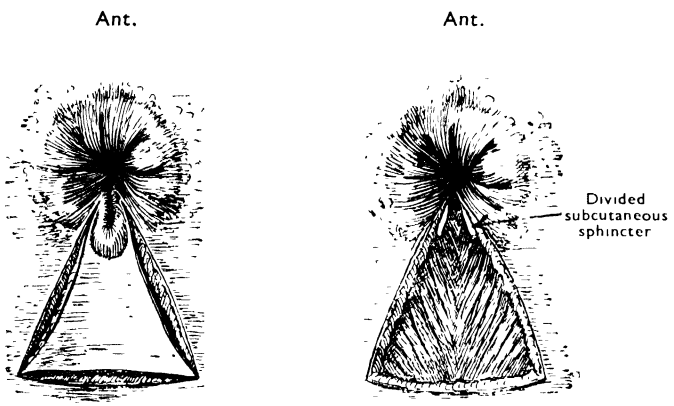


Fig. 428.—Showing the triangular incision and portion to be excised in the treatment of anal fissure.

Application of Tannic Acid.—Small bleeding points are compressed in artery forceps, and then, after drying the wound surface with dry gauze swabs, a 40 per cent solution of tannic acid in 1–1000 aqueous flavine lotion (i.e., 20 g. of tannic acid in 50 c.c. of lotion) is applied on gauze to the wound for a few minutes: when it is seen that a brownish-yellow surface coagulum has been produced, the operation is concluded by injection of sterile vaseline, insertion of a tube, and tucking in a flat gauze dressing: in this case the dressing is of much importance, and serves to keep the skin margins flat.

It may be noted here that the chief object of the open wound which is left after this operation is to secure drainage of the fissure, and if the surfaces of the wound are allowed to fall together in the immediate post-operative period, inadequate drainage will result: to this end the tannic acid treatment is of assistance, partly because the surface coagulum reduces the likelihood of the wound surfaces adhering, and also it reduces the pain of the exposed wound, so that sphincter spasm after operation is consequently diminished.

USE OF OIL-SOLUBLE ANÆSTHETICS

The injection of oil-soluble anæsthetics, such as proctocaine and nupercaine in oil, into the external sphincter ani and peri-anal tissues is a method of accepted value, the chief indication being the relief of anal spasm such as that caused by an acute fissure, or the post-operative spasm which may occur in ultra-nervous individuals after any operation on the lower rectum or anal canal.

Technique.—The patient is placed in the right lateral position with the knees drawn up. The posterior anal margin is shaved and the skin prepared with iodine.

A wheal of 1 per cent procaine is made an inch posterior to the anus. The warmed oily anæsthetic solution (10 c.c.) is drawn up into a dry sterile Record syringe, and a 1½-in. or 2-in. No. 20 needle attached. The operator's forefinger is passed into the anal canal as a guide, and the needle is inserted through the wheal deeply into the sphincter on each postero-lateral aspect of the anus; the solution is slowly injected, care being taken not to puncture the lining of the anal canal: a few drops may be reserved in the syringe for injection beneath a dorsal fissure if present (*Fig.* 429). As a result of this injection an almost immediate relaxation of the sphincter takes place, together with some local anæsthesia. The sphincteric relaxation may last for several



Fig. 429.—Injection of the external sphincter through an anæsthetic wheal posterior to the anus.

weeks. After operation upon the anal canal, notably for anterior fissure, an injection of proctocaine often saves the patient a good deal of suffering, and renders the after-treatment easier.

The subcutaneous injection of proctocaine or nupercaine in oil in the peri-anal region is given in certain intractable cases of pruritus ani. The technique is to inject 10 to 15 c.c. in a fan-shaped manner, chiefly on the posterior and postero-lateral aspects of the anus. The solution is injected deeply into the tissues, and affects the sensory supply of the anus (inferior hæmorrhoidal and perineal branch of the 4th sacral nerve). Care must be taken to avoid 'pooling' in the tissues, and at the conclusion of the injection the anal tissues should be massaged gently. Re-injections are given according to indications, and as a rule the treatment should be completed in two or three sessions at intervals of a week. During this time local treatment to improve the anal dermatitis is taken in hand.

CHAPTER XLIV

GYNÆCOLOGICAL PROCEDURES AND MINOR OPERATIONS

By NORMAN WHITE and STANLEY W. WRIGHT

VAGINAL EXAMINATION BY SPECULA

FOR gynæcological treatment and operative procedures, specula are indispensable, for by their use alone can the condition of the mucosa of the vagina and vaginal cervix and the origin of a discharge be determined.

If Sims' position is correctly employed and the right leg is well flexed, even in an obese patient the nurse need only separate the nates to expose the vulva. It is unnecessary for the leg to be held up for this purpose.

Sims' Duck-bill Speculum.—The warmed, lubricated speculum is introduced as shown in *Fig.* 430. It is then rotated, as depicted in *Fig.* 431.

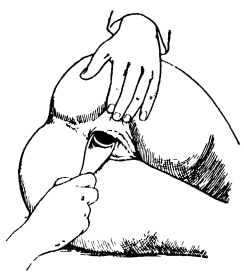


Fig. 430.—Introducing a Sims' speculum.

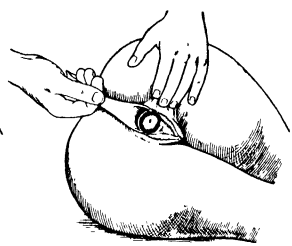


Fig. 431.—Showing Sims' speculum in place and the cervix exposed

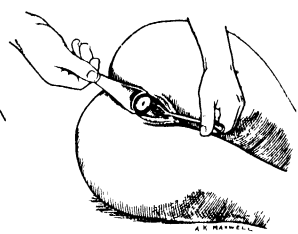


Fig. 432.—When the anterior vaginal wall bulges forwards a vaginal depressor aids in obtaining a good view of the cervix.

If the upper buttock is lifted up and backward and outward traction is exerted on the handle of the instrument, a good view of the cervix and the anterior vaginal wall is usually obtained. When the anterior vaginal wall obstructs the view, as in the case of a cystocele, a vaginal depressor is employed to keep the anterior vaginal wall out of the way (*Fig.* 432).

Bivalve Speculum.—As a rule, it is best to have the patient in the lithotomy position with the examiner sitting facing the vulva. The labia are separated with the index and middle fingers of the left hand, and the warmed lubricated speculum is inserted with its blades parallel to the labia. The speculum is then rotated so that the blades lie parallel with the anterior and posterior vaginal walls. By separating the blades a view of the cervix and the lateral walls of the vagina is obtained (*Fig.* 433). For inspecting the anterior and posterior vaginal walls the blades are turned so that they lie parallel with the vulvar opening.

Fergusson's Speculum is not often employed at the present time, one disadvantage being that several sizes are necessary. It has, however, certain advantages in particular procedures, an example of which is shown in *Fig.* 438.

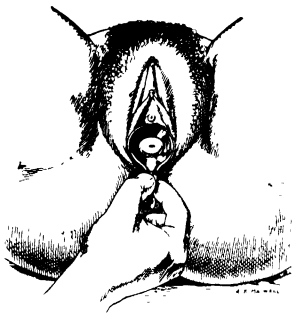


Fig 433.—Cusco's bivalved speculum in use.



Fig. 434.—Auvard's speculum.

Auvard's Speculum (*Fig.* 434) is almost indispensable for many gynæcological operations. A vaginal depressor (*Fig.* 435) should be available, for it is often required when this speculum is used.



Fig 435.—A vaginal depressor

PURULENT VAGINAL DISCHARGE: OBTAINING SPECIMENS FOR BACTERIOLOGICAL EXAMINATION

Equipment.—Besides the usual armamentarium for collecting a specimen for bacteriological examination (*see* p. 164) and a vaginal speculum, it is desirable to have a Playfair's probe (*Fig.* 436) and a sterile pipette (*see Fig.* 438) to hand. If not too thick, the discharge can be sucked up by the pipette.

Fig. 436 —Playfair's probe.

Technique.—The external genitalia are inspected. The mouth of the urethra is swabbed and palpated through the anterior vaginal wall. In many cases of acute gonorrhœa pus can be expressed from the urethra (*Fig.* 437). Skene's ducts are sometimes infected, and pus may be expressed from their openings, which lie on the dorsal edge of the urinary meatus, or just within the orifice. An enlarged Bartholin's gland may be felt by pinching up the deep tissue between the posterior thirds of the labia. A normal gland is not palpable. If the gland is enlarged, by gently squeezing, pus may be expressed from the orifice of the duct, which opens into the introitus just external to the margin of the hymen. A speculum is now passed, and it is better not to use an *antiseptic* lubricant. Sims' speculum is a good type to employ, but a bivalve speculum may be used. Fergusson's speculum gives limited exposure of the cervix, but

it has the advantage of ensuring that a cervical smear does not become contaminated by the swab touching the vaginal wall (*Fig.* 438).

With a dry swab on sponge-holding forceps the cervix is mopped dry. It is very important that the cervical smear should be *endocervical.*

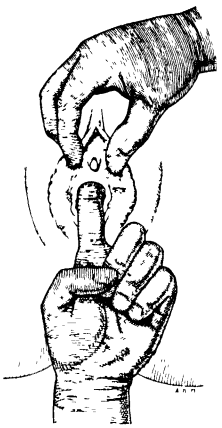


Fig. 437.—Expressing pus from the urethra.



Fig. 438.—Taking an *endocervical* specimen of discharge. A pipette is being used in this instance.

Specific Vaginal Discharges may be due to infection by the gonococcus, the *Trichomonas vaginalis*, or to the *Monilia candida* (*Oidium albicans* or thrush). The trichomonas produces a vaginitis associated with a thin, irritating, profuse greenish-yellow pus which is often frothy in appearance as it lies in the vaginal vault. The discharge of monilia, which is commonly seen in pregnancy and in diabetes, is thick and caseous in its consistency. If trichomonas is suspected, immediate examination of the discharge is essential, and the house surgeon should be prepared to undertake this examination himself (*see* p. 169).

Non-specific Vaginal Discharge (Leucorrhœa).—The commonest cause is excessive production of mucus by the cervix, which may show an erosion on the vaginal surface. This may be due to chronic cervicitis, but there is usually no active infection present.

THE TREATMENT OF VAGINAL DISCHARGES

Having arrived at a scientifically-proved diagnosis of the nature and cause of the discharge, rational treatment can be instituted.

Gonococcal Infections are considered in Chapter LX.

Trichomonas Vaginalis Infection.—Stovarsol vaginal compound tablets (May & Baker), one or two introduced into the vagina at night, and an acid douche every third morning to wash away the debris, is a good method of controlling this infection. The tablets should be inserted as high as possible into the posterior fornix. It may be necessary to continue treatment for as long as three months, since relapses are common. Other reliable pessaries are picragol (John Wyeth); and carbarsone (Eli Lilly & Co.), which are used similarly.

Another efficient form of treatment is by the insufflation of picragol powder, after mechanical cleansing and drying the vaginal wall. This method must not be used in pregnant women owing to the risk of air embolism from air entering the uterus through the cervix.

Monilial Infections respond readily to treatment by the aniline dyes. The discharge is wiped away, and the whole vagina and cervix thoroughly swabbed with Bonney's blue paint, or 1 per cent gentian violet. Five or six treatments usually suffice to effect a cure.

Simple Leucorrhœa.—A mucoid, non-purulent discharge may be treated with glyco-gelatin pessaries, one introduced into the vaginal vault each night. Endocervical diathermy is more effective.

Senile Vaginitis.—Antiseptics only injure the delicate vaginal epithelium. Douches of lactic acid (120 m. to the pint) or vinegar (1 oz. to the pint) are free from this objection. An œstrogen such as stilbœstrol may be given to restore this epithelium to its preclimacteric condition. It is advisable to start with a dose of 0·5 mg. three times a day—reducing this to once daily or less frequently, or replacing it by œstrone 1000 international units daily, after the vaginal smear begins to show mature epithelial cells and many Doderlein's bacilli. The œstrogen treatment should not be continued indefinitely, as it may cause hypertrophy of the endometrium and uterine hæmorrhage.

Infection of Skene's Tubules sometimes causes recurrent vaginitis, together with pain and frequency of micturition. The tubules may be syringed out with 10 per cent mercurochrome, using a small syringe with a blunt needle such as is used for the nasolacrimal duct. A better way is to destroy the tubule by an electric cautery or diathermy, under general anæsthesia, opening it up into the urethra.

CAUTERIZATION OF THE CERVIX

Cauterization of the cervix can be carried out in the out-patient department without an anæsthetic; a swab soaked in 2 per cent novocain can be pressed against the cervix for a minute or two if the patient is unusually sensitive. If the mucus comes from the cervical canal, and not from an erosion, it may be necessary to give an anæsthetic and dilate the cervix. The cervical canal should be cauterized deeply in three lines from the internal os downwards (*Fig.* 439). Cauterization should not be performed just before or during a period, for under these conditions the hæmorrhage would be unduly heavy. It is not uncommon for secondary hæmorrhage to occur from the cervix about the tenth or fourteenth day after cautery. This bleeding may be mistaken for a period, but the blood is often of a fresher appearance. The bleeding may continue for several days, and it is sometimes necessary to admit the patient to hospital and pack the cervix with sterile gauze. The ulceration will probably take a month to heal, and douches should be given during this time. If the cervical canal has been cauterized, the patient must attend for observation and, if necessary, dilatation of the external os, to prevent stenosis.



Fig. 439.—Showing lines of cauterization of the cervix.

If facilities are available, intracervical diathermy is the best treatment for chronic cervicitis, as by this means infection within the substance of the cervix may also be eradicated.

Another useful method of treating chronic cervicitis associated with erosion is by the use of zinc chloride. A porous clay pencil of suitable size is soaked in a 50 per cent solution of zinc chloride, and is then inserted into the cervical canal, which is steadied by a volsellum. Any excess of the zinc solution is carefully wiped away to prevent its caustic action upon the vaginal epithelium. The pencil is removed from the cervix four hours later. A cast of the cervical mucosa is shed about a week later, and healing is complete in about three weeks.

DILATATION AND CURETTAGE

The vulva must be shaved and cleansed with soap and water before operation. Specific vaginal discharges should be treated prior to curettage. As a rule, douching is unnecessary.

When anæsthesia has been induced, the patient is put in the lithotomy position and the vulva and vagina are swabbed with an antiseptic, such as 30 per cent dettol or a 1–1000 solution of flavine in spirit. A bimanual examination is made and the position of the uterus specially noted; this is a most important part of the operation. If the vagina is small, a Sims' speculum will be used to expose the cervix; in most cases Auvard's speculum is not too large and gives better exposure. The anterior lip of the cervix is seized with one or two volsellum forceps, and steadied. A uterine sound is passed into the cervical canal in the direction in which the uterus was found to lie on bimanual examination. The sound must be held lightly, and no force should be used in passing it, for a false passage can be made easily. For instance, if the uterus is retroverted and the sound is passed with the point forwards, the wall may be perforated; a senile uterus, and a uterus which has recently been pregnant, are so soft that the wall offers little or no resistance.

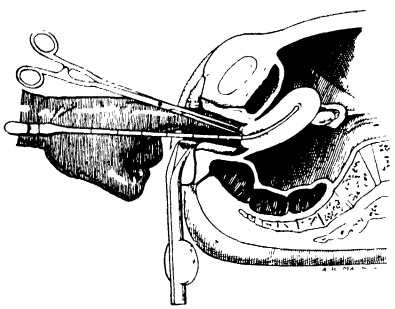


Fig. 440.—Estimating the length of the uterus by means of a uterine sound.

The uterine sound is bent at $2\frac{1}{2}$ in from the tip, the length of the cavity of the normal virgin uterus, and the rest of the shaft is marked by grooves at $3\frac{1}{2}$, $4\frac{1}{2}$, and $5\frac{1}{2}$ in., so that a longer cavity can be measured (*Fig.* 440).

Hegar's dilators are now passed in successively larger sizes, each being held with the finger and thumb about $2\frac{1}{2}$ in. from the end, so that the point will not perforate the fundus if the dilator slips suddenly through the internal os. The operator must be careful not to lacerate the cervix by dilating it too quickly, or by passing unnecessarily large dilators. The next procedure is to pass a pair of forceps—narrow-bladed sponge forceps are quite suitable—into the uterus, and open, close, and withdraw them, in order to remove any polypoid material. If the material removed appears to be products of conception or if a suspicion of carcinomatous material is aroused, curettage should be proceeded with very cautiously. The question of the selection of the curette is extremely important. The blunt curette (*Fig.* 441) is usually to be preferred to the sharp instrument. It must not be forgotten that the edge of a flushing

curette is often extremely sharp, and although often used for curetting abortions, it is liable to excavate the myometrium. The blunt loop curette is a safer instrument to use in these cases. The selected curette is passed gently to the fundus of the uterus in the direction taken by the sound. The cutting edge is then turned backwards towards the posterior wall, and the curette drawn down firmly, but gently, in contact with the uterine wall, and withdrawn from the cervix. A single long strip of endometrium may often thus be secured for biopsy. The curette is then reintroduced, and the whole cavity is similarly denuded of endometrium. The uterine cornua must be carefully explored, particularly when a placental polyp is suspected, for it is in this situation that retained products are often to be found. Fragments separated by the curette are removed from the uterus by means of the sponge-holding forceps (*see above*).

Fig. 441.—Sims' blunt curette. It is made in three sizes—¼ in., ½ in., and ¾ in.

Except as indicated below, douching is unnecessary. Microscopical examination of the tissue removed should never be omitted, as only by this means can diagnosis be established; apparently innocent curettings sometimes prove to be neoplastic.

Complications of Curettage.—Excessive hæmorrhage is unusual, except when conception products are being removed. Sudden profuse bleeding can be controlled at once by compression of the body of the uterus between two or more fingers of the right hand in the vagina and the left hand pressing down the uterus per abdomen into the anteverted position. A douche of sterile water at 120° F. is very useful in stopping a less acute loss, and should always be available when the operation is being performed in a case of recent pregnancy. A special uterine douche tube with a channel to allow escape of the

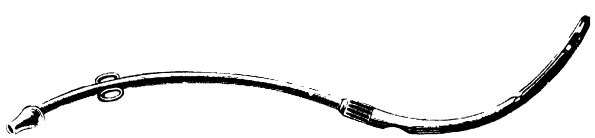


Fig. 442.—Bozemann's intra-uterine douche.

fluid should always be used (*Fig.* 442). A vaginal douche tube, or ordinary tubing, may block the cervix, and fluid may be forced through the Fallopian tubes into the peritoneal cavity. Pituitrin or pitocin, 5 to 10 units, may be given intramuscularly, or, in the case of the latter drug, intravenously. Alternatively, or in addition, ergometrine 0·5 mg. intramuscularly, or 0·25 mg. intravenously, may be used. If other means fail, the uterus and vagina may be plugged with a roll of sterile gauze. Very little gauze can be introduced into the uterus after ordinary dilatation and curettage, but the vagina can be plugged, and this must be done thoroughly if it is to be of any use. The plug should be removed in 6 to 12 hours.

The dilators or the volsellum forceps sometimes lacerate the cervix; such laceration should be repaired with catgut. Infection is a rare complication, unless the organisms are already present in the uterus, as in some cases of abortion.

Should the uterine fundus be perforated by a sound, dilator, or curette, the operation must not be continued. The patient should be returned to bed and nursed in high Fowler's position, and a watch kept on the pulse, temperature, and abdomen. In the majority of cases the perforation heals without incident. Perforation of the uterus during evacuation of an abortion is more serious, but even in this instance, as a rule, the patient should be treated expectantly. A course of sulphanilamide should be given. Occasionally hysterectomy is indicated, for instance, if the abortion is obviously infected, or if bleeding persists as a result of the retained products.

TREATMENT OF ABORTION

The patient should be examined to determine whether the bleeding is due to threatened, inevitable, or incomplete abortion, and to exclude other causes of bleeding, such as a polyp, cervical erosion, and cancer accompanying a pregnancy. A polyp can usually be twisted off with sponge forceps without disturbing the pregnancy. It should always be examined microscopically, to exclude malignancy.

Threatened Abortion.—The patient should be kept at complete rest until ten days after the bleeding ceases. Rest is the most important part of the treatment. An initial injection of morphine (¼ gr.) should be given, and subsequently a sedative mixture of bromides may be helpful. Light, nourishing diet should be given. Constipation should be relieved by olive-oil enemata. Drastic purges should be avoided. If possible, the daily pregnanediol excretion in the urine should be measured: if persistently low (normal 4–10 mg. per 24 hours), indicating corpus luteum deficiency, progesterone should be given intramuscularly. An initial dose of 10–15 mg. followed by 5·0 mg. daily until the loss ceases, and subsequently 5·0 mg. twice weekly, is a suitable routine. This routine is more often given empirically, although the high cost of the drug should be borne in mind. Theoretically, its use could be discontinued after the sixteenth week, when placentation is complete, but more often the injections are continued until the twenty-fourth week, as progesterone is held to desensitize the uterus.

Both progesterone and wheat-germ oil (vitamin E) are also of value in the treatment of habitual abortion. The latter drug must be given in large amounts

Inevitable Abortion.—When the ovum is in the process of expulsion, it is rarely necessary to give any treatment, although some authorities advise the giving of pituitary extract to hasten expulsion. If pain is severe, morphine (gr. ¼) should be given: it does not retard labour at this stage. The conception products should be carefully examined as soon as passed, in case the ovum is incomplete, in which case the uterus will need to be evacuated. If bleeding is severe, it may be necessary to evacuate the uterus under anæsthesia, using a finger and sponge forceps. Rarely, if the os is not dilated, the cervix and vagina may require to be plugged with sterile gauze, but this should be avoided if possible, owing to the great risk of sepsis.

Incomplete Abortion.—The majority of cases of abortion are incomplete when first seen. When bleeding is slight, and the cervical canal is closed, it is often difficult to decide whether there has been complete extrusion of the conception or whether some has been retained. Such a case should be kept under observation for a few days. If there is fever, a vaginal swab should be examined for pathogenic organisms, and a course of a sulphonamide drug started while awaiting

the result of the examination. The patient should be sat in Fowler's position to aid drainage. If bleeding persists, the uterus should be evacuated digitally (*Fig.* 443), if possible, or with sponge-holding forceps and blunt loop curette several days after the pyrexia subsides.

If the bleeding is excessive when the patient is first seen, it will usually be found that a portion of retained conception products is lying in the cervical canal: the canal should be at once cleared of debris, with the finger or sponge forceps, when the internal os will shut down and the bleeding at once diminish and almost cease. *This fact is a most important one to recognize in the treatment of abortion.* With the bleeding controlled, the patient may be prepared for evacuation at leisure: infection may be treated and blood-loss made good.

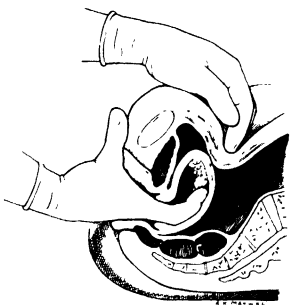


Fig. 443.—Digital evacuation of the uterus

Septic Abortion.—It should be remembered that the temperature may be raised during the process of abortion and for a short time subsequently and without actual infection being present. In such circumstances, although the case is suspect, the pyrexia will subside completely within twenty-four hours of abortion.

If an abortion is infected, operation, particularly curettage, is likely to spread the sepsis. Unless bleeding is severe, the patient should be nursed in Fowler's position and the lochia examined for pathogenic organisms, particularly the hæmolytic streptococcus. A full course of a sulphonamide drug should be given. If need be, evacuation may be undertaken about ten days after the temperature has settled, by which time the uterine contents are usually free of pathogenic organisms.

A large piece of retained placenta may, however, cause persistent bleeding. Under such circumstances, the infected material should be gently removed from the uterus by digital exploration and sponge forceps. Under no circumstances should the cavity be curetted, as sepsis is almost certain to be spread thereby. Douching should also be completely avoided in the presence of sepsis. Following the removal of the infected debris, sterile glycerin may be introduced into the uterine cavity by means of a sterile catheter, in order to promote drainage. Its use is not essential, however. *Conservatism is the essence of treatment of abortion.*

INDUCTION OF ABORTION

This is sometimes necessary in certain medical conditions. The earlier abortion is induced, the better; certainly, if possible, before the sixteenth week of pregnancy. Up to the eighth week it is sufficient to dilate the cervix under anæsthesia and remove the ovum with sponge-holding forceps or a blunt curette. After this time, the cervix should be dilated beforehand by the introduction of laminaria tents into the cervical canal. The gradual dilatation and softening of the cervix brought about by the swelling of the tents may, in some cases, bring about a spontaneous abortion. More often, the ovum is removed digitally and with sponge-holding forceps twenty-four hours after the tents are inserted.

PESSARIES: INDICATIONS AND MANAGEMENT

Pessaries for Prolapse.—Unless the patient is unfit for operation a pessary should be regarded as a purely palliative, temporary form of treatment of uterine and vaginal prolapse.

The most useful is the ring type, made of watch-spring covered by indiarubber. It is introduced into the vagina by squeezing it into an oval shape with the finger and thumb, pushing it through the introitus, and guiding the upper end past the cervix into the posterior fornix. A suitable pessary should cause no discomfort. When the introitus is narrow, a piece of tape is wound round the pessary and fixed with a pair of Spencer Wells forceps, to keep it compressed (*Fig.* 444) until the upper end reaches the posterior fornix, when the release of the forceps and removal of the tape allow the pessary to take its correct position, with the cervix in the centre (*Fig.* 445).

A rubber pessary perishes quickly, and must be replaced by a new one every three months. It is removed by traction with the forefinger, and rotation into the antero-posterior diameter as it comes to the outlet. A vulcanite ring pessary, or a Simpson's shelf pessary, is useful when the outlet is so large, or the perineum so lax, that a watch-spring pessary cannot be retained. It may last longer than the three months, but should be removed and inspected at intervals of six weeks. It is necessary for a patient wearing a pessary to douche daily with saline solution or some very mild antiseptic, in order to prevent the vaginitis and leucorrhœa which the foreign body is liable to cause.

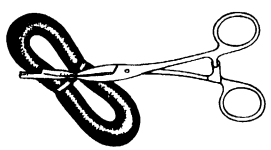


Fig. 444.—Watch-spring pessary ready for insertion in a case where the introitus is narrow.

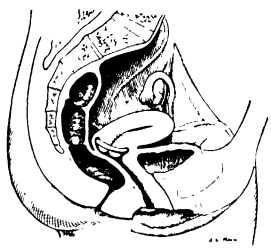


Fig. 445.—Ring pessary position

Pessaries for Retroversion.—Congenital retroversion, and fixed retroversion caused by pelvic inflammation, are usually suitable only for operative treatment.

Puerperal Retroversion.—Puerperal retroversion of the uterus may be treated by replacement with a pessary. The type of pessary generally employed is the Hodge, the upper end of which is rounded to fit the posterior fornix, and the lower end square to rest against the lower vaginal wall and the lower part of the symphysis; it is S-shaped, and when it is in place, the upper end projects forwards, above and behind the cervix. A ring pessary will also maintain the uterus in anteversion, and is useful when the introitus is too lax to retain a Hodge pessary.

Introduction of the Pessary.—The uterus must first be replaced into the anteverted position by digital manipulation. With the patient in the left lateral or semi-prone position, two fingers of the right hand are introduced into the vagina, and the body of the uterus is pushed up in the posterior fornix as far as possible with the middle finger; the forefinger then presses the cervix backwards, and so levers the body forwards till it can be pushed down by the left hand per abdomen. The fingers are now withdrawn and the pessary is taken in the right hand, the

left forefinger retracts the perineum and assists its introduction through the introitus (*Fig.* 446), and the right forefinger then guides the upper end of the pessary into the posterior fornix above the cervix (*Fig.* 447). If the pessary is of suitable size, the patient should not be conscious of anything in the vagina.

Treatment by a pessary, after replacement, will usually effect a permanent cure of puerperal retroversion, if it is begun at about five weeks after delivery; the pessary should be retained for three months. When the condition has not been diagnosed till later, the uterus can generally be anteverted, but removal of the pessary may allow the retroversion to recur. It may be necessary for the patient either to continue wearing the pessary, which is removed and inspected every three months, or to have an operation. In difficult cases replacement may be performed under anæsthesia, with a sound or dilator in the uterus; it is of course quite useless to introduce a pessary without first manipulating the uterus into anteversion.

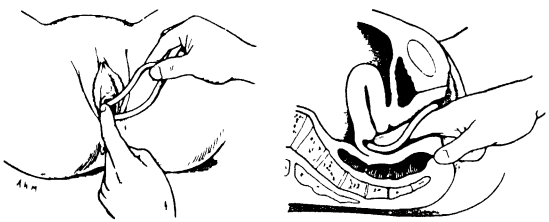


Fig. 446.—Introduction of the Hodge pessary. Steps 1 and 2



Fig. 447.—Pessary in place

Retroverted Gravid Uterus.—This condition causes trouble at about ten to twelve weeks' gestation. No treatment is needed till the uterus is of ten weeks' size, when it may be found to be undergoing spontaneous anteversion, which occurs in the majority of untreated cases. The anteversion may be assisted by pushing up the fundus with one or two fingers in the posterior fornix with the patient in Sims', or, better still, the knee-chest position, and a pessary may be introduced if the retroversion seems likely to recur. It is safer to keep the patient in bed and attempt replacement by postural means rather than manipulation, especially if the retroversion has been responsible for a previous abortion.

Another method of securing anteversion in cases of retroverted gravid uterus is to introduce a ring pessary, the continuous pressure of which will gradually press the uterus upwards into place, provided the bladder is kept empty.

If the condition has not been treated early in pregnancy, retention of urine may occur when the uterus is large enough to fill the pelvis and force the bladder above the pubes. The treatment for this is catheterization, the urine being removed at the rate of about a pint an hour, in order to avoid the danger of hæmorrhage, which may occur if the pressure in the bladder is released too suddenly. When the bladder is kept empty by a catheter, spontaneous anteversion of the uterus generally follows, and may be assisted by keeping the patient in the prone position. If necessary, the fundus uteri can be pushed up with the fingers in the posterior fornix, while the patient is in the knee-chest position.

OTHER CONDITIONS NOT ALREADY CONSIDERED

Bartholin Abscess should be opened on the inner aspect of the labium minus, and opened widely. The cavity is packed with gauze and allowed to heal

from its depths, otherwise a sinus is prone to follow. If the abscess has not burst, most authorities advise its complete excision, using the same technique as about to be described.

Bartholin Cyst.—The cyst should be approached through a vertical incision on the outer side of the labium majus, posterior to the vascular vestibular bulb. An incision through the labium minus leaves a scar painful during coitus. An attempt should be made to dissect the cyst in its entirety, together with any recognizable gland tissue. Bleeding is free and perfect hæmostasis must be secured before the cavity is obliterated by deep sutures. When hæmostasis is imperfect, a troublesome hæmatoma of the labia and surrounding structures is a frequent sequel. Consequently, in cases where oozing is considerable, it is advisable to pack the cavity and allow the cavity to heal by granulation.

Papillomata of the Vulva.—These are commonly called gonorrhœal warts, but they occur in the absence of gonorrhœa, and are due to a filter-passing virus. They are usually easily removed by touching once or twice with a wart paint, such as equal parts of liquor epispasticus and tinct. ferri perchloridi, or with acid nitrate of mercury, or trichloracetic acid.

Vulvar Adhesions.—Congenital adhesions between the labia sometimes obstruct the vaginal opening. Similar adhesions may follow vulvitis in childhood. They can easily be broken down with the finger under light anæsthesia, and prevented from re-forming by dressing with sterile vaseline afterwards.

Imperforate Hymen.—So-called imperforate hymen is usually due to a transverse septum just above the hymen, which is visible below it. This condition is often not diagnosed till puberty, and the vagina, uterus, and tubes may be distended with menstrual fluid. The operation required is simple excision of the septum, which can be seen bulging with dark-coloured blood. The patient must be admitted to hospital, because strict asepsis is necessary during drainage. An ascending infection may cause salpingitis and peritonitis. During the later stages of treatment it is important to prevent the hymenal opening from closing up again. A small-sized vaginal dilator should be passed at intervals.

Vaginismus and Dyspareunia.—The majority of cases of vaginismus are of psychological origin. The patient should be carefully examined under anæsthesia, and local inflammatory lesions excluded. In many instances the vagina will be found to admit three fingers or a large speculum with ease. In others an intact hymen may be present, which should be incised at positions corresponding to 2, 4, 8, and 10 o'clock. Bleeding is usually slight; occasionally persistent bleeding may require the insertion of a fine catgut suture at the base of the hymen. A large-sized (No. 7) glass vaginal dilator should be inserted in both these cases and retained by a diaper or a T-bandage. The following morning the patient should herself remove the dilator, and she is subsequently encouraged to pass the well-lubricated instrument herself each day, although a size smaller may be at first needed until her confidence is obtained. A confidential talk to the patient concerning the origin of her difficulties usually successfully completes the treatment.

A narrowed introitus causing dyspareunia may require a small plastic operation to enlarge it permanently. Vaginal dilators should subsequently be passed.

CHAPTER XLV

MINOR OPERATIONS AND OTHER PROCEDURES WHICH CONCERN THE FEET

By F. P. FITZGERALD

BEFORE any open operation is performed upon the foot scrupulous cleansing is necessary. It is often advisable to spend several days in the pre-operative preparation of the skin.

IN-GROWING TOE-NAIL

Palliative Treatment.—A common form of treatment is to lift the nail up gradually from its bed by packing a pledget of cotton-wool soaked in flavine beneath its edge once or twice a day. When the nail has been elevated the offending sharp splinter can be excised.

The Wedge Resection Operation.—This is indicated in comparatively early cases. An Esmarch's bandage is applied and then a special sphygmomanometer is fixed about the calf over a layer of wool. It is kept at a pressure of 210 mm. throughout the operation. The incision begins a quarter of an



Fig. 448.—Wedge resection operation for in-growing toe-nail.

inch above the eponychium on the affected side. It is continued distally through the nail to its free edge, so as to include the diseased part and the adjacent quarter of the nail. Another incision joins the extremities of this cut by passing through the skin an eighth of an inch from the affected margin (*Fig.* 448).

Both incisions are deepened, and the nail edge with its attached bed and skin is removed. It is essential that all the nail bed be removed completely from the phalanx. The skin margins are sewn across with a few interrupted sutures.

Excision of the Nail Bed.—This is indicated in severe cases. If obvious sepsis is present, the nail is avulsed and operation deferred for a month. An Esmarch's bandage and sphygmomanometer are applied as described above. A horseshoe-shaped incision, open proximally, is made in the skin around the nail an eighth of an inch from the edge. The extremities of the horseshoe are joined, one quarter of an inch from the root, by an incision which is convex

proximally (*Fig.* 449, A). The wound is deepened down to the phalanx and the nail with *every remnant* of its bed and the adjacent skin is removed. The distal one-third of the phalanx is dissected free and excised with bone forceps (*Fig.* 449, B). The rough bone surface is smoothed with a file, and the distal skin-flap sewn into place with interrupted sutures (*Fig.* 449, C).

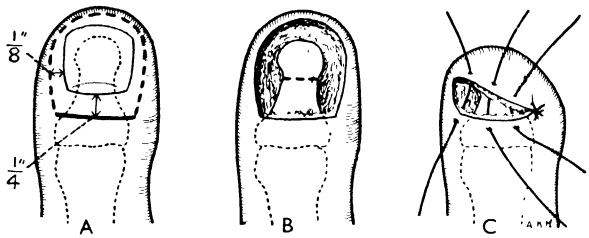


Fig. 449.—Excision of the nail bed.

Avulsion of the Nail.—This is indicated in onychogryphosis, and in septic cases, as a preliminary to the above operation. A special avulsion forceps may be used Failing this, it is helpful to employ two Spencer Wells' forceps, which are inserted under the nail parallel to each other Both forceps are grasped in one hand, and the nail removed by a rotatory movement.

Subungual Exostosis.—In minor cases, local excision of the nail and curettage with a sharp spoon is sufficient. A large exostosis may require preliminary avulsion of the nail.

CORNS

Conservative Treatment.—This consists in repeated applications of corn paint, the use of corn plasters, and paring the corn after bathing.

Operative Treatment.—Excise the corn by a transverse elliptical incision, as in the operation for hammer-toe. It should be remembered, however, that so long as the hammer-toe or tight shoe remains, no treatment will be permanently effective.

Plantar Warts.—(See p. 459.)

HAMMER-TOE

A simple hammer-toe should never be amputated. The deformity can be permanently rectified by Higgs's spike arthrodesis (*Fig.* 450)

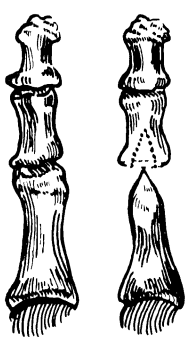


Fig. 450.—Spike arthrodesis.

Fig. 451.— An awl for hammer-toe operations.

Operation.—The contracted extensor tendon is tenotomized over the metatarso-phalangeal joint and the toe is forcibly flexed. A transverse elliptical incision is then made across the affected joint so as to include the corn which is usually present. This piece of skin is removed and the joint opened by cutting across the extensor tendon Incidentally, it should be mentioned that the ends of the tendon unite without suturing. The articular ends of both bones are then elevated. With an awl (*Fig.* 451), a hole a

quarter of an inch deep is bored in the base of the distal phalanx. The distal end of the proximal phalanx is then shaped with small bone forceps to form a spike, care being taken to preserve the cortical bone on the upper surface. The spike is pushed firmly into the hole (*see Fig.* 450), and the skin sewn with two or three interrupted silkworm-gut sutures.

AFTER-TREATMENT.—The toe is dressed with a few layers of gauze soaked in collodion reinforced by strips of a sterile matchbox, which forms an efficient splint. The dressing is discarded at the end of three weeks, but the patient need not be prevented from walking during this period. The only contra-indication to the operation is poor circulation, such as occurs in the aged. Gangrene is a possible complication when the nutrition of the digit is sub-normal.

HALLUX VALGUS

Conservative Treatment.—This is seldom effective. A young patient is fitted with a hallux valgus splint (*Fig.* 452) to wear at night, or may be treated by fixation in the overcorrected position in a plaster shoe.



Fig. 452.—Hallux valgus splint.

Operative Treatment.

Excision of Base of Phalanx.—The incision is deepened and the capsule dissected back to expose the joint. The base and shaft of the phalanx are now cleaned. A sharp hook is driven firmly into the cartilaginous base of the phalanx, which is distracted forwards, thus separating the joint surfaces (*Fig.* 453).

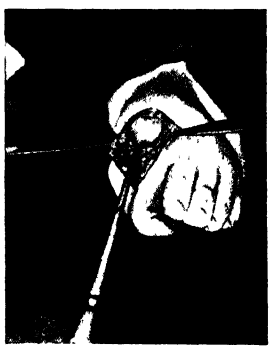


Fig. 453.—Excision of the base of the phalanx. The head of the metatarsal is elevated by two bone spikes. The phalanx is pulled forwards by the bone hook.

This allows the flexor tendon to be dissected and freed. The base of the phalanx is now gripped firmly in a lion forceps while the proximal end of the shaft is cut through with a saw. Up to half of the phalanx may be removed. The rough edges of the divided bone are filed smooth and the skin is approximated by means of closely placed interrupted sutures. Excision of the head of the metatarsal is preferred by many orthopædic surgeons, but should never be performed by the inexperienced, for if too much be removed, the body-weight will be transferred to the head of the second metatarsal, with consequent pain and even a fracture of the bone.

AFTER-TREATMENT.—Movements and toe-stretching exercises may be commenced within a few days of operation, without disturbing the dressings, and continued for a few weeks. If it is noticed after the operation that the patient is not walking 'down' on the great toe-joint, the *sole* of the shoe should be fitted with a one-fifth of an inch outside wedge.

HALLUX RIGIDUS

In this condition the toe is straight, but dorsiflexion is limited. The toe is usually fixed in slight plantar flexion, while there is compensating dorsiflexion at the interphalangeal joint.

In cases of moderate severity the toe is manipulated. A piece of gauze is wrapped around the toe and the joint forcibly stretched. The surgeon, still maintaining traction, puts the toe through all its movements. This is followed by a course of diathermy to the joint.

In more severe cases a metatarsal bar, three-quarters of an inch wide, should be fitted to the sole of the shoe, just under the tread. If pain persists in spite of conservative treatment, arthroplasty similar to that just described is recommended.

FLAT-FOOT OR FOOT STRAIN

Treatment in Relation to Age.—

The Young Patient.—A young patient who is standing most of the day and who has complained of pain for a short time, needs a course of faradic foot-baths, massage, and flat-foot exercises. If this does not relieve symptoms after a period of four to six weeks, manipulation and further physical treatment is indicated.

The Middle-aged Patient.—The patient of thirty to forty-five years of age, in whom the condition has persisted for many months, should have the foot manipulated under an anæsthetic. This is followed by a course of physiotherapy as above.

The Elderly Patient.—The old person whose feet are still fairly mobile and in whom the rigid osteo-arthritic foot has not developed, is treated by a course of physiotherapy as above, and is provided with a gutta-percha arch support moulded to the long and anterior arches.

SPASMODIC FLAT-FOOT

Treatment.—The patient is usually a youth whose work entails much standing. The foot is manipulated into full inversion under an anæsthetic. It is maintained in this position in plaster for six weeks.

After-treatment.—When the plaster has been removed, the patient is fitted with a short outside steel and an inside T-strap. The boot is altered so as to have a quarter-inch inside wedge on sole and heel, and a valgus pad under the long arch of the foot. To save time, the instrument and alterations to the boot should be ordered *before* the manipulation is performed.

This instrument should be worn until all spasm and pain have disappeared. If the patient's work necessitates much standing, he should be advised to change his occupation.

TENDER HEELS

A tender spot can be found on pressure on the plantar surface of the heel. A radiograph may reveal a spur arising from the under surface of the os calcis. In other cases no spur is seen, but on further examination the patient may be found to have a highly arched foot with a narrow weight-bearing heel surface. A new pair of shoes in which the surface for the heel is flat instead of concave is another cause of the complaint. In any of these cases it is wise, at first, to fit a sponge rubber insole shaped to take the heel. In addition, a course of local diathermy for several weeks is desirable. If conservative treatment fails, a painful spur may be removed through a small incision along the inner aspect of the heel.

PLANTAR FASCIITIS

This condition may resemble the former. When the foot is forcibly dorsiflexed a tender spot is found on the taut plantar fascia. It is not so noticeable when the fascia is lax.

The cause is usually some infection, and commonly gonorrhœa. As well as specific treatment, local applications of diathermy give relief.

PES CAVUS

This condition is due to an incompetence or paresis of the lumbricals and interossei muscles of the foot. The normal function of these members is to extend the toes at the interphalangeal joints.

Treatment.—Lambrinudi's operation rectifies this disability by arthrodesing all the interphalangeal joints of the toes; that is, the arthrodesis acts as a substitute for the function of the muscles. The high arch gradually becomes flat over a period of about six months.

CONGENITAL TALIPES EQUINOVARUS (CLUB-FOOT)

Treatment.—This condition is best treated by repeated manipulations and the application of Denis Browne's splints and boots (*Fig.* 454). It is essential that treatment should be initiated during the first few weeks of life. No anæsthetic is then necessary.

Measuring for the Splints.—The splints are made from 12-gauge aluminium, in three sizes, thus :—

X–X and Y–Y	.	$3\frac{1}{2}$, $4\frac{1}{2}$, and 6 in.
Z–Z		$1\frac{1}{4}$, $1\frac{1}{2}$, and $1\frac{1}{2}$ in.
Cross-bar	.	$1\frac{1}{4}$ by 5 in. $1\frac{1}{2}$ by 6 in. $1\frac{1}{4}$ by $6\frac{1}{2}$ in.

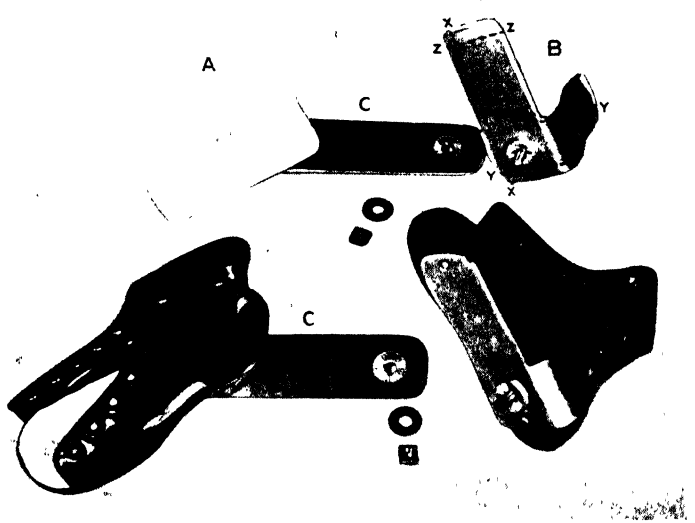


Fig 454.—Denis Browne's splints and boots A, Right splint; B, Left splint; C, Cross-bar. A larger splint is used for the boots (*see* p. 349), but the same cross-bar. X–X, Y–Y, Z–Z, Measurements of splints (*see text*).

It is essential that the lower part of the leg-piece be well curved out to accommodate the lateral malleolus, which may otherwise develop a pressure sore.



Fig. 455.—One-hand method used by Denis Browne.

Manipulation.—Browne dorsiflexes and everts the foot forcibly until it is possible to touch the anterior surface of the leg with the little toe (*Fig.* 455). For the beginner, this method is not without risk, as it is possible to 'break' the foot and thus form a 'rocker sole'. To use both hands and less force is safer, and gives the same end-result.

It must be remembered that metatarsus varus (*Fig.* 456) may be the most troublesome part of the deformity to correct. In *Fig.* 457 this is being overcome, using the thumb as fulcrum and the forefoot as the long arm of the lever. The forefoot is then everted forcibly on the hind foot (*Fig.* 458).



Fig. 456.—Metatarsus varus.



Fig. 457.—Correcting metatarsus varus.



Fig. 458.—Correcting inversion of the forefoot.



Fig. 459.—Small felt pad in position.

Application of Felt Pads.—To maintain this correction on the splint one small felt pad is placed along the inner side of the great toe and another is placed at the fulcrum site (*Fig.* 459).

Following the first manipulation, when swelling is to be expected, felt pads are not used. Thereafter a quadrilateral piece of ¼-in. adhesive felt approximately equal to the size of the sole is cut diagonally to form two triangular strips. These are pressed together to form a double thickness and then applied to the outer aspect of the sole and toes (*Fig.* 460).

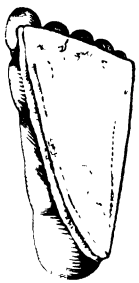


Fig. 460.—Felt pads applied to the sole of the foot.

Application of Splints.—The cross-bar must be removed and the splints put on separately. The sole-plate is placed along the sole of the foot with the felt in position (*Fig.* 461), the nurse holding the splint in place, and at the same time *pressing the heel and the inner border of the foot firmly against the plate*. The surgeon binds the foot to the sole-plate with 1-in. strapping (*Fig.* 462). A turn is taken around the heel, and then the leg-piece of the splint is swung into position and fastened to the leg with a few more turns of strapping. The cross-bar is fixed in place, the feet being rotated outwards into the 'Chaplin' position (*Fig.* 463). A normal foot is placed in 20° and a club-foot in 60° or more of external rotation. If one foot is normal, the felt



Fig. 461.—The splint sole-plate is led along the pads and sole. The leg splint is swung outwards



Fig. 462.—The fore-foot is strapped to the sole-plate. The vertical leg-piece has not yet been swung into position. The strapping on the leg is covering an abrasion.

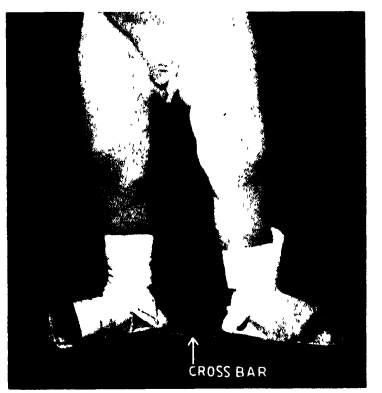


Fig. 463.—The application of the splints completed in a bilateral case

pads are omitted on that side and a single felt strip cut to the size of the sole is substituted.

After-treatment.—The child should never be allowed to leave hospital until it is certain that the circulation in the toes is satisfactory. The feet must be fully manipulated into the over-corrected position and the splints reapplied at regular fortnightly intervals until the manipulation can be performed

easily and painlessly. This takes approximately six months. Then the child is fitted with the special ' hobble ' boots (*see Fig.* 454) to wear *at night*, until voluntary eversion is possible. They are fixed in the same angles of external rotation as the splints. During this period, which lasts for about two years, the mother manipulates the foot three times daily. If relapse is threatened, immediate resumption of the splints is necessary. Recently, Denis Browne has devised a new night splint (*Fig.* 464) instead of the ' hobble ' boots. It consists of a metal



Fig. 464.—The new Denis Browne splint. By means of the adjustable strap the foot can be held in eversion and dorsiflexion.

grip which is strapped to the thigh just above the knee. From this a strap passes down the back of the heel, then along the sole of the foot and upwards to reach the lower part of the grip once more.

Later cases: Cases commencing treatment when more than six months old need manipulation under anæsthesia and plaster in full eversion and dorsiflexion at intervals of four weeks. When the deformity can be fully corrected without an anæsthetic the Denis Browne routine may be commenced.

In adults even severe cases can be treated effectively by arthrodesis of the foot.

CHAPTER XLVI

THE TREATMENT OF ABSCESSES

By HAMILTON BAILEY

GENERAL PRINCIPLES

As soon as pus has made its presence manifest, either by the phenomenon of fluctuation or by a softening or bogginess in an area of induration, no time must be lost in giving it an exit. Most abscesses should be opened as soon as they have declared themselves; and they should be opened freely, with due respect to the anatomy of the parts concerned, and in such a position that drainage is favoured.

Anæsthesia.—For the opening of abscesses intravenous anæsthesia (*see* Chapter LXXV) is unsurpassed.

Obtaining a Specimen for Bacteriological Examination.—Before commencing the operation it is a good practice to have in readiness a sterile test-tube so that a sample of pus can be collected.



Fig. 465.—A finger is introduced into the abscess cavity and is used to explore and when necessary break down loculi.

Making the Incision.—In opening an abscess, aseptic precautions must be as perfect as in a clean case. The curved scalpel, generally called a 'Syme's knife', is often recommended, but a straight blade is better. Whatever knife is used, it should be sharp. The rule is that incisions should be made parallel to, and not across the direction of, structures which it is desired to avoid.

Hilton's Method.—If important structures are likely to be encountered or injured, Hilton's method should be employed: this consists in incising the tissues down to the deep fascia and inserting a director into the most prominent part of the swelling, or where fluctuation is most obvious, until the pus flows along the groove. The opening is then enlarged with sinus forceps or Spencer Wells forceps, until a track of sufficient size has been established. When once the opening has been made, it is usually unnecessary to do more than insert a drainage tube.

Exploration of the Abscess Cavity.—A finger is introduced into the abscess cavity. When necessary, loculi are broken down in order that subsequent drainage may be facilitated (*Fig.* 465).

Counter-openings.—As a rule, abscesses, especially acute ones, must be opened where they point, but this is very often not the spot which would be chosen by the surgeon, who would prefer to make his opening at the most dependent part; this may necessitate the making of a *counter-opening* by passing a director through the sac from the upper pointing aperture to the bottom of the cavity, and cutting down upon the point of the instrument, so held that it can be felt there through the skin.

Drainage.—All acute abscesses require drainage, though the duration and form of this drainage vary in individual cases. Generally a rubber tube of fair size is the best. When the position of the abscess is unsuitable for tube drainage (e.g., it might cause pressure necrosis of an artery), corrugated rubber or a piece of a rubber glove is substituted.

After-treatment.—

The 'Closed' Method.—Especially when the overlying skin is involved, I do not hesitate to excise the skin comparatively widely. Having mopped the pus from the abscess cavity, the interior is dusted with sulphonamide powder and packed with vaseline gauze, the area being encased preferably in a Viscopaste bandage, or, when this is impracticable, covered by strips of flexible adhesive plaster (*Fig.* 466). I have been employing this principle more and more, and find the results are better and quicker than those of the bottle-neck drainage (*Fig.* 467). The cavity soon fills in with healthy granulation tissue, and, contrary to expectations, skin-grafting is rarely necessary.

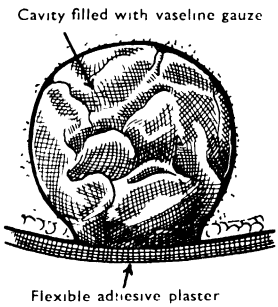


Fig 466.—Treatment of an abscess by excision of overlying skin and packing abscess cavity

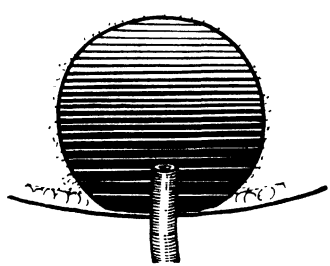


Fig 467.—Bottle-neck tube drainage. Older standard method of treatment of an abscess

Drainage should not be too prolonged, since a tube is a source of irritation; sinuses are often caused by a too zealous adherence to the tube. When the temperature has been normal for three days, and when the discharge has become clear, it is time to withdraw the drain.

Rest is an important factor in the healing of abscesses. Neglect of this detail is another cause of troublesome sinuses. The part should be immobilized as far as possible. Splints, bandages, or whatever apparatus may be most suitable, should be applied.

If the 'closed' method has been employed there is seldom any need to disturb the dressing for a week, when fresh packing should be inserted, not in the ward, but in the operating theatre.

TREATMENT OF SOME SPECIAL ACUTE ABSCESSES

Deep Cervical Abscess.—Early recognition of the presence of pus beneath the deeper fasciæ of the neck is of the highest importance, yet sometimes it is extremely difficult; the pus is so confined and so deep, and there is often so much general swelling, that fluctuation cannot be made out.

Constitutional disturbance is generally great, and the temperature chart will be evidence of the formation of pus. If a localized induration can be felt, make

a 2-inch incision at the anterior border of the sternomastoid (*Fig.* 468). Incise the deep cervical fascia and gently search with the finger and a blunt director for pus, having due regard to the great vessels.

Non-tuberculous Suppurating Cervical Lymphatic Glands.—In dealing with this condition one can usually delay operation with safety and advantage until the centre of the swelling is soft. A comparatively small incision is then made, and the abscess is opened by Hilton's method.



Fig. 468.—Incision for opening a deep cervical abscess.

Abscess of the Breast.—In cases of acute suppurative mastitis there is no occasion to hurry to open the breast. Large magnesium sulphate fomentations are applied and the patient is given a dose of morphine, for in all probability she has not had much sleep owing to the pain. If she is feeding her child it must be weaned and the healthy breast emptied by a breast pump. The milk secretion is minimized by giving saline aperients and atropine.

The breasts are examined daily. In a few cases, under the treatment outlined above, resolution will occur. In the majority one will see the blush, tenderness, and induration become mainly confined to a quarter or, at the most, half the breast—usually the lower half. *Fluctuation should not be awaited*; it is usually wise to wait until there is some semblance of localization.

Open Operation.—The first incision is made in a line radiating from the nipple into that quadrant which is deemed most indurated (*Fig.* 469). When necessary, counter-openings are made.



Fig. 469.—Incisions for opening an abscess of the breast mainly confined to the lower and inner quadrant.

The Closed Method of Treating Breast Abscesses.—This method of treating breast abscesses offers certain advantages:—

1. Secondary infection is largely avoided.
2. The method is practically painless.
3. It necessitates very little skilled nursing.
4. Scar formation is reduced to a minimum.

The Operation.—Under gas or intravenous anæsthesia a single incision $\frac{3}{4}$ in. in length is made at the most dependent portion of the indurated area. The finger is inserted and loculi of the abscess cavity are broken down. A $\frac{1}{2}$-in. drainage tube is introduced into the cavity. The edges of the wound are approximated snugly around the tube by a single silkworm-gut stitch, which passes also through the side of the tube, anchoring it into position. The tube is cut off nearly flush with the skin. Into the large tube is passed a small

¼-in. drainage tube with a number of perforations near its distal end. The small tube is then fastened to the large one by a fine silkworm-gut stitch, which also serves to close the hole snugly in the gauze about the tube. The patient is now allowed to come out of the anæsthetic.

Dressings.—A liberal amount of fluffed-up gauze is arranged over the vaseline-gauze-protected breast. This in turn is covered by a large piece of oiled silk. Through these layers is brought the *small* tube. The whole is supported by a many-tailed bandage, which encircles the upper abdomen, both breasts, and the opposite shoulder (*Fig.* 470). The reader may be thinking that this is complicated

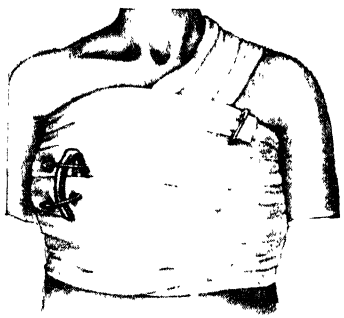


Fig. 470.—Method of applying the overall many-tailed bandage, and of fixing the end of the irrigating tube when not in use. In practice the free end of the tube is wrapped up in a piece of gauze moistened with Dakin's solution.

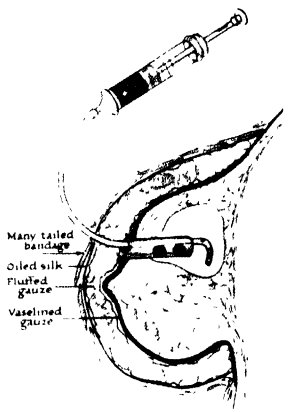


Fig. 471.—Diagram illustrating the technique described in the text. The amount of Dakin's solution to fill the abscess cavity has been ascertained at the time of operation. This quantity is injected down the small tube every four hours. The overflow runs out of the large tube and is absorbed by the gauze. A layer of vaselined gauze protects the skin from the irritating effect of the fluid.

and unnecessary, but the whole procedure is carried out in a very few minutes if the simple requisites are got ready beforehand. The boon of this method becomes apparent in the supreme simplicity of the after-treatment.

After-treatment.—The patient lies in bed in a comfortable semi-recumbent position. Every four hours a measured quantity of azochloramid or Dakin's solution is injected down the tube (*Fig.* 471). The overflow is automatically absorbed into the fluffed gauze. If necessary, this instillation can be done by an unskilled nurse, or even by the patient herself. The dressing is not disturbed for twenty-four hours. At the end of that time the many-tailed bandage is loosened and the fluffed gauze is changed. Provided the temperature chart is satisfactory, and the patient does not complain of discomfort, the inner dressing of vaseline gauze and the tubes are not touched. This labour-saving, pain-sparing régime is followed until the fourth or fifth day, when the dressings and tubes are removed.

More Remote After-treatment.—A fresh piece of vaseline gauze is applied. By means of a rubber catheter the abscess cavity is washed out with the solution twice a day. It will not be long before irrigation need be undertaken but once a day. By approximately the tenth day the wound presents a healthy, granulating appearance, but there appears from time to time some seropurulent discharge, probably admixed with

a little leakage of secreted milk. The latter is washed away with solution diluted with saline to one half or quarter strength. The time has now arrived for the vaseline gauze square to be discarded. It is usually advisable to keep a wisp of vaseline-impregnated gauze in the mouth of the wound for a day or two.

Convalescence.—The only dressing now required is a piece of dry folded gauze over the wound, kept in place by adhesive plaster. The patient can get up, wearing an ordinary brassière for support. There is always a considerable indurated area in the breast at this period, and it persists for some time.

Axillary Abscess.—Abscesses of the axilla must be opened promptly, for the pus tends to extend along the path of the nerve-trunks into the neck. The site of the incision will depend upon the situation of the pus. *In acute abscesses pus usually lies under the pectoralis major.*

Abduct the arm fully. Make an incision quite 2 in. long just below the fold of the pectoralis major (*Fig.* 472).

Hilton's Directions for Opening a Deep Abscess in the Axilla.—Cut through the skin, cellular tissue, and fascia of the axilla about half an inch behind the axillary edge of the great pectoral muscle. At that part we meet with no large blood-vessel. Then push a grooved director upwards into the swelling in the axilla; if you watch the groove in the director, a little stream of pus will show itself. Take a blunt pair of forceps and run the closed blades along the groove in the director into the swelling. Now open the handles and so tear open the abscess.

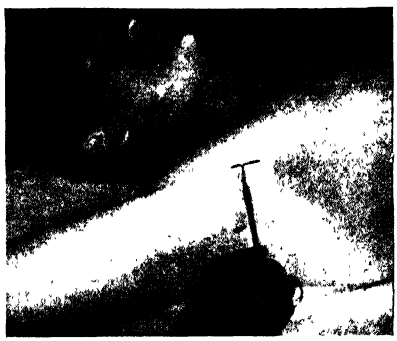


Fig. 472.—Opening a deep-seated axillary abscess.

In late cases, when the whole axilla is merely a bag of pus, an incision into the lower part of the middle of the space will be found convenient.

Suppurating Glands of the Groin (syn. **Bubo**).—This term is applied to all glandular or periglandular abscesses of the femoral and inguinal glands. The exciting causes are various. In children, a sore heel or inflamed scratch on the leg often produces suppuration in the femoral group of glands.

In adults, the most frequent cause of buboes are gonorrhœa and soft chancres. These buboes are almost always abscesses *around* the glands, which run a subacute burrowing course.

Buboes should always be opened early, from the tendency they have to form long fistulous tracks in the cellular tissues. A vertical incision is made, and the abscess cavity kept open so that it may heal from the bottom. Many buboes, particularly those associated with soft sores, run such a chronic course that some surgeons prefer to dissect out the affected glands. After the glands have been removed, every bleeding point is ligatured and the interior of the wound is sprinkled with sulphonamide powder. The wound is closed without drainage and firm pressure applied by means of strips of flexible adhesive plaster.

Popliteal Abscess.—This arises most commonly from an infection of the lymphatic glands of the popliteal space, via the lymphatics, from a sore on the heel.

A free incision is made on the lateral aspect of the space parallel to the tendon of the biceps. Pus is evacuated and the space drained by a corrugated rubber strip or a length of vaseline gauze; a rigid rubber tube should not be used in this situation.

Ischiorectal Abscess.—In no circumstance should pointing of an ischiorectal abscess be awaited. A brawny induration about the base of the ischiorectal fossa is sufficient indication that an incision is necessary. With the patient in the lithotomy position a liberal incision is made through the skin and fat overlying the ischiorectal fossa. An adequate portion of skin, which includes most, if not all, of the floor of the ischiorectal fossa, is excised. The cavity is explored, and if septa exist they should be broken down gently with the finger, care being taken to avoid injuring the sphincter muscle. The skin is excised to a point just within the anal canal. In cases where an internal

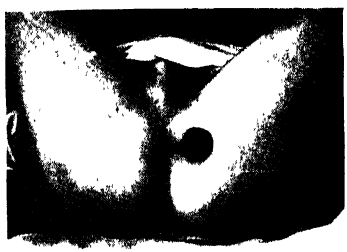


Fig. 473.—Drainage of an ischiorectal abscess showing the amount of skin which should be removed

opening is present, the mucous membrane is slit up and the completed operative procedure may be likened to a pear. The body of the pear is represented by the excised skin and the stalk of the pear by the slit-up mucous membrane (*Fig.* 473). When the abscess is bilateral both sides should be opened up by the technique described, together with the communicating track. A flat moist dressing soaked in flavine or a saturated solution of magnesium sulphate is applied to the wound. The cavity is not packed. Hip baths can be commenced on the following day in most cases. No plugging is used in the after-treatment.

Alveolar Abscess.—*See* p. 450.
Retropharyngeal Abscess.—*See* p. 405.
Peritonsillar Abscess.—*See* p. 404.
Psoas Abscess.—*See* p. 584.

CHAPTER XLVII

THE TREATMENT OF CARBUNCLES AND BED-SORES

By Hamilton Bailey and J. A. East

THE TREATMENT OF CARBUNCLES

The first consideration is to test the urine. If the patient is a diabetic, he must receive appropriate treatment for diabetes. It is important to realize that the toxæmia resulting from a carbuncle can give rise to glycosuria ; should perplexity arise on this score, the blood-sugar level will provide the clue. When facilities exist (the house surgeon is exceptionally well situated) a full blood-count should be ordered. The white-cell count will provide interesting and instructive data ; the red-cell count and the hæmoglobin estimation will ensure that unsuspected anæmia is not overlooked.

GENERAL TREATMENT

From the outset general treatment is of cardinal importance. A high fluid intake must be insisted upon. Because the causative organism is the *Staphylococcus aureus*, it is rational to prescribe a full course of sulphathiazole. Penicillin, when available, will probably supersede sulphonamide therapy. Anæmia must be rectified ; occasionally, blood transfusion is indicated.

As soon as there are signs that the patient is overcoming the infection, Easton's syrup, min. 30 bis. die., or some similar iron-containing tonic, is prescribed, together with a saline aperient in the morning. A light, but highly nutritious diet is an important detail, and some alcohol, if thought desirable, is not out of place. Mixed vitamins, abundant fresh air, and other common-sense means must be taken to build up the patient's resistance, for further carbuncles and boils are very prone to follow in what is termed ' the negative phase ' which follows seemingly encouraging early convalescence. In patients who tolerate it well, perhaps the most valuable of all general adjuvant treatment is natural sunlight. In its absence, local and general ultra-violet light is a good substitute.

Such are our ideas on building up the patient's resistance, but we realize that there are remedies not mentioned here in which others put much faith. On many of these we keep an open mind. This is not the case where vaccines, whether mixed, autogenous, or detoxicated, are concerned. After a fair trial, it is our opinion that even when they are administered strictly in accordance with the pathologist's instructions, vaccines seldom do good, and often harm.

LOCAL TREATMENT

There are many ways of treating carbuncles. There is little doubt that a large number of them are successful in the hands of those who practise them conscientiously. To avoid confusion and save space, we will detail our own methods only.

If the surrounding area is hairy, wide atraumatic shaving is indicated. The shaved area is washed with ether, and ung. hyd. ammon. is wiped on to the

peripheral skin with a swab. The object of this is to try and prevent satellite furunculosis—a common local complication.

Abortive Treatment appears to be seldom successful in the case of a carbuncle, but it is often valuable for a boil. This statement is relevant, for no one has defined where a large boil ends and a small carbuncle begins. We ourselves have had comparatively little experience of early cases ; it is the practitioner who will have more opportunities to try abortive treatment, which consists in :—

a. Covering the shaved area with firmly and evenly applied flexible adhesive plaster or, what is preferable in the case of the back of the neck, an ample Viscopaste bandage. The idea is to protect and splint the tissues bearing the carbuncle.

b. Exposure to X rays. A half-erythema dose (approximately 200 r units) is given.

Conservative Local Treatment.—A large experience of these common cases in municipal hospitals has shown us that simple conservative measures, although rather slow, are most successful. Such treatment is particularly well suited to the aged, the obese, the alcoholic, and, in general, the poor surgical risk patient, which constitute a high percentage of the class of case to which we refer. A saturated solution of magnesium sulphate is prepared. Pieces of Gamgee tissue are cut of such a size that they overlap the extreme limits of the carbuncle. Two pieces of jaconet, which will more than cover the Gamgee, are also provided. The Gamgee is wrung out in the magnesium sulphate solution so as to leave the former thoroughly moist, but not dripping wet. We do not think that this ' fomentation ' should be applied hot ; it is so moist that the hot solution would probably scald the skin and add to its further devitalization. Moreover, hot applications cause considerable pain. The jaconet and a suitable overall bandage complete the dressing. A piece of jaconet is used as a spare, so that it can be washed in antiseptic solution and is in readiness for the next dressing. The dressing is changed every six hours, but the patient is not awakened for this purpose.

Active Local Measures.—While the relative inactivity just described is surprisingly successful in the majority of cases, provided there is not a contra-indication to a general anæsthetic, there should not be undue reluctance to resort to the active measures which will be detailed immediately if : (*a*) after forty-eight hours the pain is sufficient to cause the patient to request that something be done to relieve him, or the nurse reports that he is not sleeping on account of pain ; (*b*) the patient is comparatively young, and time is a consideration.

These factors influence a change in attitude. It is emphasized that we never resort to operative treatment unless the carbuncle has been present for several days, and there is evidence of softening in its centre.

Combined Auto-injection of Blood, Cruciform Incision, and Limited Excision of Carbunculous Skin.—Auto-injection of blood into the tissues around the carbuncle is a valuable subsidiary measure, but for its performance a general anæsthetic is required. So it comes about that only certain cases—in our practice those selected for operative measures—get this form of therapy. The combined operation about to be described has proved more than satisfactory in a large number of selected cases.

Such critical and well-informed patients as a nurse and two general practitioners testified with enthusiasm as to the immediate freedom from pain and the feeling of general well-being which quickly followed. So much so that one of the doctors with a carbuncle 2 in. in diameter, against advice, resumed his practice on the third day after operation with, fortunately, no ill effects.

The operative procedure consists of four phases. The important detail is that good access to the part is essential, as so often a carbuncle is situated on the nape of the neck, the back, or the buttocks. A few moments spent in consultation with the anæsthetist as to the patient's position during the operation is time well spent.

1. *Auto-injection of blood*: At least 30 c.c. of blood are withdrawn from the median basilic vein and the blood is mixed with citrate solution in the proportion of about six parts of blood to one of citrate. Three to six punctures are necessary and, what is very important, a new sterile needle is used for each injection. Commence each injection beyond the margin of induration. Injection is begun in the subcutaneous tissues under considerable pressure. Gradually the needle is pushed deeper until but little pressure is required to force the blood. By this time, the point of the needle has probably penetrated deep enough for blood to ooze through the necrotic tissue. About 10 c.c. of blood is injected for each puncture.

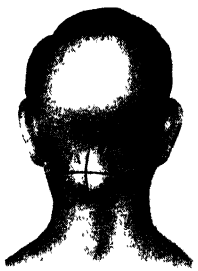


Fig. 474 — Showing the points where auto-injection of blood can be made, and the crucial incision

2. *Crucial incision*: A large crucial incision is made in the whole of the carbuncle, well into the red skin at the periphery (*Fig.* 474). On no account is any scraping performed; loose slough can be removed by wiping it firmly with a gauze swab.

3. *Excision of carbunculous skin*: The four flaps resulting from the incision are dissected up and their apices are removed, erring on the side of liberality.

4. *Application of close dressing*: Because sulphathiazole is not available in our clinics, for local wound treatment we have crushed some tablets and dusted the resulting powder into the wound. The wound is then packed with vaseline gauze in exactly the same way as described on page 352. A Viscopaste bandage or strips of flexible adhesive plaster complete the dressing, which is not disturbed for a week, unless there is some indication.

CARBUNCLE OF THE FACE

A patient with a carbuncle of the face (the upper lip is the commonest location) must be admitted at once. Conservative treatment in this case is insisted upon; indeed, in our practice, the question of incising a facial carbuncle does not arise. Keeping the magnesium-sulphate-soaked Gamgee in place upon the face requires some ingenuity to meet particular circumstances. An elastic band or eye-shade is sometimes helpful.



Fig. 475.—Ligature of the angular vein.

Spreading œdema towards the inner canthus, accompanied by suffusion of the eyelid on that side, calls for ligation of the angular vein, which may prevent the dreaded complication of thrombophlebitis of the cavernous sinus.

Ligature of the Angular Vein. — A hypnotic is administered twenty minutes before operation. Castor oil should be introduced into the eye, and a damp gauze covering applied over the lids, to prevent the skin antiseptic from running into the conjunctival sac. The lip is covered with gauze wrung out in perchloride

solution; dry gauze becomes easily displaced. The angle made by the junction of the nose with the cheek is the surface marking for the vein. After novocain has been infiltrated, an incision is made commencing a little below the inner canthus and passing downward and very slightly outward for about 1 in. There is always a lot of troublesome oozing which can be quelled by packing with gauze soaked in adrenaline. After more novocain has been injected, dissection in the wound will reveal the levator labii superioris alæque nasi. The fibres of the muscle are teased apart, and the angular vein will be found either in or beneath this muscle (*Fig.* 475). It is divided between ligatures. Skin sutures and a collodion dressing complete the operation.

BED-SORES

Prevention, if thought of in time, is often comparatively easy; treatment is difficult. Strife and bed-sores seem inseparable. Let us examine the last statement, which so many house surgeons have only verified after unpleasant experiences. The nursing profession regard (sometimes rightly, but not always) the advent of a bed-sore as a reflexion upon their skill. So it comes about that threatened and early bed-sores tend to be hidden rather than reported, and when finally they come to view there is alighted a conflagration which may spread as far as the matron's office. Dr. Bernard Fantus, the Director of Therapeutics at the Cook County Hospital, Chicago, a post which, we take it, is comparable to a Medical Superintendent in this country, considers "that a physician who does not on his daily round examine the back of patients who are especially predisposed to bed-sores is remiss in his duty". If this is so, then the house surgeon who carried out his duties could never be faced with the problem of the unreported fully-developed bed-sore.

When the type of case likely to develop a bed-sore is admitted, e.g., an old person with a fractured femur, or a patient with paralysis, there can be no possible harm in discussing with sister the possibility of future complications and in trying some of the expedients detailed in this chapter, which, if carried out thoroughly, will undoubtedly help to prevent a bed-sore, or allow it to heal.

It is beyond the scope of this work to enter into the nursing details, and we are in the same difficulty as we were with carbuncles—that there is a host of various methods of treatment, many of which are admirable.

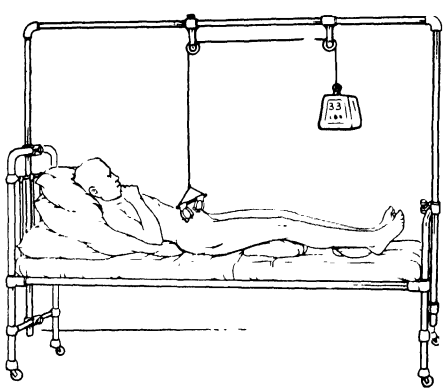


Fig. 476.—'Half-suspension' of the pelvis (*after Westhues*).

Pelvic Suspension.—What is undoubtedly a splendid method of preventing bed-sores in cases where they are almost certain to develop on the sacrum, and for the treatment of established bed-sores in this situation, is what is known as 'half-suspension of the pelvis' (*Fig.* 476). 'Half-suspension', which takes pressure off the lower part of the back, is extremely comfortable. The patient, as he lies in bed, says he feels wonderfully 'light'.

Especially in old, enfeebled subjects, we have found Kirschner's wire unsatisfactory for pelvic suspension. The wire tends to cut through the cancellous iliac bone. For this reason Steinmann's or other nail (*see* p. 314) is better for

pelvic suspension, and the counterweight which is employed should be reduced to a minimum—just enough to keep the sacrum off the bed sheet.

The pins should be introduced a short distance above the anterior *inferior* iliac spine on each side. These points are selected because they are approximately the centre of gravity of the pelvis. The horseshoe pieces attached to the pins

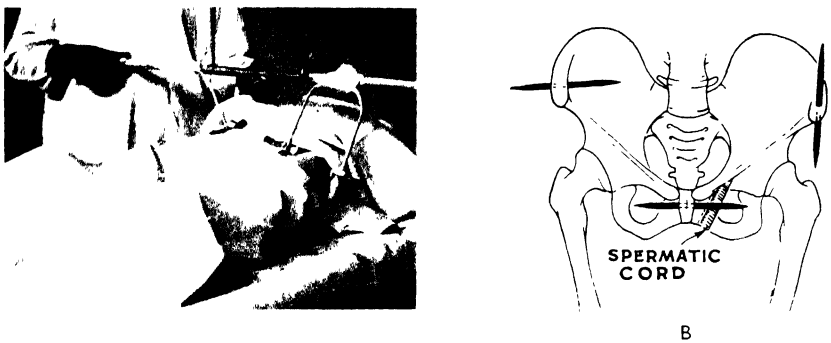


Fig. 477.—A, Pelvic suspension by means of Steinmann's pins. B, Various methods of transfixing the pelvis in order to suspend it (*after Schneider and Stapff*).

are fixed to a cylindrical piece of wood or metal by means of plaster bandages (*Fig.* 477, A).

An alternative method is to transfix each anterior superior iliac spine in a direction tangential to the ilium (*Fig.* 477, B). A disadvantage of this method is that it limits flexion of the hip-joint. Although we have not tried it, in thin subjects transfixion of the pubic bones is said to be the best. The spermatic cords are displaced backwards (*Fig.* 477, B).

Flexible Adhesive Plaster as a Preventative Measure.—The skin is washed, swabbed with alcohol, painted with tinct. benzoin co., and the flexible plaster is laid on perfectly evenly over the sacrum (*Fig.* 478) and the heels. It is of paramount importance that the plaster be applied with skill and care. It must neither be too tight nor must it wrinkle; if the plaster is allowed to wrinkle it will probably do more harm than good.



Fig. 478.—Adhesive plaster applied in the case of an old lady with a fractured neck of the femur

Toughening the Skin, when it is soft, undoubtedly helps to prevent bed-sores. Alum alcohol is a good preparation for this purpose.

℞		
	Alum	30·00 g.
	Water	250·00 c.c.
	Alcohol	to make 1000 c.c.

Dissolve the alum in the water and add the alcohol.

Tannic Acid/Silver Nitrate Treatment.—Bed-sores can be divided into three classes: (*a*) threatened; (*b*) unavoidable; (*c*) ulcer. For the unavoidable

class it is difficult to improve upon the tannic acid/silver nitrate treatment. A 5 per cent freshly-made solution of tannic acid is dabbed on and dried. This is followed by painting the area with 10 per cent silver nitrate solution applied, preferably, with a brush. The resulting coagulum is softer, thinner, and more rubbery than that produced by plain tannic acid.

Flexible Adhesive Plaster Treatment is valuable for small and moderate-sized ulcers. The ulcer and the surrounding skin for at least an inch is covered and the plaster is left in position for as long as it will adhere ; usually in the early stages, when the discharge is plentiful, this is twelve to forty-eight hours. It is then renewed. It should be noted that at all times the plaster is left on until it ceases to adhere.

Cod-liver Oil Treatment.—For large bed-sores, lightly packing the ulcer with gauze soaked in cod-liver oil is a method of treatment which is as good as any. At any rate, it may be employed as an alternative in cases which are not progressing under one of many dressings not necessarily detailed here. In such cases nothing is likely to succeed unless pressure is prevented absolutely, and it would appear that here is the indication par excellence for half-suspension of the pelvis.

PROTECTING THE SKIN OF INCONTINENT PATIENTS

Incontinence of urine and/or fæces is a potent predisposing factor in bed-sores. For (what is believed to be) temporary urinary incontinence, a length of

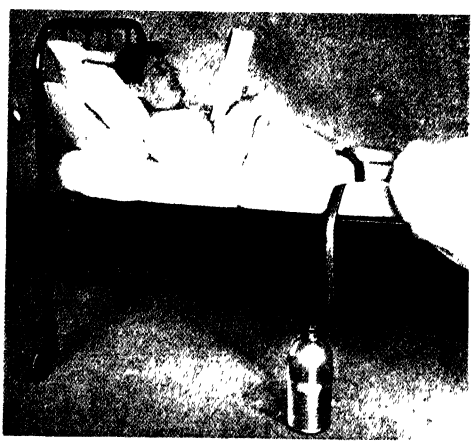


Fig. 479.—Patient with incontinence of urine treated by Paul's tubing attached to the penis.

wide colostomy tubing fixed by adhesive strapping to the penis and shaved pubes is led to a receptacle at the bedside (*Fig.* 479). When the urinary incontinence is likely to be of long standing, the question of the advisability of suprapubic catheterization should arise early in the treatment of the case.

For incontinence of fæces little can be done, except regular rectal wash-outs. The successful prevention of bed-sores in this instance is, indeed, a tribute to excellent nursing.

CHAPTER XLVIII

THE TREATMENT OF INFECTIONS OF THE HAND

By HAMILTON BAILEY

Pre-operative Treatment.—In the preliminary stages (i.e., when it is hoped that an infection may be aborted, or when it is as yet impossible to decide the location of the pus), a Bier's bandage is applied to the arm (*Fig.* 480) in such a way as to produce congestion, but there should be no blueness or duskiness. If pain is increased by the bandage, the bandage is too tight. The bandage is left on for from 12 to 24 hours, during which time sulphanilamide is prescribed.



Fig 480.—Bier's bandage applied to the upper arm; there should be no blueness or swelling of the forearm

INFECTION OF THE TERMINAL PULP COMPARTMENT

The pulps of the fingers and thumb are subjected to more pricks, and therefore infections, than any other part of the body. Nature has provided in this situation a closed fascial compartment which extends from the tip of the digit to the level of the epiphysial line of the terminal phalanx (*Fig.* 481).

TREATMENT.—If treated correctly, infection of the terminal pulp compartment is seldom serious. When tenderness is most marked over the pulp compartment, it is permissible to wait for localization of pus. When the pulp feels indurated is the time to open it. In the whole realm of surgery there is not a more heinous offence than to incise downwards through the pulp into the tendon-sheath. *The incision must on no account extend in a proximal direction farther than half an inch from the terminal flexor crease.*

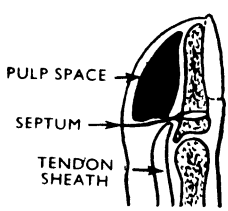


Fig. 481.—The terminal pulp compartment.

The Transfixion Operation.—A tourniquet in the shape of a rubber catheter is placed around the base of the digit. Keeping half an inch distal to the terminal flexion crease, two incisions are made, one on each side, 2 mm. in front of the nail edge. The knife, which should be a narrow-bladed one, is thrust through the pulp space from one incision to the other with its blade directed towards the finger-tip (*Fig.* 482). If pus is not found, it probably lies more superficially in the pulp space, so with the scalpel in the transfixion incision, cuts are made forward into the pulp, care being taken not to perforate the skin. A through-and-through drain is left in position and the tourniquet is removed.

The best dressing is a Viscopaste bandage, and a wooden spatula makes an excellent dorsal splint. The patient is given an arm sling and told to report next day. If a Viscopaste bandage has been used, there is no need to disturb the dressing until the third or fourth day, when the drain is removed. A flexible

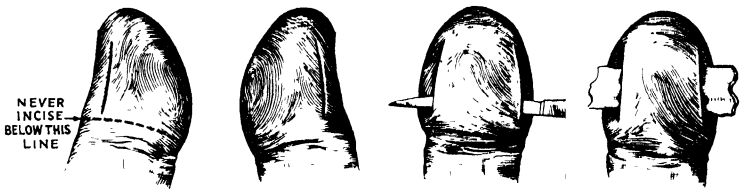


Fig 482.—The transfixion operation for terminal pulp space infection

adhesive plaster bandage is then applied directly to the finger and is changed every third or fourth day, or oftener if the discharge is profuse.

Complication.—If the wound has not healed within fourteen days a radiograph should be taken. If necrosis is proceeding, the purulent discharge will continue until the diaphysis can be picked out of the wound as a sequestrum. A weekly X-ray examination will aid in determining when the sequestrum has separated.

PARONYCHIA

Organisms gain entrance through a hang-nail, and the tissues about the base of the nail become inflamed. Suppuration follows frequently, and in 63 per cent of cases pus accumulates under the nail, as well as beneath the cuticle.

TREATMENT.—Early operation is indicated. Lateral incisions are made (*Fig.* 483, *a*), and the flap is turned back. In order to keep the flap elevated a wisp of gauze soaked in paraffin is inserted under the flap (*Fig.* 483, *b*). In very early cases one lateral incision may be sufficient, but it is wise to err on the side

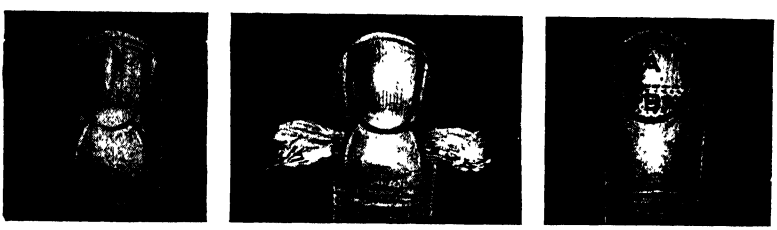


Fig. 483.—Treatment of paronychia. *a*, Incisions for turning back the flap, *b*, A wisp of gauze soaked in paraffin is used to maintain elevation of the flap, *c*, When there is pus under the nail the portion B is removed and the portion A is retained.

of radicalism. A Viscopaste dressing will be found most satisfactory. On the third or fourth day the wisp of gauze is removed and the flap allowed to fall back. A dressing every third or fourth day is all that is required if this method is employed.

When there is Pus under the Nail.—In addition to the above, the base of the nail (*Fig.* 483, *c*) should be removed in the following way: after the flap has

been turned down, one blade of a pair of scissors is inserted under the base of the nail, and the portion B is removed. It is unnecessary and harmful to remove A unless it is detached. The portion A will exercise a protective action until the new nail grows up and forces it away, a process which takes about two months.

SERIOUS INFECTIONS OF THE HAND

Serious infections of the hand fall particularly into three categories: (1) Lymphangitis; (2) Suppurative tenosynovitis; (3) Fascial space infections. The third group is often a sequel of the second.

LYMPHANGITIS

Organisms, almost always streptococci, gain entrance through an abrasion which may be minute. A portion of the hand immediately adjacent becomes swollen and painful, and there is often considerable elevation of the temperature. Later, red streaks, so characteristic of lymphangitis, can be seen coursing up the arm. It is of cardinal importance to distinguish lymphangitis from suppurative tenosynovitis and fascial space infections. The two latter conditions require urgent operation, while in lymphangitis, at any rate in its early stages, incision is highly mischievous.

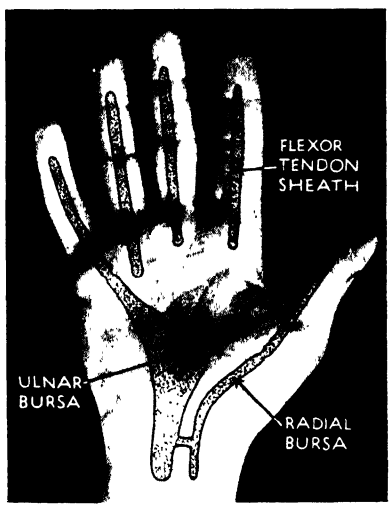


Fig 484.—The flexor tendon-sheaths of the hand.

SUPPURATIVE TENOSYNOVITIS

It is of fundamental importance to be able to visualize the surface anatomy of the tendon-sheaths and their connexions (*Fig.* 484).

The essential signs of an infected digital flexor tendon-sheath are: (1) Swelling of the finger; (2) Flexion of the finger with exquisite pain on extension; (3) Tenderness, maximum over the infected sheath.

The point of maximum tenderness is found by palpating systematically with some blunt-pointed instrument. A burnt match-stalk with the loose charcoal removed answers the purpose admirably.

The greatest swelling does not necessarily indicate the position of the pus. Frequently there is œdema (swelling) of the dorsum, whereas in 90 per cent of cases the pus lies on the palmar aspect. Œdema gives rise to pitting on pressure. If pus is present, induration of the tissues can be felt.

Serious as it is at all times, suppurative tenosynovitis becomes a lesion of the first magnitude when the tendon-sheath of the thumb or the little finger is involved. In the case of the little finger the *ulnar bursa* (the palmar bursa of British anatomy) will almost certainly be implicated quickly. If the infection is primarily in the flexor tendon-sheath of the thumb, the *radial bursa* (syn. sheath of the flexor pollicis longus) must be simultaneously infected along its whole course—that is, right up under the anterior annular ligament to above the wrist (*see Fig.* 484).

Nor is this the whole gloomy story. If the tendon-sheath of either the thumb or the little finger becomes infected, there is an 80 per cent chance that within forty-eight hours there will be total infection of both the ulnar and radial bursæ, for, as shown in *Fig.* 484, there is usually an intercommunicating channel between them.

Signs of Involvement of the Radial Bursa.—

1. Flexion of distal phalanx of the thumb with rigidity.
2. Swelling just above the anterior annular ligament.
3. Tenderness over the flexor pollicis longus sheath.

Signs of Involvement of the Ulnar Bursa.—

1. Œdema of the hand, especially the dorsum.
2. Fullness of the palm, but the concavity is still present.
3. Fullness immediately above the anterior annular ligament.
4. Kanavel's sign—a point of maximum tenderness over that part of the ulnar bursa lying between flexion creases (*see Fig.* 484).

General Principles in the Treatment of Suppurative Tenosynovitis.— Effective drainage must be instituted at the earliest possible moment. Gas-and-oxygen or evipan anæsthesia is employed. The hand is raised for three minutes and a *tourniquet is applied to the forearm.* The hand is placed upon a small table and the surgeon sits down to operate. The infected tendon-sheath should be opened widely, not exactly in the middle line, but somewhat to one side of it. The middle line is avoided in order to prevent, as far as possible, prolapse of the tendon during the later stages of treatment. In early streptococcal cases there is very little pus within the theca, but the synovial fluid is slightly opalescent or tinged with blood.

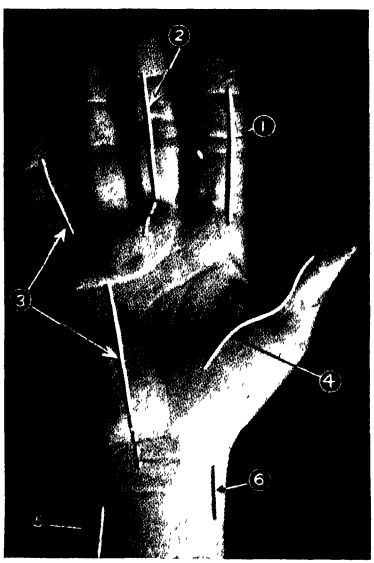


Fig. 485.—A symposium of incisions for draining infected flexor tendon-sheaths. 1, Usual incision for opening an infected tendon-sheath; 2, When a lumbrical canal is infected in addition, the incision is prolonged into the appropriate web space; 3, Incisions for opening an infected ulnar bursa; 4, Incision for opening an infected radial bursa, 5, Incision for opening all infections of the forearm from the hand, 6, Counter-incision used in the case of infection of the forearm from the radial bursa.

A Consideration of Individual Tendon-sheaths from the Point of View of Treatment.—

The Index Finger.—The sheath should be opened somewhat to the radial side (*Fig.* 485, 1), unless it has been shown at the clinical examination that the lumbrical canal between the index and middle finger is involved. In any case, as soon as the sheath has been opened pressure should be exerted over the second lumbrical canal and over the thenar space; if pus wells out of either of these spaces, it must be drained.

The Middle Finger.—One must decide upon which side to open the sheath so as to be able to drain the appropriate lumbrical canal by a suitable short extension. In doubtful cases the ulnar side is chosen (*Fig.* 485, 2). As soon as the sheath is opened, pressure is exerted over the mid-palmar space, and if pus wells out the space should be drained.

The Ring Finger.—The same principles govern this finger, with the exception that when in doubt the radial side is chosen.

The Little Finger.—The sheath is opened (*Fig.* 485, 3); pressure is then exerted over the ulnar bursa. If pus exudes, the ulnar bursa must be opened.

Drainage of the Ulnar Bursa.—The method is important. The hypothenar eminence is inspected; the incision runs down its centre rather nearer the radial side. It begins at the distal flexor crease, and ends just distal to the first crease encountered at the wrist (*Fig.* 485, 3). A pad of œdematous fat bulges into the wound; this is dissected away. A director is then passed from the sheath of the little finger into the bursa, which is opened along its length as near to the ulnar side as possible. When the anterior annular ligament is reached, pressure is exerted above the wrist; pus is usually present here. It is advisable to divide the anterior annular ligament. *The forearm must be drained* as described below. As a general rule, if the infection has been present more than forty-eight hours, there should be no hesitation in opening the radial bursa, which is so often implicated.

The Thumb.—The sheath, opened somewhat on its radial side, is followed through the muscular masses of the thenar eminence (*Fig.* 485, 4). The tendon lies nearer the palm than one is inclined to think. The dissection is carried down towards the wrist until a point *a thumb's breadth distal to the anterior annular ligament* is reached. The dissection then ceases abruptly, for the motor nerve to the thenar muscle crosses the sheath between this point and the anterior annular ligament. The forearm must be drained as described below. Once more, as a general rule, if the infection has been present for more than forty-eight hours, do not hesitate to open the ulnar bursa, which is so often infected as well.

Involvement of the Forearm from the Hand.—The spread of pus from the hand to the forearm occurs along the plane between the flexor profundus and the pronator quadratus. It is in this deep plane that pus first tracks up the arm, and only late in the course of the disease does it become more superficial. Utilizing this knowledge, drainage of the forearm in infections from the hand can be carried out with precision. The styloid process of the ulna is palpated. The incision commences 1½ in. above this point upon the flexor surface of the ulna. The incision is at least 2 in. long (*Fig.* 486) and it passes deeply right down to the periosteum. A hæmostat is thrust across the flexor surface beneath the flexor tendons and the jaws of the forceps are opened. Next the proximal extremity of the infected bursa is ruptured thoroughly into the space beneath the flexor tendons. In the case of a radial bursa infection, a counter-incision is made upon the radial side (*Fig.* 486). If the infection has extended far up the forearm, a second incision, as shown in *Fig.* 486, will be required.

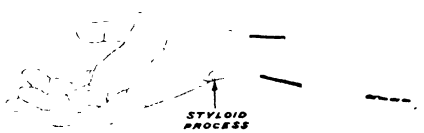


Fig. 486.—Incisions for draining the space beneath the flexor tendons.

FASCIAL SPACE INFECTIONS

The Thenar Space.—

Boundaries of the Thenar Space.—

On the palmar aspect: The palmar fascia, which in this situation is thin and elastic.

On the dorsal surface: The adductor transversus pollicis.

On the ulnar side: A septum of strong fascia attached to the middle metacarpal bone. This septum separates the thenar from the middle palmar space (*Fig.* 487).

The thenar space may become infected directly from a wound. More frequently it is involved by the bursting of a pus-filled flexor tendon-sheath of the index finger. Infections of the thenar fascial space produce much swelling. There is ballooning of the thenar eminence.

TREATMENT.—Operation is imperative; the danger of delay is great. The results of opening a non-infected space are minimal.

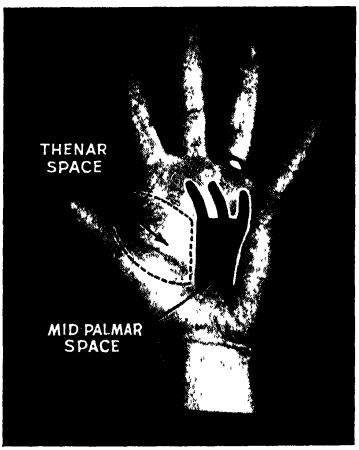


Fig. 487.—The thenar and middle palmar fascial spaces. The three diverticula from the middle palmar space are the lumbrical canals.

The incision is made on the dorsum, and is shown in *Fig.* 488. The incision passes just to the radial side of the metacarpal of the index finger. A

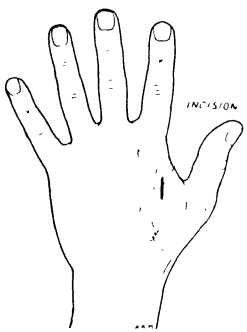


Fig. 488.—Incision for draining the thenar space.

hæmostat is passed into the space and opened. This gives perfect drainage and no tube or other drainage material is necessary.

It is, of course, essential to attend to a suppurative tenosynovitis if such is present.

The Middle Palmar Space.—

Boundaries of the Middle Palmar Space.—

On the palmar aspect: Fascia separating it from the flexor tendons of the middle, ring, and little fingers, with their lumbricals.

On the dorsal aspect: Fibrous tissue separating it from the interosseous muscles of the third and fourth spaces.

On the radial aspect: That fascial septum attached to the middle metacarpal which separates it from the thenar space (*see Fig.* 487).

The middle palmar space has three diverticula—the lumbrical canals of the middle, ring, and little fingers. It is overlapped on the ulnar side by the ulnar bursa; therefore, *it must never be incised directly from the palm*, otherwise the ulnar bursa will become infected, a very grave matter.

The middle palmar space may become infected from rupture of the tendon-sheath of the middle, ring, or little finger. It can also be infected directly by penetrating wounds of the palm or from osteomyelitis of the middle or ring metacarpal bones.

Obliteration of the concavity of the palm, and a slight bulging thereof, is almost pathognomonic of an infection of the middle palmar space. There is no point of maximum tenderness.

TREATMENT.—Efficient drainage of the middle palmar space may be secured via a lumbrical canal. This is effected by opening the web between the ring and middle fingers, or the ring and little fingers. If a choice exists, the former is chosen (*Fig.* 489). The fingers are spread. The incision begins on the dorsum, and passes over the web on to the palm, *but never beyond the distal flexor crease.* The incision is deepened. Pressure is exerted over the middle palmar space. If pus wells up, a grooved director is inserted along the lumbrical canal. The incision is extended until the web is split completely, almost to the distal flexor crease. A closed hæmostat is now inserted under the flexor tendon, and its jaws are opened widely. No drainage material is necessary.

An abscess of the middle palmar space is usually secondary to suppurative tenosynovitis of the middle or ring finger, which of course will require appropriate attention.

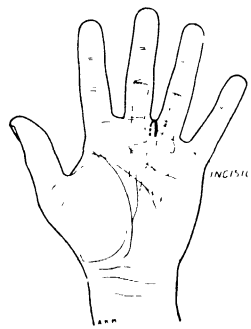


Fig. 489.—Incision for draining the middle palmar space.

THE 'DRY' AFTER-TREATMENT OF SERIOUSLY INFECTED HANDS

Soaking infected hands in hot baths and applying fomentations "as hot as can be borne" are methods of pre- and post-operative treatment which are so ingrained in the medical and nursing professions that it will take time for them to be supplanted.



Fig. 490.—The bandaged arm suspended from an irrigator stand.

Having had experience of both the 'wet' and the 'dry' methods, I am certain that the latter is the correct one. The disadvantages of the 'wet' method are as follows:—

a. It is extremely painful.

b General swelling and tenderness of the hand due to the hot applications mask localized swelling and tenderness due to extension of the infective process; consequently, an all-important accurate diagnosis of the location of the pus is often delayed unduly.

c. The hot-water treatment causes scalding, which, in addition to causing pain, predisposes to superficial inflammation.

d. Sodden, swollen tissues tend to narrow exits through which pus can escape.

Technique of the 'Dry' Method.—For purposes of description a case of suppurative tenosynovitis will be taken. After adequate drainage has been effected, a wisp of vaseline gauze is inserted in the lower end of the incision. A piece of Gamgee having been wrapped around the forearm, a length of Cramer wire is bandaged firmly to the dorsal aspect of the forearm. A suitable piece of sorbo sponge is placed between the Cramer wire and the dorsum of the hand. The incised finger is encased in a Viscopaste bandage

without fixing it to the splint, but as the bandage reaches the base of the finger it is carried around the splint and the palm. The sound fingers are lightly bandaged to the splint in order to extend them. The patient having been transferred to bed, the arm is elevated by suspending the end of the Cramer wire from an irrigator stand (*Fig.* 490). Sulphonamide therapy is instituted. The nursing instructions are that if the patient is comfortable and the temperature falling, neither should the dressing be disturbed nor the position of the arm altered for 48 hours. On the third or fourth day the dressing is changed and a Viscopaste bandage re-applied. Each day the flexed, uninfected fingers are bandaged back a little more on to the Cramer wire, until they are completely extended. While the treatment is essentially ' dry ' this is not a fetish. About the fourth day the vaseline drain is removed and the hand put in an antiseptic bath for five minutes. If there are sloughs present, the wound is irrigated. The hand is then dried and the splint, etc., re-applied. The arm is kept elevated for 14 to 20 days. For about 2 hours each day it is lowered, and during this period the bandage is undone and the patient performs finger exercises under infra-red rays.

In a very few instances the progress under the ' dry ' treatment is unsatisfactory. In such cases it can be changed to what is known as ' rotation ' dressings for about 48 hours. With the hand still immobilized, every 4 hours the following moist dressings are applied in turn : (1) Eusol (normal strength) ; (2) Hydrogen peroxide (10 per cent) ; (3) Magnesium sulphate (5 per cent) ; (4) Normal saline. The ' dry ' treatment is then recommenced.

CHAPTER XLIX

THE TREATMENT OF VARICOSE VEINS AND ULCERS

By J. B. OLDHAM

VARICOSE VEINS

THERE are three forms of treatment for varicose veins: (1) Palliative; (2) Injection of sclerosing solutions; and (3) Simultaneous ligature and injection of the saphenous vein. Each of these methods has definite indications, contra-indications, and limitations. Frequently a combination of the methods is essential for success.

Selection of Cases.—Before commencing treatment, it is essential to determine (1) the competence of the valves in the veins of the legs, (2) the patency of the deep veins, and (3) the efficiency of the arterial supply of the limb. The last of these points is settled by noting the pulsation in the dorsalis pedis and posterior tibial arteries; the other two are determined by the following tests:—

Trendelenburg's Test.—The patient lies down on a couch, the leg is raised, and the varicosities are stroked towards the groin until they are empty and collapsed. Then the thumb is pressed over the termination of the internal saphenous vein in the groin and the patient stands up, the pressure being maintained. The pressure of the thumb is now removed; if the varicosities fill immediately from above, the valves at the upper end of the saphenous vein are defective, and combined ligature and injection will be needed. If, however, the vessels only fill slowly and from below, the valves are sound, and injections alone will be sufficient. Instead of the thumb, a narrow piece of rubber tubing may be tightened round the thigh, in order to compress the saphenous vein.

The test is repeated, but this time the pressure is maintained, and the vessels are watched while the patient is standing; if they refill within thirty seconds, the valves in the communicating veins between the saphenous vein and the deep veins of the thigh are defective, and the saphenous vein must be ligatured below the communicating vein as well as in the groin. The level at which it is necessary to ligature the saphenous vein in order to control the reflux from the communicating veins, can be determined by repeating the test with the thumb pressure applied lower and lower on the saphenous vein until a level is reached at which there is no longer any backflow.

The competence of the valve at the upper end of the external saphenous vein can be tested in the same way, pressure being applied over the upper end of the dilated vein in the popliteal space. Just as it is essential to ligature the main saphenous vein as close as possible to the femoral vein, so must it be our aim to locate and ligate the incompetent communicating veins as they perforate the deep fascia.

Tourniquet Test.—In the tourniquet test of Ochsner and Mahorner the veins are watched, first with the patient standing, and then after walking. A tourniquet is next applied at the top of the thigh, just tight enough to obliterate the superficial veins, and once more the patient walks. Improvement indicates defective valves at the junction of the internal saphenous vein with the femoral vein; no change means that the valves are competent; and if the veins become larger and turgid, we have evidence that the deep veins are obliterated. The test is repeated with the tourniquet at the middle of the thigh and then just above the knee. If any further improvement is noted, the valves in the deep communicating veins are defective, and it will be necessary to ligature the saphenous vein, not only in the groin, but also immediately below the level at which the maximum improvement is obtained.

PALLIATIVE TREATMENT

Palliative treatment should be given in all cases where active treatment is contra-indicated; it is also an essential adjuvant to the other forms of treatment and should be continued for a long time after an apparent cure has been obtained.

The various factors which conduce to varicose veins and ulcers should be explained to the patient and every effort made to avoid constipation, prolonged standing, tight garters, and obesity.

Except in cases with peripheral arterial disease, some form of support is advisable. If there is no œdema, a crêpe bandage, put on before rising and applied from the toes to above the knee, will be sufficient. In more severe cases, an elastic stocking may relieve symptoms, but if considerable œdema is present, a flexible adhesive or Viscopaste bandage will be needed.

INJECTION TREATMENT

Injection treatment alone is indicated in cases in which there is no incompetence of the valves. It may, too, be used in cases in which operative treatment is indicated but refused, and it is frequently needed to complete the sclerosis of any varicosities that may remain after operative treatment.

Contra-indications.—

1. *Severe Debilitating Diseases* such as diabetes, renal disease, and heart failure, should be under control before starting active treatment of the veins.

2. *Severe Impairment of the Arterial Blood-supply*, as shown by absence of pulsation in the dorsalis pedis or posterior tibial arteries.

3. *Active Phlebitis.*—No injection should be given in the presence of active phlebitis, nor for at least three months after the inflammation has settled, and even then the dose should be smaller than usual.

4. *Pregnancy* is no longer considered a definite contra-indication, but, as patients are liable to blame the injections if they have a miscarriage, a phlegmasia, or any other complication of pregnancy, it is as well to postpone active treatment until after the confinement.

5. *Occlusion of the Deep Veins.*—There is generally a history suggesting that the deep veins have thrombosed, such as a swollen leg after typhoid fever, pneumonia, an operation, or confinement. The limb is usually heavy and readily tired, there is non-pitting œdema and the skin is thickened and scaly. If the deep veins are blocked, the varicose veins are compensatory and both operative and injection treatment should be avoided.

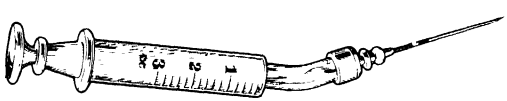


Fig. 491.—A convenient type of syringe for use in the injection treatment of varicose veins

Requirements.—(1) A special varicose vein syringe (*Fig.* 491), or a 2-c.c. or 5-c.c. Record syringe; (2) Several perfectly sharp needles—size 12 for large veins and size 16 for smaller ones; (3) Sterile swabs; (4) Spirit, or some other skin disinfectant; (5) Adhesive felt, cut the size and shape of a finger; (6) Flexible adhesive plaster and crêpe bandages.

Sclerosing Solutions.—There are several solutions in common use; each has its advocates, and not infrequently it will be found that varicosities resistant to one solution sclerose with another.

1. *Quinine Hydrochloride and Urethane.*—A very effective solution, causing little pain on injection. The dose is 2–4 c.c., but, as idiosyncrasy is not infrequent, it is advisable to start with a small dose ($\frac{1}{4}$–$\frac{1}{2}$ c.c.). Any leakage outside the vein is liable to produce necrosis and ulceration.

2. *Lithocaine.*—Dose 2–4 c.c. A painless and effective agent usually given simultaneously with quinine hydrochloride. In handling the solutions, the respective syringes and needles must be kept apart, for, if the two solutions make contact, precipitation occurs and blocks the needles.

3. *Sodium Morrhuate* is mentioned to condemn it. It is not a stable chemical substance, and batches differ greatly in their efficiency and toxicity. Urticarial manifestations are not infrequent, and some fatal reactions have been reported. Like ethamoline, it is nearly painless and does not produce necrotic ulceration if any escapes into the subcutaneous tissue.

4. *Sodium Chloride* (20 per cent).—This solution is the ideal reagent for combined injection and ligature. It is easily obtained, causes little perivenitis, can be used in large doses (20–40 c.c.), and has no toxic effect. It has one disadvantage: 30–60 seconds after injection, the patient feels a severe cramp-like pain, extending downwards from the site of injection. This pain lasts only 2 to 3 minutes

5. *Ethamoline,* dose 1–5 c.c., is related to sodium morrhuate, and has the advantage of being a constant and true chemical compound. It produces no general toxic effects and is a very good agent for simple injection. When used for simultaneous injection and ligature, it is not as satisfactory as sodium salicylate; the clot is more bulky, there is greater perivenitis, and the healing of the wound is often unsatisfactory.

6 *Sodium Salicylate* (20–40 per cent).—This is a good solution for combined ligature and injection; it can be used safely in doses of 5–20 c.c. Like sodium chloride, it causes only minimal perivenitis, and produces a similar cramp-like pain. A fatal case of salicylate poisoning has been caused by injecting an excessive quantity



Fig. 492.—The needle has entered the vein, and blood is being withdrawn into it

Technique of Injection.—It will generally be best for the surgeon to sit down when making the injection, with the patient either standing on a stool or seated on a chair placed on a low table. Occasionally, a patient may faint during the injection; it is therefore advisable to have him held up by an assistant, or to provide some form of support for him to hold on to.

The surgeon sterilizes his hands and the skin over the proposed site of injection. The vein is steadied by placing the left thumb and index finger on either side of it and the needle is introduced (*Fig.* 492). It is most important to be sure that the needle is in the vein, and this is verified by aspirating a little blood into the syringe. After the needle is in the vein, the left index finger is placed so as to compress the vein 1–1½ in. above the needle; this empties the vein. Then the left thumb is placed on the vein below the needle; a segment of vein is thus isolated between the two fingers. The solution is injected slowly. If a swelling appears, it means that there is a leak into the subcutaneous tissue; the injection therefore must be stopped, the needle withdrawn, and a new attempt made. Re-aspiration of blood in such cases does not necessarily mean that the needle is in the vein again, for the blood may be coming from a hæmatoma.

When the solution has been injected the needle is held in position for thirty seconds. After it is withdrawn, the leg is elevated and the puncture is lightly compressed with a wool swab for a minute.

Firm compression of the varicosities will aid sclerosis and minimize the formation of large bulky clots. Strips of adhesive felt 3 in. by $\frac{1}{4}$ in. are placed along the line of the varicosities and fixed in place by strips of flexible adhesive plaster, which encircle about half of the circumference of the leg. If possible, it is well almost to bury the pads by folding over from each side some skin—all being held in place by the adhesive plaster.

The patient can walk home five to ten minutes after injection. The treatment is entirely ambulatory, and need not interfere with the patient's daily routine.

The order of injection makes little or no difference, but it is usual to start with the veins on the upper part of the calf, progressing downwards to the ankle and upward to the thigh. One large injection or two or three smaller ones may be given at one time, depending on the type of vein. If a large comparatively straight vein is being dealt with, a single large dose is most advantageous, but for a group of minor varices on the calf a small injection may be made into the highest point of three or four branches.

The intervals between treatments should be about one week, though, if there is any urgency, injections may be repeated every three to four days.

Complications of Injection.—Provided that there is no contra-indication to injection, that care is taken that there is no leakage into the subcutaneous tissues, and that a suitable solution and dosage are used, there is little likelihood of any unpleasant results.

Fainting.—The possibility of the patient fainting during injection has been mentioned already. He should be in a comfortable position and well supported, so as to safeguard him from a fall.

Perivenitis and Phlebitis.—If the dose has been too large, or injections started too soon after phlebitis, there may be an excessive reaction with perivenitis. A thick adhesive felt pad is placed on the vein just above the inflamed area, and smaller pads along the inflamed vein, and a flexible adhesive bandage is applied tightly from toes to above the adhesive pad. The patient must be kept up and about and the bandage is kept on for from two to six weeks, provided it stays tight and in position. The use of large doses of sodium citrate is often recommended, but it has no effect on the inflammation, and may even increase the clot.

Injection Ulcer.—With the exception of sodium morrhuate and ethamoline, all of the solutions in common use are liable to cause necrosis and form an ulcer if any of them escape into the subcutaneous tissues. There is immediate pain at the site of leakage and within a few days the overlying skin turns black and forms a slough. The best treatment is to apply flexible adhesive plaster and leave it on until the ulcer heals—about two months.

SIMULTANEOUS LIGATURE AND INJECTION

Every case in which the saphenous valves are incompetent should be treated by combined ligature and injection, provided none of the contra-indications to injection are present. Injection alone in such cases is followed sooner or later by recurrence of the varicosities in not less than 50 per cent. The need, and the levels, for ligature are determined by the Trendelenburg and tourniquet tests.

There are three possible sites for ligature: (1) Internal saphenous vein at its junction with the femoral vein; (2) External saphenous vein at its junction with the popliteal vein; (3) In the middle or lower thigh at the site of an incompetent perforating vein. In the case of varicosity of the internal saphenous

system high ligature—at the saphenous opening—must be done in every case, the lower ligatures being complementary. Ligature of the saphenous vein in the middle or lower thigh, unless combined with a ligature of the vein at its junction with the femoral vein, is followed by almost as high a rate of recurrence as simple injection.

Ligature of the Saphenous Vein in the Groin.—

Preparation.—The patient is prepared and shaved as for an operation on an inguinal hernia. If there is incompetence of any communicating vein the site for ligature must be accurately determined and marked before operation. In male patients it will be found helpful to retract the penis and scrotum away from the site of the operation by a strip of adhesive plaster.

Anæsthesia.—While local infiltration with 1 per cent novocain will give a satisfactory anæsthesia, some form of general anæsthesia will usually be more suitable, especially when the veins are being ligatured at more than one site.

The Incision is 2 in. long in the line of the groin, and centred on a line dropped vertically from the pubic spine.

Ligature of the Vein.—The vein is exposed by dissection (*Fig.* 493) and divided between hæmostats. Either before or after dividing the main saphenous vein, ligature and divide all its terminal tributaries—external pudendal, external circumflex iliac, superficial epigastric, and external superficial femoral veins. The saphenous vein is then tied just below its junction with the femoral vein, and distal to this ligature it is again tied after transfixion.

Injection, either of sodium chloride, 20 per cent (10–20 c.c.), or of sodium salicylate 30 per cent (5–10 c.c.) is made into the distal cut end of the saphenous vein. It is difficult to make the injection with an ordinary needle and, instead, a blunt-ended cannula should be used. Having completed the introduction of sclerosing solution into the lumen of the vein, the distal cut end is transfixed and doubly tied. More and more surgeons are refraining from injecting the varicose vein at the time of operation, injection being postponed until a day or two later, when the patient is ambulant. This modified technique reduces the period of incapacity; time alone will show whether the results are as permanent as those obtained by simultaneous ligature and injection.

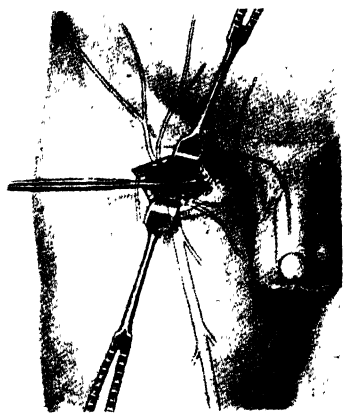


Fig. 493.—Exposure of the termination of the saphenous vein.

The wound is swabbed out with saline to remove any of the sclerosing fluid which may have leaked into it. The incision is closed with two vertical mattress sutures of silkworm-gut and is covered with gauze and Elastoplast.

The patient should be encouraged not to lie up in bed, but to walk about from the start. Beginning two or three days after operation, any varicosities which remain are dealt with by injection of ethamoline or other sclerosing solution, and when this is completed a flexible adhesive bandage is applied from the toes to just below the knee. The stitches should be removed from the incisions on the fourth or fifth day after operation.

Ligature of Internal Saphenous Vein at Site of Incompetent Communicating Branches.—Careful localization and marking of the site for ligature must be done before operation. A transverse incision is made over the skin mark, the saphenous vein is isolated and is ligatured and divided above and below the communicating vein which is ligatured as it comes through the deep fascia. The distal end of the saphenous vein may be injected before it is ligatured.

Ligature of the External Saphenous Vein.—A vertical incision, 2½ in. long, over the upper end of the saphenous vein—the exact position must be marked out beforehand—gives the best exposure, and the easiest convalescence. After incising the skin, the popliteal fascia must be divided, and the saphenous vein traced up to its junction with the popliteal vein, where it is tied and divided. After all the terminal tributaries have been ligatured and divided, the distal end of the cut vein is injected with sclerosing fluid, or injection may be left over till the patient is convalescent. The deep fascia and skin are sutured and the wound dressed with gauze and Elastoplast.

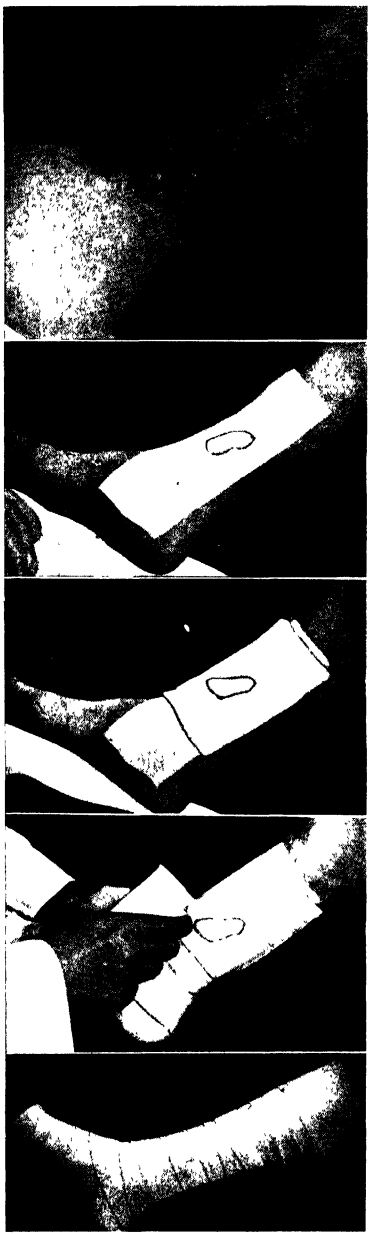


Fig 494.—Pressure bandaging an ulcer in the lower third of the leg. A, The ulcer. B, The longitudinal strip of Elastoplast has been applied. C, A rectangular piece of stuck felt with bevelled edges is now placed over the site of the ulcer. D, E, The leg from toes to knee is now bandaged tightly with adhesive plaster

VARICOSE ULCERS

The modern treatment of varicose ulcers consists in the application of elastic compression to the leg from the toes to the knee, combined with the obliteration of the varicose veins. Usually the veins can be dealt with at the same time as the ulcer.

Before applying compression treatment, it is essential to exclude syphilis, diabetes, and severe arterial disease of the leg. If there is no pulsation to be felt in the dorsalis pedis or posterior tibial arteries, compression is contra-indicated, as it might precipitate gangrene in the leg.

Flexible adhesive plaster bandages provide the most efficient method of applying the compression. In every case it is advisable to start with two strips of flexible adhesive plaster placed longitudinally one on each side of the leg from the sole up to the level of the upper calf. When there is much œdema or the ulcer is very large, additional strips up the front and back of the leg will help to prevent the spiral bandage cutting into the skin. The bandage is applied spirally from the

toes upwards, enclosing the heel, to just below the knee, each succeeding turn overlapping two-thirds of the preceding one (*Fig.* 494, E). During the application of the bandage, the ankle-joint should be kept in a position of dorsiflexion to prevent rucking of the bandage when the patient walks.

Firm application is an absolute essential; the tightness of the bandage should be proportional to the degree of œdema and induration. The patient may complain that the bandage is too tight, but usually, after walking a short distance, all discomfort disappears.

When œdema is very marked, the bandage rapidly loosens, and renewal may be necessary every three or four days, but in most cases it will not be necessary to change the bandage more often than every week or fortnight.

Preliminary cleansing of the ulcer is unnecessary, no matter how foul or how large the ulcer. The patient must be told that discharge from the ulcer may come through the bandage, and that if it does the bandage should be washed over with a wet sponge and then covered with a roller bandage. Itching under the bandage sometimes worries the patient, but usually this can be relieved by bathing with cold water.

In some patients, the use of adhesive plaster produces eczema or dermatitis. Such cases can be treated with Viscopaste bandages or the application of Unna's paste (*see* p. 520) over-bandaged with crêpe or a flexible adhesive bandage.



Fig. 495.—Showing pad of Sorbo rubber being used in the bandaging of a varicose ulcer near the bony prominence of the internal malleolus.

In dealing with large and deep ulcers with much surrounding œdema, it will be found helpful to put the patient to bed with the leg elevated for twenty-four hours. When the œdema has been reduced by the rest, the ulcer is covered with longitudinal strips of flexible adhesive plaster, then a piece of sponge rubber is placed over the ulcer, overlapping it all round by several inches. Finally, over all, a flexible adhesive bandage is applied as tightly as possible. This method is especially useful in the treatment of ulcers in the region of the malleoli (*Fig.* 495).

The compression treatment is essentially ambulatory. The patient must be encouraged either to work or to take exercise to improve the circulation, and to keep up the pressure massage of the œdematous tissues between the adhesive bandage and the calf muscles. When the ulcer has healed, it must continue to be supported for at least another three months with a Viscopaste or flexible adhesive bandage, and we must insist on seeing the patient then, and completing the treatment of any varicose veins that may remain.

THE TREATMENT BY INJECTION OF BURSÆ AND GANGLIA

By HAMILTON BAILEY

Bursæ and ganglia respond to treatment by aspiration and injection in a manner comparable with that of varicose veins. After using this method in a large number of cases, I have been astounded at the regularity with which these swellings are obliterated.

Ganglion.—A very wide-bore hollow needle is necessary. After infiltrating the overlying skin with a few drops of novocain, the needle is plunged into the ganglion. No attempt is made to aspirate the fluid, which is usually of the consistency of calves'-foot jelly. The contents of the ganglion are squeezed through the needle and the sclerosing solution injected. This is followed by a little massage in order to distribute the sclerosing solution. The puncture is sealed and a compression dressing (*see* p. 296) applied.

For ganglia I have found that the twin injection of lithium salicylate and quinine hydrochloride and urethane* is very effective, and in many instances only one injection is required. (*a*) A 10-c.c. syringe is loaded with 3 or 4 c.c. of a 30 per cent solution of lithium salicylate containing 1 per cent tutocain; (*b*) Another 10-c.c. syringe is loaded with 3 or 4 c.c. of a 2 per cent solution of quinine hydrochloride and urethane; (*c*) A 2-c.c. syringe contains sterile water. The injection is made in the order (*a*), (*c*), and finally (*b*).

Bursa.—It is essential to be sure that the bursa does not communicate with a joint. This, and the more obvious fact that injection treatment should not be undertaken while a bursa is inflamed, constitute the only contra-indications. The fluid in the bursa is aspirated through a fairly wide-bore hollow needle, and a dose, usually of 5 c.c. of quinine hydrochloride and urethane, is injected. A compression dressing is applied.

---

* Supplied by British Drug Houses Ltd.

CHAPTER L

MEDICAL 'OPERATIONS'

By F. DUDLEY HART

VENESECTION

THE removal of blood from a patient was once a very popular form of treatment, and in some cases blood-letting is still a valuable measure. The condition that benefits most markedly is chronic congestive cardiac failure, where the patient, dyspnœic, distressed, and with distended veins in the neck, is much relieved by withdrawal of ½ to 1 pint of blood. Other indications are hypertension with symptoms of severe headache and general distress, polycythæmia vera with like symptoms, acute congestive failure with pulmonary œdema, and some cases of status epilepticus and acute uræmic convulsions (where the benefit is largely due to relief of the heart). Contra-indications are few, given the above indications. It should not be done in cases with marked anæmia.

Technique.—The old practice was to inject local anæsthetic over a suitable vein in the arm—such as the cephalic—and nick the vein across with a sharp lancet or tenotomy knife. Such a practice is rapid and painless and is still used. Bleeding stops on raising the arm and applying light pressure.



Fig. 496.—
Venesection apparatus.

For all practical purposes the following technique is most suitable. Place a sphygmomanometer band round the arm high up towards the shoulder and keep the pressure between 70 and 90 mm. Hg. Feel the pulse to make certain the pressure is not so high as to cause obliteration of the arterial pulse. Infiltrate a small area with local anæsthetic over the most suitable vein—preferably the median cubital. Take a wide-bore, conical needle with a sharp point (e.g., French's needle) and attach to it a piece of sterile rubber tubing. Fill the needle and tube with 3·8 per cent sodium citrate solution and clamp the bottom of the tubing. Slide the needle through the area anæsthetized, just through the skin, then obliquely through the wall of the vein. Hold a graduated receiver containing citrate solution below the tubing, unclamp, and collect the amount required—usually 12 to 25 oz. The whole process takes about fifteen to twenty minutes. The blood may clot in the needle if an unsuitable needle of too small bore is used, or if it is not correctly in the vein.

Alternatively the tubing may be attached to a bottle to which some suction apparatus is connected. Such an apparatus is that of Dr. French. A similar apparatus may be made with a bottle, cork, and two pieces of glass tubing, to one of which is attached a piece of rubber tubing leading to the needle, to the other rubber tubing leading to a reversed Higginson's syringe (*Fig.* 496). Light suction by squeezing the bulb of the syringe prevents clotting, and makes the whole

process quicker. A suitable amount of citrate solution should be placed in the bottle beforehand. The rubber tubing should be fairly thick-walled, as thin-walled tubing may collapse on suction. Before insertion into the vein, a small quantity of citrate solution should be sucked through the needle into the bottle.

APPLICATION OF LEECHES

This form of treatment, once extensively used, is now rarely practised, but it is still a recognized method of relieving congestion and inflammation and allaying pain. Two varieties of leech are in common use, the speckled leech (*Hirudo medicinalis*) and the Australian leech (*Hirudo quinquestriata*). They are stored in unglazed earthenware pans, half-filled with soft water, with pebbles, turf, or moss in the bottom. The top of the pan is covered with muslin. The pan should be placed in a shady place, and the temperature of the water kept at 10° to 20° C. When required for use, cleanse the part of the patient to which the leeches are to be applied, and moisten the skin with sugar water, but do not apply antiseptics to the skin. Without touching the leeches with the fingers, apply the required number—usually 1 to 4—to the site elected. If they fail to bite, a small scratch with a needle on the skin will overcome the difficulty, the leech immediately taking hold. Each leech draws off about 6 millilitres of blood, will fall off when sated, and should not be forcibly removed. If their removal is required, a little salt dropped on their backs acts as an emetic and they immediately drop off. If further hæmorrhage is needed, the part may be fomented; if not, dress the wounds lightly with a thin layer of cotton-wool. Excessive bleeding is checked by firm pressure or touching with a silver nitrate stick.

The site of election is over the affected area—the liver in hepatic congestion, precordium in pericardial effusion, lung base in pulmonary congestion or pleurisy. Much relief often follows their application.

TREATMENT OF ANASARCA

The practice of puncturing swollen areas to relieve the patient of œdema is much less popular than it was. It is purely a palliative measure, and though often attended by temporary relief has seldom a lasting effect. The wounds in such swollen, waterlogged, and devitalized tissues tend to become infected, and the actual process may be very unpleasant to the patient.

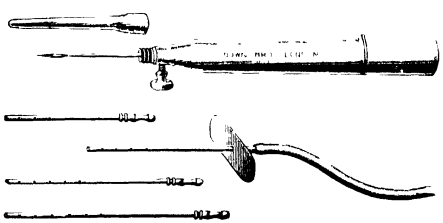


Fig. 497.—Southey's fine trocars and cannulæ.

A cardiac bed, with the foot low, is the best method of nursing such patients. A mackintosh is placed over the foot of the bed, tucked to form a gutter running into a suitable receptacle. The feet should be frequently dried and kept warm, otherwise they become cold and clammy with fluid.

Two methods have been frequently used: multiple small skin incisions and Southey's tubes. In the former small incisions are made through the skin ½ to 1 in. long, dressed with gauze and much cotton-wool, and the part wrapped in sterile towels. Incisions on the dorsum of the feet seem over-liable to become septic. Asepsis must be rigid. The legs are kept hanging down, with a mackintosh arranged as above. Frequent dressings are necessary, and are continued until wound healing is complete.

If Southey's tubes (*Fig.* 497) are preferred, one or two are inserted into each leg. Trocar and cannula are pushed obliquely up to the hilt into the subcutaneous tissues, the trocar withdrawn, and a thin rubber tube attached, which conveys the fluid to a bottle at the foot of the bed. Dressings have to be repeated frequently, as fluid leaks round the cannula.

PARACENTESIS ABDOMINIS

In certain conditions the abdomen becomes distended with fluid: (1) as part of a generalized œdema; (2) due to tuberculous ascites; or (3) due to portal obstruction. Removal of fluid in such cases may give much relief, and should be resorted to as a palliative measure when the patient is suffering much discomfort from abdominal distension. Although the fluid is likely to return, it does not always do so, and after two or three aspirations no more may collect.

The fluid is under positive pressure, and as it is clear and watery no difficulty is experienced in its aspiration. A Southey's or other fine trocar and cannula is attached to a rubber tube, which drains into a large receptacle at the side of the bed.

The best site is either in one or other iliac fossa, or in the middle line 1 to 3 in. below the umbilicus, care being taken first to empty the bladder. The intestine, even if touched, recedes before the cannula, and there is little chance of injuring the gut if reasonable care is taken. If nothing else is available, a hollow needle of medium bore may be used.

The flank is perhaps the best site, and the safest place is just external to McBurney's point. Some 3 to 6 c.c. of local anæsthetic are introduced into the skin and down to the parietal peritoneum, and the trocar and cannula slowly and firmly inserted. A rotary movement helps to break through a resistant skin. With a binder around the abdomen, gradually tightened as the abdomen lessens in size, the fluid drains into the receptacle. As much fluid as possible is removed, and a tilting of the patient to the side aspirated usually increases the efficacy of the drainage and lessens the (very slight) risk of injuring the bowel. Several pints may be removed in this manner, to the great relief of the patient.

MERCURIAL DIURETICS

The above-mentioned methods of withdrawing œdema fluid are only called for when other forms of diuresis are either contra-indicated or fail to work. Intravenous mercurial diuretics are by far the most effective. Salyrgan (Bayer), i.e., mersalyl (B.P.), and neptal (May & Baker), contain approximately 38 per cent of mercury, and have now largely replaced other drugs and methods.

Indications.—Generalized œdema as in congestive cardiac failure or chronic nephrosis.

Contra-indications.—Renal insufficiency (as in acute and chronic nephritis), urinary obstruction (e.g., enlarged prostate), purpuric states, recent cardiac infarction. The patient should not be given the drug if he is unable to concentrate the urine above a specific gravity of 1020.

Technique.—The patient is at rest in bed with fluids charted on an intake-output chart. Fluid intake is best restricted to 2 pints a day. One c.c. of the diuretic solution (e.g., 1 ampoule) is injected intravenously, care being taken lest any escape from the vein as the solution is very irritating. It is best given in the morning so that the action is largely over by nightfall. If satisfactory diuresis is obtained 2 c.c. are given intravenously 2 days later, the injection being repeated every 4–5 days as desired. A satisfactory response is anything from 2–8 pints increase in output over intake a day. The drug may also be given intramuscularly, but the effect is much less dramatic.

Undesirable effects may be vomiting, nausea, stomatitis, diarrhœa, fever, abdominal pain or discomfort, headache, hæmaturia, or (rarely) circulatory

collapse. In some cases no effect is obtained, good or bad; in such cases ammonium chloride, gr. 30, in capsule form may be given four times daily for 2–3 days prior to the injection.

SPLENIC PUNCTURE

Splenic puncture as a diagnostic measure is—with reasonable care—a safe procedure, and may be required in splenic enlargement where Gaucher's disease is suspected. In kala-azar it is apt to be dangerous, and, though still often used, has largely given place to marrow-blood culture and venous-blood culture in special media.

Technique.—Fix the enlarged spleen firmly against the lower border of the ribs. The organ is now felt quite superficially under the palpating fingers. Insert a large-bore needle with syringe attached, push in until the point is well into the spleen, and aspirate a portion of tissue into the needle. Keep up the negative pressure while withdrawing the needle. Apply firm pressure on the needle wound for two minutes with a swab.

The same technique may be used when the usual biopsy is impossible in soft tissues elsewhere. Aspirate the tissue—e.g., malignant glands of the neck—and, with negative pressure maintained in the syringe, give the needle a lateral jerk before withdrawal. This detaches the tissue aspirated, and prevents it being left behind on withdrawing the needle.

BONE-MARROW BIOPSY

In certain blood diseases it is of great advantage to ascertain what changes have taken place in the blood-forming tissues. The sternum is the most suitable bone, for it is superficial and accessible and the marrow changes are there early and well marked. Some cases of leukæmia can only be diagnosed with certainty by sternal biopsy. In certain infections the causative organisms may be seen in marrow smears, e.g., malaria, kala-azar, filariasis, and trypanosomiasis, and culture from marrow blood occasionally gives positive results in enteric fever and pyogenic infections when venous blood-cultures have been negative. Malignant cells are sometimes seen in cases of secondary bony deposits. If biopsy is being done for the four tropical diseases mentioned above the needle and aspirating syringe must be completely dry.

Technique.—The marrow may be aspirated through a medium-bore needle quite easily, but in some cases (e.g., aplastic anæmia and myelosclerosis) it is desirable to examine the histological structure of the blood-forming tissue. In such cases local anæsthetic is injected over the site of election near the centre of the body of the sternum, using a fine needle with short bevel, the skin, subcutaneous tissues, and periosteum being infiltrated. An incision is then made and the periosteum cut and retracted. With a small trephine an area of bone 1 cm. in diameter is removed, together with a small spoonful of marrow. The latter is transferred to a sterile test-tube containing Wintrobe's mixture (*see below*), the bone space is packed with bone wax, and the periosteum and skin are sutured.

If simple aspiration of marrow tissue is all that is required, this may be done in one of two ways :—

1. Feel for the sternomanubrial junction, infiltrate the overlying soft tissues with local anæsthetic down to the bone, and, using an 18-gauge spinal puncture needle, push obliquely in at an angle of 60° to the surface of the chest in the

midline. Now depress the angle of the needle to about 30°. The point enters the marrow of the body of the sternum. Remove the stylet and aspirate 0·25 c.c. of marrow, using a dry 1-c.c. syringe. Do not go deeper than 1·5 cm., and rotate the needle, exerting pressure all the time, if resistance is encountered. Transfer the aspirated matter, which strongly resembles blood, from the syringe to a sterile test-tube containing Wintrobe's dry oxalate mixture. (For 0·25 c.c. of fluid place 0·1 c.c. of a solution of 0·2 per cent potassium oxalate and 0·3 per cent ammonium oxalate in the tube and dry in the incubator.) The marrow fluid clots very rapidly, so thorough mixing with the oxalate mixture should not be delayed. Direct smears may be made if the fluid is not to be immediately examined. The procedure is best done from the head of the bed, the patient lying on her back with the sternum prominent and her head thrown back. In children, and with some adults, it is wise to administer chloral or luminal 30 to 40 minutes previously.

2. The second (and preferable) method is to use a special short-bevel needle of medium bore with sharp point and adjustable guard (*Fig.* 498). An area near the centre of the body of the sternum opposite the third rib is infiltrated with local anæsthetic down to and including periosteum, and the needle is thrust through the area anæsthetized until the point touches bone. The guard is now adjusted so that it is some 3 mm. from the skin surface, and with a few sharp taps with a small hammer the needle is driven through the outer table into the marrow. Aspiration is effected as above, 0·25 c.c. being added to the oxalate mixture. If the point of the needle is in marrow, aspiration is as easy as from a vein.

Fig. 498.—Sternal-puncture needle and stylet.

Sternal puncture may be performed at any age, but in childhood the aspiration should be from the centre of the manubrium sterni and the needle should be gently pushed through by hand, not driven by a hammer. Premedication is desirable. Both in adult and child the procedure is free from complications and is painless but for a drawing sensation in the sternum during the actual aspiration. This is not severe and tells the operator that the aspiration is proceeding normally.

FRACTIONAL TEST-MEAL PROCEDURE

To ascertain the stomach contents before and during digestion, the fasting juice is taken off first thing in the morning, the meal given, and samples of the stomach contents withdrawn and analysed for total acid, free hydrochloric acid, starch, and bile. Mucus and blood are noted if present.

It should not be forgotten that an apparent achlorhydria is often due to apprehension or nausea, rendering the first test-meal result unreliable. Should there be an apparent achlorhydria, a histamine test-meal should be performed. This consists of giving an injection of 0·5 mg. histamine acid phosphate in 1 c.c. of water subcutaneously after the fasting specimen has been withdrawn, and taking further specimens every ten minutes for an hour. Certain patients react unduly towards the drug, and it should not be given to weak and very debilitated subjects, nor to anybody with a systolic blood-pressure under 100 mm. Hg. Children may receive anything from 0·1 to 0·3 mg. according to their age. Neither a histamine nor a fractional test-meal should be performed if there is aneurysm

of the aorta or uncompensated heart disease, nor should it be done shortly after severe gastric hæmorrhage.

An alternative meal is the alcohol test-meal. After a twelve-hour fast, which includes the ingestion of no water for several hours before the meal, the tube is swallowed and a fasting specimen withdrawn as before. Empty the fasting stomach as completely as possible. Introduce 50 to 100 c.c. of 7 per cent alcoholic solution, and after five minutes withdraw specimens every twenty minutes for eighty minutes.

Technique.—The test is done on a fasting stomach. If the patient is on milk feeds, the last feed is given at 10 p.m.

At 5 a.m. a Ryle's tube is passed to the second mark on the tube, and the resting juice is withdrawn from the stomach by means of a Record syringe. This is put into a test-tube labelled ' resting juice ', the amount being measured. The free end of the Ryle's tube is lightly fixed to the patient's cheek with adhesive tape, and a spigot inserted. The patient is then given prepared oatmeal—one pint. (To prepare the oatmeal for this test boil two tablespoons of fine oatmeal in two pints of water until the quantity is reduced to one pint, and then flavour with salt unless estimation of chlorides is to be done.) Twenty minutes later the first specimen is withdrawn and put into a test-tube labelled ' 1 '. Other specimens are withdrawn at intervals of twenty minutes until ten in all have been obtained, the test-tubes being labelled numerically. Approximately 5 c.c. are taken for each specimen.

INDUCTION OF ARTIFICIAL PNEUMOTHORAX

Induction of an artificial pneumothorax is the procedure by which air is introduced into the pleural cavity, so separating the surfaces of visceral

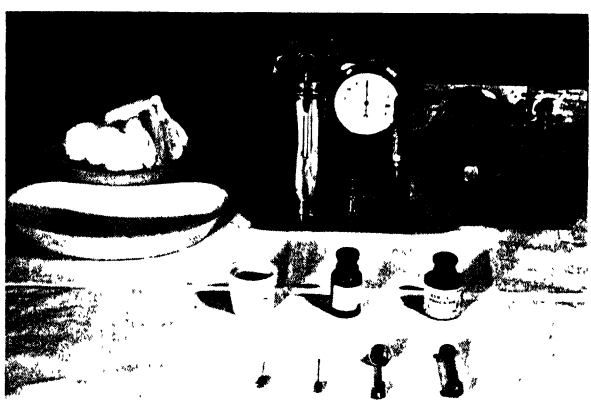


Fig. 499.—The Maxwell artificial pneumothorax apparatus with induction and refill needles in the rack. Local anæsthetic (2 per cent procaine) and adrenaline in case of pleural shock.

and parietal pleuræ, lowering the negative pressure in the pleural sac, lessening the normal tension of the lung, and so allowing relaxation and partial rest of that organ. It is a passive partial collapse, and in no sense an active collapse by compression. The circulation through such a collapsed lung is decreased.

Indications.—The usual indication for induction of an artificial pneumothorax is pulmonary tuberculosis with cavitation. It is also performed: (*a*) for diagnostic purposes to decide whether a tumour is in the lung or chest wall; (*b*) to ease pain by separating the inflamed parietal and visceral pleuræ in severe pleurisy; (*c*) prior to thoracoscopy; (*d*) for certain other conditions mentioned in this chapter.

Apparatus.—Many types of apparatus are on the market, of which that of James Maxwell (*Fig.* 499) is perhaps the most compact. The most commonly used in hospitals is the Lillingston-Pearson apparatus, as it is simple and easily kept in running order.

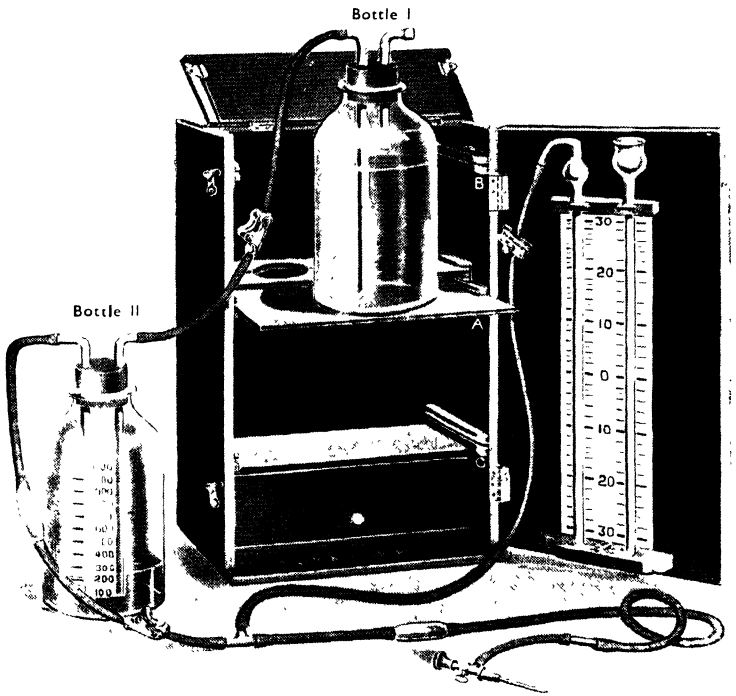


Fig 500.—The Lillingston-Pearson artificial pneumothorax apparatus.

Fig. 500 shows the apparatus ready for use. Coloured water is present in the two bottles. For an induction the fluid levels in both bottles are equal when ready for use; for a refill Bottle I is full and Bottle II has fluid up to the zero mark. If an air lock prevents the flow of fluid from I to II the mouth is applied to the open glass tube in Bottle I and a few cubic centimetres of fluid are blown from one bottle to the other to start the flow. The coloured water in the manometer should be level with the zero mark before starting.

The principle is simple: when fluid flows from Bottle I to Bottle II the air in the latter is forced along the rubber tubing through two cotton-wool filters and so through the needle into the pleural sac. To start the flow the tap on the needle is opened, and the clips on each side of Bottle II are opened. The amount of air introduced is read on Bottle II—i.e., if the fluid level has risen from zero to 600, 600 c.c. of air have been introduced. Readings are taken from the left limb of the manometer, a negative reading being shown by a rise above zero, a positive by a fall. Care should be taken to pinch

the tube if the patient coughs, for the high positive pressure so caused may blow the fluid out of the manometer. For an induction an induction needle such as Rivière's (*Fig.* 501) or Kuss's (*Fig.* 502) is used. On withdrawing the trocar care should be taken that the cap does not leave the end of the needle, for if this occurs the pleural sac is thrown open to the room air. This will not happen if it is first seen that the cap is firmly screwed on. Refills are done with refill needles such as Saugmann's (*Fig.* 503). As soon as the point is in the pleural space the stylet is withdrawn, the tap turned on, and the air introduced.

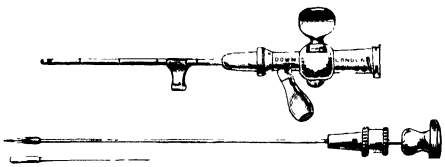


Fig. 501.—Rivière's needle.

Technique of Induction of an Artificial Pneumothorax.—The apparatus is placed on a table or trolley alongside the bed with all taps closed and the fluids at equal levels in the two bottles. The patient lies comfortably flat on the bed on his unaffected side with only one pillow to support his head. His arm is thrown upwards in front of his face to expose the axilla on the affected side. After cleaning the skin an area over the site of election—usually the 4th to 6th space in the mid- or anterior axillary line—is infiltrated with 5 to 8 c.c. of local anæsthetic, care being taken to raise a small

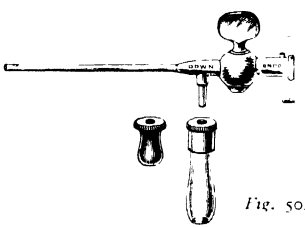


Fig. 502.—Kuss's needle.

bleb in the skin, to avoid the ribs, and to infiltrate right down to the parietal pleura The induction needle is then attached to the apparatus, and with a rotary movement the needle is passed through the skin and down between the ribs. When the pleura is reached the trocar is withdrawn and the cannula passed through the parietal pleura into the pleural sac. The needle tap is turned on, and a negative excursion on the manometer shows that the cannula is in the pleural sac. Any excursion on the manometer of less than 3 cm. is discounted. A common reading is −16 −11, an excursion of 5 cm., but anything from −30 −36 to −6 −2 may be seen. A reading of −1 + 1 means that the end of the cannula is in the lung, and it should be gradually withdrawn until a suitable reading is obtained. A gradually rising positive pressure indicates that the cannula is in a blood-vessel, and it should be withdrawn before blood flows through the rubber tubing into the apparatus. If no reading at all is obtained, either the cannula is in the chest wall or a pleural effusion, or the needle or tube is blocked. The trocar should be passed into the cannula and the tubing pinched several times to make certain this is not so. If still no reading is obtained it is likely that the lung is adherent in this area, and the process should be repeated in a fresh place—preferably in the 7th or 8th space posteriorly. The third and last site to be tried is high in the axilla or in the 2nd to 4th spaces anteriorly, care being taken to avoid the heart and great vessels.

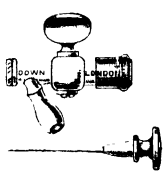


Fig. 503.—Saugmann's refill needle.

When a suitable reading is obtained the taps are turned on, allowing the air to be *sucked* into the chest by the negative pressure in the pleural sac. As the fluid level

falls in Bottle I it may be raised so that the fluid levels remain equal in the two bottles. Any amount of air from 100 c.c. to 300 c.c. is introduced.

The final pressure should be a negative one, and the tap should be closed periodically to take a reading. A slight excursion throughout the induction is seen on the manometer which indicates that the cannula is still in the pleural space. A common reading obtained is −16 −12 : 250 c.c. : −13 −9. On no account should the pressure be left positive. A reading such as −12 −12 : 100 c.c. . −2 +2 means that adhesions are present between visceral and parietal pleuræ and only a small pocket of pleural sac has been filled with air. The final reading should not be lower than −4 −0. The needle is then withdrawn, the puncture wound covered with cotton-wool and collodion, and the patient ordered absolute rest for the subsequent twenty-four hours, lying on the side most comfortable to him—preferably the side induced. He is asked not to cough, and is given linctus codeinæ if a troublesome cough is present.

A possible danger must be emphasized. An intractable cough arising during induction may be due to puncture of the lung. This usually occurs when anæsthetizing the deeper structures ; moreover, the sudden inspiratory movement may break off the needle in the chest wall.

Complications.—

1. *Bleeding from the puncture wound.* This is easily controlled by a pad and firm pressure for ten minutes.



Fig. 504.—Artificial pneumothorax. If too much air has been introduced into the chest, elevation of Bottle II of the artificial pneumothorax apparatus sucks some air back. Note the positive pressure on the left limb of the water manometer (+ 7).

2. *Pleural shock.* At any time during the induction the patient may become shocked. His pulse becomes weak and rapid, his blood-pressure drops, and his skin becomes cold, pale, and clammy. The induction is immediately stopped, restoratives are given, and the patient is treated for shock. The cause of this complication is unknown. Adrenaline should always be kept on the trolley, and 5 to 10 min. of 1–1000 solution injected immediately subcutaneously.

3. *Tightness or discomfort in the chest.* In mild degree this is of no significance, but if severe the patient should be examined to ascertain if the breath-sounds are absent, the percussion note hyper-resonant, or the heart displaced. Any of these signs may indicate a superadded spontaneous pneumothorax caused by the tearing of a pleural adhesion or laceration of the lung. A refill needle is inserted and a reading taken. If a positive pressure is present, air should be gradually withdrawn until the patient is eased. This is done by reversing the flow in the two bottles, so that the fluid runs from Bottle II to Bottle I (*Fig.* 504).

4. *Subcutaneous emphysema.* A mild degree of this is commonly present after induction and is of no significance.

5. *Hæmoptysis.* This probably means that the lung has been injured by the trocar during induction. It is never severe. The patient is reassured and told that slight staining of the sputum may persist for some hours but is of no significance.

Refills.—After the induction of an artificial pneumothorax a refill should be performed after twenty-four hours, and subsequently (if desired) after 2, 4, and 8 days, maintaining the collapse at weekly intervals as found necessary. Thus the refills would be spaced: Day 1, induction; Day 2, refill; Day 4, refill; Day 7, refill, and so on, missing a day each time until weekly intervals are reached. Satisfactory collapse is usually not achieved until the fourth or fifth refill. Refills (*Fig.* 505) are performed with a suitable refill needle, using the same technique as for an induction. The fluid is run from Bottle I to Bottle II, the latter starting with the fluid level at zero. The



Fig. 505.—A refill of an artificial pneumothorax in progress. Note negative pressure on manometer

amount of air introduced is read, and varies from 200 to 800 c.c. The first three refills should not exceed 500 c.c. It is rarely necessary to give more than 700 c.c. at any fill. The final pressure should never be positive, i.e., should not exceed −2 +2. Bottle I may be raised slightly to accelerate the procedure.

The only physical sign after the induction of an artificial pneumothorax is lessening of the breath-sounds on that side. After two or three fills the breath-sounds may disappear completely, but the percussion note remains normal. A mediastinal shift may or may not occur, and is of little or no significance after the 3rd refill unless extreme and/or causing symptoms.

AIR REPLACEMENT OF A PLEURAL EFFUSION

The patient sits on a couch with his head and shoulders upright. For comfort it is better to have his back supported, as the replacement, if difficult, may take time. He puts the arm on the affected side well forwards to expose his axilla, and leans slightly to the opposite side.

Two areas are infiltrated with local anæsthesia, one high in the axilla between the 3rd and 4th or the 4th and 5th ribs, the other lower in the 7th interspace in the posterior axillary line, in the 6th space in the mid-axillary line, or posteriorly in the 7th–8th space below the angle of the scapula. Two such areas are anæsthetized, and a small portion of fluid from both areas withdrawn into the syringe, to make certain fluid is present at both sites.

Into the lower area an aspirating needle is inserted and connected with the aspirator. Commonly-used types are Dieulafoy's and Potain's. The latter has certain disadvantages, but is the model to be found in most hospitals. Its chief drawback lies in the irregularity of its suction, but for general purposes it is a very useful apparatus. Dieulafoy's aspirator is a large syringe with a two-way cock.

Through the upper area an artificial pneumothorax refill or induction needle is inserted and connected up with the artificial pneumothorax apparatus. If fluid extends above the site of the upper needle—as shown by aspiration of a few drops into the local anæsthetic syringe—a refill needle is used. If not, an induction needle, and readings are taken from the start.

Aspiration is commenced, and the upper needle kept closed if in fluid. After some 10 oz. have been withdrawn, insert air via the upper needle from the artificial pneumothorax apparatus (*Fig.* 506). Continue the aspiration, never allowing air to enter from above faster than fluid is escaping below. As the fluid level sinks below the upper

needle a swing in the manometer of the artificial pneumothorax apparatus becomes apparent. The intrapleural pressure is kept slightly negative—a swing of −6 −2 is suitable. A high negative, such as −12 −8, means that too little air has been introduced and too much fluid removed. When the flow becomes less steady through the aspirator and interrupted by air-bubbles, let the patient lean over to the affected side. In this way all the fluid may be aspirated.

The final reading is then taken, and should be slightly on the negative side Both needles are removed, the puncture wounds covered with cotton-wool and collodion, or cotton-wool alone, and the aspirated fluid and introduced air measured.



Fig. 506.—Air replacement of a pleural effusion. Potain's aspirator is on the left of the picture, the needle to be inserted into the chest at the lower mark. The Lillingston-Pearson artificial pneumothorax apparatus is on the right, the needle to be inserted at the upper mark on the chest wall

It is unnecessary and unsatisfactory to aspirate lower than the 7th–8th space, as mentioned above. All fluid can be removed by aspiration at this level. Thick fluids—pus or sero-fibrin—will require stronger suction than is necessary with a clear fluid, and Potain's or Dieulafoy's aspirator is the apparatus of choice. Sometimes no aspiration can be effected until a small pocket of air is introduced through the upper needle. In such a case 100 to 200 c.c. of air are slowly introduced from above as aspiration is attempted below. A thick fluid will then sometimes come through a wide-bore needle when aspiration was previously a failure

TREATMENT OF HÆMOPTYSIS

Hæmoptysis, if copious, may cause sudden death. The cause is almost always bleeding from a ruptured artery in a cavity; such a cavity is usually of tuberculous origin. Hæmorrhage may also occur from bronchiectasis, new growth, and various other lesions. The patient may become drowned in his own blood, which is partly coughed out and partly inhaled into all parts of the lung. Inspiration of blood may cause massive collapse.

Treatment.—The immediate treatment is to lower the head over the side of the bed if the patient is choking, and allow the blood to flow from the lung bases towards the bifurcation of the trachea, whence it will be coughed up. Usually the bleeding is too slight to warrant this procedure. Morphine always does more good than harm, as such a patient is anxious and terrified at the sight of his own blood, and imagines death to be imminent. Nothing seems to soothe as much as morphine. Only ¼ gr. should be given, for tuberculous subjects seem to respond more readily than others to the injection. The patient is ordered absolute rest. If bleeding continues, and the signs of cavitation, clinical and/or radiological, are present on one side, induce an artificial pneumothorax on that side. Often the patient will tell you from which side the blood is coming. Complete collapse of the cavity for hæmoptysis necessitates introduction of much more air than is permissible in any other condition at one fill. Anything up to 1200 c.c. may be introduced, but at the first sign of distress the procedure should be stopped. Usually

only 400 to 600 c.c. are necessary. Shift of the heart and mediastinum does not matter if no distress is caused. The fill should be repeated if bleeding continues. Such a measure should only be adopted if hæmoptysis is copious and bleeding is continuing, as shown by the usual signs of hæmorrhage. In these cases collapse of the lung may be a life-saving measure, and the artificial pneumothorax is maintained afterwards to prevent the lung from re-expanding.

TREATMENT OF SPONTANEOUS PNEUMOTHORAX

The usual causes are rupture of an emphysematous bulla or pulmonary tuberculosis. A patient with an artificial pneumothorax may rupture an adhesion containing lung tissue and develop a spontaneous pneumothorax in addition. Symptoms may be absent or slight, or there may be severe pain in the side, palpitations, or shock. The onset is acute. Diagnosis is made on the signs of a displaced heart and absence of breath-sounds on one side. The percussion note is usually hyper-resonant, but not always so.

Treatment.—Take a radiograph to verify the diagnosis unless the condition is urgent. Insert an artificial pneumothorax needle into the affected side, connect with the artificial pneumothorax apparatus, and take a reading. Instead of the normal negative pressure (about −14 −8) the swing shows −2 + 2 or a positive reading such as + 2 + 6. If not distressed the patient is left severely alone; if short of breath and in pain remove sufficient air to give him relief, but no more than 700 c.c. at one time. The air is withdrawn by reversing the flow in the bottles of the artificial pneumothorax apparatus. If acutely urgent and the physical signs are such as to warrant the diagnosis, and if no artificial pneumothorax apparatus is to hand, thrust into the chest any wide-bore needle. The best site is in the 7th space in the axilla, but almost anywhere between 2nd and 9th ribs will do. The air will be heard to rush out if under great pressure. This often occurs where a valvular leak is present, allowing air to enter the pleura but none to leave. If the dyspnœa is increasing, a valvular pneumothorax is almost certainly present. In such a case leave the needle in and attach to it a rubber tube leading to a glass tube placed in a bottle containing water at the side of the bed. When the patient coughs bubbles will appear through the tube only if the fistula has persisted.

If fluid appears in the pleural space the condition is probably tuberculous; if not, probably non-tuberculous. The latter cases are common, and almost all get well on rest alone, no removal of air being necessary. If the lung in such a case is slow in re-expanding, removal of air occasionally may accelerate the process.

CHAPTER LI

VACCINATION

By ALLAN H. MORLEY

IT is extremely probable, though not conclusively proved, that vaccinia (or cow-pox) is variola modified by natural spread to animals. Both are inoculable, and mutually protective, but vaccinia only spreads by inoculation.

Nowadays *glycerinated calf lymph*, supplied in capillary tubes, is used almost exclusively for vaccination, although it is possible to use lymph from ripe vesicles. The lymph should be kept in a dark cool place, and it is best not to use lymph which has been removed from cold storage for more than seven days.

Two main principles should be observed :—

1. The production, with a fair degree of certainty, of a satisfactory vaccinia with the minimum of injury to the tissues.

2. Complete asepsis ; and this should be maintained until a firm protective scab is formed.

Unless exposure to small-pox has occurred or is expected, it is recommended that only one inoculation be made in primary vaccinations.

Technique.—

The site usually selected is the outer side of the arm in the region of the deltoid, except when a scar on the arm is considered undesirable, in which case a suitable site is the outer side of the leg about 1 in. above the external malleolus. In older children or adults the thigh is a suitable site, but in the case of infants there is the difficulty of keeping it dry. The selected site should be freed widely of all clothing and then swabbed with cotton-wool soaked in ether, the inflammability of which must, of course, always be borne in mind. Spirit may be used instead, but is not so satisfactory unless it is rectified. Friction should be used to cause slight congestion of the skin, and then the contents of a tube of lymph are evacuated on to the site by means of an artificial blower. This can be obtained from an instrument-maker, but an entirely satisfactory one is a teat from an infant's feeding bottle, with a round hole at the tip. The unbroken tube of lymph is passed through the hole into the cavity of the teat until the end projects through the open end of the teat (*Fig.* 507). This end is then broken off and the tube pulled out again in the reverse direction until only a small portion remains inside. The other end of the tube is now broken off, and by compressing the open end of the teat the contents of the tube can easily be blown on to the vaccination site.

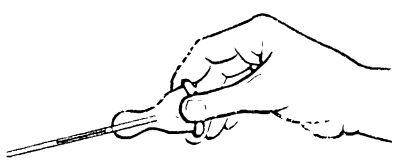


Fig. 507.—Method of transferring lymph from the capillary tube.

Methods :—

1. *Multiple-pressure* : This is the technique of choice in the U.S.A. " Pressures " are applied through the drop of lymph with the side of the point of a

Hagedorn needle held almost horizontally to the skin. The needle is moved rapidly up and down for $\frac{1}{8}$ in., with sufficient pressure to demonstrate the elasticity of the skin, but not so vigorously as to draw blood. Thirty pressures are used, except for primary vaccinations in adults, when ten should be sufficient.

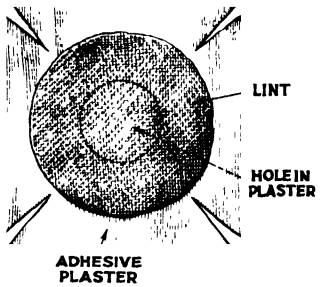


Fig. 508.—An excellent dressing after vaccination.

In this method trauma to the skin is negligible and it has definite advantages, including smaller scars and less severe local reaction.

2. *Scarification*: This, the older method, is still generally used in Great Britain. The skin should be stretched slightly while the scratching is made through the drop of lymph until the superficial layers of the skin are penetrated, and the appearance of a tiny area of redness shows that some capillaries have been laid bare. It is undesirable to cause actual bleeding. Scarification may be performed by means of a special instrument resembling a minute fork, obtainable from instrument-makers, with a lancet, or simply with a needle. Sterilization of the instrument is best produced by holding it for a few moments in the flame of a spirit or 'Meta' lamp. After scarification it is wise to allow time for the lymph to show definite signs of drying in.

Finally, a *protective sterile dressing* is desirable. The most suitable is a self-adhesive pad made of plain white lint and zinc oxide plaster. An important



Fig. 509.—A typical successful vesicle of primary vaccination at maturity on the ninth day.

point is that if plaster is used it should not be allowed to cover the whole of the lint (*Fig.* 508). A good-sized hole should be present to allow evaporation, or the site will become sodden and risk of infection occur. Instructions should be given that the dressing must be kept dry. Inspection of the result should be made between the seventh and tenth days in the case of primary vaccinations (*Fig.* 509), and between the fifth and seventh days in the case of re-vaccination.

In primary vaccination a *papule* appears about the third or fourth day and this becomes a *vesicle* on the fifth or sixth day. An inflamed red areola appears and the vesicle enlarges till (as shown in illustration) *incrustation* begins in the centre, about the ninth day. *Decrustation* and *scarring* follow in due course. These stages are remarkably constant in their manifestation in the case of primary vaccination, but all the stages in secondary vaccination tend to be shorter and less clearly defined, depending on the remaining degree of immunity conferred by previous vaccination.

Intra-epidermal Vaccination.—This practice has recently been advocated. The technique is exactly similar to a Schick test. A sterile needle, held almost parallel to the skin, is inserted through a drop of lymph into the epithelial layer for about a twelfth of an inch. It is claimed that the method is simple, rapid, efficient, and economical. No dressing is required until the vesicle appears, and severe local or constitutional disturbances are said to be very rare. There is also a great saving in the amount of lymph used, and this is an important factor when in an emergency a large number of vaccinations are required with a limited amount of lymph available.

CHAPTER LII

LUMBAR PUNCTURE AND ALLIED PROCEDURES

By HAMILTON BAILEY and C. ALLAN BIRCH

LUMBAR PUNCTURE

LUMBAR puncture should always be performed under the most rigid asepsis. The hands of the operator must be prepared as for a surgical operation, the lumbar puncture needle boiled, and the skin of the patient prepared with iodine Spinal puncture should never be attempted through unhealthy skin or infected subcutaneous tissue.

Lumbar Puncture Needles.—Barker's needle is unnecessarily large for routine use ; the smaller needle illustrated (*Fig.* 510) will be found to be perfectly

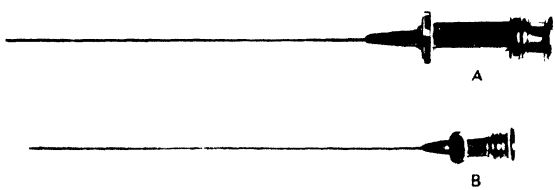


Fig 510.—A, Barker's needle ; B, A smaller lumbar puncture needle for routine use

satisfactory for most cases. It is, however, useful to have a Barker's needle for use in difficult cases, i.e., where the patient is fat or osteo-arthritis prevents a full flexion of the spine.

Position.—This is the most important single factor in successful lumbar puncture. *The vertical position* is used by some operators. The patient is seated with his legs dangling and the back flexed strongly. It is as well to have a nurse to stand in front of the patient to support him. Obviously the position cannot be employed if the patient is unconscious or gravely ill. It is for this reason that *the lateral position* has so much to recommend it—it is applicable to all cases. In order to get the spine fully flexed an assistant places one arm under the knees and the other round the back of the neck (*Fig.* 511), explaining to the patient the necessity to get the chin as near to the knees as possible. The purpose of this flexion is to widen the intervertebral spaces and thereby facilitate the entry of the needle. A roller towel placed round the neck and knees and tightened by twisting with a rod, sometimes helps to obtain and maintain the flexed position when other methods fail.

As emphasized throughout this article, full flexion of the spine is a prime consideration : running it closely is the prevention of sagging of the spine. The long axis of the spine should be parallel to the floor. If the puncture has to be

made in bed, it is wise to insert a flat board between the mattress and the springs. Failing this, get the patient right on to the hard edge of the bed.

No attempt should be made to proceed with the puncture unless the operator is satisfied with the position.



Fig. 511.—An assistant places one arm under the knees and the other round the back of the neck in order to flex the spine as fully as possible

Site of the Puncture.—The puncture can be made at any level, but the site of election for general purposes is between the 3rd and 4th lumbar vertebræ. This space lies on a line joining the uppermost points of the iliac crests *Fig.* 512).

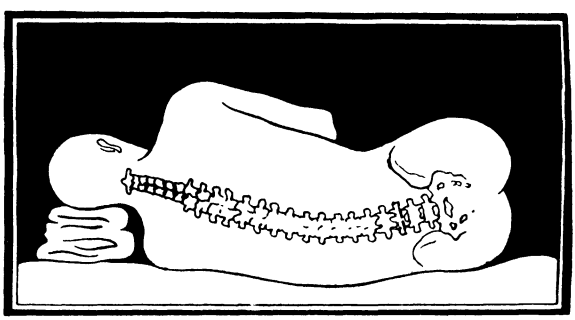


Fig. 512.—Method of defining the interspace between the 3rd and 4th lumbar vertebræ.

Sterilization of the Skin.—A wide area of the skin of the back is sterilized with iodine, and sterile towels are arranged about it.

Defining the Intervertebral Space and Injecting Local Anæsthetic.—Using the left thumb, a space between two spinous processes is selected. The spinous process below must be felt and the spinous process above. Resting the pulp of the thumb on the spinous process above, the skin is stretched in an upward direction, the patient is warned that there will be a prick, and a little procaine

is injected into the skin. The needle is then inserted more deeply, and some more local anæsthetic injected.

The Puncture.—The left thumb again determines the space, and, as before, the skin is stretched by moving the thumb upwards so that it rests on the inferior surface of the upper spinous process. The lumbar puncture needle is grasped firmly by the hilt in the right hand, and its point is inserted through the skin of the interspace, guided by the left thumb-nail (*Fig.* 513). Because of the risk of meningitis some operators hold the needle and palpate the skin through a sterile towel. The needle is advanced a short way perpendicular to the skin surface. At this juncture the left thumb is removed, and the needle advanced carefully by steady pressure with *both hands*, the left hand holding the shaft of the needle to prevent it going too far when the resistance of the deep tissues is overcome. A slight 'give' will be felt when the ligamentum flavum is



Fig 513.—Method of holding an infant for lumbar puncture

pierced. Often a second sensation of 'give' is experienced when the dura has been punctured.

The stylet is then removed and, in a successful puncture, the cerebrospinal fluid drips or pours from the hollow needle.

Difficulties.—If the cerebrospinal fluid fails to appear, the needle, without the stylet, is advanced very cautiously a few millimetres. If this fails, the needle is rotated and withdrawn a little. When there is still no flow, the stylet is replaced and then withdrawn. If cerebrospinal fluid still fails to appear on removing the stylet for the second time, the needle is again rotated, since it is possible that the point may be obstructed by a nerve-root or the arachnoid. In the event of the patient complaining of pain down the leg, the needle has struck one of the roots of the cauda equina. The point of the needle must then be withdrawn almost to the skin and reinserted, giving it a slight upward tilt.

Bone is encountered: When the point of the needle, instead of finding the interspace, impinges upon bone, it usually means that the flexion is insufficient. The needle should be withdrawn and another attempt to get more satisfactory flexion of the spine must be made. This requires patience on the part of the patient, the assistant, and the operator, but it is time well spent.

Another attempt is made to insert the needle, this time altering the direction so as to give the needle a somewhat upward tilt. If this is of no avail, instead of introducing the needle exactly in the middle line it is inserted about a quarter of an inch laterally. If no success is achieved by these expedients, another interspace is selected, local anæsthetic injected, and the procedure begun anew, this time using a Barker's needle.

Even an experienced operator will meet cases where osteo-arthritis of the spine prevents proper flexion and consequently the dura cannot be entered. Such cases should constitute not more than 1 per cent.

Blood or blood-stained fluid: 'Bloody taps' usually occur when difficulty is experienced in performing the puncture. Often the needle has been introduced too far, and by withdrawing it slightly the blood-stained fluid becomes progressively less bloody. In cases of head injury when blood-stained fluid is withdrawn, it is necessary to know whether the blood is due to trauma caused by the needle or if it is due to previous subarachnoid hæmorrhage. The following table will be helpful in elucidating this important differential diagnosis (Merritt and Fremont-Smith).

	'Bloody Tap'	*Previous Subarachnoid Hæmorrhage*
Pressure	Often low	Usually high
Amount of blood	Varies in different tubes	Admixed evenly
Clotting	May occur	Always absent
Centrifuging	Supernatant fluid colourless	Supernatant fluid xanthochromic

Post-operative Headache.—In a small, but definite, group of cases headache occurs after lumbar puncture and spinal anæsthesia. Although it is admitted that persistent headache is more frequent after spinal anæsthesia than after simple lumbar puncture, it is the lumbar puncture, rather than the anæsthetic agent, which is the cause. Possibly a few of these troublesome headaches, which are often occipital or even located in the back of the neck, are due to a mild chemical meningitis in cases in which a spinal anæsthetic is responsible.

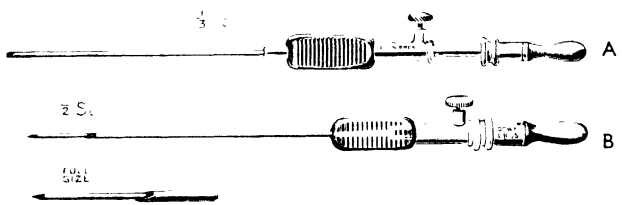


Fig. 514.—Dattner's needle. A, Arranged for introduction. B, with needle projecting after introduction

In the majority of instances the headache is due, not to increased pressure, as was thought formerly, but to reduced pressure consequent upon cerebrospinal fluid leaking through the puncture hole in the dura into the epidural space. If this theory is correct, measures to reduce intracranial pressure are misdirected, and would only aggravate the symptoms.

Prevention.—Headache can be prevented by performing the puncture with the patient in the recumbent position, and keeping him flat in bed for 48 hours (J. E. Moore). This is not always convenient, and for ambulant patients Dattner's needle (*Fig.* 514) has proved useful in obviating headache. It consists

of two needles, one inside the other, and a stylet. A screw fixes the position of the inner needle. The outer needle reaches the ligamentum flavum and the inner needle punctures the dura. (The needle should be turned so that its cutting end separates rather than transects the fibres of the ligamentum flavum.) The sitting position is best and a syringe must be used to withdraw cerebrospinal fluid. Pressure readings are not easily obtained.

Treatment.—Time should not be wasted in administering usual remedies for headache; in this instance they are useless. The foot of the bed should be raised on blocks and as much fluid given by mouth as the patient will tolerate. Pituitary extract, 0·5 c.c., intramuscularly may help.

MEASURING THE CEREBROSPINAL FLUID PRESSURE

It is erroneous to suppose that the cerebrospinal fluid pressure can be estimated, even approximately, by observing the rate at which the fluid escapes through a lumbar-puncture needle; a spinal manometer (*Fig.* 515) must be employed. A simple one is illustrated in *Fig.* 516, and is used as follows:—

A needle such as that in *Fig.* 510 is inserted into the theca. The stylet is withdrawn and the butterfly adaptor with bicycle valve tubing attached is

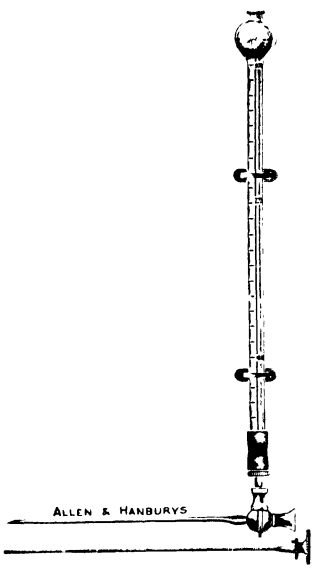


Fig. 515.—Greenfield's spinal manometer

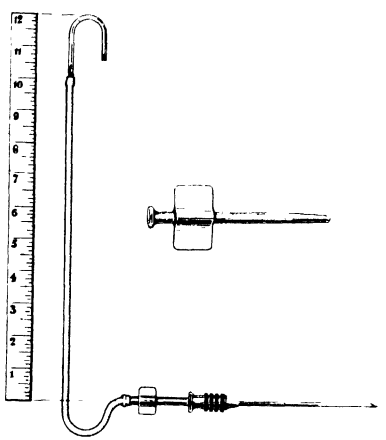


Fig. 516.—Northfield's apparatus for measuring the cerebrospinal fluid pressure

fitted into the end of the needle. The glass U-tube at the other end of the rubber tubing is held below the level of the needle until cerebrospinal fluid is seen in it. It is then raised until the fluid level in one of its limbs is steady. The metal ruler is held with its zero mark level with the needle. The U-tube is held against this and the fluid level read off. Queckenstedt's test is performed in the usual way.

Normal pressures vary between 100 and 200 mm. of fluid. Often the pressure rises above the normal at first, but soon settles to a steady level, which is marked by the slide attached to the tube. Pressures over 200 mm. indicate increased intracranial pressure if they are not due to nervous embarrassment of respiration. In Queckenstedt's test an assistant presses gently on the internal jugular veins. Normally this causes a rapid rise of fluid in the manometer, but when the space between the cord and the dura is blocked or narrowed, there is no such rise or only a sluggish one.

SPINAL ANÆSTHESIA

There are a large number of anæsthetic agents, and the technique of their administration is so variable that it would be dangerous to detail any description of spinal anæsthesia in a work of this character. The house surgeon must receive practical instruction in the particular product which is employed in the hospital where he works.

In a different category is low spinal anæsthesia, which is a perfectly safe method of anæsthetizing the anus, perineum, male urethra, and external female genitalia. Stovaine, ½ c.c. in saline, is injected intrathecally between the 4th and 5th lumbar vertebræ. The patient sits up for one and a half minutes. There is no shock and no need for cardiac stimulants.

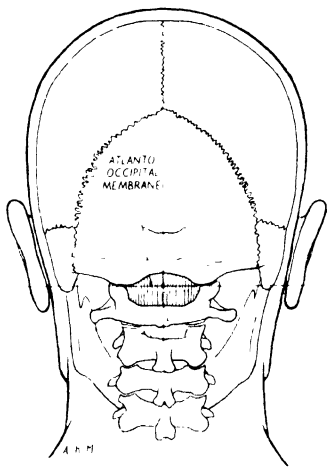


Fig. 517.—The point of entry of the needle at the intersection of a line joining the tips of the mastoids and the vertical midline of the neck.

CISTERNAL PUNCTURE

The most reliable technique is that of Castex and Ontaneda, which depends on the fact that a line joining the tips of the mastoid processes bisects the occipito-atlantoid space.

The neck is shaved and the external landmark made at the point where the horizontal curved line joining the tips of the mastoids cuts the vertical line of the neck (*Fig.* 517). These lines are made by the use of a tape measure and grease pencil. The patient lies with his head at the foot of the bed so that the bed-post is not in the way, and the head is supported on a small pillow so that the cervical spine is horizontal and flexed (*Fig.* 518). The skin is dabbed with iodine and the landmark is anæsthetized with procaine.

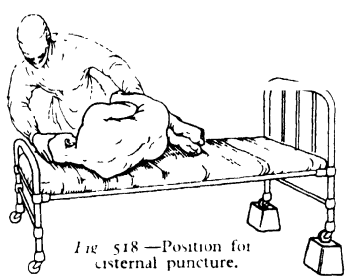


Fig. 518.—Position for cisternal puncture.

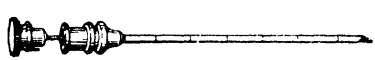


Fig. 519.—Purves-Stewart's cisternal needle.

A Purves-Stewart needle (*Fig.* 519), graduated in centimetres, is introduced horizontally at the entry point and kept strictly in the midline (*Fig.* 520). The

blunt stylet is pressed home after each cautious advance until the atlanto-occipital ligament is felt. The stylet is then withdrawn a little and the ligament penetrated. A characteristic 'feel' may be experienced. As soon as fluid appears the needle must not be moved farther lest the medulla be injured.

A refinement is to determine before puncture the exact depth at which the cistern will be punctured. This is done by measuring how far in a sagittal plane the entry point is behind the vertical plane through both mastoids. This 'skin-mastoid'

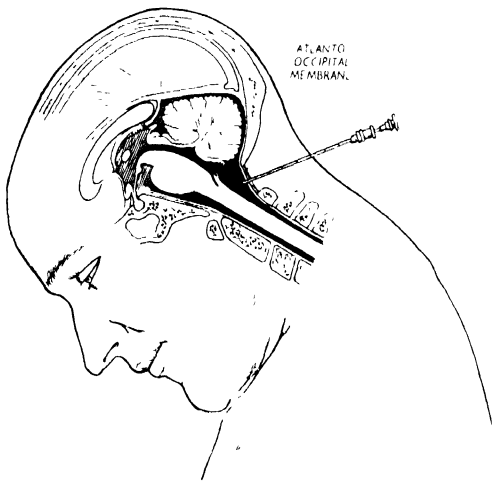


Fig. 520.—Showing the direction of the needle, which has reached the atlanto-occipital ligament.

distance is the shortest distance from the tip of one mastoid to a transverse line through the entry point. It is measured by placing one limb of a folding ruler transversely over the entry point while the other limb at right angles to the first is placed antero-posteriorly under the lobule of the ear. The distance from the mastoid to the transverse limb is read off. An average reading is 7 cm. By subtracting 2½ cm. we have the depth of the atlanto-occipital ligament in any given patient. But since the ligament and dura are about ½ cm. thick, we subtract 2 cm. to get the depth of the cistern. Roughly the cistern is reached 2 in. from the skin and there is another ½ in to go before the medulla is injured.

CHAPTER LIII

OPERATIONS UPON THE TONSILS

By DENIS BROWNE

REMOVAL OF TONSILS

Anæsthetic.—Intratracheal gas and oxygen for choice. The safety of the airway given by this more than compensates for the slight obstruction of the tube. Otherwise ether vapour given through a weighted hooked airway hung in the mouth.

Position.—On the back, on a horizontal table, with a sandbag under the shoulders, raising them till the face lies naturally at an angle of 45° to the vertical. This allows blood or fragments of tissue to drop into the nasopharynx rather than into the glottis.

Gag.—A Waugh's gag (*Fig.* 521) combined with a sharp tongue forceps has the advantage that the tonsillar fossa is opened widely and pulled forward rather than stretched and narrowed at the back of the throat as by the Davis gag. The latter, however, when once adjusted does not need an intelligent assistant to hold it, as is the case with the tongue forceps.

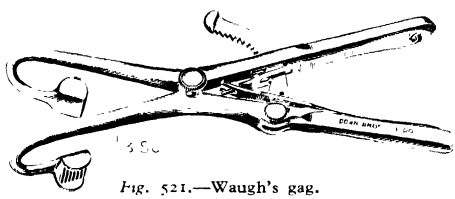


Fig. 521.—Waugh's gag.

Anatomy.—The descriptions of the tonsil in anatomical text-books are notoriously contradictory and inaccurate. The main points of importance in tonsillectomy are :—

1. The upper half of the capsule of the tonsil is separated by a loose areolar space from the palate muscles. In this space the dissection should begin, and it is in it that a quinsy forms.

2. The lower half of the capsule has the palate muscles inserted into it, so that they lift it up and back over the descending bolus during swallowing.

3. In addition to the muscular suspension there is a fibrous one, as in the case of the testis. The suspensory ligament runs from the sheath of the tongue muscles to the angle of the tonsil that lies between the tongue and the anterior pillar (*Fig.* 522). The early identification and cutting of this ligament is essential for a neat and rapid dissection.

4. There is one artery of supply—that from the facial, which enters the lower pole close to the tongue. Like all arteries of this size, it ceases bleeding rapidly after division owing to the contraction of its walls, unless it is atheromatous.

5. There is a vein unaccompanied by an artery, running in this areolar space, the paratonsillar vein (*Fig.* 523), which is the almost invariable source of dangerous bleeding. Like most unpaired veins, it varies greatly in size and may be double or treble. When it is divided the bleeding end retracts into the upper corner of the tonsillar fossa, and has to be ligatured there.



Fig. 522.—Showing artery, veins, and nerves entering the hilum of the tonsil. The paratonsillar vein is seen lying free on the muscular bed. The suspensory ligament running from the anterior angle of the tonsil into the tongue is also shown.

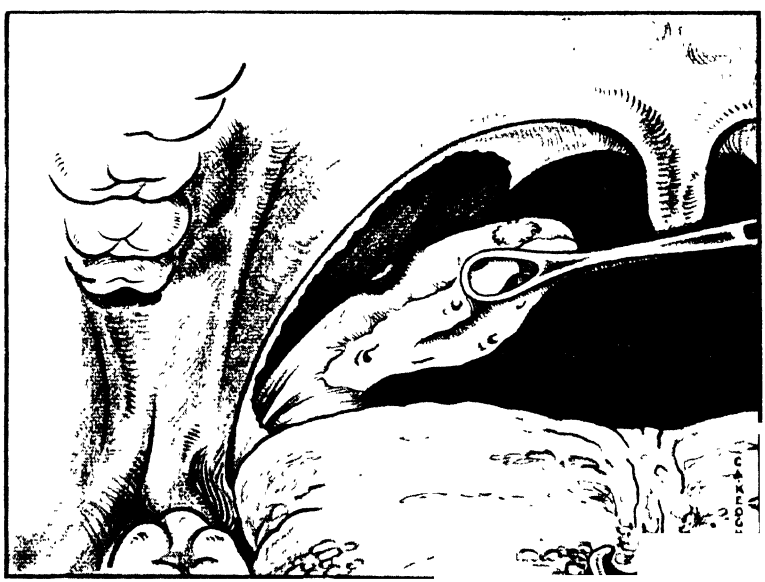


Fig. 523.—The paratonsillar vein adheres to the tonsil as it is dragged from its bed. The suspensory ligament is seen as it appears in tonsillectomy.

Instruments.—

1. Tonsil-holding forceps, with blunt overlapping jaws (Browne's, *Fig.* 524). The only part of the tonsil which will allow the strong grip needed for dissection is the capsule, and this will stand far more tension when held by a blunt grip of this sort than when perforated by a vulsellum.

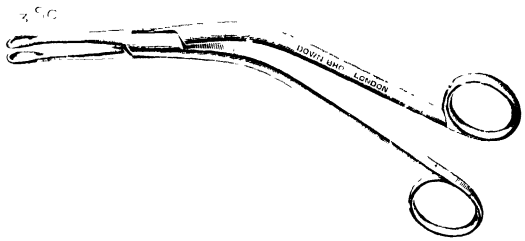


Fig. 524.—Browne's tonsil-holding forceps.

2. Waugh's dissecting forceps, or the author's 'needle-catching forceps' (*Fig.* 525). The latter has the advantage that the points can be inserted closed, and then expanded: always the best way of finding an areolar plane of cleavage.

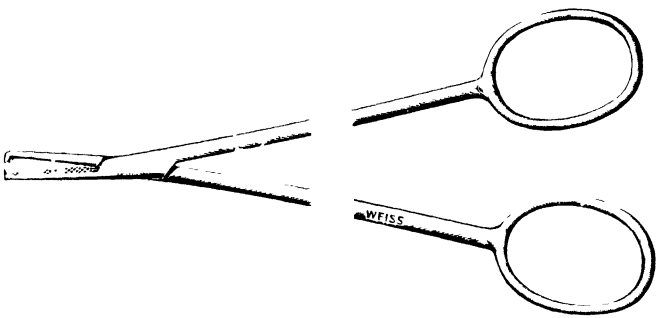


Fig. 525.—Browne's needle-catching forceps.

3. Ligature-carrying forceps (*Fig.* 526). The author's pattern is bent so that the hand does not obstruct the view.

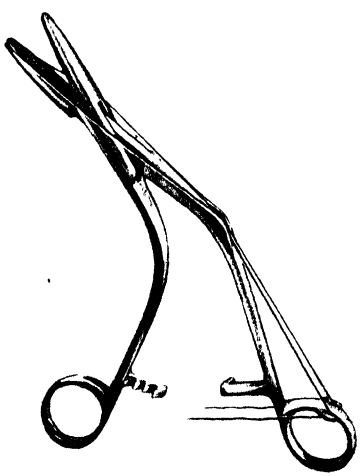


Fig. 526.—Browne's ligature-carrying forceps.

4. Dissecting scissors.

5. Suction aspirator, if possible.

6. A liberal supply of gauze swabs, of size suitable to the patient.

Method of Operating.—Stand on one side of the patient, as this allows a far better view of the important upper part of the fossa than when at the head of the table. Insert one blade of the holding forceps into the slit in the surface of the tonsil, called by anatomists the supra-tonsillar fossa, and close them so that the other blade grasps the extreme edge of the mucosa of the anterior pillar. Put this on the stretch by lifting the tonsil inwards and forwards, and with the sharp-toothed end of the forceps make a clean tear extending from the middle of the tongue border of the tonsil, along the anterior pillar, round

the upper pole, and as far as possible down the posterior pillar. One of the commonest causes of difficulty is too small a first incision.

Still holding the tonsil so that it bulges through the anterior pillar, deepen the incision till the white capsule shows. Then shift the grip of the holding forceps on to this, and thrust in a swab that is about the size of the tonsil when tightly compressed. This will define the suspensory ligament running from the angle between the anterior pillar and the tongue, and this should now be divided by light snicks with the forceps. The tonsil can now be swung right out into the middle of the throat, and the posterior pillar pushed off it by gauze dissection, which is continued firmly downwards to strip off the muscle attached to the lower part of the capsule.

This finally should leave only a narrow pedicle containing the artery, which can be caught close against the tongue by the holding forceps and twisted off by a half turn of the wrist.

A swab is held firmly in the fossa with one forceps, and the throat kept clear of blood with the other till the bleeding diminishes, as it will rapidly do. Then any bleeding points should be treated precisely as they would be in an ordinary surgical operation and ligated immediately. It is no more justifiable to try to stop venous bleeding by pressure, by stitching in swabs, and so forth, in this operation than it would be in a dissection on the outer side of the neck. The artery to the tonsil, or the tiny branches to the mucosa along the tongue border, almost invariably cease bleeding rapidly and completely. The reason why almost all writers on the subject believe the dangerous bleeding to be arterial is that venous bleeding in the neck usually comes in pulsating jets, though without the true arterial pressure.

If bleeding should occur soon after the operation, it is best for all concerned to re-anæsthetize the patient and ligature the vessel. The mental and physical suffering caused by attempts to stop it by pressure in a conscious patient are quite unjustifiable.

A blood transfusion should be given if there has been much bleeding in such a case, not only as a life-saving measure, but because of its great help towards convalescence.

After-treatment.—The patients should be encouraged to take as much glucose-sweetened drink as possible, and allowed to eat what they feel inclined to. Ice cream is very useful with the young. Never in any circumstances should a child be sent out of hospital within twenty-four hours of the operation, and at least three days in bed is desirable.

PERITONSILLAR ABSCESS

(syn. *Quinsy*)

This means suppuration in the areolar space round the upper half of the tonsil, analogous to perirenal abscess or orbital suppuration. It is due to infection in a tonsillar crypt spreading through the capsule. If in a case of tonsillitis a swelling of the palate above the tonsil proper, and increase of pain on one side, show that a quinsy threatens, it may be aborted by sulphanilamide treatment. In any case no operation should be attempted till fluctuation is present.

Operation.—This can be done in a tolerant patient without a general anæsthetic by incising over the middle of the fluctuant swelling (*Fig.* 527) either with a tiny (No. 15) Bard-Parker blade, or with an ordinary scalpel with all except the tip of the blade guarded with sticking plaster. A cocaine spray beforehand will

reduce the pain of incision; local injections, as in all septic conditions, are not successful. Through the incision sinus the 'needle-catching' forceps should be inserted, directly backwards, and opened to allow pus to flow. This is, at the best, a painful procedure; and it is preferable to give a general anæsthetic. An aspirator to remove the pus as it appears will avoid any danger of inhaling it.

Severe bleeding may occur at the time of operation or later, from the paratonsillar vein. Packing the abscess with ribbon gauze may control it, but if it does not it is necessary to remove the tonsil and ligate the bleeding point.

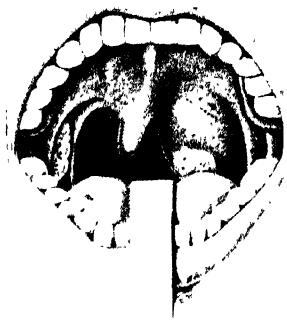


Fig 527.—Peritonsillar abscess: site of incision.

RETROPHARYNGEAL ABSCESS

This is suppuration starting in the prevertebral lymphatic glands, analogous to the acute streptococcal abscess of the neck often seen in children. It should be suspected when a child complains of difficulty in swallowing or breathing coming on fairly rapidly in the course of a throat infection; and can be best diagnosed by palpation with the finger. This finds a fluctuant swelling on one side or the other of the posterior pharyngeal wall, just behind the tonsil. It must be distinguished from tuberculous infection of the same glands, and also from congenital aneurysm of the internal carotid artery.

Operation.—Only in the most urgent obstruction should drainage of the abscess be attempted without an anæsthetic. When an anæsthetic is given for this condition it should not be deep. The control of the airway given by a gag and tongue forceps may suddenly become very necessary indeed.

The head should be hung well over the edge of the table, as one of the main dangers is that of inhaling the suddenly released pus if this is allowed near the larynx. The best method of opening the abscess is by thrusting a 'needle-catching' forceps into it with one hand, while the other uses a suction aspirator to clear away the pus immediately it appears. If this is deftly done not a drop is let free in the pharynx.

Alternatively a guarded knife followed by sinus forceps may be used, and the pus cleared away with swabs.

CHAPTER LIV

THE NOSE AND ACCESSORY SINUSES

By M. VLASTO

Preliminary Remarks.—As the mucous membrane of the nasal fossæ is continuous with that of the accessory sinuses, pathological processes which affect the one are liable to affect the other. Certain conditions are, however, predominantly nasal and others predominantly sinusal. It cannot be sufficiently emphasized that the ciliated epithelium which lines these cavities is one of Nature's barriers to invasion by germs, and should be treated with the greatest respect. All treatment of nasal conditions should be—so far as possible—on conservative lines. When surgical measures become indispensable, they should be carried out with the minimum of disturbance to normal tissue.

The great majority of patients with nasal symptoms will complain of nasal obstruction. Other common symptoms are nasal discharge, loss of smell, headache, and epistaxis. The patient's history will often give a clue to the diagnosis, but this 'spot',

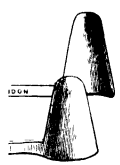


Fig. 528.—Thudichum's nasal speculum.

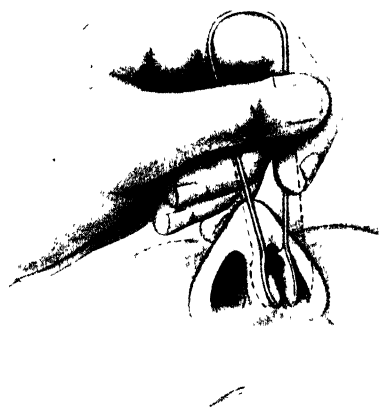


Fig. 529.—Method of using a nasal speculum.

diagnosis will have to be checked by throwing a beam of light into the nasal fossæ—*anterior rhinoscopy*. Although practitioners may find an electric forehead lamp more convenient to use when the patient is in bed, it must be stressed that to obtain a good view of the interior of the nasal fossæ the use of a head mirror with reflected light is essential to sound diagnosis and treatment. Most surgeons look through the central aperture of the mirror with their right eye and manipulate their instruments with their left hand. In this case, the source of illumination should be on a level with the patient's left shoulder. With some practice, the reflected beam of light can be accurately focused into the nose.

A nasal speculum (*Fig.* 528) is then gently introduced into one side of the nose. To obtain the best result, the speculum should be held in the manner shown in *Fig.* 529. The first landmark will probably be the inferior turbinate

bone on the lateral side and the septum on the medial side. By slightly tilting the speculum and the patient's head, other parts of the nasal fossæ will come into view. Note particularly the colour of the mucous membrane, the presence of discharge, crusts, polypi, septal deflection or perforation, foreign body, or a bleeding area.

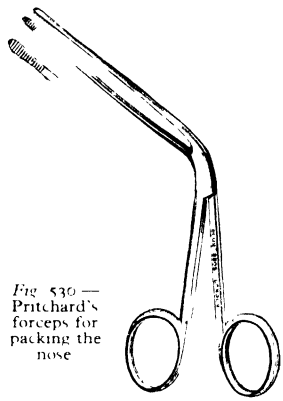


Fig. 530.—Pritchard's forceps for packing the nose

Posterior Rhinoscopy.—By using a specially bent mirror, it is possible to gather useful information by reflecting a beam of light into the nasopharynx. This examination requires considerable practice both in technique and interpretation, and is best left to the specialist. This method is frequently used when adenoids are suspected. It is submitted however, that in the few cases where confirmation is needed, more precise information can be obtained by the gentle introduction of the tip of the fore-finger into the nasopharynx.



Fig. 531.—Medicated steam inhalation. A wide-mouthed receptacle is necessary

In addition to the nasal speculum, the surgeon needs a nasal forceps (*Fig.* 530), metal or wooden probes to carry cotton-wool, and a supply of cocaine and adrenaline. Cocaine 5–10 per cent is perfectly safe to use if it is applied to a limited area on a swab and not sprayed haphazard into the nose.

NASAL OBSTRUCTION OF RECENT ORIGIN

Acute Rhinitis.—This will affect both sides of the nose and will be associated with a 'cold'. The inflammatory process may have spread from the nasal fossæ to the paranasal sinuses, over which tenderness may be elicited. It will be noted that frontal sinus pain due to this cause is at its worst in the forenoon, and eases off during the day. The greater the amount of discharge, the more likely are the sinuses to be infected, corresponding to the more widespread inflammatory area. Moreover, the sense of smell is often in abeyance. Treatment is entirely palliative and should include nasal inhalations of mentholated steam (*Fig.* 531).—

℞ Menthol in S.V.R. 10%
5 to 10 drops in 1 pint of boiling water.

Confirmatory evidence of an infected maxillary sinus may be obtained by transillumination. This is carried out by introducing a bright light into the closed

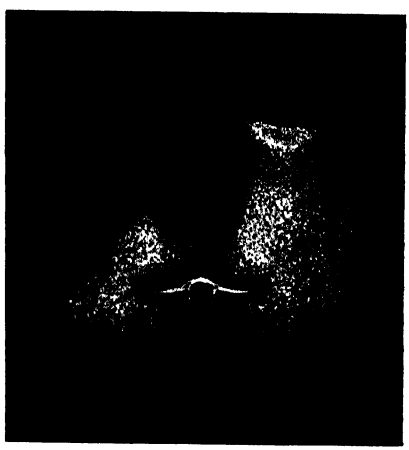


Fig. 532.—Suppuration of the right antrum of Highmore.

mouth after removal of an upper denture. By excluding the light from outside, a relative opacity on one or both sides may be noted (*Fig.* 532). This method is of more value in unilateral than in bilateral cases.

Further confirmatory evidence of an infected maxillary or frontal sinus can be obtained by radiography and by exploratory puncture and lavage of the maxillary antrum. This little operation is usually carried out in chronic conditions.

Exploratory Puncture and Lavage of the Antrum.—The majority of surgeons prefer to puncture the medial wall of the antrum through the inferior



Fig. 533.—Lichtwitz's antrum trocar and cannula.

meatus with a straight trocar and cannula (*Fig.* 533). The inferior meatus and adjacent parts are anæsthetized with cocaine and adrenaline and after a few minutes—when the point of the needle can no longer be felt—a point is selected high up under the centre of the inferior turbinate and the needle is gently pushed into the antrum by a boring action through the mucous membrane and the antral wall. To prevent the point of the needle entering the orbit, the tip of the forefinger acts as a brake. When the trocar and cannula are felt to be free in the cavity, the trocar is removed and a Higginson syringe is connected with the cannula, and the sinus can be washed out with warm saline or some other solution.

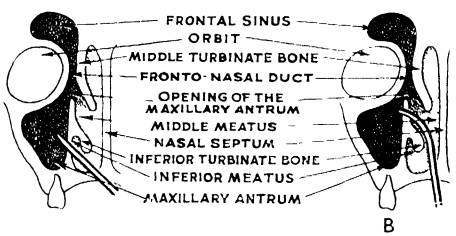


Fig. 534.—A, Showing puncture of the antrum through the inferior meatus with a straight trocar. B, Showing puncture of the antrum through the middle meatus with a curved trocar.

When the middle meatal route is selected, a curved needle is introduced beneath the middle meatus with the concavity of the curve downwards. When the point has entered the antrum, fluid can be pumped in through the attached syringe (*Fig.* 534).

Hæmatoma or Abscess of the Septum.—A history of recent nasal obstruction supervening on an injury to the nose may be due to this condition. Although at first unilateral, the obstruction soon becomes bilateral (*Fig.* 535). It can be recognized by tilting up the tip of the nose and noting the sagging bulge of the septal area. Although the swelling may subside under conservative measures, it usually suppurates and requires to be evacuated. This is carried out under a local or short general anæsthesia by a horizontal incision from behind forwards over the lower part



Fig. 535.—Hæmatoma or abscess of the nasal septum.

of the bulge. The pus which flows out can be expressed from the opposite side.

Traumatic Septal Displacement.—This may or may not be associated with a fracture of the nasal bones (Chapter LXX). There is usually a history of epistaxis, and if the septum is not replaced soon after the injury a condition of chronic nasal obstruction will result.

Foreign Body in the Nose.—This is a frequent cause of unilateral nasal obstruction in a child. Sometimes the child is stated to have pushed a foreign body up the nose, and it is still in situ. Sometimes there is no foreign body present. In many cases, neither parents nor child is aware of the incident, and the case is no longer one of acute nasal obstruction but one of indefinite duration and associated with a unilateral offensive discharge. Whether or not the surgeon is satisfied that the case is a 'true bill' he may proceed as follows: the child sits on his lap and the nasal fossa on the affected side is gently swabbed with a mixture of 5 per cent cocaine and adrenaline. Inspection under reflected light illumination may show the foreign body impacted in its commonest situation, the inferior meatus; sometimes, the discharge which coats it may be a guide to its situation. After a few minutes, a small-sized Eustachian catheter is passed horizontally backwards above the foreign body and with its beak downwards along the middle meatal region. As soon as the surgeon feels that the beak of the catheter is behind the foreign body, the beak is tilted down and pulled gently forwards. The foreign body is almost invariably extruded. In some cases, the child will not allow this removal under local anæsthesia, and a short general anæsthetic must be given.

CHRONIC NASAL OBSTRUCTION

Septal Deviation.—This is one of the most frequent causes of nasal obstruction. A history of old trauma is usually obtained, but defective septal development is another frequent cause. Obstruction often affects both sides, but is usually more marked on one side than the other. Treatment is surgical and consists in the removal of the obstructive elements (cartilage and bone) whilst interfering as little as possible with the mucous membrane of the septum.

Nasal Polypi.—These are found growing from the region of the middle turbinate bone, and are practically only seen in adults. They are recognized by their glistening gelatinous appearance when the light is focused on them. They are believed to be associated with an allergic diathesis, but it is best to regard them as an expression of ethmoiditis. Patients suffering from this condition will also complain of nasal discharge and some loss of smell. Although removal of nasal polypi alone will not necessarily cure the patient of his underlying condition, it may relieve him of his worst symptoms for a considerable time. But prognosis should be guarded.

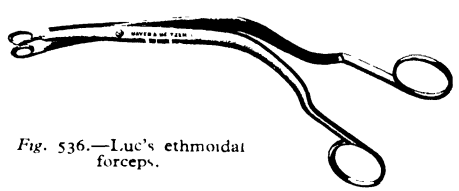


Fig. 536.—Luc's ethmoidal forceps.

Removal of Polypi.—A fairly effective removal can be carried out under local anæsthesia in favourable conditions. But for any serious attempt to remove polypi together with the underlying cause, one must have recourse to general anæsthesia. After suitable anæsthesia, the polypi are carefully identified and seized with holding forceps (*Fig.* 536). A gentle pull is

exerted, and as one polypus is removed others come into view and can be similarly dealt with. Pieces of carious ethmoid may come away in the grip of the forceps, but the operator should desist from any forcible traction which might trespass on normal tissue.

Many operators prefer to remove polypi with a snare. The risk in so doing is slightly less, but the removal is less radical and the liability to recurrence is correspondingly greater.

Atrophic Rhinitis.—Although patients suffering from this condition usually complain of unilateral or bilateral nasal obstruction, the nasal fossæ are abnormally roomy. The obstruction is caused by crusts which fill the nares and emit a revolting odour, of which the unfortunate sufferers are happily unaware, as their sense of smell is much reduced.

Treatment consists in frequent cleansing of the nose, including the removal of crusts. It is also of importance for the sufferer to find employment away from human contacts.

Allergic Rhinitis.—This is a frequent cause of nasal obstruction and is often associated with the presence of polypi. Apart from the removal of polypi, the condition should be treated on the same lines as that of other allergic manifestations.

DUTIES OF THE ASSISTANT AT A NASAL OPERATION

These are very simple, and consist in supplying the surgeon with strips of gauze in the following manner: the gauze strips should be 1 in. wide and about a yard in length. They are introduced into the nasal orifice—but no farther—so that the surgeon can insert them himself into the nasal fossa. The more vascular the operation, the longer should be the strips, and the more rapid their replacement. The assistant should be prepared to remove the strips very rapidly, so that the surgeon may have a few seconds to work in a bloodless field.

THE TREATMENT OF EPISTAXIS

Before 'rushing' to treat epistaxis, the student should pause to consider whether the cause is local or general. In the majority of cases the cause is local, and even when the cause is general it may be advisable to stem the flow of blood. It is important in these cases, however, not to overlook the treatment of the underlying condition of which epistaxis is only an expression. Hyperpiesis is not an infrequent cause, and the student should appreciate that a moderate amount of bleeding is beneficial in this condition. Robust children about the time of puberty frequently have attacks of epistaxis, and no particular treatment is needed in their case. It should also be recognized that adenoids sometimes cause bleeding in young children and plugging the nose in these cases is not going to relieve the condition.

Immediate Arrest.—The great majority of cases of epistaxis are bleeding from an area in the front and lower part of the septum. This area can often be controlled by firm pressure between the thumb and forefinger. The patient should have the clothes loosened about the neck and these are replaced by a towel. He is made to lie down on his side, and water as cold as possible is held against the bridge of the nose. Many cases of epistaxis will cease under this treatment. But if it persists, the condition will require further treatment. The patient must be seated facing a window unless the surgeon proposes to adopt the more satisfactory course of using reflected light. A cotton-wool swab soaked

in hydrogen peroxide solution, or better, adrenaline, is introduced under pressure well inside the nose and finger pressure is again exerted. If hæmorrhage still persists, the nose will have to be packed. By the aid of reflected light and a nasal speculum, an attempt is made to locate the bleeding area. A long strip of 1-in. ribbon gauze is then passed with a nasal forceps (*see Fig.* 530) deeply into the nose and packed from below upwards. The operation will be greatly facilitated if the gauze has been wrung moist from a solution of equal parts of 5–10 per cent cocaine and adrenaline, or of hydrogen peroxide.

The gauze packing should not be left in for longer than twenty-four hours. By this time the gauze has become foul and septic complications may ensue if it is not removed.

Cauterization for Epistaxis.—This small operation may have to be performed in cases where recurrent epistaxis becomes a nuisance. The anterior and lower part of the septum is inspected for a confluence of dilated blood-vessels



Fig. 537.—Galvano-cautery for epistaxis. A, B Varieties of cauterizing points.

from which hæmorrhage is known to have arisen. The area is covered with a swab soaked in 5 per cent cocaine, and in a few minutes is ready to be cauterized. The object of the cauterization is to destroy by burning a very small area of the mucous membrane of the septum which by cicatrization will enmesh and strangle the offending vessels. The cauterizing agent may be chemical (e.g. silver nitrate, trichloracetic acid, pure carbolic), or the galvano-cautery may be used. In the latter case a flat-tipped burner is employed (*Fig.* 537). The operator must be careful not to overheat the tip of the burner. A dull cherry-red heat is all that is required.

REMOVAL OF ADENOIDS

Although this operation nearly always follows the removal of the tonsils, it is sometimes performed independently. It should always be carried out under general anæsthesia. After the tonsil operation is completed and the throat is

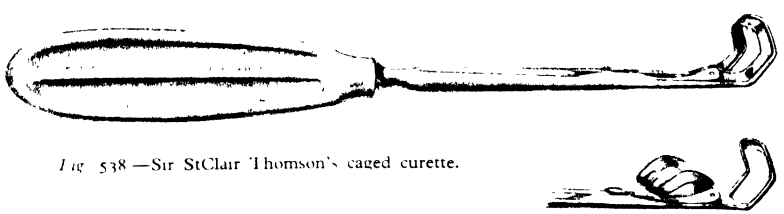


Fig. 538.—Sir StClair Thomson's caged curette.

dry (Chapter LIII) the surgeon—standing at the head of the patient—introduces his left forefinger beneath the soft palate in the middle line. With his right forefinger he explores the cavum pharyngis to note the details of growth of the adenoid tissue. He then passes the closed cage of an adenotome (*Fig.* 538) over the back of the left forefinger, so that there can be no danger

of injuring the soft palate. It is passed high up into the nasopharynx until the end is felt to be lying up against the posterior border of the septum. A firm sweeping movement is then carried out: at first slightly upwards and then round the cavum and down the posterior wall. *This movement should be strictly in the middle line* and should be carried on a little lower than appears necessary so as to avoid leaving a tag of adenoid tissue which is one of the most frequent sources of

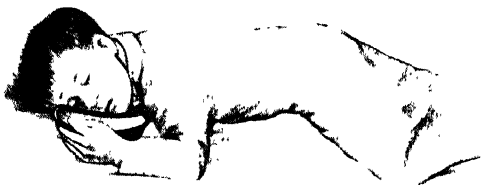


Fig. 539.—Position of patient after removal of adenoids.

post-operative bleeding. Hæmorrhage will be free at this stage, and the patient should immediately be turned over to the right side and the tongue drawn forward with a clip. The operator then clothes his right forefinger with a single layer of gauze and explores the nasopharynx for pieces of adenoid tissue which the curette may not have removed. These are often found in the small fossæ behind the Eustachian tubes. The face should then be sponged with ice-cold water, when the hæmorrhage will rapidly cease.

As soon as the patient is returned to his bed, he should be placed in the position shown in *Fig* 539.

CHAPTER LV

THE LARYNX

By CECIL P. MALLEY

URGENT TRACHEOTOMY

IN cases of dire necessity the operation has been undertaken successfully with a pen-knife; in such circumstances the addition of a hair-pin to act as a retractor may be considered a luxury. As a rule, the house surgeon will have access to a sterile set of instruments (*Fig.* 540).

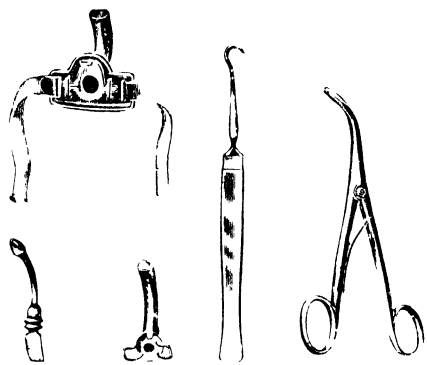


Fig. 540.—Instruments for tracheotomy (excluding hæmostats).

A child should be wrapped securely in a blanket. In all cases it is a tremendous asset to have the head held strictly in the middle line in an extended position. When a sandbag or a rolled-up towel is placed beneath the shoulders (*Fig.* 541) the larynx and trachea are thrown into prominence.

While an anæsthetic is not essential, it is desirable to infiltrate the skin and subcutaneous tissues with 1 per cent novocain. The larynx is steadied by the thumb and middle finger of the left hand. The right hand swiftly palpates the trachea, a scalpel is taken, and an incision is made from the thyroid notch to just above the top of the manubrium in the suprasternal recess. The incision is made strictly in the middle line and passes through all the superficial tissues (*Fig.* 542). Although there may be a good deal of bleeding, provided the operator keeps strictly to the middle line there is no danger. The index finger of the left hand is employed to identify the trachea, the rings of which can be felt readily. Again making sure that the exact middle line of the trachea is about to be entered, the trachea is incised longitudinally for half-an-inch, the scalpel being guarded from penetrating the posterior tracheal wall by being



Fig. 541.— position for tracheotomy.

held (preferably wrapped in gauze) half-an-inch from its tip. *The scalpel is not withdrawn.* With the scalpel still in the trachea the hands are changed and the scalpel, held by the left hand, is rotated so as to dilate the tracheal opening. The dilator is taken in the right hand, its beak is passed alongside the scalpel into the opening in the trachea and its jaws are opened; and the scalpel is then withdrawn. (Note that the action of the dilator is precisely opposite to that of all other hinged instruments, and do not become confused by this.) Holding the dilator in the left hand, the tracheotomy tube, with its pilot in place, is passed into the dilated tracheal incision; the dilator is then removed. The pilot is removed with the right hand while the left hand holds the wings of the cannula firmly against the neck. The ends of the tape, which has been passed behind the neck, are threaded through the slots and knotted at the correct tension (*Fig.* 543). It should be noted that up to this time no attempt has been made to secure hæmostasis, and it is astonishing how even alarming hæmorrhage abates as soon as the tracheotomy tube is in place and the dyspnœa is relieved. If the bleeding continues after the few skin stitches, which are necessary to close the incision about the tube, have been inserted, pressure deftly applied by packing gauze around the cannula will usually control it.

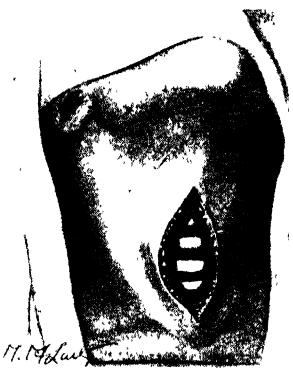


Fig. 542.—Incision for urgent tracheotomy.

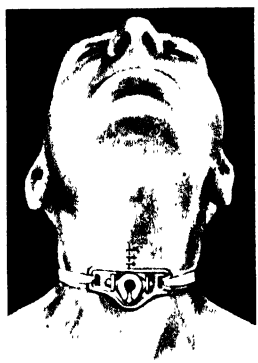


Fig. 543.—Tracheotomy tube in place. Stitches have been inserted to approximate the skin about the tube.

As a rule, as soon as the tracheotomy tube is in place, most of the anxieties of the case fade perceptibly. Should respiration fail, artificial respiration must be commenced immediately, with due regard to a clear airway via the cannula.

Once the operator is assured that the condition of the patient is satisfactory, a square piece of gauze is taken, and slit three-quarters of the way down the middle. This is inserted beneath the tapes and made to fit snugly beneath the wings of the cannula. The inner tube is passed into place, and instructions are given that it should be removed, sterilized, and reinserted as often as needed. A duplicate tracheotomy tube should always be at hand, and also oxygen and CO_2 in case the respiratory excursions become inadequate. Arrangements must be made for constant attention to the patient. Remember that a patient with a tracheotomy cannot call for help.

Post-operative Care.—A special nurse is desirable for the first day or two following the operation. The room should be well ventilated, free from dust, and the temperature of it about 70° F. For the first few days the head of the bed should be protected by a tent (*Fig.* 544), and when the air is dry a steam kettle may prove helpful.

Nursing Instructions.—Beside the bed there should be a trolley containing

duplicate cannulæ, retractors, a tracheal dilator, a fine rubber catheter with a well-fitting syringe attached, and dressings. Oxygen and CO_2 should be at hand to relieve acapnia, which sometimes occurs after the relief of long-standing laryngeal obstruction. If possible, the patient should be nursed sitting up, and the inner tracheotomy tube must be removed and cleansed with a pipe-cleaner before boiling as often as needed. The respiration of a patient with a properly fitting tracheotomy tube, which is kept free from obstruction by secretion, is inaudible. In order to remove secretion from the trachea the nurse must be shown how to pass a rubber catheter into the tube and apply suction. A most important duty of the nurse is to wipe away secretion quickly after a patient has coughed, before it is sucked in. The incision in the neck is covered by a piece of slit gauze, allowing it to fit under the wings of the tracheotomy tube in the manner described on p. 414; this should be changed as often as it is necessary.

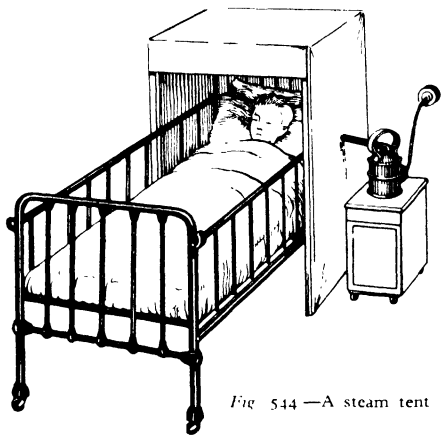


Fig. 544.—A steam tent

Removal of the cannula should not be attempted until the patient can sleep with the tube corked completely. First of all, half-corking is used as a method of trial.

EXAMINATION OF THE LARYNX

A complete examination of the larynx includes: (1) Inspection of the interior, either by direct or indirect method; (2) External palpation; and (3) Radiography

LARYNGOSCOPY

The direct method requires skill and patience, tact and gentleness. *The indirect method* is the easier, and is especially suitable for young children. One of its advantages is that structures can be palpated with a probe. It is necessary to employ some form of local anæsthesia in each of these procedures.

The Indirect Method.—For those not experienced in the use of a head mirror, a laryngeal mirror lighted from a battery within the handle (*Fig.* 545), and supplied by several firms, will be found serviceable (*Fig.* 546). In other circumstances a plain laryngeal mirror at least one inch in diameter is required, together with a reflected light and a spirit lamp. The source of light can be obtained from a standard lamp which is placed on the left side of the patient.

Anæsthetizing the Pharynx.—The patient is given two benzocaine tablets to suck, or the throat is sprayed with 10 per cent cocaine by means of a de Vilbiss No. 15, or similar, spray. When a spray is used the patient should hold out his tongue, grasping it with gauze while the spraying is in progress.

The Examination.—Dentures must be removed. The patient is seated in a chair with his feet firmly planted on the ground; he is instructed to lean slightly forward. The room is darkened. If possible, an assistant should steady the patient's head. The examiner sits facing the patient. The laryngeal mirror is warmed by the flame of the spirit lamp and after so warming it is tested on the

back of the hand. The patient is instructed to put out his tongue ; it is grasped by the examiner in a piece of gauze. The mirror is passed into the mouth until



Fig 545.—Self-illuminating laryngeal mirror



Fig 546.—Mirror laryngoscopy. Showing the relative positions of the examiner and the patient. Note the head is being steadied by an assistant

the back of it lies against the uvula. The mirror is then tilted forwards gradually by levering the handle and at the same time pushing the uvula and the soft palate backwards without touching the back wall of the pharynx. Thus the larynx comes into view. First the base of the tongue and the valleculæ, then the epiglottis, then the arytenoids and posterior

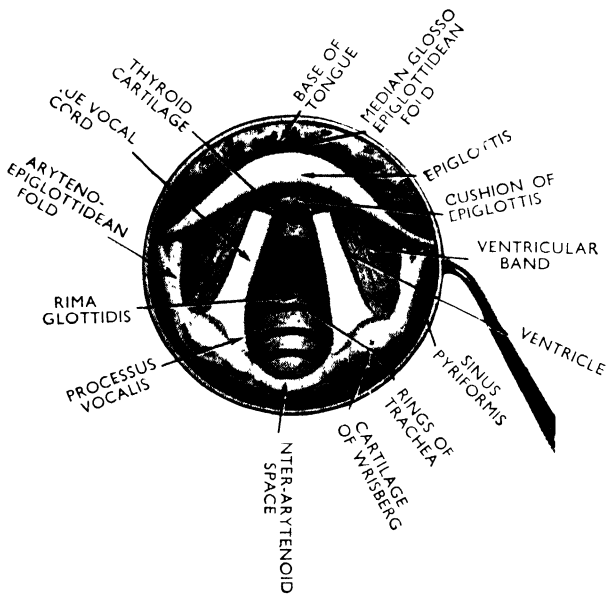


Fig. 547.—Indirect laryngoscopy. Enlargement of the laryngeal image during inspiration.

part of the larynx, and finally the anterior commissure where the vocal cords meet in front (*Fig.* 547). It is not always possible to view the entire interior of the larynx at once. Portions of it only may be seen in the mirror at one time and a composite picture will have to be formed with the mirror at different angles. The patient can aid in the examination by breathing quietly, and later he should say " Eeeeee " while breathing out. This procedure brings the vocal cords into apposition. Care must be taken not to pull the tongue out too far. Should the patient gag during the examination further spraying of the larynx may be necessary. The examination is not complete unless the anterior commissure and the interior of the ventricles are clearly visible.

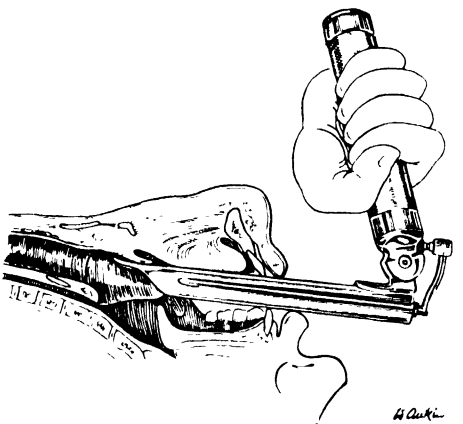


Fig. 548.—Direct laryngoscopy, Magill's instrument in use.

The Direct Method.—This is indicated in young children and in others where the indirect method has been unsuccessful; also for the removal of foreign bodies, biopsy, and for intubation for anæsthesia.

Except in the case of a child when a general anæsthetic is essential, local anæsthesia is the method of choice. The patient is instructed to suck benzocaine tablets; afterwards his throat is sprayed with 10 per cent cocaine. If difficulty is experienced in carrying out the examination with the local anæsthetic, the local anæsthesia should be supplemented by an intravenous anæsthetic, when as a rule sufficient relaxation can be obtained for a satisfactory view of the larynx.

A laryngoscope obtains its source of illumination from the battery within the handle of the instrument. Magill's laryngoscope (*Fig.* 548) has the advantages that (1) the blade can be detached and sterilized; (2) when the instrument is not in use it can be folded, and occupies a comparatively small space; (3) there is no danger of the light being left on.

Before the examination the patient should be told that it is necessary for him to relax and breathe easily.

Position.—The patient lies on the operating table; his head must project over the end of the table. An assistant sits on the right side and passes his right hand underneath the patient's neck so that the hand comes to rest on the left side of the patient's face. With his left hand the assistant supports the

occiput, and in order to do so, he will find it convenient to rest his own elbow on his knee (*Fig.* 549). He is thus enabled to control the head and keep it in any position desired by the examiner. A gauze swab covers the lower front teeth. The laryngoscope is held in the left hand. To prevent the tongue from interfering with the view, it is best to introduce the instrument at the right side of the mouth. As the posterior third of the tongue is reached, the tip of the instrument is turned towards the middle line, and this brings the epiglottis into view. The back of the instrument is then gently passed under



Fig. 549.—Method of holding the pa

the epiglottis, which is lifted forwards by tilting the laryngoscope, and after advancing the instrument 1 cm. the glottis comes into view. It is at this stage that the patient may hold his breath and gag. If this is the case, a small swab soaked in 10 per cent cocaine can be applied to the area by means of a pair of alligator forceps. After a few moments relaxation should occur, when the vocal cords will be seen. Suction to remove excessive secretion or, failing that, swabs on a holder are nearly always necessary at this stage of the examination. At all times direct laryngoscopy calls for patience and great gentleness. Particular care should be taken not to use the upper teeth as a levering point, and not to injure the epiglottis or posterior pharyngeal wall with the beak of the instrument.

CHAPTER LVI

THE EAR

By R. Scott Stevenson

EXAMINATION

The prelude to instrumental examination should be inspection of the auricle, and, after the pinna has been turned forward, inspection and palpation of the mastoid region.

The Use of the Otoscope.—For those who have not had the advantage of holding an appointment in an ear, nose, and throat department, the electric otoscope (*Fig.* 550) will be found more generally helpful than the head mirror and naked speculum. The electric otoscope is simple to use. The largest speculum which will enter the meatus comfortably is selected and connected to the otoscope; the light is then switched on. The auricle is pulled backwards to straighten the natural curve of the meatus and the instrument is inserted gently, remembering that the meatus is sensitive. The speculum is introduced for only about half an inch and no force is used. The view of the drumhead may be obstructed by wax, debris, or pus; if this is the case preliminary syringing and gentle mopping with cotton-wool is essential.

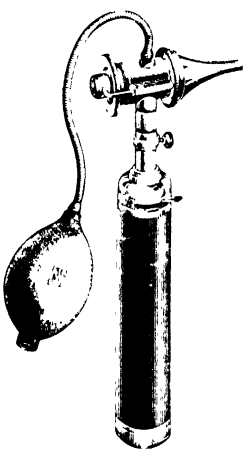


Fig. 550.—An electric

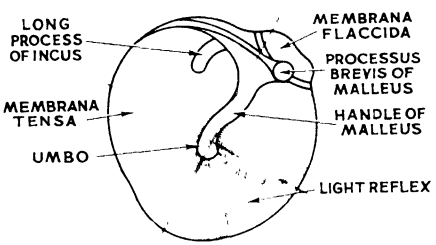


Fig. 551.—Diagram of the right tympanic membrane as viewed through the electric otoscope

It is easy to mistake the upper and inner part of the meatus for the drumhead, but the pearly-grey colour of the membrane is characteristic. The chief landmark of the drum is the handle of the malleus, which resembles the hands of a clock at five minutes past one (in the right ear, *Fig.* 551) and five minutes to eleven (in the left ear), though its lower extremity is rather lower than the middle of the drumhead. From the lower tip a definite cone of light passes downwards and forwards to the circumference of the membrane. In many cases it is the short process of the malleus that is the most prominent point, owing to the inward slope of the drumhead. Sometimes the membrane is indrawn and the

appearance of the malleus exaggerated, or the membrane may be scarred, or white calcareous patches present in it. When the membrane is reddened and swollen, or if a perforation or granulations are present, careful note must be made of these facts. When it is doubtful whether a small perforation is present, the membrane may be moved to and fro by the aid of the rubber bulb attached to the otoscope; the speculum must fit closely into the meatus, the large lens fitted and the rubber ball alternately compressed and released, so that the air in the external meatus is similarly alternately condensed and rarefied. Normally the membrane will be seen to move to and fro, but when a perforation is present there will be no such movement. While examining the drumhead do not forget to look at its uppermost part, i.e., above the handle of the malleus. Here is Shrapnell's membrane (membrana flaccida). There may be a small perforation in this membrane denoting attic suppuration whereas the main part of the drumhead is normal. Sometimes the patient's head has to be tilted in order to see Shrapnell's membrane properly.

SYRINGING THE EAR

Cerumen is recognized as a brown, black, or grey mass blocking the ear passage. Forcible syringing must never be employed. If the wax is hard and there is any difficulty in removing it, it is wiser to delay a day or two to instil morning and evening five to ten drops of liquid paraffin or a similar amount of the following prescription :—

℞	Sod. Bicarb.	gr. 15
	Glycerini	m. 120
	Aq. Dest.	ad m. 240 (half an ounce)

The patient should be seated. A towel or mackintosh is fastened round his neck, a kidney dish held to the ear by the patient, with its edge under the lobule, and the auricle is pulled back by the left hand to straighten the meatus (*Fig.* 552). The best solution is one of bicarbonate of soda at 100° F., two tablespoonfuls (1 oz.) to a pint. With ordinary care the usual metal ear syringe will never cause harm. After the syringe has been filled with lotion it is pointed upwards and any air in it is expelled. The right hand only is employed in holding the syringe and the nozzle points just within the meatus, directed towards the roof or the floor. On no account must it be inserted deeply into the meatus or pointed towards the drumhead. After the wax has been expelled, the meatus is mopped dry with pledgets of cotton-wool and the ear is again inspected with the otoscope. The drumhead is moved to and fro by means of the attached rubber ball, which as a rule soon removes any sensation of discomfort and stuffiness in the ear.



Fig. 552.—Method of syringing the ear

EXTERNAL OTITIS

External otitis is often associated with eczema of the pinna, or of the skin behind the ear, or of the scalp. One must first ascertain whether the infection

is confined to the external auditory meatus, or whether there is middle-ear suppuration also. In external otitis the patient is not usually deaf.

Treatment.—It is important not to use irritating antiseptics such as hydrogen peroxide or glycerin and phenol. First of all the debris in the external meatus should be removed by syringing. When the meatus is clear, the drumhead is examined to ascertain whether there is a perforation of the tympanic membrane. Squeezing the rubber bulb attached to the otoscope may cause pus to exude from a small perforation. When there is middle-ear suppuration the external otitis will probably abate when this underlying cause has been removed. When there is no such underlying cause, local treatment is carried out by packing the meatus once daily with a wick of ribbon gauze wrung out of 10 per cent ichthammol (ichthyol) in glycerin, or painting the meatus right down to the drumhead with 2 per cent watery solution of gentian violet; when the inflammation is subsiding a wick soaked in 8 per cent aluminium acetate in water will help; and when it has quite subsided boric and spirit drops will help to harden the skin and prevent recurrence. If none of these is available (as may sometimes happen in the Services) the gauze wick may be wrung out of ung. hydrarg. nit. dil. or oxid. flav. and when inflammation has subsided boric powder may be blown into the meatus, after mopping out all debris. The patient should be warned that on no account is he to touch his ear with anything except his elbow!

FURUNCULOSIS

The differential diagnosis between furunculosis of the external auditory meatus and mastoiditis is sometimes difficult, and unless the clinician feels assured that he is dealing with a boil, a second opinion should be sought. Treatment in most cases is conservative. A strip of ½-in. gauze soaked in a saturated solution of magnesium sulphate in glycerin is inserted into the meatus, beyond the boil. This should be changed daily. After three days this dressing is inclined to make the skin sore and a similar wick soaked in 10 per cent ichthyol in glycerin should be substituted, or this can be used from the beginning. For the pain heat is comforting, but it should be dry—a hot-water bottle is efficient; if it is available, short-wave diathermy is a useful method of applying heat. Under this régime the boil usually bursts into the meatus. In order to prevent recurrence, treatment should continue after the boil has burst. During the final stages, in order to harden the skin, the wick is wrung out of surgical spirit.

Exostosis may be confused with a boil in the ear. When examined with the otoscope an exostosis appears as a yellowish-white excrescence, standing out from the deeper part of the external meatus, usually where the bony and cartilaginous parts meet. Exostoses are often multiple, and the diagnosis is confirmed by touching them with a probe, when the characteristic hardness is noticed. Unless an exostosis is causing serious blockage to the ear passage, it should be left alone.

TRAUMATIC RUPTURE OF THE DRUMHEAD

There is no doubt that the ears are protected from the effect of explosions by wearing ear-plugs; but no type of plug is any better than cotton-wool moistened with vaseline or (in an emergency) soap. Recent traumatic rupture of the drum must not have any active treatment, and any syringing, lavage, or instillation of drops must be forbidden, as such treatment interferes with the sealing of a perforation by blood-clot, which should not be disturbed but allowed to dry; all the treatment necessary is a piece of cotton-wool in the meatus. A ruptured drumhead soon heals, and after a week the dried clot may be removed

by forceps or a cotton-wool mop. If suppuration ensues this must be treated as described on p. 423. Hæmorrhage from the ear, after an explosion, may sometimes be due to bleeding from granulations or from the surface of the tympanum exposed through an old perforation; a careful examination by the otoscope must always be made in every case of head injury or exposure to explosion. In the Services many cases of deafness or bleeding from the ear are attributed to explosions or gun-fire, quite genuinely, when an old chronic otitis of one type or another is actually present.

Labyrinthine Concussion may be the cause of deafness after an explosion without any rupture of the drumhead. It is usually accompanied by high-pitched tinnitus and sometimes giddiness, but gradually improves with time unless there is some actual labyrinthine lesion, the detection of which requires an experienced otologist; sometimes a slight degree of labyrinthine concussion may be the basis of progressive deafness later on.

Aero-otitis is usually deafness of a middle-ear type, brought about by blocking of the Eustachian tubes by rapid changes in altitude when an airman has neglected to keep the tubes open by forced ventilation in swallowing or using Valsalva's method; but sometimes the deafness is labyrinthine, due to pressure effects on the cochlea.

ACUTE OTITIS MEDIA

On examining the ear with the otoscope, the drumhead in the early stages is seen to be congested; later it becomes purplish-red and bulges. The introduction of the sulphonamide drugs has changed the outlook in such cases. Nearly all cases are caused by the streptococcus or the pneumococcus, so treatment with sulphapyridine (M & B 693) should be instituted as soon as a diagnosis is made; there is no particular advantage in preferring sulphanilamide, as it is but little less toxic and has no effect on the pneumococcus. The usual initial dose for an adult is 2 g. (4 tablets), followed in four hours by a further 2 g., and thereafter 1 g. (2 tablets) every four hours until the temperature has been normal for 24 hours. During this period the patient must be in bed and under supervision, as the drug is a potent one and complications, slight or severe, from its use are not uncommon. Many cases of acute otitis media abort under this treatment, but not all, and paracentesis is by no means obsolete. If the patient has had a bad night I am disinclined to let him have another bad night and prefer to incise the drum, but whether this really ever "prevents a mastoid operation" is debatable. In some cases treated by sulphapyridine the middle ear is still full of pus and the drum bulging, though pain has disappeared and the temperature has fallen to normal; in such cases paracentesis should be done for purposes of drainage. Even an acute mastoiditis under sulphapyridine treatment—so that signs and symptoms of the inflammation have disappeared and the temperature and pulse-rate fallen to normal—may require operation two or three weeks later which will reveal the mastoid cells broken down and full of pus.

Paracentesis is a bad term, for the drumhead is not punctured but incised. The operation can be carried out by any doctor accustomed to the electric otoscope. The glass end of the instrument is removed so that the paracentesis knife can be passed down the speculum. The type of knife shown in *Fig.* 553 will be found efficient. A general anæsthetic is desirable, preferably nitrous oxide or evipan; in children, however, a few drops of 20 per cent cocaine, warmed and instilled into the ear, can be employed as a local anæsthetic. It is true that cocaine solutions will not produce perfect anæsthesia in this instance, but they dull the drumhead sufficiently to carry out the operation with only momentary pain.

Technique.—The external meatus is mopped out with 2 per cent picric acid or surgical spirit. The largest size of speculum which will fit the external meatus is placed in the otoscope and the drumhead examined carefully. Maintaining a good view of the drum, an incision is made just behind the handle of the malleus, through the tympanic membrane right down to the floor of the meatus (*Fig.* 554). The field becomes obscured by blood and pus; this is mopped out.

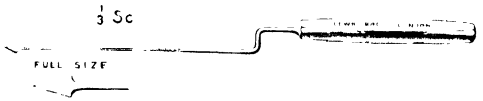


Fig. 553.—Fagge's myringotome

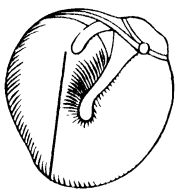


Fig. 554.—Showing site of incision through the tympanic membrane (paracentesis tympani)

When the bleeding has abated, pus in the middle ear is sucked out with the aid of the rubber bulb attached to the otoscope. The external meatus is mopped dry and a strip of gauze placed in it. For the next few days 2½ per cent carbolic acid in glycerin should be instilled into the ear night and morning.

OTITIS MEDIA IN INFANTS

Post-mortem examination in infants dead from obscure conditions shows a high percentage of middle-ear suppuration, which was not suspected during life. It is evident that when the diagnosis is obscure, examination of an infant should not be considered complete without an examination of the drumhead. When symptoms of meningeal irritation are present, even if no acute inflammation of the middle ear can be diagnosed, it is often desirable to carry out paracentesis, and it has been found that this gives relief to meningeal symptoms. It is far wiser to do such a paracentesis early than to wait for definite ear symptoms to develop.

CHRONIC SUPPURATIVE OTITIS MEDIA

A discharging ear should be cleansed. The first step is to ascertain whether the discharge is coming from the middle ear or whether the condition is due to an external otitis.

When the external meatus has been mopped clear the drumhead is examined, and in cases of chronic otitis media the perforation will usually be seen. Perforations may be large or small, marginal or central, and sometimes granulations or a polypus may be present. If the perforation is a large one and drainage is adequate, the condition is not usually difficult to cure with efficient treatment; it is when the perforation is small, particularly if it is high up (attic perforation) or marginal, that conservative treatment, however thorough, may prove ineffective. A polypus should always be removed before commencing local treatment; it is better to do this under nitrous oxide, but 20 per cent cocaine or Bonain's solution, applied as near the root of the polypus as possible, is often adequate.

Removal of a Polypus.—A snare is employed. It must be emphasized that the snare is used to cut through the base of the polypus; it must never be used to pull a polypus out by its root. The attached polypus having been removed, any granulations should be touched with silver nitrate.

Discharging Ear: Routine Conservative Treatment.—The popular treatment of middle-ear suppuration by hydrogen peroxide drops should not be employed. If the skin of the external meatus is excoriated from irritation of the discharge, 2½ per cent carbolic acid in glycerin drops are employed for a

day or two; otherwise I have found the most effective treatment to be daily mopping out of the discharge and blowing in iodine and boric powder. The first time this method is employed the external meatus is cleansed right down to the perforation in the drumhead. With the aid of a Eustachian catheter the middle ear is inflated, blowing the discharge still in the tympanic cavity out through the perforation; this discharge is also mopped out. The iodine and boric powder is blown into the middle ear by means of a simple powder blower (*Fig.* 555) and the patient is instructed to mop out the ear each day and continue to blow in the powder once daily. The patient should be seen at least once a week, to check that the treatment is being carried out effectively. If the nose and throat are healthy, this method of treatment conscientiously carried out will cure in a comparatively short time many cases of chronic middle-ear suppuration of even several years' duration. If a cure is not effected in several weeks of this treatment, a mastoid operation is usually indicated. The following is the prescription for the iodine and boric powder:—

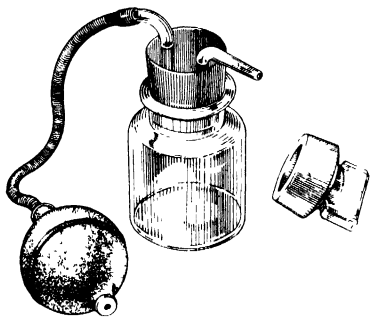


Fig. 555.—All-glass powder blower for use in chronic suppurative otitis media. The bottle is kept stoppered when not in use. (*Made by Down Bros.*)

℞ Iodi Resublimati gr. 4
Pulv. Acid. Boric. gr. 480 (one ounce)

Rub down the iodine crystals with a few drops of spirit. vini rect. until solution is effected, and gradually incorporate the finely powdered boric acid. The powder should be used freshly prepared and kept in a stoppered bottle to prevent volatilization of the iodine.

DEAFNESS

Deafness may be due to impacted wax, to obstruction of the middle ear by catarrh, inflammation, or suppuration, to otosclerosis, or to nerve deafness affecting either the cochlea or the acoustic nerve, or sometimes to hysteria—more frequent than true malingering. The first step in the examination is to exclude the presence of wax. If not due to wax, the drumhead is examined, noting if it is indrawn, scarred, or has a perforation.

Hearing Tests.—If the drumhead is intact, the patient's hearing is tested by the voice and the tuning-fork. Both ears are tested with the ordinary conversational voice and with a whisper. A normal person should be able to hear a whisper at twenty feet. A doctor who is not an otologist need use only C 256 tuning-fork (middle C of the piano). After knocking the tuning-fork on his own patella, the clinician first holds it one inch from the external meatus, then in a couple of seconds he places the base of the tuning-fork on the mastoid process. If the patient hears the first (air conduction) better than the second (bone conduction) Rinne's test is said to be positive. This is normal. When bone conduction is better than air conduction, Rinne's test is negative. If bone conduction is appreciably better than air conduction, some form of middle-ear deafness is present. When the patient is a young woman and the drumheads appear to be normal, deafness is likely to be due to otosclerosis. If deafness improves after inflation of the middle ear, it is very unlikely that the deafness is due to otosclerosis;

the case is probably one of catarrhal deafness. Inflation of the middle ear is a method of diagnosis as well as treatment, and is carried out by Politzer's method or by Eustachian catheterization.

Politzerization (*Fig.* 556).—Lennox Browne's modification of Politzer's bag (*Fig.* 556, A) has a long rubber tube attached, and consequently is much easier to use than the original model. One end of the auscultation tube (*Fig.* 556, B) is placed in the patient's ear and held there by him; the examiner places the other end in his own ear. A rubber nozzle connected to the Politzer bag is

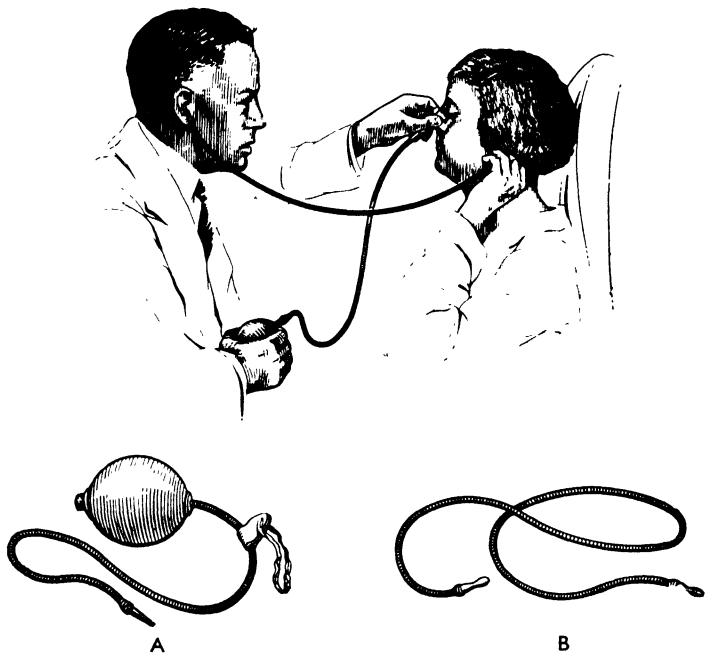


Fig. 556.—Politzerization. A, Lennox Browne's modification of Politzer's bag, B, Auscultation tube.

inserted into the patient's nostril on the side which is being examined and held in position by the examiner's forefinger and thumb, which at the same time close the other nostril. The patient is instructed to blow out his cheek as if he were going to blow a trumpet; as he does so, the examiner firmly and suddenly compresses the rubber bag. When inflation is carried out successfully, air enters the Eustachian tube and the middle ear, and a characteristic blowing sound is heard; sometimes the sound is crackling or bubbling, due to a catarrhal condition of the Eustachian tube or middle ear.

Eustachian Catheterization.—This is a more exact method than the foregoing. To pass a Eustachian catheter successfully requires practice. The patient's nostrils are swabbed or sprayed with a little 5 per cent cocaine solution. After waiting several minutes, a nasal speculum is inserted with the headlight directed into the nostril (*Fig.* 557). The Eustachian catheter is held with its beak turned downwards and its ringed end between the thumb and the first

finger. It must be remembered that the floor of the nasal passage is horizontal. The tip of the catheter is pushed along the floor until it begins to glide downwards towards the soft palate. It is then rotated outwards so that the beak touches under the posterior end of the inferior turbinal until the ring at the outer end

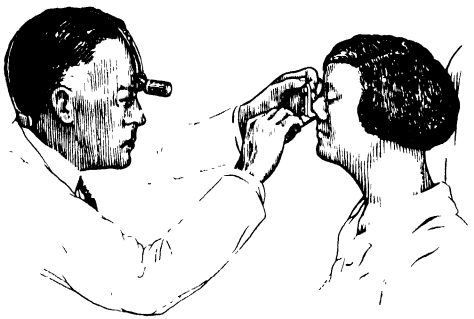


Fig 557.—Passing a Eustachian catheter

points towards the eye on the side which is being catheterized. In ordinary circumstances the tip of the catheter should now be within the opening of the Eustachian tube (*Fig.* 558), but sometimes two or three attempts have to be made before the tip engages the opening. When the catheter is in position it should be held in the examiner's left hand and not moved until the inflation has been carried out. The vulcanite connexion is fixed into the end of the catheter and the bag is compressed gently. When inflation has been carried out successfully, by means of the auscultation tube, air can be heard entering the middle ear. If the characteristic blowing sound is not heard, the Eustachian catheter should be moved slightly forwards or backwards and the process repeated. When inflation is not successful after two or three attempts, the Eustachian catheter should be withdrawn and the procedure started afresh.

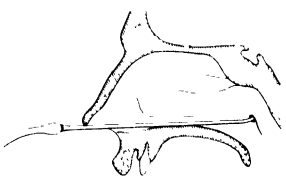


Fig 558.—Eustachian catheter in position and connected to the inflation apparatus

Deafness due to acute catarrh or inflammation should never be treated by inflation. Deafness resulting from recent catarrh which has subsided will usually clear up after several treatments by one of these inflation methods.

Vertigo, or giddiness, may often be due to aural causes and is not necessarily a sign of Ménière's disease; it may be caused by impacted cerumen, a blocked Eustachian tube, healed middle-ear suppuration or otosclerosis, chronic middle-ear suppuration causing labyrinthine irritation, as well as diseases of the nervous system. It is a symptom demanding careful examination of both ears.

FOREIGN BODIES

Most foreign bodies can be removed from the ear by syringing. When this is not the case and the patient is a child, a general anæsthetic is indicated. Care and gentleness are essential. A small blunt hook or a probe with a large eye will usually be more useful than forceps. The end of the hook is insinuated between the foreign body and the meatal wall, turned, and withdrawn, bringing

the object with it. Especially when it has become deeply impacted, it may be necessary to remove the foreign body by an incision akin to a mastoid incision through the cartilaginous meatus behind the ear. When an incision has to be made it is best to admit the patient to the ward.

HÆMATOMA OF THE AURICLE

If seen early the blood may be aspirated. It is best to evacuate the blood through a small incision. A troublesome complication is the supervention of infection. If perichondritis and suppuration have resulted, free incision right through the auricle should be carried out.

THE AFTER-TREATMENT OF MASTOID OPERATIONS

There is rarely much pain after the simple mastoid operation; the patient is usually quite ready for breakfast the morning after the operation. On that day the outer dressing, which is probably soaked with blood, should be changed without interfering with the layer of gauze next to the skin. Unless there is a rise of temperature, the inner layer need not be changed until the fourth day. When there is a rise in temperature, all dressings should be removed and one or two stitches taken out from the lower part of the wound. Some aural surgeons leave the posterior wound open and continue to pack it for two or three weeks; others put in a rubber tube from the mastoid antrum to the lower end of the wound, stitching the skin incision for three-quarters of its length. My own practice is to swab out the mastoid cavity with bipp and place a $\frac{1}{2}$-in. strip of gauze, moistened with the paste, leading from the mastoid antrum out of the lower end of the wound, and stitch up the remainder of the skin. I am prepared to remove the drain and some of the stitches before the fourth day if the patient's condition appears to demand this. Otherwise the less after-treatment the mastoid area receives the better. Usually the whole dressing is removed for the first time on the fourth day and then a dry dressing is applied, which is left on until the sixth or seventh day, when the remaining stitches are removed. A gauze wick dipped in bipp is packed into the external meatus at the time of operation and renewed when the dressing is changed; this prevents its collapsing and narrowing.

Similarly with the radical mastoid operation, after-treatment should be reduced to a minimum. A wide-bore rubber tube is placed in the enlarged external meatus at the time of the operation. This is left untouched until the fourth day. On that day the bipped gauze drain at the lower end of the posterior wound is removed and also a bipped gauze drain which has been placed in the rubber tube in the external meatus. The rubber tube is turned so as to prevent its sticking to the skin, and a little iodine and boric powder blown into the cavity. On the sixth or seventh day the dressings and the stitches are removed from the posterior wound and the rubber tube is shortened by a quarter of an inch. It is removed altogether about the tenth day, when iodine and boric powder is again insufflated. Keeping a wide-bore rubber tube in until the tenth day prevents contraction of the external meatus, which is otherwise likely to follow the cutting of a meatal flap in the radical operation. Thereafter the cavity is inspected daily, any granulations are touched with silver nitrate, and iodine and boric powder insufflated freely. The patient should be fit to leave hospital by the end of three weeks. Cerumen and debris are apt to collect in the healed cavity later on; there need never be any hesitation in removing this with forceps or ring probe.

CHAPTER LVII

THE EYE

By F. A. WILLIAMSON-NOBLE

THE house surgeon's duties fall into two categories: (*a*) those in the out-patient department; (*b*) those in the wards.

This chapter is written for the house surgeon who is in charge of ophthalmic cases in a general hospital, rather than the house surgeon at a special eye hospital.

A. IN THE OUT-PATIENT DEPARTMENT

1. EYELIDS

The lashes, if misplaced and pointing inwards (*trichiasis*), may rub against the cornea and cause much discomfort. They can be permanently removed by electrolysis or more satisfactorily by diathermy. A fine needle is used as the active electrode and a current of 150 ma. is passed for 1–2 seconds after infiltration of the lid with novocain. If the lash resists gentle traction with forceps the coagulation should be repeated. Temporary removal is effected by flat-pointed epilation forceps (*Fig.* 559), a constant gentle pull bringing the lashes away with little pain. Removal of a lash from the centre of a stye (hordeolum) may aid materially in its resolution.



Fig. 595.—Epilation forceps for removal of lashes.



Fig. 560.—Skin and muscle operation, the fold of skin included in the grasp of the T-shaped forceps is being cut off with scissors. The forceps are rather smaller than those usually employed.

Entropion.—In the aged it is not uncommon for spasm of the orbicularis to occur with resulting inversion of the lower lid, which turns the lashes in so that they irritate the conjunctiva and cornea. Such a condition is a frequent cause of intractable uni-ocular conjunctivitis, and is easily dealt with by the following simple "*skin and muscle operation*" (*Fig.* 560).

After cleaning the skin of the lids with spirit or tincture of iodine, infiltrate along the whole length of the lower lid with 4 per cent novocain. Apply a T-forceps (*Fig.* 561) to the skin of the lid, so that the upper arm is parallel with the margin and distant about 1 mm. from the line of the lashes. The amount of skin included between the blades of the forceps has to be rather carefully estimated, so as to be sufficient to correct the defect—it is usually a strip about 6 mm. wide. This is then cut off with a straight pair of scissors, leaving a raw area in which lies the orbicularis, whose exposed portion is grasped with fixation

forceps (*Fig.* 562) and cut away with scissors. Hæmorrhage is easily controlled by swabbing and catching the bleeding points with Spencer Wells' forceps, twisting the latter off. The margins of the wound are united by three or four interrupted silk sutures, taking care to pass them deeply enough to include the

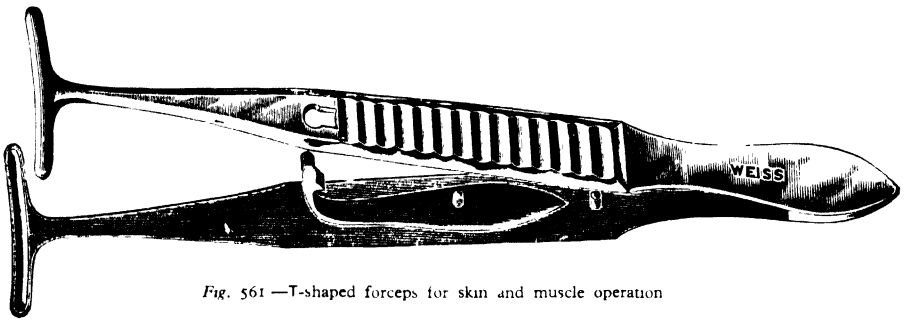


Fig. 561.—T-shaped forceps for skin and muscle operation

muscle. No dressing is needed, but the line of the incision is painted with tincture of iodine, a process which should be repeated daily until the stitches are removed on the sixth or seventh day. An immediate over-correction is not uncommon, but this usually remedies itself in the ensuing few weeks.

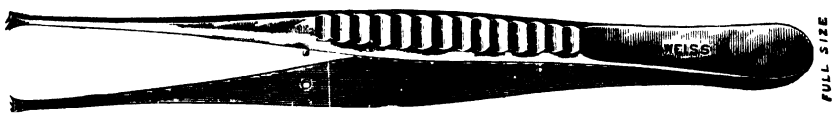


Fig. 562.—Fixation forceps, used for grasping the orbicularis fibres in the skin and muscle operation. Also used for grasping the conjunctiva of the eyeball in intra-ocular operations.

Eversion of the Lids.—Examination of the lower conjunctival fornix is simple. The patient looks up, the lower lid is pulled downwards, and gentle pressure backwards will then reveal it in its whole extent. To get a similarly good view of the upper fornix requires the knowledge of a little manœuvre very readily acquired and yet very frequently bungled. The method I adopt requires the use of



Fig. 563.—Application of silver nitrate solution to the conjunctiva of everted upper lid (*see* text).

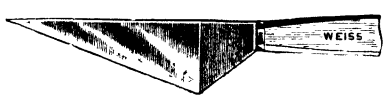


Fig. 564.—Beer's knife.

only one hand, leaving the other free for any purpose such as painting the lids. First of all persuade the patient to look steadily downwards at the floor or at his own hands, with the head thrown slightly backwards; then place the ulnar border of the index finger on the upper lid immediately above the margin of the tarsal plate; the thumb is placed on the lower lid, pressing gently backwards. The index finger then gently presses the margin of

the eyelid down on to the thumb, and by a slight movement the thumb completes the eversion. Straight pressure backwards on the eyeball will then bring the folds of the upper fornix into view. Standing in front of the patient, use the right hand for the left eye, and vice versa.

Foreign bodies can usually be removed from the conjunctival surface of the lids by wiping them off with cotton-wool, moistened in boracic lotion and wound round the end of a glass rod. The conjunctiva can also be painted with silver nitrate solution (1–2 per cent) by using cotton-wool round a glass rod, after eversion of the lids (*Fig.* 563).

Conjunctival concretions are often the source of ocular discomfort and may act as foreign bodies. To remove them, the eye should be cocainized —instill 3 drops of 5 per cent cocaine hydrochloride solution at five-minute intervals—and then the lids everted. The concretions are readily visible as small yellowish-white areas, and are readily picked out by the point of a Beer's knife (*Fig.* 564).

Expression of the Meibomian Glands.—This may often give relief in cases of chronic conjunctivitis and blepharitis, particularly when associated with thickening of the lids. After cocainization (*see above*), the lid is everted and pressure is made with a glass rod on its conjunctival surface, against the finger or thumb-nail held in contact with the skin surface of the lid. In this way, the contents of the Meibomian glands may be squeezed out and a mixture of fluid and sebaceous secretions accumulates at the gland orifice on the lid margin. The procedure should be continued until no more secretion can be expressed, and is usually carried out on both upper and lower lids. An alkaline lotion (as below) is employed afterwards for bathing the lid margins night and morning, and an ointment of resorcin, 1 per cent, is applied to the lid margins at night.

℞	Sodii Bicarb.	gr. 8
	Liq. Carb. Det. (Wright)	m. 6
	Aq.	ad fl. oz. 1

Mix with an equal volume of warm water before use.

Meibomian Cysts (Tarsal Cyst, Chalazion).—When this affection occurs in the upper lid, the patient may complain of blurred vision owing to distortion of the cornea produced by pressure of the cyst on it, which results in a temporary astigmatism, sometimes amounting to as much as 3 D. In the early stages, when the lid is swollen and inflamed, surgical interference is inadvisable owing to the danger of spreading the infection, and at this stage much relief can be obtained by hot bathing, which can be carried out by the patient as follows: wind some cotton-wool round the bowl of a wooden spoon and dip it into a bowl of hot lotion, e.g., 60 gr. of boric acid in 1 pint of hot water. Hold the wool up against the closed eyelids, having it as hot as can be comfortably tolerated. As soon as it cools, dip the wool again, and continue the treatment for 10 to 15 minutes. Care should be taken to keep the lotion hot during this period, and it may be necessary to warm it up once or twice. When finished, a little yellow oxide ointment (Ung. Hyd. Ox. Flav., 1 per cent) should be rubbed gently into the lid, and a pad applied for an hour or so. Internal administration of some anti-staphylococcal reagent, e.g., stannoxyl, 2 tablets, four times daily, or albucid (sulphacetamide), 2 tablets, three times daily, is useful in aiding resolution. As a result of these measures, or sometimes without any treatment at all, the cyst may disappear. Should it remain, however, it should be dealt with as follows:

evert the lid and apply one or two crystals of solid cocaine over the conjunctival surface of the swelling. Leave it to act for two minutes, then with a fine-needled hypodermic syringe inject *into the cyst* about 5 minims of 2 per cent cocaine in 1–1000 adrenaline. Let this again act for two minutes. With a Beer's knife (*Fig.* 564) make a vertical incision through the wall of the conjunctiva (*Fig.* 565), and then thoroughly scrape away with a small curette all the gelatinous and diseased tissue from the walls of the cyst. It is best to apply a pad and bandage for a few hours, and to have the eye bathed frequently with boric lotion for some days. It sometimes happens in old cysts that most or all of the contents are fibrous and cannot be removed by curetting. In such cases, a fine-toothed pair of forceps should be introduced into the wound and made to grasp the small mass of tissue at the bottom of it. It is then possible to remove this with scissors and a Beer's knife.

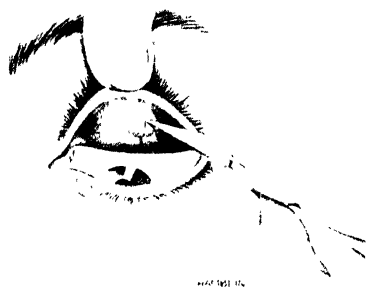


Fig. 565.—Incision of Meibomian cyst (chalazion) of upper lid. The lid has been everted and the cyst is being opened by a vertical incision with a Beer's knife

Should the cyst involve several glands, it is better to make an incision through the conjunctiva parallel with the lid margin and about 4 mm. distant from it, over the affected area. The edges of the conjunctiva are dissected up and the underlying mass of degenerate tarsal cartilage and glands grasped in the forceps and dissected out in a sausage-shaped mass. The edges of the conjunctiva can be brought together by a continuous suture, which can be left untied so as to avoid the irritation caused by knots. This is a procedure which requires previous infiltration of the lid from the skin surface with novocain and adrenaline.

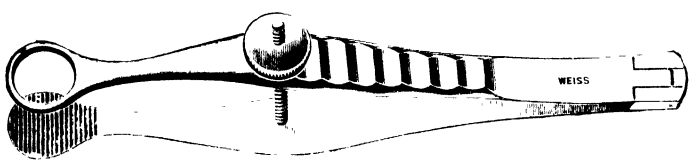


Fig. 566.—Blepharostat, used for grasping the lid and controlling hæmorrhage

Hæmorrhage is usually slight, but should it be troublesome, a blepharostat (*Fig.* 566) may be applied to the lid. This is also a useful instrument when the cyst is near either end of the lid and difficult to expose by eversion.

Stye (Hordeolum).—Cases of orbital cellulitis have been reported from time to time as following the injudicious or too early opening of one of these small abscesses. It is therefore advisable, in the early stages, to limit surgical procedures to removal of the infected lash from the swelling and to order hot bathing (p. 430), and perhaps some antistaphylococcal treatment (p. 430). The abscess usually ruptures of its own accord, but if not, and it is definitely pointing, a small prick with a sterile Beer's knife, will allow the contents to escape, especially if followed by hot bathing.

Wounds of the Eyelid usually heal readily after cleaning and the insertion of fine silkworm-gut stitches. If the lid margin is involved, very careful

co-aptation of the wound is needed or an unsightly gap will remain, with perhaps one or two ingrowing lashes. Such cases are best left to the visiting surgeon, but if this is not possible, an effort should be made to unite the edges of the wound by means of a stitch passed as shown in *Fig.* 567.

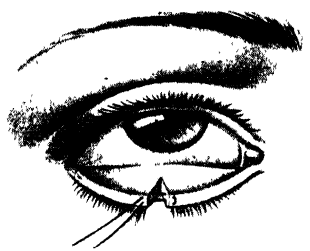


Fig. 567.—Method of passing a stitch to secure accurate co-aptation of a wound involving the lid margin.

Tarsorrhaphy is an operation which is required in cases of **neuroparalytic keratitis** —a degenerative change of the cornea which is liable to occur when the eye is anæsthetic. The condition is most commonly seen following alcohol injection of the Gasserian ganglion for trigeminal neuralgia, or as a sequel of herpes zoster, involving the ophthalmic division of the fifth nerve, though there are other causes. The operation is sometimes done in cases of exposure keratitis, to protect the cornea when the lids do not cover it, e.g., pronounced exophthalmos. It is performed as follows: if the skin of the lids is sensitive, infiltrate them with novocain; if insensitive, no injection is needed. Evert the lower lid, and with a pair of squint scissors curved on the flat, cut off the posterior sharp margin of the lid (*Fig.* 568) for the middle two-thirds of its extent. Evert the upper lid and treat it similarly. Unite the lids by three double armed No. 1 silk sutures passed from their conjunctival surfaces forwards so as to co-apt the raw areas, and tie fairly firmly. A dressing is applied, which can be changed daily. The stitches are removed at the end of a week, by which time a firm adhesion will have formed. This is usually left for three months. At the end of this time, divide about 1 mm. of the adhesion on the nasal side, repeating the process each month until only a narrow band 2 mm. wide is left uniting the lids on a line overlying the temporal margin of the cornea. If the eye regains sensation, this band may also be divided; if not, it is wise to leave it, or the keratitis will recur.



Fig. 568.—Tarsorrhaphy, the lower lid is everted and its posterior sharp edge is being cut off with scissors.

An alternative to tarsorrhaphy is the use of a contact lens, the fitting of which requires considerable skill and experience.

Inflammation of the Lid Margins (Blepharitis) is primarily an infection of the lash follicles and of the sebaceous and sweat glands leading into them. For effective local treatment it is essential to remove the crusts of exudate and epithelial debris which cover them. This is best done by swabbing the lid margins with an alkaline lotion (p. 430), picking off with forceps any specially adherent crusts. A variety of different agents may then be applied: among them are Liquor Tinctorium, which is painted on, Ung. Hyd. Ammon., 1 per cent, Ung. Hyd. Hydroxy Nit. Nig., ½ per cent (A. & H.), and Ung. Albucid, 5 per cent,

which are rubbed in for at least five minutes. Loose lashes should be removed, and, if possible, the Meibomian glands expressed (p. 430). Errors of refraction, particularly of the hypermetropic variety, should be corrected with glasses and the patient's general health attended to, special attention being paid to securing an adequate intake of vitamin A and the B complex. Local treatment is usually carried out three times a day and should be continued until at least a fortnight after apparent cure, or the condition will relapse.*

Ectropion, blepharitis, and chronic conjunctivitis are sometimes associated with eversion of the lower lid and cannot be cured until this displacement is overcome. Mild cases can be dealt with by daily painting of the exposed conjunctiva with 2 per cent silver nitrate. More severe ones often respond to applications of the cautery, especially if combined with the passage of Snellen's sutures (*Fig.* 569). The lid should be infiltrated with novocain, everted, and with the electric cautery a series of punctures made 3–4 mm. behind the lid margin, and 2 mm. from each other. The punctures should pass into the tarsal plate, but not through it. Snellen's sutures may then be passed as shown in *Fig.* 569. If this procedure fails, a plastic operation will be required.

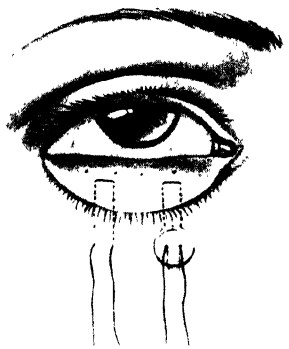


Fig 569.—Snellen's sutures for the correction of ectropion. Two double-armed sutures are employed. They are passed through the most prominent part of the conjunctival swelling and brought out through the skin, being tied fairly tightly over pearl buttons, thereby pulling the lid back into position. The dots indicate the sites of application of the cautery

2. LACRIMAL APPARATUS

The commonest task the house surgeon will have to perform in this connexion is to determine the patency, or otherwise, of the lacrimal passages. The first thing to do is to press over the sac, situated on the side of the nose just below the internal tarsal ligament, and see whether any mucus or pus regurgitates through the lacrimal punctum. Should this occur, it is fairly conclusive evidence of a block in the naso-lacrimal duct. Absence of regurgitation does not, however, prove patency of the duct, and in these cases, as also in those where pus is in the sac, syringing is required. It is carried out as follows: instil two to three drops

Fig 570.—Nettleship's dilator for enlarging the lacrimal puncta

of 5 per cent cocaine at five-minute intervals, evert the lower lid and rub a few crystals of cocaine hydrochloride into the conjunctiva lining the inner surface of the lid between the punctum and the inner canthus. Wait a further three minutes and evert the lid again to expose the inferior punctum, inserting into it the point of a Nettleship's dilator (*Fig.* 570). If this is not at hand, or the point is too blunt to enter the punctum, a sterilized safety-pin may be employed, but it must be used carefully or a false passage will be made. The lacrimal cannula (*Fig.* 571) fitted to a 1-c.c. syringe can then be passed into the inferior canaliculus

* Penicillin ointment, 600–800 Oxford units per gramme of vaseline, applied to the lid margins three times daily with a wooden probe for 3 to 10 weeks has recently been advocated.

and the lacrimal passages syringed through with boracic lotion. Passage of fluid into the throat can be avoided by making the patient bend his head forward, when it will come out of the nose if the nasal canal is patent; if blocked, the fluid will return by the upper punctum accompanied by mucus and pus, if these have been present in the sac. Should the latter occur, the sac should be washed clean with several syringefuls of boric acid lotion and then filled with 2 per cent cocaine in 1–5000 adrenaline. After waiting for a few minutes, fluid may pass

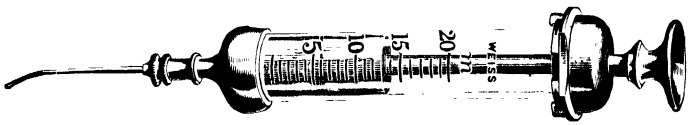


Fig. 571.—Lacrimal cannula and syringe.

into the nose, when syringing is repeated. If it does not, the question of probing will have to be considered. Before attempting this, it is advisable to get the sac as clean as possible. This may be done by showing the patient how to express the contents and instructing her to do so every hour or so during the day. She should apply a little boric vaseline to the finger-tip each time to avoid excoriating the skin. A few days of this treatment will usually suffice to convert the contents of the sac from mucopus to clear mucus, and in elderly people may be enough to bring about relief of symptoms.

Probing.—To accomplish this painlessly, the eye should be cocainized as for syringing and the sac washed out with a little 4 per cent cocaine in adrenaline 1–10,000. The skin over the sac and naso-lacrimal duct should be infiltrated with 4 per cent novocain, some of the solution being injected deeply so as to pass if possible behind the sac and duct. A small-sized probe (No. 0 or 1, Bowman, *Fig.* 572) is passed through the dilated inferior punctum and along the canaliculus



Fig. 572.—Bowman's probes

until it can be felt impinging on the lacrimal bone. The probe is raised into the vertical position so that it points towards the fold of the ala nasi, and keeping its point a little backwards it will be felt to engage the opening of the naso-lacrimal duct. A stricture will probably be encountered here, but with a little patience, this and others farther down the duct can usually be negotiated, and the probe passed into the inferior meatus of the nose. It is unwise to syringe immediately after, but local treatment for the eye and nose is indicated if the condition is not to relapse. The following régime has given satisfactory results; it is carried out three times daily and kept up for 3 to 4 weeks: glycerin of thymol, 1–8 as an eye lotion, and also for sniffing up the nostrils. Drops of argyrol, 10 per cent, ephedrine, 1 per cent, for the eye, an oily spray for the nose, e.g. :—

℞	Thymol	gr. 1
	Eucalyptol	m. 1
	Menthol	gr. 10
	Parolene	ad fl. oz. 1

To be used after sniffing the glycerin of thymol.

Should the condition recur, probing may be repeated, but if this has to be done more than two or three times, excision of the sac or dacryo-cystorhinostomy should be performed.

Three Snip Operation.—This is a useful method of curing epiphora in elderly people, where, although the lacrimal passages are patent, troublesome



Fig. 573.—Stilling's knife for slitting up the lacrimal canaliculus

watering of the eyes occurs. Inspection of such cases will show that the punctum is not in apposition with bulbar conjunctiva, either because of slight eversion of



Fig. 574.—Iris scissors used for removal of posterior wall of lacrimal canaliculus. Also employed for iridectomy.

the lid from laxity of the orbicularis, or from atrophy of the lid tissues, leaving the punctum on the top of a tiny papilla where the tears cannot enter it. The eye is anæsthetized with a drop of 5 per cent cocaine and a little solid cocaine is rubbed into the conjunctiva of the lower lid from the punctum to its inner end. The punctum is dilated, the lid everted, and the canaliculus slit up by a Stilling's knife (*Fig.* 573) passed along it with its cutting edge directed towards the eyeball. Part of the posterior wall of the canaliculus is gripped in fine forceps and a small triangular portion removed by two snips with a pair of iris scissors (*Figs.* 574, 575).



Fig. 575.—Three snip operation completed, showing the triangle of tissue which has been removed to prevent healing of the slit canaliculus.

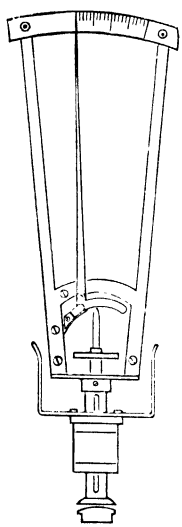




Fig. 576.—Tonometer.

Tonometry is used in cases of glaucoma to measure the intra-ocular pressure. The eye should be anæsthetized with two drops of ½ per cent decicaine with a five-minute interval (cocaine dilates the pupil, which might be dangerous; it also injures the corneal epithelium). The patient lies flat on a couch and is directed to hold his index finger of the same side above the eye, and look at it with both eyes open. The house surgeon moves the patient's hand until the

eye to be examined is looking vertically upwards. The lids may have to be retracted ; if so, it helps the patient to allow him to retract his lower lid with his unoccupied hand. The tonometer (*Fig.* 576) is applied vertically and a reading is taken. The weight should be chosen so that the deflection of the pointer is between 5–10°. The intra-ocular pressure is read off from the table provided with the instrument. In recording the result, the deflection and the weight used should be mentioned as well as the pressure, e.g., if it is a 7·5 weight with 6° deflection, it would be recorded 6/7·5 = 23 mm. Hg. The normal pressure is from 15–25 mm. Hg, though figures up to 30 mm. may, in the absence of other symptoms, be taken as high normal. Tensions of 30–45 mm. are called + 1 ; 45–70 mm., + 2 ; and above 70 mm., + 3.

3. AFFECTIONS OF THE CONJUNCTIVA

Trauma.—The removal of foreign bodies has already been described (p. 430) ; burns from acids or alkalis demand immediate irrigation of the eye. Theoretically, an acid burn should be treated by alkaline lotion (Sodii Bicarb., gr. 4, ad fl. oz. 1) and an alkaline burn by an acid lotion (Acid. Acetic. m. 15, ad fl. oz. 1, or Acid. Boric. gr. 8, ad fl. oz. 1), but in practice these may not be readily obtainable, and normal saline (Sodii Chlorid. 1 teaspoonful, to pint 1) or even tap water may have to be used. A drop of fluorescein is instilled after irrigation, to determine the extent of conjunctival damage, and the integrity or otherwise of the cornea. In the event of the latter being damaged, a drop of 1 per cent atropine should be used ; if not, it can be omitted, but parolene should be instilled in both cases, the instillation being repeated four hourly, after gentle irrigation with normal saline. Later treatment should include the daily examination for adhesions between the conjunctiva lining the lids and that covering the eyeball (symblepharon), and the breaking down of them by a blunt probe or a glass rod. Should a large surface be involved, a mucous membrane graft will be required.

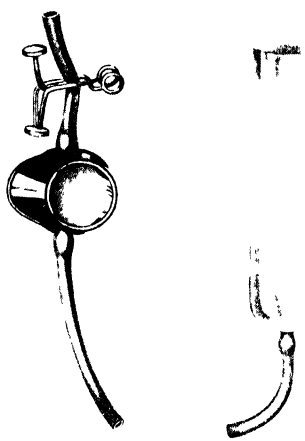


Fig. 577.—Batten's hydrophthalmoscope for keeping fluid in contact with the eyeball

Particularly dangerous are the burns resulting from ammonia or lime. In the former, although the initial injury may appear slight, rapid necrosis of the cornea may ensue, and in the latter the cornea may also be seriously affected. In the case of lime burns, all the particles should be carefully picked out, and an attempt made to dissolve what remains in the cornea by bathing the eye, four or five times daily, with 10 per cent neutral ammonium tartrate (this is painful and requires previous instillation of decicaine, ½ per cent), 2 per cent cane sugar, or 15 per cent glucose. Since the solution has to be kept in contact with the eye for some time, the ' bathing ' should take the form of introducing 3–4 drops at a time with a pipette every three minutes, for ten instillations, or Batten's hydrophthalmoscope (*Fig.* 577) may be used for periods of ten minutes

Conjunctivitis.—The treatment of this disease is a large subject, and only a few general points can be touched upon here.

1. If possible, identify the organism by taking a smear and culture from the conjunctival sac, using a diphtheria swab or a platinum loop and plating out on blood-agar. This should be done before treatment has started, but the latter should begin immediately the swab has been taken.

2. Treat the less inflamed eye first.

3. Bathe the eye, using eye drops, and in severe cases give an adequate course of sulphonamides. If the infecting organism is sensitive to penicillin, dramatic results may be obtained by its use. The strength of the solution employed is 500 units per c.c. and 2–3 drops are instilled hourly day and night, the frequency being reduced after the first 2–3 days.

4. Apply a bland ointment, e.g., Ung. Acid. Bor., to the edges of the lids, especially at night to prevent the lashes sticking and so converting the conjunctival sac into a closed incubator. An alternative plan is to instil a drop of parolene at night.

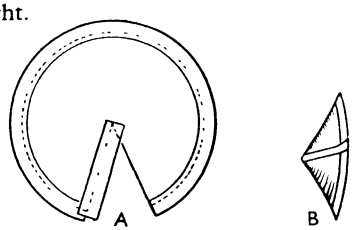


Fig 578.—A, Disc of X-ray film emulsion removed by hot water) sufficiently large to cover eye, segment removed and edges bound with strapping B, Cone ready for application over eye

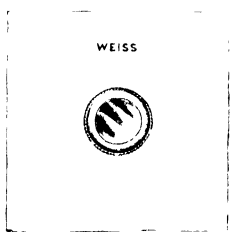


Fig 579.—Buller's shield, consisting of a watch glass surrounded by strapping

5. Avoid pads, bandages, cocaine because it injures the corneal epithelium, and adrenaline because it interferes with the natural processes of cure.

6. Do what is possible to encourage local and bodily resistance.

7. Prevent spread :

a. Keep all utensils, undines, trays, etc., scrupulously clean.

b. Use a separate swab for each eye and destroy after use.

c. In serious cases, the house surgeon or nurse should wear gloves and goggles when treating the eye.

d. If only one eye is involved, and especially if the conjunctivitis is severe, protect the fellow eye by a cone of X-ray film (*Fig*. 578) or a Buller's shield (*Fig*. 579).

8. In some cases stimulate local changes by painting the everted lids with silver nitrate, 1 per cent every twenty-four hours, or, in milder cases, instil silver proteinate B.P.C., 10 per cent, night and morning. This treatment should not be continued for longer than two weeks, or permanent silver staining (argyrosis) of the conjunctiva ensues.

9. Application of solid substances to the everted lid, e.g., copper sulphate in trachoma.

10. In cases of persistent uni-ocular conjunctivitis look for : (*a*) A foreign body, conjunctival concretion, or inturned lashes ; (*b*) Lacrimal sac infection (*see* p. 433).

There are some twenty different types of conjunctivitis, with numerous sub-groups. It is, therefore, not possible to deal here with their differential

diagnosis, though this is important from the therapeutic standpoint. Suffice it to say, therefore, that the causative agent may be bacteria, a virus (e.g., trachoma), fungi, spirochætes, allergic hypersensitiveness, mechanical (e.g., ectropion or entropion), or some unidentified agent, e.g., Parinaud's conjunctivitis, and that treatment has to be modified according to the cause. In all cases, however, the above general principles hold good.

A few more points remain for comment. Inspection of the eyes is best carried out in diffuse daylight, and it is usually advisable to evert the lids (p. 429). In adults this is simple, but in babies the following technique is advised : sit opposite the nurse, who holds the child's body with its hands down to its sides, the head being grasped in a towel between the house surgeon's knees. Wash away all secretion and endeavour to separate the lids, being careful not to press upon the eyeball, when they will usually become everted. It is important to wear goggles while doing this, because the pus in the conjunctival sac may be under pressure and spurt up into the examiner's eyes, when the lids are separated. It is usually necessary to examine the cornea in these cases, and if the lids do not open easily, small bent wire retractors must be slipped under their edges and gently separated. By this means, pressure is not exerted on the eyeball and so the risk of causing an ulcer of the cornea to rupture is avoided. Should the eyeball roll upward in the effort to keep the eye closed, it usually suffices to wait a short time with the lids separated, and it will then roll down.

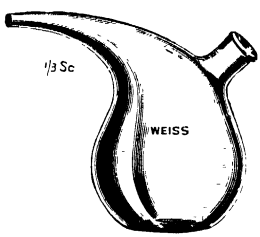


Fig. 580.—Undine, for irrigation of eye.

Irrigation is best carried out with an undine (*Fig.* 580). The patient should be prone and a stream of lotion usually at body temperature or a little higher, directed first on to the closed lids from which the discharge can be wiped away with pledgets of wool. The lids are then everted (p. 429) and the irrigation continued until all discharge has been washed away. The frequency of irrigation varies with the severity of the case, usually it is carried out three times daily, but sometimes it may be needed two-hourly. The employment of sulphonamides or penicillin,* particularly in ophthalmia neonatorum, has, however, rendered such frequent irrigations seldom necessary. One per cent saline, provided it is freshly made, is often used, but a buffered solution of correct *p*H is really better, for example :—

℞	Boric Acid, (12·4 g.)	gr. 6½
	Potassium Chloride (anhydrous), (7·4 g.)	gr. 3½
	Sodium Carbonate, (1·6 g.)	gr. ¼
	Aq. Dest., (1000 c.c.)	ad fl. oz. 1

Alternatives are hyd. oxycyanide 1–6000, dettol 1–400, and glycerin of thymol 1–8.

4. AFFECTIONS OF THE CORNEA

Injuries.—*Abrasions* of the cornea are apt to be overlooked, since when fresh the transparency of the cornea is not interfered with. When any corneal injury has taken place, and an abrasion is suspected, a drop of fluorescein

* A recent recommendation for ophthalmia neonatorum is to instil drops of penicillin, 2,500 units per c.c., every 5 minutes until the eye is free of discharge, which takes ½ to 3 hours; then at longer intervals.

neuralgia never crosses the midline. The offending tooth should be treated or removed.

Chronic Suppurative Periodontitis (Pyorrhœa Alveolaris).—In the periodontal membrane a chronically inflamed condition may arise independent of sepsis from a dead pulp. If treatment is undertaken early it usually cures or checks the progress of the disease, but chronic cases of long standing are very intractable.

Thorough scaling of the teeth, especially the removal of the tartar below the gum margins, and massage of the gums either by means of the fingers or with wooden toothpicks to get between the teeth, go a long way to enforce shrinkage of the gums and their return to normality. These measures eliminate or decrease the pocket formation and flabbiness of the gums around the teeth. If after a fair trial has been given the gums have not shrunk to normality, then gingivectomy may be undertaken. This is a minor operation, and consists of the surgical removal of the excess gum, thereby eliminating the pockets of gum around the teeth and establishing drainage. The healed tissues are left normal

The chief difficulty of treatment, however, exists in diagnosing the pyorrhœa correctly. *It is of the utmost importance that systemic disease be excluded before the local treatment of pyorrhœa is undertaken.*

Acute Alveolar Abscess.—In order to prevent serious conditions and symptoms supervening, and to avoid the pointing of the abscess outside the mouth, the first essential is to evacuate the pus. This may be done in two ways—namely, by removing the tooth or by incising the abscess. It is best to incise the abscess, as in some cases the dentist will be able to save the tooth. If no pus or palpable swelling can be demonstrated, removal of the tooth is indicated. The incision should be into the mouth if possible. The best place for the incision is that shown in *Fig.* 598.

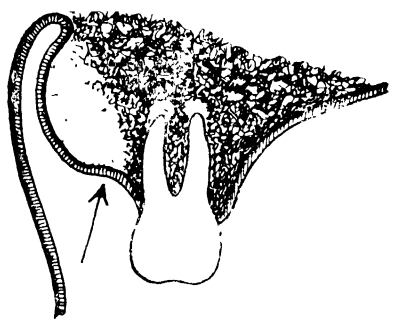


Fig 598.—Subperiosteal abscess. Arrow indicates point of incision.

The incision is made under a short general anæsthetic or the site is frozen with ethyl chloride. If much pus is present, a wick of gauze is put in as a drain and removed within twenty-four hours. Actually, by opening the abscess the acute condition is converted into a chronic one, and after a few days the dentist is able to treat the tooth, which if single-rooted can probably be restored to a healthy condition.

Neglect of an acute alveolar abscess may lead to osteomyelitis.

EXTRACTION

Local Anæsthesia for Tooth Extraction.—If possible a syringe designed for the purpose should be used, as it gives greater control than the ordinary type of Record syringe.

Sterilization of the mucous membrane of the mouth is difficult. After the patient has thoroughly rinsed out the mouth with an antiseptic solution, the area about to be injected should be painted with tincture of iodine. A 2 per cent solution of novocain is injected into the sulcus around the tooth. It is best to push the needle deep enough to strike the bone and then gently to retract before delivering the solution. This avoids the possibility of injecting beneath the periosteum and stripping the latter from the bone, with subsequent after-pain. A quantity of fluid—about 1 c.c.—is deposited, and the same procedure repeated on the palatal side in the upper jaw or the lingual side in the lower jaw. The liquid is allowed to seep in for about ten minutes, by which time complete anæsthesia will have ensued.

Principles.—It is of the utmost importance to realize that *pulling or the application of violent force or indiscriminate wrenching* is likely to have no other result than fracture of the tooth, and possibly serious injury to the jaw.

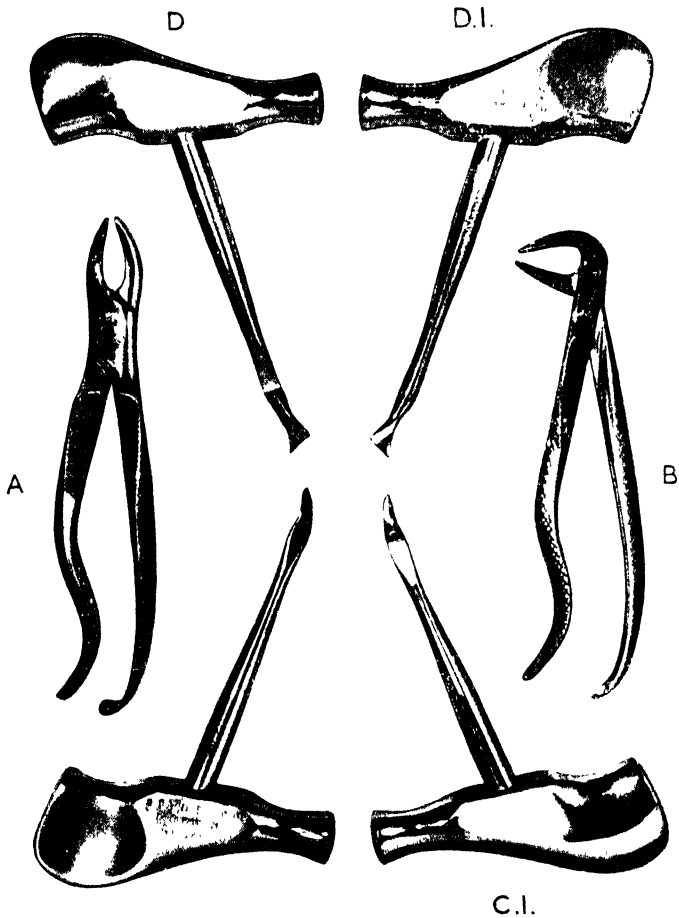


Fig. 599.—A, Universal upper forceps, showing thumb rest; B, Lower hawksbill forceps showing thumb rest; C and C1, Right and left straight elevators; D and D1, Right and left curved elevators.

The patient should be sitting in a firm, strong chair, with the neck and head well supported, and the head leaning slightly backwards. The operator is always on the patient's right side, sometimes in front and sometimes behind, according to the tooth to be extracted.

The removal of teeth is usually undertaken with forceps, of which various types exist. For ordinary uncomplicated extractions only two are necessary, an

upper universal type (*Fig.* 599, A) and a lower (*Fig.* 599, B). The modern forceps all have a thumb rest to give greater control and power during extraction. Levers are sometimes employed for removing lower molars and roots (*Fig.* 599, C, D).

Application of Forceps.—The operator always stands on the right-hand side of the patient.

The crown, or whatever part of the tooth is left above or level with the gum margin, is used as a guide for the blades of the forceps. One blade is first applied either lingually or buccally against the crown, the opposite blade of the forceps usually following into its correct position. Gentle pressure pushes the blades between gum and tooth until they have been forced well up in the upper jaw or down in the lower jaw, as the case may be Closure of the forceps grips the base of the tooth. Pressure is now applied with the closed forceps in the direction of the tooth root so as to force the tip of the root, or roots, to become the fulcrum of the leverage. If this is borne in mind throughout the process of extraction, the danger of fracture of a tooth is reduced to a minimum. A gentle lateral movement loosens the tooth, the final removal of the tooth being in an outward direction. This lateral movement applies to the extraction of all teeth except the upper incisors and lower premolars, which have more or less conically shaped roots. In the case of the latter a continuous slight rotary movement simplifies their extraction. In the multiple-rooted teeth the forceps should always be applied over the anterior roots, as these are usually the stronger and fracture of the tooth is less likely to ensue

Extraction of the Individual Teeth.—

Upper Incisors and Canines.—The blades are applied and driven upwards, and the tooth is firmly grasped and then gently tilted inwards and outwards and slightly rotated at the same time. The forefinger and thumb of the left hand guide the forceps into position, support the alveolus during the extraction, and hold the lip out of the way (*Figs.* 600, 601).



Fig. 600.—Showing use of left hand when operating on left side of upper jaw.



Fig. 601.—Showing use of left hand when operating on right side of upper jaw.

Upper Premolars.—The first premolar usually has bifurcated roots, and is, perhaps, the most difficult of all the teeth to extract, and the most liable to break. No rotary movement should be undertaken.

Upper Molars.—Apply the forceps and lever outwards. The tooth should not be pulled, but rather pushed firmly into its socket and levered sideways.

Lower Incisors, Canines, and Premolars.—In all lower extractions the left hand supports the jaw. On the left side the forefinger holds away the lip, the

second finger the tongue, and the thumb gives a supporting grip to the whole jaw. On the right side the forefinger holds away the lip, the thumb holds the tongue, and the middle finger supports the jaw (*Figs.* 602, 603).

After application of the forceps, the incisors are removed by tilting inwards and outwards, as they have flattened roots. The canines and premolars have conical roots, and rotation combined with tilting may be employed.



Fig. 602.—Showing use of left hand when operating on left side of lower jaw.



Fig. 603.—Showing use of left hand when operating on right side of lower jaw, and standing behind the patient

Lower Molars.—For the right lower molars the operator stands behind and to the right of the patient. The jaw is supported by the left hand (*see Fig.* 603). The lower molars have two roots. Application and grip of the forceps should be made over either one or other of these roots, preferably over the anterior root, but never between them. The tooth is tilted inwards and outwards until well loosened before its ultimate delivery is undertaken.

The Use of Elevators.—These are chiefly employed in the removal of lower molars and roots. Their application is seldom indicated in the upper jaw. The straight elevator, of which there are two—namely, a left and a right—is inserted between the molar teeth. The flat surface of the blade lies against the tooth which is to be extracted. The point of the blade is forced downwards into the alveolus, and the lever bent backwards so that its point engages with the root, the tooth in front being used as a fulcrum. It is an especially useful and easy method for the removal of the third lower molar.

The curved elevators are chiefly used for removing fractured roots of lower molars. If a fractured portion of one root remains, the curved elevator is passed into the empty socket, and, with a rotary movement, its point is forced through the septum, which it breaks away, engages the root, and elevates it from its socket (*Fig.* 604).

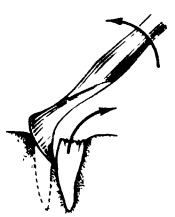


Fig. 604.—The use of a curved elevator for removal of a root in the lower jaw.

After-treatment.—The modern technique is not to allow the patient to use mouth-washes. It is far better to take a pad of cotton-wool and make the patient bite on it for a few minutes. No rinsing should be undertaken for at least 24 hours. Where a great deal of trauma has occurred, ice packs are indicated and applied to the outside of the cheek; they are only useful for the first 12 hours. Anodyne drugs can be given to act as a sedative. If sepsis in the

wound occurs, the wound must be washed out and disinfected. Peroxide is the best disinfectant, as it removes debris, necrotic tissue, and infection.

Hæmorrhage after Extraction.—Hæmorrhage may be primary, reactionary, or secondary.

Primary and Reactionary Hæmorrhage.—The treatment is the same for both forms. Hot mouth-washes are usually of no avail. Plugging the socket with gauze soaked in adrenaline 1–1000 solution may be tried. Gauze dipped in oil of turpentine and plugged into the socket is a good hæmostatic. A standard method is the local application of snake venom from the Russell viper (Stypven, Burroughs Wellcome & Co.). Gauze saturated with the solution is plugged into the socket and repeated in twenty to thirty minutes. In the case of hæmophiliacs, its local application is always indicated. Fibrin foam and thrombin are now obtainable and may prove more reliable local applications than the foregoing. Blood transfusion should be insisted upon if the bleeding is not under control within an hour or two.

Secondary Hæmorrhage.—This is rare. The socket should be cleaned of its septic clots, syringed with some mild antiseptic, and then the same treatment undertaken as for primary hæmorrhage.

Pain Continuing after Extraction.—Hot mouth-washes will give relief. Pain continuing for long after extraction is generally due to inflammation. The socket should be cleaned out and kept frequently syringed with a dilute antiseptic. If very painful it should be swabbed with 5 per cent cocaine solution and then thoroughly cleaned. Any loose fragments of bone are removed. The socket is lightly plugged with 5 or 10 per cent iodoform gauze which has been saturated with Dentalone, or the socket dusted with anæsthesin or orthoform powder, which provides a mild anæsthesia lasting about twenty-four hours.

Complications of Extractions not considered already.—

Fracture of the Tooth.—This is generally due to the blades of the forceps not penetrating deeply enough, or not being closed firmly, one blade thus being allowed to slip slightly; or to the forceps not being kept firmly pressed down until the tooth is loosened from its socket; or to hurry in manipulation. It is sometimes impossible to prevent the apex of a root with thickened cementum from breaking off.

Extraction of the Wrong, or an Adjacent, Tooth.—The tooth should be washed in sterile saline solution and replaced in its socket; the mandible is then fixed with a four-tailed bandage. The patient should be advised to consult a dentist with a view to further treatment.

Fracture of Bone.—Small fractured portions of alveolus are of little consequence and should be removed. More extensive fractures must be treated with appropriate splints.

Trismus.—A general anæsthetic is administered and the mouth carefully opened with a Mason's gag.

Laceration of the Gum.—Torn portions of gum usually reunite if pressed into place. An extensive tear may require suture. A fragment only adhering by a thin pedicle should be removed with scissors.

CHAPTER LIX

THE SKIN

By J. E. M. WIGLEY

To become proficient in examining the skin will repay the practitioner and the hospital resident.

In order to pursue the study to the best advantage, some inexpensive armamentarium is desirable.

ARMAMENTARIUM

A Good Light is essential. It should come from behind the examiner. If daylight is not available, an excellent substitute is the light-blue-coloured electric bulb, preferably with a dull white metal reflector. For the purpose of showing up colours this light emulates daylight.

Magnifying Spectacles (*Fig.* 605) are better than a magnifying glass. Each lens is 5D, combined with 10D prisms, having the base inwards. The spectacles can be made by a competent optician. In addition to providing binocular magnification, these spectacles leave both hands free for any operative procedure which may be required.



Fig. 605.—Magnifying spectacles.

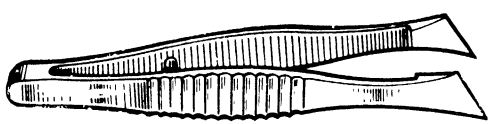


Fig. 606.—Whitfield's epilation forceps.

A Glass Spatula or a Microscope Slide is useful for exerting pressure upon the skin. For instance, in erythematous lesions the colour disappears entirely under pressure, while in purpura or granulomatous infiltrations, e.g., lupus vulgaris, some of the colour remains.

Whitfield's Epilation Forceps (*Fig.* 606) are useful for removing hair or pediculi.

EXAMINING AN ERUPTION

It is essential that the whole of the eruption should be seen, the patient being completely undressed if necessary.

The Predominating Elementary Cutaneous Lesions should be noted. These lesions are divided into two classes :—

a Primary lesions :—
Macules.
Papules.
Nodules.
Tumours.
Vesicles.
Bullæ (or blisters).
Pustules.
Wheals.

b. Secondary lesions :—
Scales or squames.
Crusts and scabs.
Excoriations.
Fissures.
Ulcers.
Scars.
Stains or pigmentation.

Distribution is important. Scabies has a distribution just as typical as herpes zoster. The position of the eruption is of great help in determining whether it is of ' occupational ' origin or not.

Colour of an eruption is often characteristic. The bright red background of acute eczema or dermatitis, the pink background of psoriasis, the brownish colour of most syphilides, and the lilac tint of lichen planus are excellent examples of this.

Symptoms are less reliable. It is as uncommon for eczema not to itch as it is for syphilides to itch, yet cases occur in which the symptoms are unusual. The presence or absence of " scratch marks " should be noticed particularly, as a check on the symptoms.

History of an eruption is important, especially regarding previous rashes. Within reason, it is wise to listen to the patient's ideas about the origin of a rash. This is especially the case if there is any question of it being a ' contact ' dermatitis (i.e., dermatitis due to an external irritant). If the patient believes a fur or cosmetic preparation, or a plant, has caused the rash she is likely to be right.

CONFIRMATORY DIAGNOSTIC MEASURES

Microscopical Examination.—The microscope is essential for confirming the diagnosis of two common conditions, viz., scabies and ringworm of the scalp. No staining is necessary. The material is simply mounted on the slide with a few drops of liquor potassæ B.P.C. The diaphragm of the microscope should be partly closed, for too much light makes the examination more difficult. The 2/3 or the 1/6 objective gives all the magnification necessary.

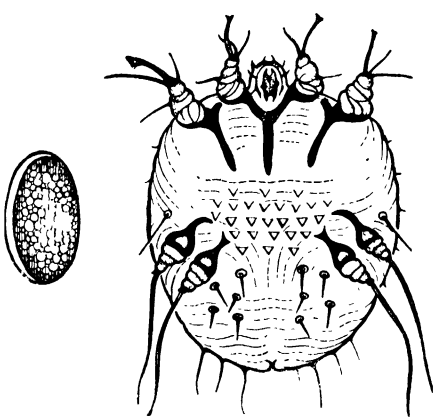


Fig. 607.—Female *Sarcoptes scabiei* with ovum.

Scabies.—It is best to shave off the superficial layers of the suspected ' burrow ' with a sharp scalpel and to mount the material in liquor potassæ. Using the 2/3 objective the acarus or some of her ova will readily be seen (*Fig.* 607).

Ringworm (*Tinea of the Scalp*).—A few broken hairs, called ' stumps ', should be pulled out with Whitfield's forceps and mounted in the liquor potassæ. With the 2/3 objective the irregularly broken ends of the ' stump ' can be seen, and it is evident that the normal

structure of the hair is obliterated (*Fig.* 608). With the 1/6 objective the spores can be made out as a ' mosaic ' pattern wrapped round, and replacing, the hair structure (*Fig.* 609).

Fluorescence of Infected Hairs under Wood's Light.—Wood's light is produced by filtering the light from an ultra-violet lamp, preferably the Krohmayer lamp through a cobalt nickel impregnated glass (Wood's glass) in a darkened room. Individual hairs infected with the ordinary ringworm fungus fluoresce brilliantly with a definite greenish tinge under these conditions. Scales, scurf, and greasy substances also fluoresce, but without the greenish tinge, so it is desirable to have the scalp thoroughly washed two or three times before making the examination. Wood's light is invaluable for use in examining a number of children, as in a school clinic.

Pediculosis Capitis.—Using the same technique as for tinea, ' nits ' attached to the hairs can be demonstrated. By employing the microscope the diagnosis can be settled in a way which will convince any sceptical parent.

The Patch Test (syn. ' Eczema Test ').—This is used in the search for the responsible external irritant in cases of suspected ' contact dermatitis '. It is carried out as follows : The test substance is placed in contact with intact non-hairy skin, covered with gutta-percha or similar waterproof material, and held



Fig. 608.—Stumps of hair infected with ringworm. (2/3 objective.)

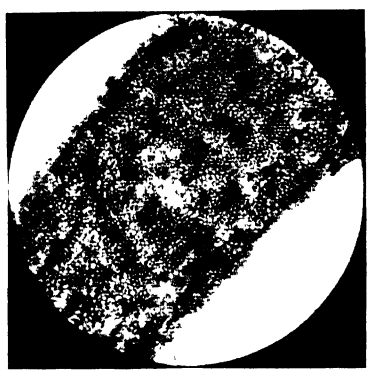


Fig. 609.—Small-spored ringworm of scalp (Jacobi). (1/6 objective.)

in place by strapping. A ' control ' piece of gutta-percha and strapping is, of course, necessary. The substance is left in contact for varying periods up to 72 hours, and only those cases are said to be ' positive ' in which the reaction is in the form of eczema, i.e., besides redness and swelling, papules and vesicles occur.

Patch tests need careful interpretation. A positive test has been reported after a delay of 24 days, and I have seen one after a delay of 5 days. A positive reaction is not conclusive proof that the substance has caused the dermatitis : the positive reaction may be due to the test substance being too strong, or to polyvalent sensitivity. Conversely, a negative reaction does not prove conclusively that the substance can be exonerated, for the test never quite fully reproduces the natural conditions of exposure. The test should not be carried out when the dermatitis is in the acute stage, and the result should be regarded as only one link in the chain of evidence leading to the diagnosis.

SKIN TESTS FOR TUBERCULOSIS

1. *Pirquet Test.*—A couple of drops of old tuberculin is placed on the skin and then vaccinated in by superficial scarification. Red papules or vesicles at the site within 48 hours indicate a positive reaction.

2. *Mantoux Test.*—0·1 c.c. old tuberculin in normal saline is injected intradermally. Dilutions of 1–10,000 to 1–100 are used. A positive reaction, shown by hyperæmia and infiltration, appears in 6–8 hours, is at its maximum in 24–48 hours, and subsides in 6–10 days. In assessing the value of the test the dilution of the old tuberculin used is of great importance.

In both tests a ' control ' with normal saline is essential.

SOME DERMATOLOGICAL OPERATIONS

Carbon-dioxide Snow.—This is a valuable method of treating such conditions as nævi, moles, warts, and small rodent ulcers. The snow is made by allowing liquid CO_2 to evaporate quickly. Liquid CO_2 is contained in a cylinder having a nozzle with a fine bore. A piece of baize or chamois leather is folded

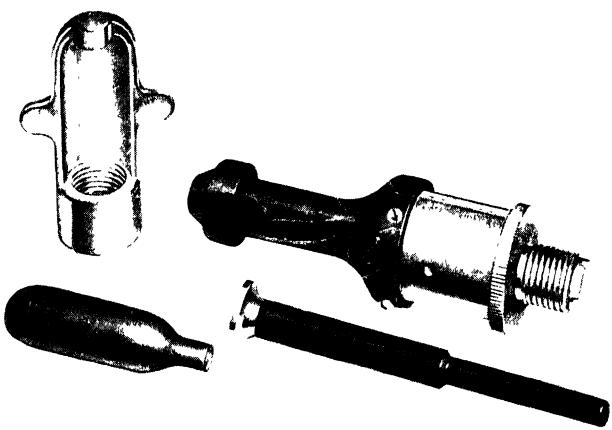


Fig. 610.—Apparatus for making CO_2-snow pencils (Sparklets Ltd.)

into the shape of a bag, and held tightly over the nozzle with the gloved hand. When the valve is opened by means of the key, the vapour rushes out and solidifies in the bag. The snow is scraped off and placed in the applicator. Applicators are made of vulcanite and resemble aural specula. They are of different sizes and each is fitted with a plunger rod so that the snow can be pressed firmly down to form a solid pencil. The applicator with the solid snow is then transferred to the lesion and the amount of pressure varied by pressing on the plunger rod with the free hand. The amount of pressure has a great effect on the reaction produced.

Small " Sparklets " of CO_2 snow, complete with an applicator (*Fig.* 610), are a convenient and economical way of using the snow.

With the solid CO_2 snow the effect is determined by the length of exposure and the degree of pressure. The length of exposure ranges from about five seconds to two minutes or more, but it is difficult to lay down hard and fast rules.

After five to ten seconds with firm pressure, the underlying skin is frozen into a solid white disc. This thaws in about a minute, and is followed in a couple of hours by an inflammatory reaction and occasionally by a blister. Healing occurs in about a week. In the treatment of nævi one seldom employs an exposure longer than thirty seconds. Exposures of one minute or more cause destruction of the soft parts and are usually followed by scarring; this is the aim when treating rodent ulcers. In the treatment of warts the thick horny surface necessitates comparatively long exposure, and less than one minute is seldom successful.

The firmer the pressure the more marked will be the destructive action of the snow. The actual application is not very painful, but thawing can be really painful, as anyone who has suffered from frost-bite can testify.

When lesions are of irregular shape, or of considerable size, it may be more effective to dissolve the snow in acetone or ether and paint the resulting mixture on with a brush. The mixture should be of the consistency of melting snow or 'slush'. It must be painted on fairly quickly. The application is painful and usually it causes a superficial blister. This method of treatment is useful for certain conditions, particularly 'port-wine stains'.

Cauterization.—An electro-cautery is efficient when the lesion is small; otherwise a Paquelin cautery is advised. Cautery points should be short, for a short point is more easily controlled. The cautery point should be at a dull red heat and care taken not to press it in deeply, or a scar will result. It is better to repeat treatment at weekly intervals than to cause scarring. No anæsthetic is necessary. The application causes less pain than would be anticipated.

Lesions which are amenable to cauterization are as follows:—

Warts, particularly multiple warts on the scalp, beard area, or those which are so often seen at mucocutaneous junctions.

Spider Nævi.—A fine-pointed cautery at dull red heat is inserted into the centre of the nævus for about one second.

Granuloma Pyogenicum (syn. Botryomycosis Hominis).—This can be treated particularly successfully with a cautery. The lesions, which are usually found to be solitary, cherry-red in colour, and elastic in consistence, vary in size from a pea to a walnut. A local or general anæsthetic is necessary and the Paquelin cautery is preferable. When the cautery is first applied there will be bleeding; cauterization should be continued until bleeding has ceased. A dry dressing is applied. When the scab separates, the area will be found to have healed without scarring.

Sharp Volkmann's Spoon.—The particular indication for the use of this instrument is *plantar warts*. These painful lesions are single or multiple, and are frequently thought to be corns. They have an appearance of a wart let into the epidermis of the sole of the foot or toes. They are surrounded by a ring of hard epidermal tissue, and are tender on pressure. Plantar warts should never be 'excised'. A general anæsthetic is necessary. The spoon should be inserted between the wart and the hard ring of epidermal tissue. Considerable force is necessary to shell out the wart. The size of the ensuing cavity is often surprisingly large and there is often bleeding. The cavity is packed with iodine gauze or trichloracetic acid. The dressing is removed in twenty-four hours and does not need repeating.

Thereafter simple cleanliness is all that is required.

TREATMENT OF BOILS

Boils should not be incised until there is definite softening in the centre, and then only to relieve pain. Hot linseed or similar poultices are the best method of spreading the infection to more follicles and should be avoided. Magnesium sulphate paste should be used with care, as it is very irritating to a number of skins. Paintings around the lesion with surgical spirit is helpful, and an elastic adhesive plaster or a mercurial plaster applied to the boil is very effective. This will need to be changed daily. The cautious use of ultra-violet light is good.

A NON-ADHERENT COVERING FOR SKIN DRESSINGS

The covering is the Stannard silk,* used in the Bunyan-Stannard envelope for the irrigation treatment of burns, etc. This is fine silk impregnated with a certain resin and perforated. The perforation is intended to prevent the dressing becoming too hot and to obviate the non-porous character of the silk. It is used in the treatment of areas of crusted, exuding, and even pustular inflamed skin, when it is desired to keep some external application in contact with it. The application, whether lotion, cream, paste, or ointment, is applied direct to the area to be treated, and then the Stannard silk, cut to a suitable size, is placed over this. It is fixed as lightly as possible with a bandage, which is preferable to flexible adhesive plaster, as the latter so frequently causes reactions of the skin. Another method, useful in certain areas, is to stitch the silk to the inner surface of the clothing.

This silk has the property of not 'sticking' to any skin surface, whether it be normal, moist, oozing, or crusted, and so healing is not delayed by minor damage, frequently caused when renewing dressings.

* The manufacturers of this silk are Irrigation Envelopes Ltd., 345 Gray's Inn Road, London, W.C. 1.

CHAPTER LX

THE TREATMENT OF GONORRHŒA

By A. E. W. McLACHLAN

THE treatment of gonorrhœa has been greatly modified since the introduction of the sulphonamide group of drugs: local treatment is now considered by many authorities to be unnecessary in the treatment of acute infections and should be commenced only when indicated by relapse or by refractoriness to chemotherapy.

General Treatment.—Rest in bed, if possible, is advisable; if this is impracticable, exercise should be curtailed to the minimum during the acute stages of infection. Diet should be non-stimulating, and should include the minimum of meat and fried and re-cooked dishes. Pickles, spices, condiments, and all forms of alcohol must be avoided. Regulation of the bowels should be accomplished with mild purgatives. A hot sitz bath lasting 20 minutes once or twice daily is of value. Increased fluid intake—water, weak tea, mineral waters—promotes flushing of the urethra.

Of value in this respect, and in relieving any dysuria, are the alkaline diuretics, e.g., potassium citrate 30 gr. q.d.s., or the following prescription:—

℞	Pot. Cit.	gr. 20	Tinct. Hyoscyam.	m. 30
	Pot. Bicarb.	gr. 25	Infus. Buchu	ad m. 240
		q.d.s.		

Tinct. bellad. 5 min. may be added if there is local spasm.

IN THE MALE

Determination of Anatomical Extent of Infection.—Before commencing treatment the anatomical extent of involvement is determined by the two-glass test. The patient is instructed to pass 3–4 fl. oz. of urine into a conical urine glass, and a like amount into a second. The contents of the first indicate the severity of infection of the anterior urethra, and the second whether the posterior urethra is involved. The presumptions from the tests are:—

1st Glass	*2nd Glass*	*Presumption*
Haze (+ threads)	Clear	Anterior urethritis
Haze (+ threads)	Haze	Anterior and posterior urethritis

A more accurate method of carrying out this test is by washing out the anterior urethra with cold clear lotion until the washings come back clear. Haze in the urine subsequently passed indicates a posterior urethritis; further glasses may be used to determine the state of the bladder urine, and in non-acute cases to collect prostato-vesicular secretions after prostatic massage.

Chemotherapy.—The principles of successful chemotherapeutic treatment may be summed up as follows: (1) Accuracy of bacteriological diagnosis and investigation as to anatomical involvement; (2) Adequate dosage for adequate period; (3) Maintenance of good drainage of the areas involved; (4) Adequate observation period (tests of cure) to exclude possibility of latent relapse.

Sulphonamides.—The drugs now commonly employed are sulphathiazole and sulphadiazine. Sulphonamide P and sulphapyridine are seldom used because of the greater incidence of toxic reactions. A dosage of sulphathiazole or sulphadiazine of 5 g. daily for five days is adequate to cure 80 to 90 per cent of all cases of gonococcal infection and is sufficiently short to prevent drug sensitization or other toxic sequelæ. The drugs should be crushed and swallowed in water or milk in three doses after the main meals of the day. A fluid intake of at least three litres daily is essential.

The sulphonamides show great rapidity of action—in the majority of cases so treated the discharge ceases in from one to three days and the urethra becomes gonococcus free. The urinary haze clears during this period, but a flocculate of threads may persist until the seventh or eighth day, gradually becoming more scanty and mucoid. The cessation of symptoms and signs does not necessarily indicate absolute cure.

Subsequent observation—i.e., clinical examination, examination of the urine, collection of urethral and prostatic secretion for smears and cultures—should be carried out at weekly intervals for one month, then at monthly intervals for three months. If all tests are satisfactory the patient may be regarded as cured.

Persistence of even slight signs indicate protraction of the infection, and, if these do not clear up in ten to fourteen days, should lead to the investigation of the prostate and vesicles and of the urethra for residual infection or non-draining foci. Inadequate dosage of, or intolerance to, the selected drug, the ingestion of alcohol during treatment, and infrequently drug resistance of the gonococcus or failure of the defence mechanism of the body to play its part, are the common causes of persistence of infection. The signs may vary from the persistence of a florid urethral discharge and hazy urines to a scanty or intermittent urethral discharge with almost clear urine. In general, the earlier a relapse occurs the more marked are the signs.

The treatment of relapse cases is (1) by searching out and promoting drainage, by local measures, from the residual foci of infection, (2) vaccine therapy, (3) further courses of sulphonamide after free drainage has been established. Relapse cases may react better to another type of drug than the one originally employed. Pyrexial methods are of value. If a cabinet (inductotherm, Kettering hypertherm, etc.) is available for physical hyperpyrexia a single fever session of 106° F. for eight hours will prove curative. Alternatively, fever reactions resulting from the intravenous injection of T.A.B. or *B. coli* vaccine at two- or three-day intervals may be employed. The commencing dose is 25 millions T.A.B. or 50 millions *B. coli*, subsequent dosage being graduated according to the reactions obtained. A peak temperature in the region of 104° F. is desirable.

Penicillin in a dosage of 30,000 Oxford units, given intramuscularly, three-hourly for five doses, i.e., 150,000 units in twelve hours, has proved curative in nearly 100 per cent of cases. The discharge rapidly ceases, and in a few hours only a slight mucoid gleet is found. This may persist for three or four days. Persistence of gross discharge indicates possible failure and the necessity for further penicillin administration, or the institution of other treatment.

Local Treatment :—

Irrigation is the mainstay of local treatment of acute gonorrhœa, and is best carried out by the gravity method, with a douche can, rubber tubing, and Janet nozzle. The hand syringe is a poor (and often septic) substitute.

The lotions most serviceable in the acute stages are potassium permanganate 1–10,000 to 1–8000, albargin 1–8000, and zinc permanganate 1–8000 to 1–6000, at a temperature of 102°–104° F.

The meatus is cleansed with soap and water and the tip of the Janet nozzle inserted into the urethra sufficiently firmly to occlude it. The pressure of irrigating fluid may be regulated by the height of the reservoir and by partial occlusion of the rubber tubing by the finger and thumb, the nozzle being held and directed by the remaining three fingers of the hand (*Fig.* 611). The anterior urethra (i.e., as far back as the triangular ligament) is first cleansed by gentle repeated distension and emptying of the urethra with irrigating fluid. This may take ½ to 1 pint of lotion. The patient then relaxes and breathes slowly and deeply, at the same time 'going through the motions' of commencing urination, and the irrigating fluid passes back and fills the bladder. The height of the douche can should not exceed 5 ft. above the pelvis. Irrigation should be carried out two or three times daily until the stage of the profuse discharge is passed.



Fig. 611.—Self-irrigation of male patient.

Soiling of the underlinen by discharge may be prevented by gonorrhœa bags or by a square of lint pinned on the under vest, and discarded when soiled.

The Subacute and Chronic Stages.—When the discharge has become scanty and mucopurulent, with only a moderate amount of pus and few if any gonococci in the smears, and the urine in the first glass is clear threads, and clear in the second, the subacute stage has been reached, which in the absence of treatment merges imperceptibly into the chronic stage. Investigation for infection in the prostate and seminal vesicles, and of the anterior urethra for infection of the gland ducts of Littré or the lacunæ of Morgagni, or for submucous infiltration, is indicated.

Palpation and massage of the prostate and vesicles (*see* p. 323), examination of smears from the expressed secretion, and haze, threads, or casts in the urine

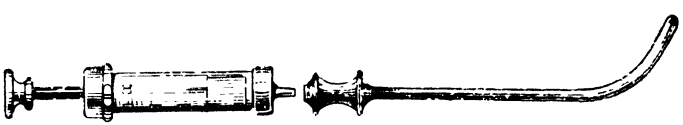


Fig. 612.—Ultzmann's prostatic cannula

passed after massage, indicate the degree of prostatic involvement. Treatment is primarily by prostato-vesicular massage twice weekly. The patient should urinate immediately after prostatic massage, or the bladder may be filled with lotion, e.g., oxycyanide of mercury 1-5000 solution. In refractory cases, instillation of glycerin, 60 minims once or twice weekly, through an Ultzmann cannula (*Fig.* 612) or soft rubber catheter attached to a Record syringe, into

the prostatic urethra, massage on a curved bougie, or diathermy may assist in establishing adequate drainage; while in cases of vesicular occlusion, vasostomy and irrigation of the vesicles with colloidal silver may be indicated.

Prostatic investigation should precede the instrumental investigation of the anterior urethra for involvement of the various glandular structures and infiltrations. The more marked degrees of the glandular involvement may be diagnosed by palpation of the anterior urethra on a straight bougie—the infected gland ducts being felt like small lead shot in the wall of the urethra—or by passing an acorn-tipped bougie. This is passed to the triangular ligament and slowly withdrawn. Non-draining glands may be felt as slight obstructions, the patient often experiencing a twinge of pain. Submucous infiltrations are felt as roughened tender patches. Lesser degrees which may be equally guilty in causing persistence of symptoms may only be recognizable by the urethroscope. Treatment is by massage on a straight bougie, dilatation by means of Kollmann's four-bladed dilator (*Fig.* 613), or suction by Mills's fenestrated bougie (*Fig.* 614). Instrumentation should be carried out at weekly intervals, and should be followed by



Fig. 613.—Kollmann's dilator.



Fig. 614.—Mills's suction bo

irrigation. The lotions commonly used in the subacute or resolving stages are 1–6000 zinc permanganate, 1–2000 zinc sulphocarbolate, 1–5000 oxycyanide of mercury, etc., the frequency of irrigation being gradually decreased.

It is essential that the course of treatment should be controlled by frequent bacteriological examination of smears, etc., and continued until the tests are satisfactory.

The routine use of a polyvalent detoxicated vaccine has proved a valuable adjuvant.

Treatment of Common Complications of Acute or Subacute Stages.—*Peri-urethral Abscess.*—If the abscess is small, expectant treatment with local applications, e.g., of ichthyol and glycerin, may be employed. If fluctuation occurs, aspiration and washing out the cavity with 4 per cent mercurochrome, or surgical incision, may be required.

Acute Prostatitis and Vesiculitis.—Rest in bed, cessation of urethral treatment, atropine sulphate (gr. $\frac{1}{75}$) and antifebrine (gr. 4) or morphine (gr. $\frac{1}{4}$) suppositories, hot hip-baths, and hot rectal lavage are the main indications. Calcium salts intravenously (10–20 c.c. 10 per cent lævulinate or gluconate, or 10 c.c. 10 per cent chloride or thiosulphate) daily for from three to six days or the sulphonamides give rapid symptomatic relief. Treatment after the acute stage is passed should be as indicated for subacute prostatitis.

Epididymitis.—The local measures include rest, cessation of urethral treatment, support of the scrotum by a pillow or a suspensory bandage, and applications of ichthyol and glycerin, lead and opium, or antiphlogistine. Pain is rapidly controlled by intravenous calcium salts or by the sulphonamides. When the acute stage is passed, resolution of the epididymal swelling is accelerated by massage with ung. hydrarg. ammon. or iodex. The associated prostato-vesiculitis must be eradicated.

Metastatic Complications.—In arthritis, tenosynovitis, and gonorrhœal rheumatism local treatment is, on general principles, directed first to the relief of pain by splintage and local applications, and later to restoration of function by massage and movement, along with eradication of the genito-urinary focus.

Penicillin is of undoubted value in many of the complications of gonorrhœa, but like the sulphonamides frequently fails to eradicate sealed-off foci of infection.

Tests of Cure.—Tests of cure, to be complete and of value, necessitate repeated observations over some considerable period of time. In cases treated under the old régime, a period of from six weeks to three months was considered essential; this is equally essential in cases treated by sulphonamides, and should be exceeded in cases of intolerance, etc.

The tests of cure may be summarized :—

1. Absence of signs and symptoms.

2. Normal clinical findings; normal urethroscopic findings. Urethra permits passage of full-sized curved bougie.

3. Negative smears and cultures from urethra, prostate, and vesicles. Provocatives may be employed, e.g., by injection of ½ c.c. polyvalent gonococcal vaccine, passage of a full-sized metal bougie, or irritation with 1–5000 silver nitrate solution, 24 to 48 hours before the taking of the test specimens. The possibility of pus due to the chemical irritation or trauma of provocation must be borne in mind; this will clear rapidly without treatment.

4. Negative blood-Wassermann reaction. Period of observation should be sufficiently long to exclude a coincident syphilis.

5. Negative gonococcal complement-fixation test.

(In vaccine-treated cases, or in cases showing a positive gonococcal complement-fixation test due to the infection, this test may be positive at the end of treatment, but should become negative or fade greatly in strength during the period of observation. The effect of provocative doses of vaccine must be remembered.)

If these tests are successfully passed, there is little risk to the individual of the later dangers of incompletely eradicated infection or of the more immediate risks of transmission of infection to others.

IN THE FEMALE

The Acute Stage.—The general measures already described are applicable in the treatment of acute gonococcal infection in the female. Rest in bed during the menstrual period is of value in preventing extension of the disease. Alternatively, liquor sedans (B.P.) 60 minims q.d.s. may be given during the period.

The aim of local treatment is to promote adequate drainage from the sites of infection—the urethra, the cervix uteri, and less frequently the Bartholin glands and the rectum—and to inhibit the gonococcus by the local application of suitable antiseptics. Douches (potassium permanganate 1–5000, chloramine-T

1–5000) do not adequately influence the sites of infection, although they cleanse the vagina of discharge and promote the local comfort of the patient. Their value is where local tenderness or inability to attend makes other treatment impossible.

Local treatment is best carried out with the patient in the lithotomy position. In practice this may be obtained by asking the patient to sit on the edge of a couch, then to flex the thighs acutely on the abdomen and grasp the front of the ankle-joints with the hands. A good light is essential, either in the form of an angle-poise standard lamp or Ever-Ready head lamp. The labia are separated and any vulval discharge is cleansed by swabbing with saline, sodium bicarbonate solution, diluted green soap solution, or other suitable antiseptic. Treatment of the urethra and cervix may be ' wet ' or ' dry '. In the ' wet ' treatment the urethra is irrigated as in the male, using a shielded Janet nozzle to prevent splashing of the operator. A vaginal speculum (Cusco's or Fergusson's) is then passed, the cervix being brought into view, and the cervical canal washed out through a back-flow irrigator. The vagina is then mopped dry and a gauze pack moistened with glycerin, boroglycerin, or ichthyol and glycerin 5–10 per cent inserted. This treatment should be carried out at least once daily during the acute stages. In ' dry ' treatment, irrigation is not employed. After the patient has urinated, the urethra is mopped dry and antiseptic applied to its whole length by dressed-cane probe sticks, or a syringe with a Janet nozzle may be used for the topical application. A vaginal speculum is then passed, and the cervix exposed. The vagina and cervical canal are thoroughly cleansed by moist swabbing and dried as far as possible. The selected application is made to the endocervix by dressed probe or uterine cannula. Finally, the fornices and vagina are heavily powdered as the speculum is being withdrawn, and the inner aspect of the labia and vulva powdered.

The applications commonly used for the urethra and cervix are ichthyol and glycerin 5 per cent, mercurochrome 1–5 per cent in glycerin, silver nitrate 1–5 per cent, colloidal silver preparations, e.g., 5–15 per cent argyrol in water or glycerin, and gonopar. Alternatively, styli may be used for the urethra and cervix, e.g., albargin $\frac{1}{8}$–$\frac{1}{2}$ per cent, mercurochrome $\frac{1}{4}$ per cent, chloramine-T $\frac{1}{2}$ per cent in a base of ol. theobrom. and white wax, or spuman. A satisfactory dusting powder, which may be applied by a de Vilbiss powder blower, is :—

R	Zinc. Oxid.	gr. 60	Mag. Carb. Lev.	gr. 120
	Bismuth. Subgall.	gr. 120	Pulv. Amyli	oz. 1

During the first few weeks daily treatment is essential, and according to progress the intervals are lengthened to alternate days or twice weekly, and finally weekly. The course of treatment should be controlled by frequent bacteriological tests.

The Subacute and Chronic Stages.—The same principles of treatment apply to the subacute and chronic stages. The female urethra is liable to many of the complications found in the male. In chronic gonococcal endocervicitis stronger applications are permissible, e.g., 5–10 per cent silver nitrate, 10 per cent picric acid in spirit, tinct. iodi mitis, applied once or twice weekly. These act by cauterization, and irritation causing increased vascularity, as opposed to the hygroscopic action of the earlier applications. In very resistant cases it may be necessary to consider medical diathermy, linear diathermic cauterization of the endocervix, ionization, or dilatation, curettage, and cauterization.

Sulphonamide and penicillin treatment are as described for the male.

Treatment of Common Complications.—

Bartholinitis.—Pain is relieved by hot hip-baths, hot fomentations, or local applications of ichthyol and glycerin. If the duct is patent, treatment is by injection of 4 per cent mercurochrome with a Record syringe and blunt-pointed needle (a silver lacrimal needle is excellent). If the duct is occluded and the gland fluctuating, aspiration and injection of 4 per cent mercurochrome, which may be repeated if necessary, effects a cure in the majority of cases. Surgical incision and drainage may be required. The sulphonamides are often ineffective.

Salpingitis.—Rest in bed, hot hip-baths, and intravenous calcium therapy rapidly control the pain and reduce the temperature to normal. The sulphonamides are almost invariably effective. Owing to tenderness during the acute stages, local treatment is often impracticable apart from massive hot douches.

Rectal Infection.—The local treatment consists of permanganate rectal washouts and protargol suppositories.

Pruritus Vulvæ.—Painting the vagina and vulva with 1 per cent aqueous gentian violet, wet applications of 1–40 carbolic or lotio plumbi subacet. dil. are of value, or painting the vulva with 1 per cent silver nitrate may give relief.

Tests of Cure.—The tests of cure may be summarized: (1) Absence of signs and symptoms; (2) Normal clinical findings; (3) Absence of gonococci and pus from urethral and cervical smears and negative cultures—tests repeated monthly after menstrual period; (4) Negative gonococcal complement-fixation test; (5) Period of observation—six months.

During the intermenstrual periods the patient should have no treatment and should lead a normal life as regards diet, exercise, alcohol, etc.

Provocation with pilocarpine nitrate (1–400 solution), silver nitrate (1 per cent solution), or vaccine ($\frac{1}{2}$ c.c. polyvalent gonococcal vaccine) should be employed twenty-four hours before each test.

CHAPTER LXI

THE TREATMENT OF SYPHILIS AND CHANCROID

By A. E. W. McLachlan

SYPHILIS

The diagnosis of syphilis depends on the symptoms and clinical signs, the demonstration of *Sp. pallida*, and in other than early primary cases a positive blood-Wassermann reaction. From the point of view of treatment, syphilis falls into one of several categories :—

Early infective syphilis	W.R.-negative primary syphilis W.R.-positive primary syphilis Secondary syphilis
Late syphilis ('tertiary' syphilis), not necessarily infective	Skin and bone lesions Cardiovascular and other visceral lesions Neurosyphilis

TREATMENT OF EARLY INFECTIVE SYPHILIS

General.—Maintenance of general health, regularity of life, adequate but plain diet, regulation of the bowels, dental care if required, and abstention from alcohol and sexual intercourse are the main indications. Anæmia, seborrhœa, or eczema, if present, should be treated on general medical principles.

Local.—Pending diagnosis, antiseptics should not be applied to the sore. Saline and sulphur powder control sepsis and do not prevent demonstration of *Sp. pallida*. After diagnosis, 33⅓ per cent calomel cream or a dusting powder of equal parts of calomel and calamine may be applied to the primary sore, condylomata, etc. Mouth lesions should be treated with gargles, e.g., potassium chlorate, alum and borax, or peroxide of hydrogen. Chancres concealed under the prepuce may necessitate dorsal or lateral slits or complete circumcision on general surgical principles. Skin lesions in general require no local treatment. Infectivity is rapidly controlled, and healing prompt under specific therapy.

Specific.—The drugs used are, in order of therapeutic efficiency, the neoarsphenamines, bismuth preparations, mercurials, and iodides.

Neoarsphenamines (e.g., N.A.B., i.e. '914', neokharsivan, novostab, stabilarsan).—These are given intravenously in dosage from 0·3 g. to 0·75 g., dissolved in 10–20 c.c. sterile doubly distilled water, 10 per cent sodium thiosulphate, 10 per cent sodium iodide, or 20 per cent glucose solution. Where the intravenous route is impracticable, sulpharsphenamine (e.g., sulfarsenol, sulphostab, kharsulphan, etc.) may be given intramuscularly (dose 0·3–0·6 g.) dissolved in 1–2 c.c. of sterile distilled water. Mapharside (arsenoxide), a recently introduced arsenical, may be substituted for the neoarsphenamines—dose 0·04 to 0·06 g. intravenously, dissolved in 10 c.c. sterile distilled water. A similar preparation is neo-halarsine, dose 0·06 to 0·09 g.

Prior to injection, the patient should have fasted for two hours and should refrain from a heavy meal for two hours after injection. Glucose (glucose gr. 240, sod. bicarb. gr. 20, ol. limonis m. 1, aq. ad oz. 3–4) may be given by mouth half an

hour before injection to increase the glycogen content of the liver and prevent reactions. The urine should be tested for bile and albumin. The ampoule of drug should be examined to exclude faults: oxidation of the drug causes toxicity and is shown by darkening of the colour (compare with another ampoule of the same batch). The dose is completely dissolved in the chosen vehicle. The syringe and needles should be sterilized and freed from antiseptics or spirit by washing in distilled water.

Bismuth Preparations.—Liposoluble bismuth (bivatol, neocardyl, stabismol, etc.) is given in dosage of 0·06–0·1 g. intramuscularly twice weekly. Insoluble salts, e.g., oxychloride, or metallic bismuth may be given intramuscularly in the upper outer gluteal quadrant in dosage of 0·2–0·3 g. once weekly. The liposoluble preparations exert a more rapid action, but are rapidly excreted, whereas the insoluble salts are more slowly absorbed from the tissues and have a more prolonged influence on the infection.

Mercurial Preparations.—Oral administration of liq. hydrarg. perchlor. 60 m. t.d.s., pil. hydrarg. c. cret. 1 gr. t.d.s., etc., is of value in tertiary skin, bone, cardiovascular, and visceral syphilis. *Inunction* of mercury is now seldom practised 60 gr. of ung. hydrarg. is thoroughly rubbed into a different area of the body daily—the limbs, abdomen, back, in rotation, avoiding hair-bearing areas.

Intramuscularly mercury is given as Lambkin's or Squire's cream (metallic mercury) 1 gr. weekly, or mercury salicylate 1½ gr. weekly. Mercury has to a great extent been displaced by bismuth.

Iodides.—Iodides may be given by mouth (potassium iodide 15–60 gr. t.d.s.), or intravenously (10–50 c.c. 10 per cent sodium iodide). They have little action on the spirochæte, but are of value in 'dissolving' syphilitic granulomatous tissue.

Courses of Treatment.—Dual therapy with neoarsphenamine and bismuth in courses of 10 weeks, with a rest of 2 to 4 weeks between, gives excellent results.

DOSAGE FOR 10-WEEKS' COURSE

Week	Neoarsphenamine	Bismuth
1	0·45 g.	0·2–0·3 g.
2	0·6 g.	0·2–0·3 g.
3	0·6 g.	0·2–0·3 g.
4	0·6 g.	0·2–0·3 g.
5	0·6 g.	0·2–0·3 g.
6	0·6 g.	0·2–0·3 g.
7	0·6 g.	0·2–0·3 g.
8	0·6 g.	0·2–0·3 g.
9	0·6 g.	0·2–0·3 g.
10	0·6 g.	0·2–0·3 g.
	5·85 g.	2–3 g.

Rest 2 to 4 weeks; repeat Wassermann reaction; repeat above course, rest, and Wassermann reaction.

Three similar courses should be given after the first negative Wassermann reaction. Thereafter blood-Wassermann observations should be carried out at three-monthly intervals for two years. (A 'provocative' dose of '914'—0·45–0·6 g.—should be given one week prior to blood-test on at least three occasions during this period.) Clinical examination of the central nervous system, and serological examination of cerebrospinal fluid for cells, globulin,

Wassermann reaction, and gold-sol test, and radiography of the thorax to exclude cardiovascular lesions are made at the end of the two years' observation period.

Intensive Arsenotherapy of Early Syphilis.—In recent years the rapid treatment of early syphilis has found an increasing number of advocates. Originally a five-day course of mapharside, total 1400 mg., was given by continuous drip or by multiple daily injections. This, because of the incidence of toxic reactions, was only applicable to young, fit adults, and has been almost completely abandoned in favour of the *twenty-day course.* A weight-dosage of 1 mg. mapharside, or 1½ mg. neo-halarsine per kilogramme body-weight is administered daily for twenty days, along with four doses each of 0·3 g. bismuth. The patient should be hospitalized, but need not be confined strictly to bed. The diet should be high in carbohydrate and protein, and should include one pint of milk daily. The urine should be tested twice daily with Ehrlich's reagent for urobilinogen. The occurrence of a positive test, the occurrence of fever persisting for more than twenty-four hours, or the onset of other complications of arsenotherapy necessitate termination of treatment.

Penicillin.—This has been found to possess marked spirochæticidal properties, and causes rapid healing of primary sores, resolution of secondary lesions, and reverses a positive serological reaction. The optimum time-dosage has not yet been completely evaluated: the course of administration at present advised is 40,000 Oxford units three-hourly for seven and a half days (total 2,400,000 units). Apart from some local tenderness at the sites of injection, and the occurrence in a number of cases of Herxheimer reactions, i.e., flaring up of a skin rash or other lesions, no complications have been recorded. Many authorities advise that on completion of penicillin therapy, a full ten-weeks' course of neoarsphenamine and bismuth should be administered.

The end-results of penicillin and intensive arsenotherapy have not yet been fully evaluated, and the most careful observation of the patient is subsequently required for a minimum period of two years.

TREATMENT OF LATE SYPHILIS

Skin and Bone (Gummatous) Lesions.—In the absence of cardiovascular or visceral lesions courses of 10 weeks' treatment, as above, should be given. The dosage may have to be greatly modified because of age or intolerance. The blood-Wassermann reaction may remain persistently positive. Local treatment is by fomentations or mildly antiseptic protective dressings, on general principles.

Cardiovascular and Visceral Syphilis.—Potassium iodide and liq. hydrarg. perchlor. or Guy's pill are of value in conjunction with bismuth and arsenicals in small dosage (0·05–0·2 g. and maximum of 0·3 g. respectively). Treat to the maximum of clinical improvement.

Neurosyphilis.—Tryparsamide (dose 1–3 g.) intravenously, the drug of choice, necessitates examination of optic discs; optic atrophy is a contra-indication. Silver-arsphenamine (dose 0·1–0·3 g. intravenously) may be used in such cases, combined with bismuth intramuscularly. Other therapy: malaria or pyrexial measures are valuable.

Intolerance and Toxic Reactions to Arsphenamine Treatment.—*Relative or absolute contra-indications* to the exhibition of '914' are diabetes, Addison's disease, nephritis, gross hepatic disease, tuberculosis, and alcoholism. Each case should be judged on its merits: where there is the possibility of a specific cause, rapid improvement should follow small dosage of '914' or bismuth.

Toxic Reactions.—

1. *Immediate*: During or within twenty-four hours of administration of '914' nausea, a taste of garlic in the mouth, vomiting, a fainting feeling, or pain in the gums may occur; these may be prevented by slow injection of a dilute solution of the drug, the use of sodium thiosulphate or glucose as solvents, or the admixture of vitamin C. A 'nitritoid' or anaphylactoid crisis—respiratory and cardiac distress, flushed face, and swelling of lips, tongue, and face—rarely occurs, and is treated by adrenaline ½ to 1 c.c. Headaches, rigors, temperature reaction, diarrhœa and vomiting, and transient albuminuria may occur within twenty-four hours and be associated with a Herxheimer reaction. For these the treatment is symptomatic. Subsequent prevention is by vitamin C, calcium salts, or glucose, while further dosage of arsenicals may require modification. Infrequently serious apoplexy occurs—nerve irritation, headache, inability to concentrate, epileptiform convulsions—and may be treated by adrenaline, venesection, thecal drainage (15–20 c.c.), or calcium salts.

2. *Late*: Malaise, depression, and loss of weight may occur.

Jaundice may vary from a mild catarrhal type to an acute liver atrophy. Treatment is by a fat-free diet, calcium thiosulphate, vitamin C, or intravenous glucose, in addition to alkaline mixtures. No arsphenamine should be administered for from 6 to 12 weeks after cure.

Dermatitis is predisposed to by alcohol, focal sepsis, or pre-existing dermatosis, and commences as an erythema, rapidly progressing to exfoliation. Local treatment is by lin. calaminæ in the early stages, bran baths or a bran bed in the exfoliative stages, and later, oily applications. More specific measures are vitamin C by mouth, or calcium or sodium thiosulphate or glucose intravenously. Further arsenic is contra-indicated.

Purpura Hæmorrhagica is rapidly controlled by calcium salts.

Intolerance to Bismuth.—A bismuth line frequently occurs on the gums and may go on to ulcerative stomatitis. Prevention is by early dental care. Treatment: alum gargles, application of hydrogen peroxide, or colloidal iodine give relief. If gastro-intestinal symptoms or albuminuria occurs, rest from the drug is advisable.

Tests of Cure.—The tests of cure of early infective syphilis have been indicated in the treatment section. Where the Wassermann reaction remains obstinately positive despite long-continued treatment, cardiovascular and nervous system involvement should be excluded. Long-continued observation is necessary to be certain that no reactivation is likely. A positive Wassermann reaction in an adequately treated patient does not necessarily indicate infectivity and is not incompatible with a long and useful life.

CHANCROID

Chancroid ulceration is rapidly healed by the sulphonamides, phagedena is prevented, and the associated bubo resolves without rupture. Cauterization, e.g., with 25 per cent thymol iodide of ether, acid nitrate of mercury, pure carbolic acid, or the electric cautery, is now seldom required. Free drainage should, if necessary, be accomplished by dorsal or lateral slits. Dressings of eusol should be applied in the first instance; later red lotion or 1–4 per cent mercurochrome ointment to stimulate healing. Subsequent observation should be long enough to exclude a concomitant syphilis.

CHAPTER LXII

TREATMENT OF BRUISES AND SPRAINS

By A. G. TIMBRELL FISHER

THE treatment of sprains and allied injuries is of considerable importance, both to the house surgeon and the practitioner, for thousands of working hours are lost and much prolonged disability results from ineffective treatment of these injuries.

BRUISES

A contusion often results in the subcutaneous escape of blood from the capillaries and an ecchymosis develops. In more severe cases a hæmatoma, the result of subcutaneous injury to a vein, occurs rapidly. When considerable bruising follows a minor injury, the possibility of hæmophilia, or delayed coagulability of the blood, should be suspected. It is not unusual for a bruise to appear at some distance from the site of the injury, particularly when the latter affects the deeper tissues; in such cases blood has travelled to the surface along fascial planes. The familiar colour changes in bruises are due to disintegration of hæmoglobin. Clotting in a hæmatoma usually first occurs at the periphery, the fluid centre being absorbed more gradually. In subpericranial cephalhæmatoma this often causes difficulty in diagnosis (*see* p. 186). Occasionally, a hæmatoma suppurates.

Treatment.—Usually, the associated injury to ligament, muscle, etc., is the principle consideration, and the bleeding (bruising) requires no special treatment. Bruising can sometimes be limited or prevented by applications of cold water, ice, or evaporating lotions. A strong solution of freshly prepared ammonium chloride, or of liquor plumbi subacetatis, applied on lint, is sometimes of value. Firm pressure by bandaging over a layer of wool, or by strapping, may be combined advantageously with these applications.

Special Bruises.—Occasionally a hæmatoma confined by deep fascia causes severe pain. In such cases the blood requires evacuation either by aspiration, or, rarely, by open operation.

Hæmorrhagic effusion into a joint only needs aspiration if it is excessive and is causing much pain and tension. Such a procedure should always be carried out with the strictest attention to aseptic ritual. It should be noted that aspiration of a traumatic effusion into a joint is very seldom necessary, as in most cases absorption occurs with a combination of firm bandaging of the joint combined with gentle active movements, which, in the lower extremity, should be at first non-weight-bearing.

In hæmorrhage associated with muscular sprains or ruptures the effused blood may spread in intermuscular planes, and subsequent organization of the clot may cause troublesome adhesions, with painful limitation of certain movements. This sequel can sometimes be prevented by massage and by early movements, and for its treatment manipulation under anæsthesia is often of great value.

An ecchymosis or hæmatoma may be associated with a ligamentous or muscular sprain or rupture. A severe ligamentous injury, or fracture into a joint, may be associated with intra-articular hæmorrhage or hæmarthrosis.

SPRAINS

A sprain may involve a ligament, muscle, or tendon, and usually follows overstretching from some sudden movement which is frequently of a twisting nature. It is associated with rupture of some of the muscular or connective-tissue fibres, and hence with more reaction than in cases of simple *strain* from minor injuries, or the chronic ligamentous strain often associated with deformities (e.g., chronic sacro-iliac or lumbo-sacral strain).

The first lines of defence of a joint are the muscles which act upon it, and a ligamentous sprain may be due to some sudden movement when the muscles are momentarily taken unawares, or, in more severe cases, to failure of the muscles to counter the strain. The knee, ankle, shoulder, and wrist are frequently involved.

Diagnosis.—Pain, swelling, and tenderness are always more marked over the affected ligament, often at one or other of its attachments. Movements of the joint which stretch the damaged ligament are painful and restricted by reflex muscular spasm. In many cases ecchymosis occurs, and, in the more severe, hæmorrhagic effusion into the joint (hæmarthrosis) usually follows. In the knee, limitation of extension following sprain and due to spasm of the flexor group of muscles must be carefully distinguished from that due to a mechanical block, as occurs in unreduced fracture-dislocation of a semilunar cartilage.

X-ray examination should never be omitted in any severe joint injury. Many sprains are associated with fracture. Common examples are sprain of the internal lateral ligament of the knee with separation of a small bony fragment from the internal femoral condyle; fracture of the external malleolus associated with sprain of the external lateral ligament of the ankle; and injuries to the great tuberosity of the humerus in sprains in the shoulder region.

Rupture of a ligament is a more serious condition, and the signs mentioned above are increased. It is associated with hypermobility of the joint; for instance, in complete rupture of the internal lateral ligament of the knee-joint there is no impediment to abduction of the leg in relation to the thigh. Diagnosis of rupture is facilitated by the local injection of an anæsthetic, such as 2 per cent novocain, to abolish muscular spasm, which might otherwise mask the presence of hypermobility. The differential diagnosis of sprain and complete ligamentous rupture is of fundamental importance, for if the latter condition is overlooked great disability surely follows.

Treatment.—Success depends upon a judicious combination of rest and movement. A sprained ligament cannot be repaired if the damaged fibres are subject to constant fresh injuries. On the other hand, if a sprained joint or tendon be kept completely at rest for too long a period, repair of the ligament takes place at the expense of (*a*) muscular wasting, and (*b*) adhesions. Active movements of the affected joint or of the tendons or muscles that pass over the joint must be commenced from the first, but in such a manner that no strain is placed upon the ligament or tendon undergoing repair.

Example: Sprain of External Lateral Ligament of the Ankle-joint.—Neglected cases are often seen in which persistent tenderness exists over the affected portion of the ligament with pain and swelling during exercise, a persistent slight

CHAPTER LXII

TREATMENT OF BRUISES AND SPRAINS

By A. G. TIMBRELL FISHER

THE treatment of sprains and allied injuries is of considerable importance, both to the house surgeon and the practitioner, for thousands of working hours are lost and much prolonged disability results from ineffective treatment of these injuries.

BRUISES

A contusion often results in the subcutaneous escape of blood from the capillaries and an ecchymosis develops. In more severe cases a hæmatoma, the result of subcutaneous injury to a vein, occurs rapidly. When considerable bruising follows a minor injury, the possibility of hæmophilia, or delayed coagulability of the blood, should be suspected. It is not unusual for a bruise to appear at some distance from the site of the injury, particularly when the latter affects the deeper tissues; in such cases blood has travelled to the surface along fascial planes. The familiar colour changes in bruises are due to disintegration of hæmoglobin. Clotting in a hæmatoma usually first occurs at the periphery, the fluid centre being absorbed more gradually. In subpericranial cephalhæmatoma this often causes difficulty in diagnosis (*see* p. 186). Occasionally, a hæmatoma suppurates.

Treatment.—Usually, the associated injury to ligament, muscle, etc., is the principle consideration, and the bleeding (bruising) requires no special treatment. Bruising can sometimes be limited or prevented by applications of cold water, ice, or evaporating lotions. A strong solution of freshly prepared ammonium chloride, or of liquor plumbi subacetatis, applied on lint, is sometimes of value. Firm pressure by bandaging over a layer of wool, or by strapping, may be combined advantageously with these applications.

Special Bruises.—Occasionally a hæmatoma confined by deep fascia causes severe pain. In such cases the blood requires evacuation either by aspiration, or, rarely, by open operation.

Hæmorrhagic effusion into a joint only needs aspiration if it is excessive and is causing much pain and tension. Such a procedure should always be carried out with the strictest attention to aseptic ritual. It should be noted that aspiration of a traumatic effusion into a joint is very seldom necessary, as in most cases absorption occurs with a combination of firm bandaging of the joint combined with gentle active movements, which, in the lower extremity, should be at first non-weight-bearing.

In hæmorrhage associated with muscular sprains or ruptures the effused blood may spread in intermuscular planes, and subsequent organization of the clot may cause troublesome adhesions, with painful limitation of certain movements. This sequel can sometimes be prevented by massage and by early movements, and for its treatment manipulation under anæsthesia is often of great value.

An ecchymosis or hæmatoma may be associated with a ligamentous or muscular sprain or rupture. A severe ligamentous injury, or fracture into a joint, may be associated with intra-articular hæmorrhage or hæmarthrosis.

SPRAINS

A sprain may involve a ligament, muscle, or tendon, and usually follows overstretching from some sudden movement which is frequently of a twisting nature. It is associated with rupture of some of the muscular or connective-tissue fibres, and hence with more reaction than in cases of simple *strain* from minor injuries, or the chronic ligamentous strain often associated with deformities (e.g., chronic sacro-iliac or lumbo-sacral strain).

The first lines of defence of a joint are the muscles which act upon it, and a ligamentous sprain may be due to some sudden movement when the muscles are momentarily taken unawares, or, in more severe cases, to failure of the muscles to counter the strain. The knee, ankle, shoulder, and wrist are frequently involved.

Diagnosis.—Pain, swelling, and tenderness are always more marked over the affected ligament, often at one or other of its attachments. Movements of the joint which stretch the damaged ligament are painful and restricted by reflex muscular spasm. In many cases ecchymosis occurs, and, in the more severe, hæmorrhagic effusion into the joint (hæmarthrosis) usually follows. In the knee, limitation of extension following sprain and due to spasm of the flexor group of muscles must be carefully distinguished from that due to a mechanical block, as occurs in unreduced fracture-dislocation of a semilunar cartilage.

X-ray examination should never be omitted in any severe joint injury. Many sprains are associated with fracture. Common examples are sprain of the internal lateral ligament of the knee with separation of a small bony fragment from the internal femoral condyle; fracture of the external malleolus associated with sprain of the external lateral ligament of the ankle; and injuries to the great tuberosity of the humerus in sprains in the shoulder region.

Rupture of a ligament is a more serious condition, and the signs mentioned above are increased. It is associated with hypermobility of the joint; for instance, in complete rupture of the internal lateral ligament of the knee-joint there is no impediment to abduction of the leg in relation to the thigh. Diagnosis of rupture is facilitated by the local injection of an anæsthetic, such as 2 per cent novocain, to abolish muscular spasm, which might otherwise mask the presence of hypermobility. The differential diagnosis of sprain and complete ligamentous rupture is of fundamental importance, for if the latter condition is overlooked great disability surely follows.

Treatment.—Success depends upon a judicious combination of rest and movement. A sprained ligament cannot be repaired if the damaged fibres are subject to constant fresh injuries. On the other hand, if a sprained joint or tendon be kept completely at rest for too long a period, repair of the ligament takes place at the expense of (*a*) muscular wasting, and (*b*) adhesions. Active movements of the affected joint or of the tendons or muscles that pass over the joint must be commenced from the first, but in such a manner that no strain is placed upon the ligament or tendon undergoing repair.

Example: Sprain of External Lateral Ligament of the Ankle-joint.—Neglected cases are often seen in which persistent tenderness exists over the affected portion of the ligament with pain and swelling during exercise, a persistent slight

limitation of inversion of the foot, and a complaint of periodical " giving way " of the ankle. In such cases, repair of the ligament has become associated with contracted scar tissue or adhesions, the formation of which the practitioner must always endeavour to prevent.

In slight cases, with little or no swelling, the ankle is strapped with overlapping strips of flexible adhesive plaster which extend from the outer border of the foot in an upwards and inwards direction, but do not completely encircle the ankle-joint. The outer side of the heel of the shoe on the affected side should be reinforced by a wedge of leather a quarter of an inch in thickness. While the external lateral ligament is thus relieved from strain, gentle exercise in the form of walking may be allowed. An alternative method is firm bandaging of the joint over a thick pad of wool placed over the damaged ligament. This method has the advantage that it facilitates such physical measures as massage and assisted movements, preceded by radiant heat, infra-red, galvanic, or hot saline, foot-baths. If the services of a skilled physiotherapist are available, these should be enlisted.

In more severe cases, considerable bruising and swelling are present, and provided associated fracture or complete ligamentous rupture have been excluded, treatment should be as follows : Rest from weight-bearing at first, with application of cold compresses or evaporating lotion. Superficial massage (effleurage) assists in relieving pain and in the diminution of swelling, and in the intervals the joint is firmly bandaged. When pain, swelling, and bruising have largely subsided, treatment is continued as for minor degrees of sprain.

Rupture of External Lateral Ligament of Ankle.—In such cases repair obviously necessitates a longer period of freedom from strain upon the damaged ligament. Treatment should at first be upon the same lines as for severe sprain. When swelling has partially subsided, the ankle is encased in plaster-of-Paris, which extends from the roots of the toes to the upper third of the leg, and the patient is encouraged to walk. At the end of a month, the plaster is removed and a crêpe bandage substituted, which is removed daily for radiant heat and massage.

Treatment on similar lines is adopted in cases of sprain-fracture of the ankle. It has been shown by Bohler and others that, owing to the movement of the tendons passing over the joint, such ambulatory plaster treatment is neither complicated by the formation of adhesions nor does muscular wasting occur to any appreciable extent.

In cases of sprain Leriche recommends infiltration of the damaged ligament with novocain, and claims that this measure, by its effect upon the reflex arc, limits effusion and reduces the period of incapacity.

In severe sprains of the shoulder, the arm should be placed on a splint in abduction and external rotation, as these movements are apt to be restricted by adhesions if the arm be kept by the side.

Muscular or Tendinous Strains and Ruptures.—Strain of a muscle or tendon involves its attachment to bone, from which a variable number of the muscular or tendinous fibres may be torn away, with some damage to the periosteum. Sometimes a portion of the bony attachment may be wrenched off by muscular action. Such muscular strains are common, both in sport and in various industrial occupations (' tennis elbow ', rider's strain of the adductor longus, etc.). Actual rupture, either partial or complete, of a tendon or muscle is a more serious lesion, and may occur almost anywhere in its course, but more

commonly at the junction of the muscle and its tendon. Partial rupture of the rectus femoris commonly occurs in football players or a transverse tear of the muscle and tendon may occur near its patellar attachment. Rupture of the long head of the biceps or of its tendon, and similar injuries to the supraspinatus tendon, the tendo Achillis, or the plantaris tendon are all common injuries.

Diagnosis.—Sudden acute pain during some strenuous exercise is accompanied by immediate loss of power, and followed by swelling, tenderness, and bruising. In rupture of muscle, if superficial, a gap may be felt, and on attempting to contract the muscle a characteristic rounded swelling appears in the course of the muscle and proximal to the tear. Hæmorrhage may be diffuse and involve intermuscular planes or take the form of a localized hæmatoma.

Passive movement in the line of action of the injured muscle is comparatively painless, but active movement is restricted or inhibited, painful, and accompanied by the signs mentioned above.

Treatment.—A muscular or tendinous strain, if slight, is best treated by massage and support in the form of a bandage or strapping, and, as in ligamentous sprain, the avoidance of those movements which stretch the damaged parts. In cases of chronic strain associated with localized pain and tenderness such measures as infra-red rays, ionization, or diathermy are often of value, or, in obstinate cases, the injection of novocain. In those cases associated with adhesion formation, manipulation under local or general anæsthesia may be of great value. In more severe cases, the principles of treatment resemble those for severe ligamentous sprain, viz., avoidance of strain upon the damaged parts until repair has taken place combined with such functional use as does not interfere with this principle.

Examples: Severe strain of the deltoid should be treated with the arm in the abducted position; in sprains of the quadriceps, extension of the leg is desirable to avoid stretching of the muscle by flexion movements; in sprain of the biceps the forearm is flexed, and in strain of the tendo Achillis the principle is achieved by plantar flexion of the foot, as by the simple device of increasing the height of the heel of the shoe on the affected side.

Rupture of Muscle or Tendon—If a muscle or tendon is completely ruptured, immediate suture is in most cases the wisest procedure and should lead to a more rapid restoration of function than is possible with conservative methods.

ADHESIONS

By careful attention to the principle of avoidance of strain during repair of the damaged ligament, muscle, or tendon, combined with early active movements, it should usually be possible to avoid the bugbear of troublesome traumatic adhesions. A certain degree of temporary stiffness often occurs, but this is normally slight and quickly disappears with use of the limb, combined, if necessary, with such measures as heat, massage, and special exercises. When rest has been too prolonged, adhesions in or around muscles, ligaments, or tendons may resist these measures, and manipulation under anæsthesia is indicated. Manipulation, often so eminently successful in suitable cases, should be adopted as soon as it is evident that the adhesions are not yielding to the usual methods of physical treatment.

CHAPTER LXIII

TREATMENT BY MANIPULATION

By A. G. TIMBRELL FISHER

MANIPULATIVE treatment is an important branch of surgical work which has hitherto been neglected by medical men. Consequently many sufferers from chronic disabilities of joints or of the spine, despairing of obtaining relief from orthodox practitioners, have drifted and still drift into the hands of bonesetters or osteopaths. Although it is folly to ignore the fact that many were promptly cured, it is equally foolish to overlook the disasters that often occur from manipulation in unsuitable cases by such unqualified practitioners. There is no mystery about manipulative work, and there is nothing in this field that cannot be better and far more safely performed by a medical man, who, having the necessary flair for the work, has taken pains to master the subject.

Some aspects of manipulative work, particularly its use in the stiffened joints of rheumatic disease, are difficult and highly specialized. However, there are many straightforward manipulations that the general practitioner or house surgeon is perfectly justified in performing.

Classification.—

Cases that may be cured or benefited by manipulation fall into four main groups .—

1. Articular and peri-articular adhesions.
2. Adhesions in connexion with muscles, tendons, or fasciæ.
3. Functional and hysterical conditions of joints.
4. Dislocations and subluxations of joints, tendons, and intra-articular discs.

ARTICULAR AND PERI-ARTICULAR ADHESIONS

Diagnosis.—The most characteristic sign of traumatic adhesions is limitation of some particular movement and pain on attempting to increase the range of this movement. Other movements are comparatively unaffected. For example, after a sprain of the external lateral ligament of the ankle-joint in which adhesions have developed, the movement of inversion of the foot is painful and restricted. Again, many cases of adhesions in the knee-joint following synovitis are associated with a painful limitation of flexion of the joint, whereas extension is unrestricted. In addition to pain on some particular movement, there may be aching, particularly after exercise. Localized tenderness at the site of the adhesions can usually be elicited. Recurrent effusion after exercise is another characteristic symptom of adhesions, as is also attacks of sudden ' giving way ' of the joint in the case of the lower extremity. Demonstrable wasting of the muscles activating the affected joint is usually present ; in the case of the knee-joint it is the quadriceps and particularly the vastus internus which become attenuated.

Differential Diagnosis.—Before attempting manipulation it is of the utmost importance to exclude certain conditions in which many of the above symptoms are present, but in which manipulation may be futile or dangerous. The chief of these is a tuberculous joint. Manipulations of a tuberculous joint may be followed by such tragic consequences as amputation or even the death of the patient. For this reason it is necessary in every case where there is the slightest doubt to have a radiograph taken of the affected joint. Space will not permit

a discussion on the differential diagnosis; nevertheless, a careful clinical examination and inquiry into the history and radiography should rule out not only tuberculous disease but other conditions in which manipulation is contra-indicated, such as neoplasm and myositis ossificans.

Prevention.—Adhesions are a frequent sequel of sprains and other joint injuries, although they occur also after rheumatic and other forms of arthritis or synovitis. In traumatic cases and in many forms of arthritis, adhesions are, to a large extent, preventable by appropriate treatment of the original condition (*see* Chapter LXII). The most potent cause of adhesion formation and obstinate stiffness of a joint after a sprain or other injury is prolonged and complete immobilization. A judicious combination of rest to enable repair of the damaged structures, together with careful active or assisted movements to prevent adhesion formation and muscular wasting, should be practised.

If a plaster-of-Paris cast is used for a severe sprain, it should be bi-valved as soon as possible so that the patient can be encouraged to move the joint, which is also thus accessible for physiotherapy. The two halves of the plaster cast are replaced after treatment. If this precaution is taken, adhesions and muscular wasting are seldom in evidence. In the case of fractures, where it is necessary to immobilize temporarily a joint or joints, a longer period in plaster may be necessary, but movements of the joints not immobilized should be practised from the first

Adhesions occurring in connexion with Rheumatic and other forms of Arthritis present a more difficult problem and in the more acute forms some degree of adhesion formation is inevitable. However, adhesions can be lessened by attention to the above principles. In such forms of arthritis we must constantly be on our guard against the insidious development of deformity owing to the more powerful action of certain groups of muscles, particularly the flexor.

Optimum Positions for Joints.—

In every case of inflammation of a joint the possibility of ankylosis should be borne in mind. It is therefore of the utmost importance to place the joint or joints, and to apply splintage, in the optimum position of function. Every practitioner should make himself acquainted with the optimum position for every joint, including the joints of the spine (*Fig.* 615).

ADHESIONS IN CONNEXION WITH MUSCLES, TENDONS OR FASCIÆ

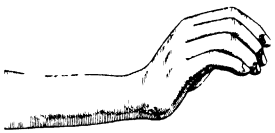
These occur frequently and are often treated successfully by manipulation. They may follow an injury or be a manifestation of rheumatism. Common examples are scar tissue or adhesions following rupture of muscle-fibres as in the adductor muscles of riders and the quadriceps of footballers. A common type of 'tennis elbow' is also an example. Often 'lumbago' is due to inflammation of the lumbar fascia and intermuscular fibrous septa and repeated attacks may be followed by adhesions which give rise to chronic backache and stiffness. Many cases belonging to this group respond well to manipulation.

FUNCTIONAL AND HYSTERICAL CONDITIONS OF JOINTS

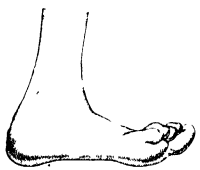
These cases fall into three main categories: (*a*) Cases that are entirely functional; (*b*) Functional cases to which from disuse an organic factor has been added, such as adhesions and muscle and tendon shortening; (*c*) Cases in which a functional element has become added to a joint in or around

which adhesions are present. This combination is very frequently seen in the rheumatic form of arthritis.

Fig. 615.—Optimum Position for Ankylosis of Various Joints.



Wrist. Extension through 45

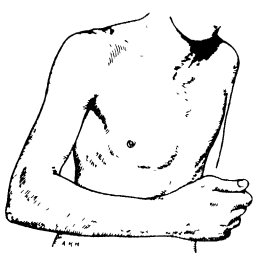


Ankle. Foot forms angle of 90 (or slightly less) with leg

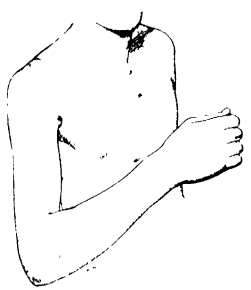


Knee. Full extension

Hip. Slight flexion, abduction, and external rotation



Right shoulder and elbow (unilateral cases). Shoulder is flexed 20°, abducted 45–75° and partially rotated outwards. Elbows at 90°.



Optimum position for an elbow. In ankylosis of both elbows, the right should be fixed at slightly less, and the left at slightly more, than this angle.

DISLOCATIONS AND SUBLUXATIONS

Major dislocations are usually diagnosed correctly; on the other hand, subluxations or partial displacements which occur mainly in arthrodial or gliding joints are frequently overlooked, as are also dislocations of tendons and interarticular discs. Of these by far the most important are the semilunar cartilages of the knee-joint.

GENERAL PRINCIPLES OF MANIPULATIVE TREATMENT

Successful manipulation depends not only upon recognition of suitable types of cases and on the right time for manipulation, but on the use of the appropriate movements and of the proper degree of force. The degree of force and the actual technique can only be learned by practice.

The commonest mistake is to use too much force, but it is almost as common an error not to use sufficient force. Extreme force is unnecessary and dangerous, and may not only lead to fracture of an adjacent bone, dislocation, or severe injury to blood-vessels, nerves or other important structures, but to a severe and painful reaction in the joint and consequent re-stiffening. If the adhesions are dense, it is wiser to conduct a series of manipulations and proceed cautiously, consolidating the gain after each manipulation by appropriate re-educational exercises. In fact, after every manipulation, it is of vital importance that the patient should perform those exercises which ensure that the increased range of movement is maintained and muscle tone restored. In difficult cases, these should be associated with radiant heat or infra-red irradiation, massage, electricity, or other methods of physical treatment.

Anæsthesia in Manipulative Work.—For successful manipulation complete muscular relaxation is necessary. In minor cases and when other forms of anæsthesia are contra-indicated, injection of a local anæsthetic, such as novocain may be used. For such short and simple manipulations as will be described later, nitrous oxide, either alone or combined with oxygen, is, if given skilfully, usually adequate. An excellent anæsthetic for manipulative work is intravenous pentothal. This is suitable even for back cases and cases with marked adhesions, and can be supplemented by gas and oxygen, though this is seldom necessary. Pentothal should not be given in the out-patient department or surgery, and admission to hospital or nursing home for a short period is advisable if this or other intravenous anæsthetic be used.

EXAMPLES OF MANIPULATIVE TECHNIQUE

Knee-joint : Replacement of Fracture—Dislocation of Semilunar Cartilage.—The term 'displaced cartilage' so often employed is misleading. In the great majority of cases a fracture of the semilunar cartilage occurs and the characteristic symptoms are due to the behaviour of the displaced fragment. In about half of the cases the fracture is longitudinal, and this when involving the whole semilunar except its extremities is sometimes known as the 'bucket-handle' type (Rutherford Morison). Other types of injury comprise oblique fractures of the anterior, middle, and posterior thirds of the semilunar cartilage.

The most characteristic sign of a lesion of a semilunar cartilage is mechanical locking, which usually takes the form of a block to extension of the knee of from 10° to 20°. In original cases locking does not invariably occur or it may be momentary, and in any case it is associated with marked muscular spasm, which in itself constitutes an impediment to extension. As such muscular spasm often accompanies a severe sprain of the knee-joint and, indeed, many other forms of injury, it is not always easy to determine at first whether true mechanical locking is present. Muscular spasm subsides gradually with rest, so that a persistent limitation of extension should arouse suspicion that a fracture-dislocation of a semilunar cartilage exists. In recurrent cases pain and spasm are usually less and the diagnosis of locking is straightforward. Repair in the semilunar cartilages is very sluggish and delay in reposition militates against union of the fractured surfaces.

Manipulative Technique for Semilunar Cartilage Derangement.—An anæsthetic should always be administered if possible. Although gas, either alone or combined with oxygen, if given by an expert, sometimes gives sufficient relaxation, it is unreliable. Intravenous anæsthesia is valuable for this type of manipulative operation.

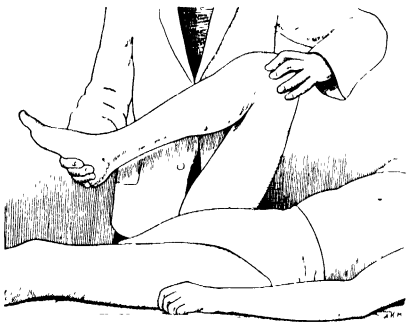


Fig. 616.—Manipulation of right knee for fracture-dislocation of internal semilunar cartilage. Stage I. Full flexion.

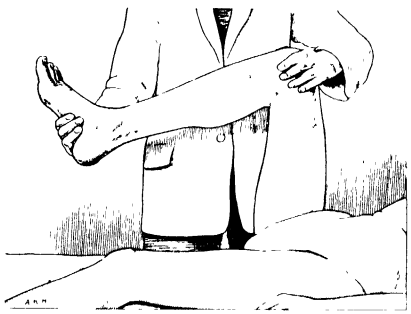


Fig. 617.—Stage II. Rotation with abduction.

Method I (*Figs.* 616–618): The patient lies upon his back upon a couch, bed, or operating table. Taking as an example locking due to a lesion of the right internal semilunar cartilage, the surgeon grasps the patient's foot with the right hand and supports the affected knee with his left hand. He then flexes the knee fully and rotates the tibia internally and externally. Next he slowly extends the

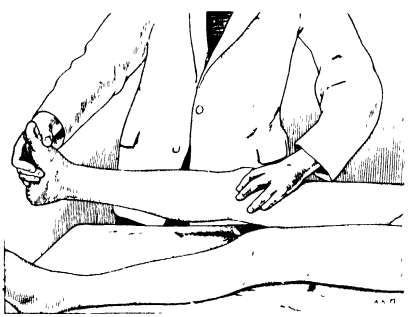


Fig. 618.—Stage III. Extension terminating in internal rotation.

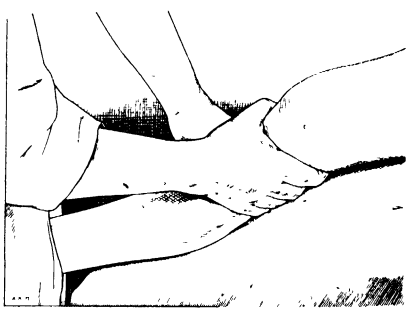


Fig. 619.—Method 2. Manipulation for fracture-dislocation of semilunar cartilage.

leg and continues rotation of the tibia while abducting the tibia to open up the inner side of the joint. This is done to encourage the fractured portion of the internal semilunar to retrace its steps. The termination of extension is accompanied by a strong movement of internal rotation of the tibia (the ' screw home ' movement).

Method II (*Fig.* 619): In difficult cases, the end of the operating table is lowered and the patient's leg allowed to hang down, or the patient sits upon a

chair or stool. The surgeon sits or stands facing the knee, which is flexed through about 20°, grips the lower part of the patient's leg between his thighs, and the head of the tibia with his hands. By means of the thigh grip he abducts the leg thus opening up the inner side of the knee-joint. Then grasping the head of the tibia firmly with his hands, he rotates the leg inwards and outwards.

The manipulative replacement of a lesion of the external semilunar cartilage differs from the above in that the *outer* side of the knee-joint is opened up by adducting the leg and at the end of extension the leg is *externally* rotated.

Satisfactory reduction is usually accompanied by an audible ' snap ' or ' click ', which usually occurs during the movement of rotation; but the most important criterion of success is the fact that the patient himself is able to extend the knee fully and comparatively painlessly.

A somewhat similar technique is employed for breaking down those adhesions in connexion with the knee which are a common sequel of sprains and synovitis, whether traumatic or infective.

Manipulation of Ankle.—

Indications.—Adhesions may occur in the ligaments of the ankle or in the tendons or their sheaths in relation to the joint, particularly after a severe sprain or fracture. Manipulation is also of great value in the treatment of congenital deformities of the feet in infants and in those following infantile paralysis (*see* Chapter XLV).

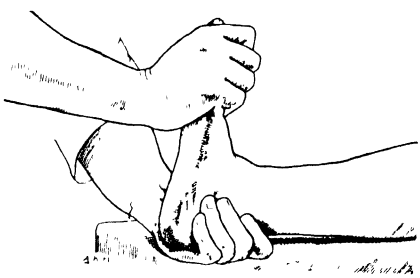


Fig. 620.—Dorsiflexion of ankle.

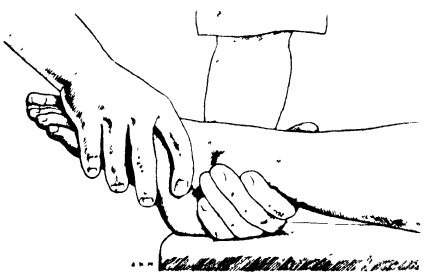


Fig. 621.—Plantar flexion of ankle.

In chronic foot-strain, whether involving the longitudinal arch or the so-called anterior arch, adhesions are of frequent occurrence and give rise to limitation of movement and pain. In the case of the longitudinal arch the movements of inversion and eversion at the mid-tarsal joint, and particularly the former, are often restricted and painful. In chronic anterior foot-strain there is usually a painful limitation of flexion of the toes at the metatarso-phalangeal joints and the proximal phalanges are hyperextended, with clawing of the toes. In many of these cases of chronic foot-strain marked benefit may result from manipulation.

Anæsthetic.—Gas, gas and oxygen, or intravenous pentothal or evipan. Local anæsthesia in the form of an injection of novocain is a useful alternative.

Technique.—

Dorsiflexion (*Fig.* 620): In the case of the left ankle the surgeon grasps the front part of the patient's foot with his right hand so that his palm is in contact with the front part of the sole. With his left hand he grips the lower third of the leg just above the ankle. Then while simultaneously applying traction with

both hands to separate the articular surfaces, he presses firmly upwards with his right hand and forces the foot into dorsiflexion.

Plantar Flexion (*Fig.* 621): The surgeon's right hand is next moved to the dorsal aspect of the patient's fore-foot and while still exerting traction as before, the foot is forced into plantar flexion. In slight cases after-treatment in the form of exercises to consolidate the increased range of movement is commenced immediately. In more marked cases of adhesions and in the congenital and acquired deformities of children, temporary retention in the corrected position by means of plaster-of-Paris or other forms of splintage may be necessary.

Manipulation of Mid-Tarsal Joint and Toes (*Figs.* 622, 623).—In the case of the left mid-tarsal joint, the surgeon grasps the front part of the patient's foot with his right hand and the lower part of the patient's leg immediately above the ankle with his left hand. He then forcibly inverts and everts the foot at the mid-tarsal joint. A certain amount of this movement also occurs at the subastragaloid joint. An alternative method of forcible eversion in which the forefoot is grasped by the surgeon's two hands is shown in *Fig.* 623. The movement of inversion is also valuable in dealing with adhesions in the anterior fasciculus of the external lateral ligament of the ankle-joint following sprain of this ligament.

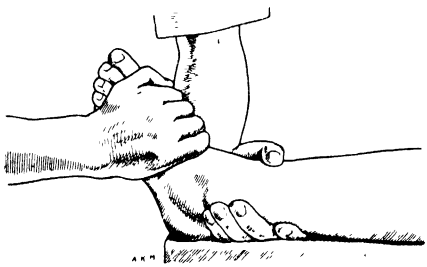


Fig. 622.—Inversion at mid-tarsal joint.

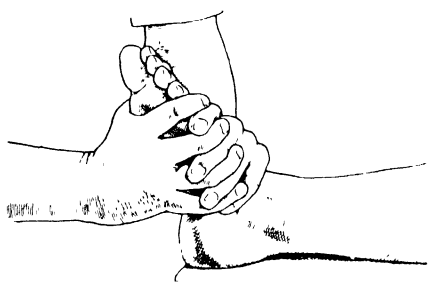


Fig. 623.—Eversion at mid-tarsal joint.

In manipulating the toes it must be remembered that flexion at the metatarsophalangeal and interphalangeal joints, as in the corresponding joints of the fingers, is accompanied by a gliding forwards of the base of the phalanx over the head of the corresponding metatarsal bone or of the proximal phalanx in the case of the interphalangeal joints. It is important, therefore, to reproduce this movement while carrying out the movement of flexion and extension and to exercise firm traction. If this fact is overlooked, a forcible hinge-like movement of flexion and extension alone may severely strain the lateral ligaments of the joint.

Manipulation of Wrist—

Indications.—Stiffness of the wrist frequently follows sprains and fractures in the vicinity of the joint, and chronic rheumatism. In many of these cases full movement returns with use of the limb supplemented by physical treatment. In others, such measures are ineffectual and manipulation is required.

Technique.—Correcting limitation of flexion and extension is first undertaken. As in the case of the ankle and joints of the foot, traction must be simultaneously exerted. The movements of abduction, adduction, and circumduction at the wrist-joint and of rotation at the inferior radio-ulnar joint are next performed, the surgeon grasping the patient's hand in the hand-shaking position and again applying traction.

Manipulation of Back.—

Selection of Cases.—Chronic backache, particularly affecting the lumbar region, is one of the commonest conditions encountered in general or hospital practice. Cure may often result from manipulation in obstinate cases which have defied other methods of treatment. The causes of backache are legion and, in many cases, manipulation is futile or positively dangerous. Accurate diagnosis by careful attention to the history and methodical examination of the patient is therefore of vital importance. X-ray examination, preferably stereoscopic, should never be omitted and should always



Fig 624.—Manipulation of lumbar spine. first movement

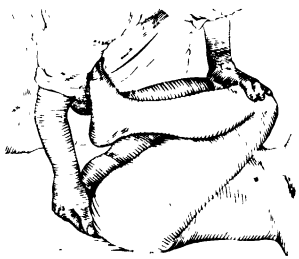


Fig 625.—Manipulation of lumbar spine second movement

include lateral views. By such measures, the disaster of manipulating a tuberculous spine or one which is the seat of a neoplasm or of some other condition which contra-indicates manipulation may be avoided.

Chronic backache due to adhesions is a frequent sequel of injuries to the back and particularly of those which have been treated by prolonged recumbency or by a rigid cuirass of strapping, and when there has been delay in instituting physical treatment and re-educational exercises. In many of these cases a functional element becomes superimposed and adds to the difficulty of treatment.

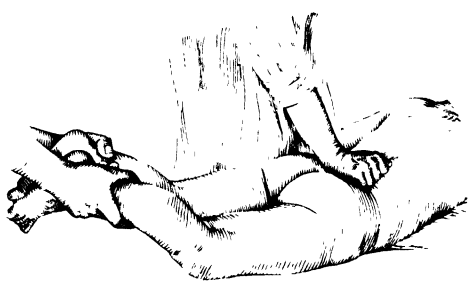


Fig 626.—Manipulation of lumbar spine. Extension combined with traction

Those cases in which limitation of some movement of the spine is present associated with localized tenderness on deep pressure respond most favourably to manipulation. When adhesions are present in the lumbar region there is often limitation of such movements as flexion, lateral bending, or rotation, with localized tenderness over some part of the erector spinæ or the interspinous ligaments. When the adhesions are deeply situated it is often impossible to elicit tenderness.

In chronic sacro-iliac strain, which is a frequent sequel to injuries to the lower back, localized tenderness is usually present in the region of the posterior superior spine of the ilium. In the equally common lumbosacral strain, tenderness is present in the mid-line over the lumbosacral articulation, with pain on full flexion of the lower back in this region. Backache or chronic lumbago is also a very common manifestation of

rheumatism and often a traumatic and rheumatic cause coexist. In rheumatic lumbago the disability is due to adhesions in the lumbar fascia and in the connective-tissue planes in and around the lumbar muscles. As in the purely traumatic cases, a functional element is often superadded.

Manipulation in such cases is often of great value, but simultaneous treatment of the underlying rheumatism is necessary and a somewhat longer period of subsequent rehabilitation is necessary.

Technique (*Figs.* 624–626).—Manipulation of the neck, dorsal spine, sacro-iliac joint and the more difficult types of manipulation of the lumbar region, such as the 'pelvic twist', cannot be considered in this book. Only the comparatively straightforward technique for manipulation of the lumbar region will be described.

Anæsthetic: Gas is unsatisfactory for manipulation of the back. Any anæsthetic which gives adequate relaxation and from which the patient recovers fairly rapidly, so that after-treatment can be commenced early, will suffice. The author has found intravenous pentothal valuable. In quite minor cases, the deep injection of a local anæsthetic, such as one of the cocaine derivatives, may be tried.

The patient lies upon his back upon a low couch or upon a mattress placed upon the floor. The operator, standing upon the right side of the patient, first fully and forcibly flexes the patient's knees and thighs upon the abdominal wall. Next, keeping the thighs and knees of the patient fully flexed by means of his left hand, he introduces his right hand under the patient's sacral region and still further increases the flexion of the lumbar spine by rotating the pelvis forwards. He next brings about lateral flexion of the lumbar spine by leverage of the pelvis both to the right and to the left. Similarly a rotatory movement of the pelvis is communicated to the lumbar spine. Finally, the patient is turned over into the prone position and the operator, grasping the patient's legs, forcibly extends the lumbar region, simultaneously applying traction. It is helpful if, at the same time, an assistant presses firmly just above the affected region.

Manipulations of the spine must be followed immediately by re-educational spinal exercises.

Manipulation in Tennis Elbow.—The type of tennis elbow which responds best to manipulation is that in which definite limitation of movement is present and which is uncomplicated by rheumatic fibrositis. Most cases are due to adhesions following sprain of the common extensor tendon at its origin from the external epicondyle of the humerus. In a minority of cases, there appears to be a form of internal derangement of the superior radio-ulnar joint due to a nipping of a fringe and reduction in this type is accompanied by a distinct 'snap' and immediate relief of symptoms. The symptoms in chronic cases of tennis elbow are pain in the joint, particularly on the outer side, on gripping objects, associated with a feeling of loss of power. Tenderness is usually most marked at a quite localized spot over the tip of the outer epicondyle of the humerus or over the antero-external aspect of the superior radio-ulnar joint.

A valuable test is as follows: The patient's fingers and wrist are flexed. The elbow is then sharply extended with the forearm pronated. This manœuvre causes pain at the above-mentioned sites.

Technique.—This is a short manipulation for which gas or gas and oxygen usually suffice, if properly given, so that adequate relaxation is obtained. Intravenous evipan or pentothal is also valuable and in slight cases a local anæsthetic may be given. In the case of the right elbow, for example, the operator grips the region of the patient's right wrist with his right hand and the elbow region with his left hand, the thumb of which presses upon the tender area on the outer side of the joint. The elbow is first fully flexed and extended. Next, the elbow

is fully flexed and slowly extended, and during the whole of the latter movement the forearm is rapidly pronated and supinated. Towards the end of extension the operator completes the movement sharply with the forearm in

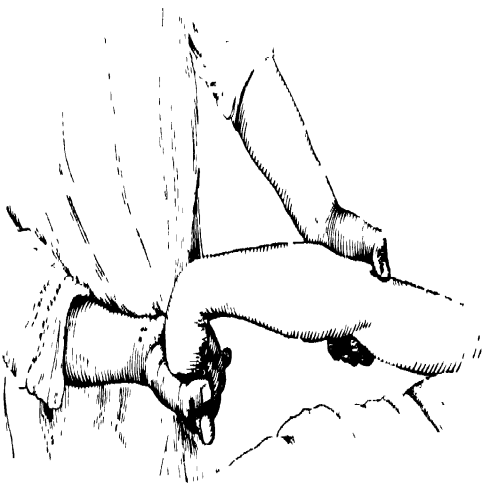


Fig. 627.—Manipulation for tennis elbow.

complete pronation and with the fingers and wrist of the patient maintained in complete flexion. This somewhat complicated manœuvre may be made clear by reference to the illustration (*Fig.* 627).

After manipulation for tennis elbow a course of radiant heat, massage, and exercises is of benefit for two or three weeks and the patient should resume playing by gradual stages.

CHAPTER LXIV

PLASTER-OF-PARIS TECHNIQUE

By F. P. FITZGERALD

PLASTER-OF-PARIS bandages are made in 8-in., 6-in., and 4-in. widths, and all are six yards in length. The bandages may be made by tearing strips of butter muslin to the requisite length and width. The threads along the free edges should be torn off. It is preferable to use ready-made cotton bandages, which can be obtained at a very reasonable price.

Making Plaster Bandages.—This is an operation which, although not very skilled, does need considerable experience. It should never be a task relegated to the most junior probationer nurse. Plaster technique is valueless unless



Fig. 628.—The plaster-of-Paris is rubbed into the bandage.

the bandage is perfect. A night porter in a hospital usually has the time, and after some experience can become proficient in this work.

Method.—A bowl of plaster is placed at the technician's right hand, the bandages on the left, and an unwound bandage between them. Then the plaster powder is sprinkled on to the opened-out bandage, and rubbed firmly



Fig. 629.—The plaster bandage is rolled on itself

into its interstices (*Fig.* 628). The impregnated bandage is then rolled upon itself (*Fig.* 629) and packed for storage in a paper wrapper.

They should weigh 17, 14, and 11 ounces respectively, and be kept in airtight tins. Immediately before use, the bandage is placed in salted water leaving the gauze end free, so as to facilitate unwinding the moistened bandage (*Fig.* 630). It is then allowed to rest until bubbles cease to rise (*Fig.* 631). Then the *ends* of the bandage are gripped firmly, and it is squeezed free of excess water

(*Fig.* 632). The temperature of the water varies according to whether slow or quick setting is required. Plaster sets more quickly with hot water. The usual maximum temperature that can be used is 130° F. Salt increases the rate of setting.



Fig. 630.—A teaspoonful of salt is added to a basin of water

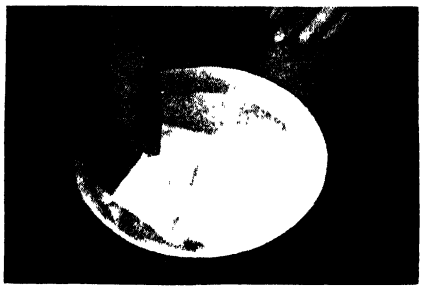


Fig. 631.—The bandage end is free.

Plaster bandages may be rolled on like ordinary bandages, or applied in the form of slabs made by rolling a bandage up and down on itself to the required length (*Fig.* 633). A narrow slab is made by folding one on itself (*Fig.* 634).



Fig. 632.—Squeezing a plaster bandage. It is grasped by its *ends*



Fig. 633.—Method of making a plaster slab.

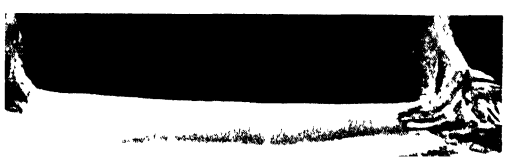


Fig. 634.—Method of folding a slab on itself

These slabs are fixed to the limb by a circularly applied open-wove gauze bandage. Where necessary, plaster bandages are applied over this.

Rules for Application of a Plaster Bandage.—

1. Apply the bandage evenly, without folds.

2. Leave an inch between the tops of the turns so that the cast will be the same thickness throughout.

3. Do not allow any creases next the skin.

4. Do not twist the bandage or attempt to do ' figures of 8 '.

5. Remember that a plaster cast does not contract while setting. (*See* PRESSURE SORES, p. 522.)

Padded or Unpadded ?—Both padded and unpadded casts have their uses in actual practice.

A *padded cast* is one in which the skin and plaster are separated by wool or stockinette or both.

An *unpadded cast* is one in which the plaster slab and skin are in actual contact.



Fig. 635.—The plaster slab is applied directly on to the skin, but does not encircle the limb completely.



Fig. 636.—Application of a dorsal slab. Note : (1) Pad of wool separating index finger and thumb ; (2) The slab does not include anterior one third of wrist ; (3) Gauze bandage being used to fix slab.

It is important that the latter definition should be qualified, for while it is true that plaster and skin *are* in contact, the *entire* limb surface is *not* so encased. A plaster slab is applied, encasing approximately two-thirds of the limb at its narrowest part (*Fig.* 635). This is kept in position by a gauze bandage *six yards long and six inches wide*, in adults (*Fig.* 636). The latter is put on loosely and provides a layer of padding about a quarter of an inch thick over at least one-third of the limb's surface. *A completely skin-tight plaster should in no circumstances be applied.*

Instructions to the Patient.—*A patient should not be allowed to leave hospital without written instructions about how to recognize obstruction to the circulation, and what to do if it should occur.*

TYPE OF INSTRUCTION CARD

1. If the fingers or toes become painful, swollen, or blue, elevate the limb.
2. If there is no improvement after half an hour, come back to hospital or call in a doctor.
3. If it is impossible to obtain medical advice, remove the plaster with a knife or saw. Soaking in water softens plaster.

APPLICATION OF PLASTER IN SPECIAL REGIONS

THE HAND OR WRIST

Materials.—

1. Two plaster bandages 6 yd. by 6 or 4 in. depending on the size of
2. A gauze bandage 6 yd. by 6 or 4 in. the limb.
3. A 4-in. band, for counter-traction.

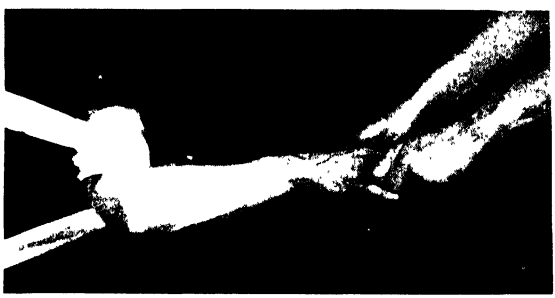


Fig. 637.—Fixed counter-traction band applied to the upper arm over a wool pad. Manual traction is maintained on the fingers and thumb.

Position of Patient.—When traction is necessary the patient lies on a table with the humerus abducted to 90° and the elbow at a right angle. The band is passed round the arm above the elbow over a pad of wool, and fixed to some stable object such as a door-handle. A layer of strapping is wrapped round the thumb, and another layer fixes the radial three fingers together, if the fracture is above the wrist. If a phalanx or metacarpal is involved, only the affected digit is strapped. An assistant then grasps the thumb in one hand and the three fingers in the other, and pulls in the opposite direction to the counter-traction band (*Fig.* 637).

Technique.—

The Hand and Fingers: A small slab is made to cover the back of the hand and a finger. It is bandaged into place with a narrow gauze bandage and covered with a small plaster bandage. If upon investigation it is found the region of the metacarpo-phalangeal joint is involved, the plaster ends at the wrist and the proximal interphalangeal joint (*Fig.* 638). If the lesion is higher, the wrist must be included.



Fig. 638. — Only the metacarpo-phalangeal joint of the affected digit is immobilized.

The Wrist: The distance from olecranon to knuckles is measured. A plaster slab of this length is laid along the dorsum of the forearm, wrist, and hand, as far as the knuckles. It is moulded to the limb, covering it dorsally and on the sides, but does not enclose the limb completely at any point. A small pad of wool is then placed between the thumb and index finger (*Fig.* 639) and the cast is bandaged on evenly, but not tightly, with the gauze bandage, two turns of which hold the wool pad in place. The second plaster bandage is now applied circularly and the cast allowed to set. Any excess can then be trimmed.



Fig 639.—The slab extends from elbow to knuckles, and is moulded to the contour of the wrist.

THE ELBOW AND FOREARM

Materials.—

1. Four plaster bandages 6 yd. by 6 or 4 in. } depending on the size of
2. One gauze bandage 6 yd. by 6 or 4 in. } the limb.
3. Band for counter-traction, with wooden spreader.
4. Small pad of wool.

Technique.—The position of the patient is as described for the wrist cast. The limb is measured from the insertion of the deltoid to the knuckles. A slab of this length is applied from the knuckles along the dorsum of the forearm, behind the elbow, and along the extensor surface of the arm (*Fig.* 640). At the elbow, cuts are made into the slab at each side and the edges folded accurately over each other. The wool is placed between the finger and thumb, and the slab is wrapped on by the gauze bandage. The wooden spreader widens the loop of the counter-extension band to allow the slab to pass through (*Fig.* 641). Two circular plaster bandages are now applied and the cast is allowed to set. The extension band is then removed from the arm and the final plaster bandage strengthens that region.



Fig 640.—Dorsal plaster slab applied



Fig. 641.—Application of cast for elbow or forearm injuries. Note (1) Manual traction, (2) Fixed counter-traction, (3) Spreader separating loop of traction band.

THE UPPER ARM

Materials.—
1. Three plaster bandages 6 yd. by 6 or 4 in. } depending on the size of
2. One gauze bandage 6 yd. by 6 or 4 in. } the limb.
3. A strip of felt 1 in. wide.
4. A cuff-and-collar sling.

Technique.—The strip of felt is fixed round the arm close to the axilla. 6-in. slab is made long enough to extend from the acromion round the elbow to the axilla. It is folded on itself to make a 3-in. slab (*see Fig.* 634). The slab is then applied to the inner and outer surfaces of the arm in the form of a U (*Fig.* 642). It is moulded to the contour of the limb and fixed by the gauze bandage and the remaining two plaster bandages. A collar-and-cuff sling (*see Fig.* 674, p. 506) is applied, with the elbow at right angles. In fractures with much displacement it is advisable to increase the weight of the plaster by adding the elbow or forearm cast. Lesions of the shoulder-joint or transverse fractures of the middle third of the humerus may require an abduction splint or plaster spica.



Fig. 642.—The U-shaped slab is placed along the inner and outer aspects of the arm.

THE SHOULDER SPICA

Materials.—
1. Twelve plaster bandages, four 6 yd. by 8 in., eight 6 yd. by 6 in. Or in a child, four 6 yd. by 6 in., eight 6 yd. by 4 in.
2. Two gauze bandages 6 yd. by 6 in.
3. Stockinette, wide and narrow.
4. Wool.



Fig. 643.—Shoulder spica. The cast should extend lower over the iliac crests.

Position of Patient.—Sitting on a stool or standing; the arm is abducted to a right angle and is 30° in front of the coronal plane. The elbow is flexed to a right angle and is in the mid-position between pronation and supination.

Technique.—A length of wide stockinette is taken long enough to reach from neck to pubis. A hole is cut on either side at the shoulder level to allow the arms to be passed through as in a sleeveless vest.

The narrower material is drawn over the arm like a sleeve from knuckles to shoulder. Pads of wool, ½-in. thick when compressed, are placed along the iliac crests, over each shoulder, and along the spine, and are held in place by the gauze bandage.

Two wide plaster bandages are now applied around the abdomen and thorax and across the shoulders. Plaster slabs made from narrow bandages are applied from the axillæ to the iliac crests, where they are accurately moulded. They are held in position by one wide bandage. Then a wide bandage is applied as a shoulder spica. A long slab is fixed to the extensor aspect of the arm, forearm, and hand as far as the knuckles, with one gauze and three narrow circular bandages. A narrow bandage is next made into a slab and folded on itself to act as a prop (*Fig.* 643), which extends from the side of the cast in the axillary line to the under surface of the elbow, and is fixed to both cast and arm by the remaining bandage. If the cast does not extend to the iliac crests it sags to one side, and may cause a pressure sore. The edges are trimmed and the stockinette folded back at the margins of the cast. Over the sternum the cast is cut in the form of a V.



Fig. 644.— The narrow slab is placed along the inner and outer aspects of the leg.

THE LEG

Materials.—

1. A high chair, table, or a traction apparatus.
2. Five plaster bandages 6 yd. by 6 or 4 in.
3. One gauze bandage 6 yd. by 6 or 4 in.

(2 and 3: depending on the size of the limb.)

4. A walking iron or Sorbo rubber.

Position of Patient.—The patient sits on a high chair or table, the operator sitting on a low stool with the patient's foot resting on his knee.

The sound leg is supported on a stool or chair.

Technique 1.—A long slab is made and folded on itself so as to be 3 in. instead of 6 in. wide (*see Fig.* 634). It is applied from the lateral condyle of the tibia along the outer side of the leg, then under the heel and along the inner aspect of the leg to the medial condyle (*Fig.* 644). Another slab is made long enough to extend from the back of the knee, passing behind the heel, to beyond the toes. It is applied along the calf and sole, and a transverse cut is made on either side at the heel. The edges are folded over evenly. These slabs are fixed to the limb by a gauze bandage. The circular plaster bandages are then rolled on from above downwards. The plaster is trimmed so that the dorsal surfaces of the toes are free. A vertical cut an inch long over the upper end of the fibula prevents pressure over the peroneal nerve.



Fig. 645.—Anterior slab method should not be used for ankle fractures.



Fig. 646.—Anterior slab accurately moulded to the contour of the leg.

Technique 2.—An anterior slab is applied and fixed with one gauze and three plaster bandages (*Figs.* 645, 646). To remove a plaster applied with an

anterior slab, it is cut down posteriorly (*Fig.* 647). If skeletal traction is being used, the leg is slung in the traction frame (*Fig.* 648).

Application of a Heel.—

A plaster heel is simply a plaster bandage which is partially unwound and fixed just in front of the heel.

A rubber heel is made from two pieces of ½-in. Sorbo rubber as wide as the sole of the cast and one-third its length. The pieces of rubber are bound together by a few turns of the plaster bandage and then fixed in position with the remainder of the bandage.

An iron heel is applied *exactly* in the line of the leg, and not tilted backwards or forwards (*Fig.* 649). It extends an inch and a half below the plaster. A turn of a 6-in. bandage is taken round the anterior part of one cross-bar. The bandage then passes behind the calf to the anterior part of the opposite cross-bar, thus forming a posterior sling. An anterior sling is formed by reversing this manœuvre. The soft cross-bars are moulded firmly



Fig. 647.—To remove anterior slabs, plaster cut posteriorly.



Fig. 648.—The bent knee rests on the padded cross-bar of the extension frame. Screw traction is applied through an os calcis nail.

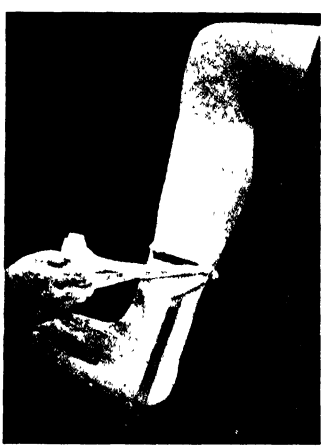


Fig. 649.—Application of an iron heel. The long axis of the heel must be in the line of the leg.



Fig. 650.—A piece of inner tubing protects the foot of the plaster.

against the cast, and two turns of the bandage fix them. The bandage is continued down the leg around the iron shaft to the ankle. The attenuated

bandage is passed through the loop of the iron, and anterior and posterior slings are again formed, care being taken to ensure that the iron is still in the line of the leg. The sole of the plaster can be kept clean by using a piece of old motor tubing a little longer than the foot, with a hole cut out to allow the plaster foot to enter (*Fig.* 650).

THE THIGH AND LEG

Materials.—

1. Eight plaster bandages 6 yd. by 6 or 4 in. } depending on the size of
2. Two gauze bandages 6 yd. by 6 or 4 in. } the limb.
3. Iron or Sorbo heel.
4. Strip of ¼-in. adhesive felt 1 in. wide.

Technique.—The strip of felt is placed round the limb at the upper limit of the thigh. A gauze bandage is wrapped round the knee. The limb is measured from the natal fold, round the heel to the toes. A slab is made from two 6-in. bandages and is applied along the thigh, calf, and sole to the toes. It is cut at right angles at the heel on either side and the edges are moulded over carefully. The slab is bound on by a gauze bandage and four circular plaster bandages. A heel may be fixed as described above.

THE SHORT HIP SPICA

Materials.—

1. Ten plaster bandages 6 yd. by 8 in., and four 6 yd. by 6 in. In a child, six 6 yd. by 6 in., and four 6 yd. by 4 in.
2. Stockinette, wide and narrow.
3. Gauze bandage 6 yd. by 6 in.
4. Wool.
5. Pelvic rest or Hawley table.

Preliminary Measures.—A piece of wide stockinette is drawn over the head and shoulders and reaches from the groin to the nipples. The narrower piece is drawn over the affected limb and reaches from groin to knee. Pads of wool, ¾ in. thick when compressed, are placed over the anterior superior spines, the iliac crests, the sacrum, and around the adductor region. All the pads are fastened into position by the gauze bandage.

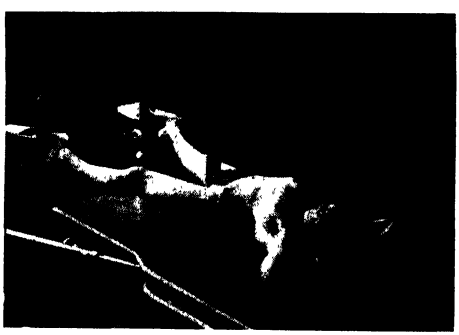


Fig. 651.—Position for application of hip spica. The knees have not yet been suspended.

Position of Patient.—The patient is placed on the pelvic rest or Hawley table. If a Hawley table is used, the feet are bandaged to the sole-plates. The knee is suspended by a bandage from the cross-bar to avoid extension of the hip and hyperextension of the knee. The table is then 'let down', so that the patient is suspended by the shoulders, pelvis, and feet (*Fig.* 651).

Technique.—Two wide plaster bandages are applied to the chest and abdomen and then as a spica over the pelvis and upper thigh. Two slabs made from narrow bandages are applied, one along the lateral aspect and the other in front of the hip. A wide bandage holds these in place, and then a slab is placed

along the back of the thigh, from the back of the hip to the knee. The remaining wide and narrow bandages are applied circularly above and below. During the application of the cast it should be moulded deeply above and below the iliac crests and around the greater trochanter so that visible grooves are formed. The cast is then cut out in the form of a V or half-moon over the upper abdomen, leaving it high at both sides. The plaster is cut away at the upper border of the pubis, and on the sound side along the groin, to permit flexion of the thigh to a right angle (*Fig.* 652). Then the patient is taken off the table, turned on to the face, and an area cut out behind to expose the upper limit of the natal cleft.



Fig. 652.—Short hip plaster. Note the moulding over the ilium and greater trochanter. On the left side it is cut away to allow the hip to flex to a right angle.

THE LONG HIP SPICA

Materials —

1. Sixteen plaster bandages, six 6 yd. by 8 in., ten 6 yd by 6 in. Or in a child, six 6 yd. by 6 in., ten 6 yd. by 4 in.
2. Three gauze bandages 6 yd. by 6 in.
3. Stockinette, wide and narrow.
4. Wool.
5. Pelvic rest or Hawley table.

Technique.—The position of the patient is the same as in a short spica (*see Fig.* 651), and the same routine is followed as far as the knee. Then a slab is made to extend from the mid-thigh to the lower third of the leg and covered with one gauze and two plaster bandages. Another slab reaches from the middle of the calf to the tips of the toes, and is fastened with one gauze and one plaster bandage. In an active child or heavy adult, the cast may need extra strength. This can be achieved by making a slab from a 6-in. bandage, folded on itself to make a 2-in. plaster rope, and incorporating it along the lateral aspect of the thigh from above the hip to below the knee. The cutting out and moulding are as before. On the plantar aspect the plaster is cut flush with the tips of the toes; on the dorsum it is trimmed along the line of the web.

THE DOUBLE HIP SPICA IN 'FROG' POSITION

Indication.—For a reduced congenital dislocation of the hip.

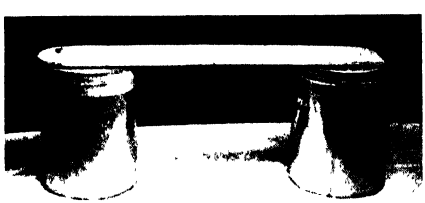


Fig. 653.—A simple pelvic rest. The child is laid upon the board, wool and plaster are applied, after which the board is extracted.

Materials.—

1. Twelve plaster bandages, six 6 yd. by 6 in., six 6 yd. by 4 in.
2. Stockinette.
3. One gauze bandage 6 yd. by 6 in.
4. Wool.
5. Stille's or other small pelvic rest (*Fig.* 653).

Position of Patient.—The child lies on the pelvic rest with thighs widely abducted, and both hips and knees flexed to right angles.

Technique.—The stockinette is drawn over the body and limbs, and a layer of wool is rolled on to cover the abdomen and both limbs to the ankles. Two wide plaster bandages are applied around the abdomen and pelvis as a double spica bandage. Slabs are placed on either side from the upper edges of the cast to the middle of the leg, and are fixed by two wide circular bandages. Finally three small circular bandages are applied on each limb as far as the ends of the slabs. A large area is cut out extending an inch above the pubis, an inch above the top of the natal cleft, and three inches from the midline on either side (*Fig.* 654).

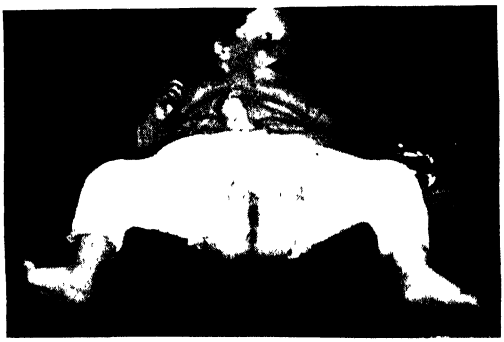


Fig. 654.—Double hip spica plaster. Note wide area cut out to prevent soiling.

The Batchelor Method:

Position of Patient: The child lies on a table. Both hips are flexed to 90°, abducted to 45°, and rotated internally so that the feet point laterally (*Fig.* 655).



Fig. 655.—Hips abducted 45° and internally rotated so that feet point laterally.

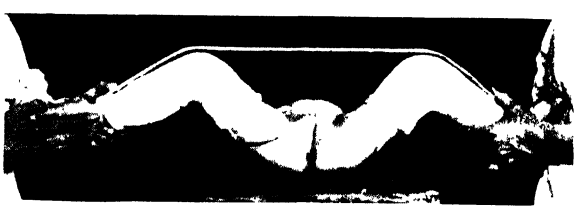


Fig. 656.—The knees only are plastered. A cross-bar is held in position.



Fig. 657.—The finished Batchelor plaster.

Plasters are then applied to the knees over padding, and an angulated bar placed along the front of the patellæ (*Fig.* 656). This is fixed in position with two plaster bandages (*Fig.* 657).

THE PLASTER JACKET

Materials.—

1. Ten plaster bandages, six 6 yd. by 8 in., four 6 yd. by 6 in. Or for a child, six 6 yd. by 6 in., six 6 yd. by 4 in.
2. Stockinette.
3. Gauze bandage.
4. Wool.

A stockinette vest as in a shoulder spica is worn ; if the neck is to be included, the vest should be allowed to extend above the head during the application of the cast, and have spaces cut out for the eyes and mouth. Wool pads, ½ in. thick when compressed, are placed over the iliac crests and the shoulders, and along the spine and sacrum. In a cervical case a layer is wound around the neck. These pads are retained in position by the gauze bandage.

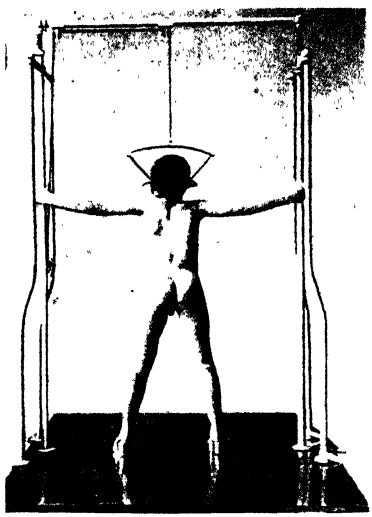


Fig. 658.—The patient holds the sides of the frame to steady himself. The feet are fixed, and traction is maintained by overhead cord and pulley

Position of Patient.—This varies according to the lesion. If a fracture of the dorsal or lumbar vertebræ is being treated, the cast is applied in a position of extension, the weight being taken by a band round the chest and attached to a block and tackle, or between two tables (*see Fig.* 710). For a case of cervical caries the child is placed in a special frame (*Fig.* 658). Shoes are strapped to the feet, and these are in turn screwed to the floor boards of the frame. A sling is attached under the chin and occiput, and most of the body-weight is taken by a cord over a pulley on the overhead cross-bar.

Technique.—

Thoracic or lumbar case : Two wide plaster bandages are wrapped around the chest and abdomen, extending to the sternal notch above and the pubis below. Four slabs made from narrow bandages are now applied. One on each side extends from the axilla to three inches below the iliac crest, another from the sternal notch to the front of pubis, and the fourth along the spine posteriorly to the upper limit of the natal cleft. These are fixed by two more wide bandages and then circular slabs made from narrow bandages are applied around the upper and lower margins of the cast. Two wide plaster bandages complete the cast. An area the size of a dinner plate may be removed over the upper abdomen. At the groin the plaster is cut on either side to allow flexion of the thighs to a right angle. It is essential that these casts be moulded accurately over the iliac crests, the lumbar lordosis, the pubis, and the sternum.

Cervical case : The routine is the same, except that alternate turns of the circular bandages are taken over the shoulders. Two circular bandages are then wound round the neck and shoulders, including the chin, skirting the lower borders of the ears, and extending up on to the occiput posteriorly. A slab is applied from the occiput to the upper part of the thorax, and fixed by two wide

circular bandages. The plaster is cut along a line running parallel to, and half an inch *above*, the lower border of the mandible, just below the ears, and along the line of the occipital bone. The stockinette is then folded back and fixed with a narrow plaster bandage. (*Fig.* 659.)



Fig 659.—Finished plaster jacket for case of low cervical caries.

THE SCIATIC PLASTER

In most sciatic units, doubtful cases of prolapsed intervertebral discs are given a trial in plaster to ascertain if immobilization of the lower parts of the spine will relieve the pain. To do this, it is best to apply a combined plaster jacket and short spica.

Materials.—These are as described under ' Spica ' and ' Jacket ', with the addition of three slabs, each made from two 8-in. plaster bandages.

Position.—The normal erect position is best. Hyperextension increases the pain ; flexion prevents walking.

Method.—As in ' Jacket ' and ' Spica '. *Fig.* 660 shows the wool pads in place for the spine. The thin, extra slabs are fixed anteriorly, posteriorly, and laterally (*Figs.* 661, 662) ; they reinforce the hip region.

When completed, the cast is cut away so that the arms and flexion of the knee are not restricted. The usual nursing creases are cut away (*Figs.* 663 and 664).

PLASTER BEDS AND ANTERIOR SHELLS

Materials.—

1. Plaster muslin. Twelve doubled sheets of this are cut beforehand. For an anterior shell the patient is measured from the nasion to the ankle ; for a bed, from the nasion *over the vertex* to the middle of the calf. In both cases the width is the distance between the tips of the elbows when the arms are abducted to right angles.
2. Plaster-of-Paris, 14 lb.
3. A basin holding 12 pints of water at 130° F., and a spoon for mixing.
4. Vaseline, a bathing cap, and wool.
5. A table covered by a rubber mattress.
6. An adjustable stool and sandbags.
7. Scalpels and linoleum knives.



Fig. 660.



Fig. 661



Fig. 662.

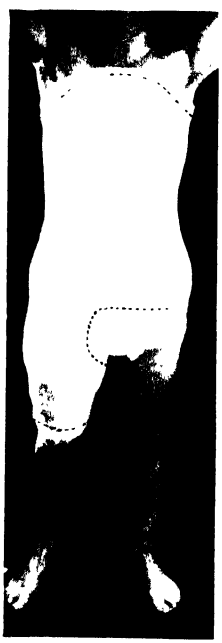


Fig. 663.

Fig. 660.—Spinal wool pads in place.

Fig 661.—Posterior and lateral slabs applied.

Fig. 662.—Showing lateral and anterior bracing slabs.

Fig. 663.—The trimming lines are marked in pencil.

Fig 664.—Trimming of the edges completed.



Fig. 664.

Position of Patient.—For a plaster bed the patient lies prone, with the chin resting on the edge of the table, arms abducted to 45°, and each leg abducted to 15° (*Fig.* 665). For an anterior shell, the patient lies on his back with legs and arms arranged similarly; the neck is allowed to hyperextend over the edge of the table until the under surface of the chin is horizontal. The head is supported in position by a sandbag resting on the stool, and the face is covered with a sheet of gauze. The bathing cap covers the hair completely. In the plaster bed, pads of wool are placed over the ears to make the finished cast more roomy. A very thin layer of vaseline is smeared over the skin and the minimum of wool used to cover the pubic and perineal regions.



Fig. 665.—Position for plaster bed. The chin is supported on the edge of the rubber mattress, leaving an airway above the table top.

Technique.—

The assistants: A team of five is the ideal, but the number may be reduced to three. The first assistant makes the plaster cream by adding the plaster to the water, and stirs the mixture to an even consistency. The second assistant hands the double sheets by their folded ends to the first, who dips them thus into the cream. The sheets, now like ropes, are lightly stripped of excess cream and are handed quickly to the other assistants, who are placed as follows: the third stands at the head of the patient, the fourth and fifth on either side near the knees.

Applying the sheets: The third, fourth, and fifth assistants open out the sheet, pull it taut to remove all creases (*Fig.* 666), let it fall squarely on to the patient, and then smooth away air-bubbles from the midline outwards. The fourth and fifth assistants, as each sheet is laid, press it down firmly to the table between the thighs and perineum so as to form a flat bridge connecting the gutters for the legs. The excess muslin—except in the first and last sheets, which determine the internal and external finish of the cast—is folded back at the level of the knees on to the thighs. At the sides the sheets are not moulded under the patient, to avoid difficulty in removing the cast. The sides may be strengthened by folding back the excess of every second sheet.



Fig. 666.—Applying the first sheet

Including the head: If a bed is being made with a head-piece, that is, in lesions above the sixth dorsal vertebra, the third assistant, standing at the head, folds back the excess of the ten intermediate sheets at the vertex and in front of the ears, moulding it to the back and sides of the neck. In the case of an anterior shell, the intermediate layers are folded back along the symphysis and body of the mandible, to form a strong horizontal chin-piece.

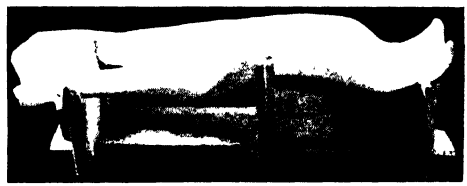
Speed is essential, as the warm plaster cream sets rapidly; if setting is delayed, half an ounce of salt should be added to the cream. The procession of sheets

must follow without break, and all must be laid within five minutes. The cast is allowed to set until it gives a high-pitched note when tapped.

Outlining: While waiting, the outlines are marked with a sharp scalpel—the sides an inch from the table level, the shoulders in line with the sides, and the upper and lower edges at the level of the folding back. An area for nursing purposes is outlined. It extends in a bed from the top of the natal cleft, or in a shell from an inch above the pubic crest, to midway between the perineum and knee, exposing the medial third of each thigh. In a bed, care is taken to make the opening a pointed arch so that the buttocks are supported adequately. When the cast has set, it is lifted off and laid on a slatted table, where the outlines already marked are quickly cut through with the linoleum knives. It is then tried on and trimmed if necessary. The whole proceedings should not take longer than fifteen minutes. The cast is dried for two days in a heated room.



A



B

Fig. 667.—A, A slatted table facilitates cutting into the bed. B, Mounted plaster bed. Three wooden uprights connected by three-ply struts allow ease of nursing and protect the plaster.

Mounting: The cast is now mounted on three shaped transverse supports of 1-in. timber, high enough to allow a bed-pan to be inserted easily. These uprights are fixed by countersunk screws at the neck, lumbar region, and above the knee, and joined by two horizontal strips of three-ply wood (*Fig.* 667). A loose lining is made of linen sheeting and thin blanket sewn together along the edges, having a piece cut out corresponding to the nursing area of the plaster cast. It is held in position by tapes which tie underneath the cast. When it becomes necessary the patient is turned out of his plaster bed.



A



B

Fig. 668.—A, The patient is held in bed by straps while being turned. B, When fully turned, the bed can be removed and the patient's back treated.

Method of Turning the Patient.—Straps, which pass under the bed, fix the patient and plaster, and both are then rotated until the patient lies face downwards. The bed is then removed and the back treated (*Fig.* 668).

FINISHING PLASTERS

A good finish to a plaster may be obtained by rubbing the setting plaster smooth with clean moist hands. This may be improved upon by rubbing the surface over with a wet plaster bandage. If stockinette is used, it is folded back over the trimmed plaster edges, and fixed by a narrow bandage.

REMOVING PLASTERS

Nowadays this is not a very difficult procedure, as casts are thinner than formerly. The instruments used are Stille's shears, Bohler's scissors, and Lloyd's opener (*Figs.* 669, 670). The last is a very useful instrument when a plaster has been cut through and the two edges have to be pulled apart.

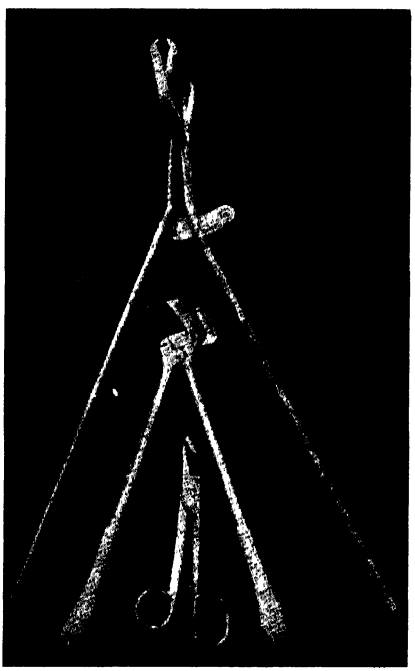


Fig. 669.—Plaster instruments: Lloyd's opener, Stille's shears, Bohler's scissors.

A few points need to be stressed. Never cut over a bone. In a leg plaster cut down vertically between tibia and fibula along the antero-lateral aspect. Cut where the plaster is thinnest. It is strange how many people cut along where the slab has been applied, instead of along the thin opposite aspect. In difficult cases or in frightened children the cast can be softened by soaking it in warm water. In a plaster which has to be split immediately after application, include a copper strip next to the skin and cut down on it before the plaster has set. The line of the strip is followed by allowing it to protrude above and below the edges of the cast. When the plaster has been split, the strip is removed by pulling it through.

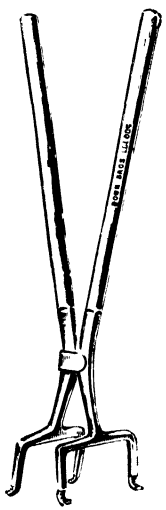


Fig. 670.—Lloyd's plaster opener.

CHAPTER LXV

EMERGENCY TREATMENT OF FRACTURES

By Sir REGINALD WATSON-JONES

THE emergency treatment of fractures includes: (1) First-aid splinting; (2) Precautions in transport; (3) Treatment of shock; (4) Temporary splinting.

FIRST-AID SPLINTING

"Splint them where they lie." Before the patient is moved from the site of accident, suspected fractures must be immobilized by splints constructed of strips of wood, walking-sticks, or folded newspapers. The splints must extend beyond the joints above and below the level of injury, and as a rule the whole limb should be immobilized. In the case of thigh injuries, first-aid splints of this type must obviously extend over the trunk as well as over the whole lower limb, and added fixation may be secured by tying the two lower limbs together.

If a Thomas's splint is available it is the best emergency splint for lower limb injuries. It is applied before the boot or trousers are removed, and before the wound is dressed. Traction is applied to the limb, so that it can be raised without angulating the fragments, and while traction is maintained, the ring of the splint is guided over the foot, leg, and thigh, and pressed firmly against the pelvis. The foot may be fixed to the notch at the lower end of the splint by means of a clove-hitch bandage round the ankle, but this method is dangerous because the pressure of the bandage may cause sloughing of the skin or even gangrene of the foot. It is better to use a metal skewer through the instep of the boot just above the sole, or a metal clip known as a Picton or Millbank clip (*Fig.* 671) which is sprung on to the margin of the sole. The skewer or spring clip is fastened to the end of the splint with strong cord. Immobilization is completed by bandages encircling the limb and splint.

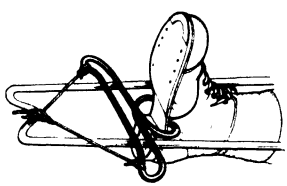


Fig. 671.—The Millbank clip.

METHODS OF TRANSPORT

If a patient is quite helpless and has to be lifted on to a stretcher or carried any distance, two assistants should co-operate with the surgeon, who steadies and controls the injured limb. The assistants take up a position on opposite sides of the patient facing each other; they then stoop down and each gradually inserts one hand under the patient's chest until they meet and are clasped; the other hands are then passed and locked under the pelvis. Having secured a firm grasp they rise together from the stooping position and are ready to move. They should not march in step; rhythmic swaying is avoided if the left foot of one is put forward with the right foot of the other.

Transport in Suspected Spinal Fractures.—Patients with suspected fractures of the spine must be moved with particular caution, because damage to the spinal cord may cause permanent paralysis. If a patient with a fractured spine is lifted face upwards by the shoulders and hips, sagging of the trunk between

the two points of support forces the injured area into flexion. The spine above and below the fracture forms such a powerful pair of levers that this apparently simple movement may crush the spinal cord or the nerves of the cauda equina (*Fig.* 672). If no other means of transport is available it is better to roll the patient carefully on to his face and lift him in the prone position. This is less dangerous because the spine then sags into extension or hyperextension. It must be recognized, however, that even this position is not entirely safe because occasionally a fracture of the spine is complicated by interlocking of articular processes and the spinal cord is then no less in danger of traction and attenuation by hyperextension movement than it is of compression by flexion movement. The only safe procedure is to avoid both flexion and hyperextension strain and to keep the spine in the neutral position. As the patient lies on his back, slings of roller towels, bandages, or strong handkerchiefs are passed under the neck, shoulder-blades, loin, buttocks, and thighs



Fig. 672.—Dangerous method of transport in suspected spinal injuries. If there is a fracture the spinal cord may be severed

The slings are grasped on each side and the patient is carried to a stretcher. If only two bearers are available the slings should be tied to long broom-handles, or Liston's splints, one on each side, so that when they are lifted the spine is equally supported at all levels. When the patient is safely on a stretcher he should not be moved from it until radiographic examination in hospital is completed.

Special precautions are necessary when it is suspected that there may be an injury to the cervical spine. Having passed many slings under the patient, tied them to wooden rods on each side of the trunk, and arranged for two bearers to lift and carry the patient, the doctor himself should hold the patient's head firmly in traction and permit no single flexion, extension, or rotation movement. His supervision must continue until the patient is safely in hospital.

TREATMENT OF SHOCK

Every patient who sustains a wound, burn, fracture, or crushing injury suffers from shock. Primary shock is a simple condition of collapse, similar

to fainting, which responds rapidly to recumbency, elevation of the foot of the bed, warmth, and relief of pain. Secondary or wound shock is due to fluid loss which may be the result of hæmorrhage in open wounds, or leakage of blood and serum into tissue spaces in closed injuries. Some of the most severe degrees of fluid loss occur in crushing injuries where there is no open wound. If the initial loss of blood-volume is less than two pints* systolic pressure is usually maintained by general vasoconstriction, but if the loss is greater than two pints the blood-pressure falls; the association of falling pressure with general vasoconstriction causes oxygen lack in the tissues and increase of permeability of the capillaries; fluid loss then continues into all the tissues of the body and it may go on despite late transfusion until death of the patient. It is clear, therefore, that restoration of blood-volume is a matter of urgency and that one-pint transfusions are of little value; from two to six pints are needed, the first two pints being given as quickly as possible. In some cases of severe war injuries as much as sixteen or eighteen pints of blood and plasma have been given during the first forty-eight hours and only after that was survival of the patient assured. The indication for transfusion must be based not on vague and uncertain assessment of the patient's condition but on precise knowledge of his blood-pressure and hæmoglobin percentage. A ten-minute blood-pressure chart is much more reliable than a single reading because the systolic pressure may be sustained temporarily by general vaso-constriction only to fall rapidly and seriously if as a result of operation there is further injury and loss of blood. The hæmoglobin percentage must be known because if the fluid loss is due to hæmorrhage from an open wound there is hæmodilution, whereas if it is due to permeation of serum into tissue spaces there is hæmoconcentration, blood transfusion being required in the first case and plasma transfusion in the second.

The steps to be taken by the surgeon when a seriously injured patient is admitted to hospital should, therefore, follow a definite sequence:—

1 Cover the patient with warm blankets and raise the foot of the bed.

2 Find out how the accident occurred and record the time of accident.

3. Make a quick examination of the whole patient—all four limbs, pelvis, spine, abdomen, chest, and head.

4. Cover wounds with a sterile towel. Control bleeding by the local pressure of a large wool pad firmly bandaged in position. Do not inspect a wound unless your face is covered with a mask.

5. Record the systolic blood-pressure, repeat the recordings at ten- or fifteen-minute intervals, and keep a chart.

6. If the systolic pressure is below 100 mm. start a blood transfusion and run in two pints rapidly. If the chart shows that systolic pressure is falling, even if it is not yet below 100 mm., start a transfusion.

7. If the patient is conscious and there is no abdominal wound give copious draughts of warm sweet tea or coffee. If there is cyanosis of lips, ears, or nails give oxygen inhalations.

8. Examine the patient more thoroughly. Do not allow your attention to be focused on one obvious injury; other more serious injuries may be less obvious. Apply temporary splinting to fractured limbs (*see below*).

9. Warn the anæsthetist and operating theatre staff and as soon as possible

* The normal total blood volume is 9 pints.

arrange for the excision of wounds and compound fractures or for the reduction and immobilization of closed fractures.

10. Continue blood transfusion during the emergency operation and afterwards until the systolic pressure is normal. Estimate the hæmoglobin every half-hour and change from blood to plasma transfusion if there is hæmoconcentration.



Fig. 673.—Temporary splinting of fractured shaft of humerus by gutter splints and collar-and-cuff.

TEMPORARY SPLINTING

Fractures of the Clavicle and Shoulder.—A small pad of wool in the axilla and a triangular sling tied over the opposite shoulder elevating the injured limb is a sufficient temporary support.

Fractures of the Humerus.—The wrist should be suspended from the neck by a collar-and-cuff sling by passing an ordinary bandage through two sleeves of basil leather or of folded brown paper. The fragments of the humerus are immobilized by three or four short padded gutter splints extending from just below the shoulder to the level of the elbow-joint (*Fig.* 673). The possibility of injury to the musculospiral nerve must be borne in mind.

Fractures of the Elbow.—The wrist is slung from the neck by a collar and cuff. The elbow must not be forced into full flexion, but should be held in a comfortable position above the right angle. When there is very severe swelling round the joint, a simple triangular sling may be used with the elbow at or just below the right angle. The limb must be examined for possible injury to the ulnar, median, or musculospiral nerves, and the circulation tested frequently by noting the colour of the fingers and by feeling the radial pulse. Severe elbow injuries are often complicated by damage to the vessels and nerves. Prompt reduction of bone displacement and continued supervision during the first few days are of great importance.

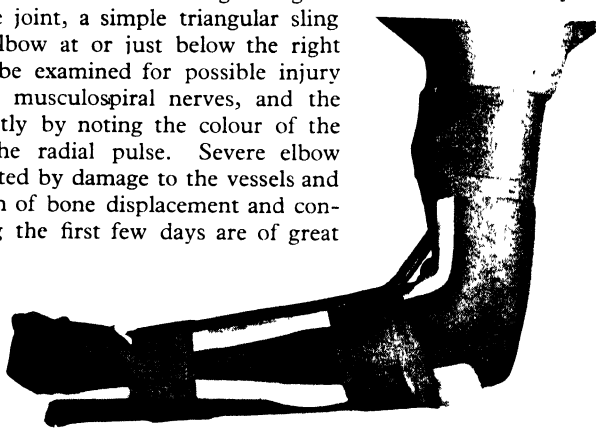


Fig 674.—Temporary splinting of fractures of the forearm bones

Fractures of the Forearm.—The forearm may be immobilized by an anterior angular splint extending from the middle of the upper arm across the front of the elbow to the wrist-joint, together with a simple gutter splint on the back of the forearm from the elbow to the knuckles (*Fig.* 674). The anterior splint must not extend beyond the skin creases of the wrist. If it reaches into the palm of the hand, undue pressure on the thenar eminence causes wasting of the muscles,

and the limitation of flexion of the fingers causes stiffness of the joints. Care must be taken that the angle of the splint does not press too firmly on the front of the elbow-joint. The circulation and movement of the fingers demand constant attention during the first few days. If cyanosis or pallor develops, or if there is the slightest difficulty in extending the fingers fully, the splints must be loosened at once. (*See* VOLKMANN'S CONTRACTURE, p. 521.)

Fractures of the Wrist.—Two padded metal gutter splints are used, one extending from just below the elbow down the back of the forearm to the knuckles, and the other a short splint from below the elbow to the level of the wrist-joint. The anterior splint falls short of the thenar eminence and should not extend into the palm (*Fig.* 675). The splints may be slightly twisted, to maintain pronation of the forearm and ulnar deviation of the hand. Two pads of wool are used to preserve the normal forward curve of the lower end of the radius. One pad over the front of the lower forearm two or three inches above the wrist level occupies the radial concavity, and a second pad is placed over the back of the lower radius immediately above the wrist-joint. The finger-joints must be left free for movement. If there is œdema of the fingers and hand, the limb must be well elevated until the swelling has subsided.

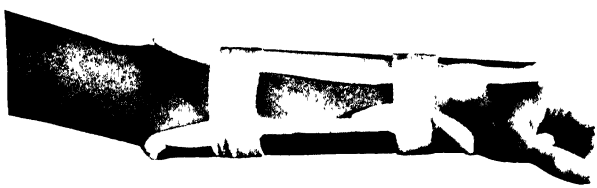


Fig. 675.—Two gutter splints and wool pads for Colles's fracture of radius.

Carr's splint, an anterior wooden splint with a bar of wood occupying the palm of the hand, should no longer be used even for temporary splinting of the wrist, because it so frequently causes stiffness of the fingers.

Fractures of the Spine.—The patient must be kept recumbent with the spine in the fully extended position. Fracture boards are essential. These are ordinary 1-in.-thick planks of wood about six inches across and slightly longer than the width of the bed, laid across the frame beneath the mattress to keep it firm and prevent sagging.

If the patient is lying face upwards, arching of the spine is maintained by two firm pillows beneath the dorso-lumbar junction. As a rule these patients are more comfortable in the prone position. The pillows must then be arranged beneath the upper thighs and beneath the upper part of the chest, so that the spine is still fully extended.

If the injury is in the cervical region there must be no pillow behind the head. A firm pillow is arranged behind the shoulders so that the neck is extended, and the head is kept at rest by sandbags on each side. Forward movement of the head is prevented by means of a small towel crossing the forehead and anchored by the sandbags.

In all spinal fractures, injury to the spinal cord must be excluded by noting the power, sensation, and reflexes of the lower limbs, and the functions of the bladder and rectum.

Fractures and Dislocations of the Pelvis.—The patient should be nursed in lateral recumbency lying on the uninjured side on a firm mattress over fracture

boards ; pillows or sandbags may be arranged to prevent him from rolling on to his back. The dislocated pelvis is like a partly opened oyster shell : laid on the hinge at the back the two halves are kept open by gravity ; laid on its side the two halves close together.

In fractures of the pelvis, the possibility of injury to the bladder or urethra must be considered.

Fracture of the Neck of the Femur.—Old and fragile patients who are kept recumbent are susceptible to hypostatic congestion and pneumonia. This is to be avoided by insisting on frequent change in posture, encouraging the patient to turn from one side to the other, and to sit up in bed while supported by five or six pillows or by a bed-rest. The lower limbs are widely abducted by pillows between them or by bandages round the ankles tied to either side of the bed. On the injured side, external rotation displacement must be prevented by the use of a carpet slipper with a piece of wood nailed to the heel projecting outwards (*Fig.* 676) The weight of the bedclothes is kept off the limbs by a bed-cage.



Fig 676.—Bedroom slipper used to keep the limb in neutral rotation and to prevent foot-drop

Fractures of the Femur, Knee, and Leg Bones.—A Thomas's splint should be applied immediately with skin traction, using a strip of brown adhesive strapping on each side of the limb. The strapping is bound to the limb with a soft encircling bandage and not with spiral strapping. The limb is supported in the splint by a wide gutter splint from the back of the upper thigh to the lower calf, suspended by two bandage-slings between the side bars. Extension tapes are fixed to the brown strapping and tied over the notch at the end of the splint. The whole splint and limb is then enclosed by an encircling bandage (*see* p. 561).

Fractures of the Ankle and Foot.—A right-angled padded wooden splint, or metal ' crab splint ', extending from the upper calf to the toes, is firmly bandaged to the limb (*Fig.* 677). A small pad of wool should be arranged just above the heel to prevent undue pressure

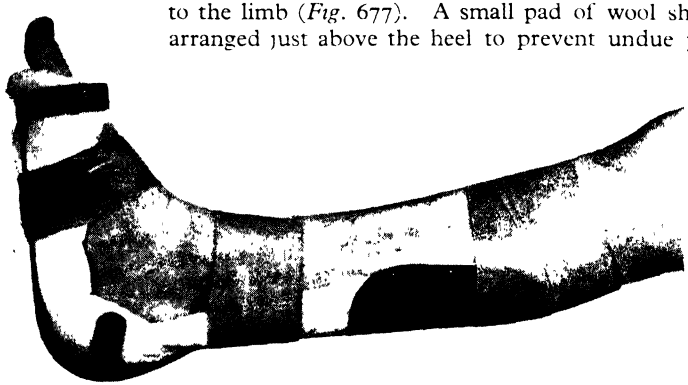


Fig. 677.—Crab splint for temporary protection of fractures of foot and ankle.

over the back of the os calcis. If the foot is swollen the limb should be elevated on pillows, and the foot of the bed raised on blocks or chairs.

CHAPTER LXVI

TREATMENT OF WOUNDS AND COMPOUND FRACTURES

By Sir REGINALD WATSON-JONES

A WOUND or compound fracture is a surgical emergency; the wound may be contaminated, but it must not become infected; operative treatment is urgent. The patient must be taken to the operating theatre as soon as the ten-minute blood-pressure chart shows that he is fit. The operation to be performed is not a simple stitching which can be done on a casualty couch; indeed, few wounds are stitched at all. Even wounds of the fingers must be properly excised and dealt with only under the best possible conditions.

PRINCIPLES OF WOUND EXCISION

The object of the operation is not to sterilize the wound by scrubbing with soap and water, by block excision as if a malignant growth was being removed, or by irrigating with powerful antiseptics. Such attempts fail to achieve the ideal of sterility, and, moreover, they kill the cells lining the walls of the wound upon which we depend for resistance to infection. The purpose of the operation is to excise dead and dying tissue, remove grossly contaminated matter, and divide both skin and fascia in the longitudinal axis of the limb so that tension will be relieved and free circulation maintained, thus securing a wound which is lined only with living tissues, freely supplied with blood and capable of destroying bacteria.

Technique of Wound Excision.—The limb should be held firmly in traction throughout the operation. If there is a compound fracture of the tibia or femur a Steinmann pin is driven through the lower shaft of the tibia and the limb is fixed on a traction table. The wound is left covered with sterile dressings until surrounding skin has been cleaned with ether, soap, and cetavlon or iodine; it is then screened off with sterile towels. No tourniquet is used.

The wound edges are lightly trimmed with a scalpel and the wound is enlarged in the long axis of the limb two or three inches above and two or three inches below. The deep fascia is similarly trimmed and freely divided throughout the extent of the wound. Each layer of tissue is then trimmed with curved scissors—first the superficial muscles, then the deep muscles, and finally the periosteum. All dead, crushed, and non-contractile muscle must be excised. No bone fragments are removed unless they are widely displaced and completely loose; the less bone removed the better. Hæmostasis is secured by pressure forceps twisted off, larger vessels being tied with fine catgut. The wound is then flat and saucerized and no recesses remain, so that it is obviously impossible to insert drainage tubes; they would fall out. Powdered penicillin is blown lightly into all parts.

The wound is not sutured—no deep layer of the wound is ever sutured. The

fascia is never sutured. The skin is never sutured unless the surgeon can be quite certain that there will be no tension and no infection. It is far better to leave the wound open so that there is no possibility of tension or impairment of circulation, and to perform secondary suture after a few days. The wound is not packed with gauze or vaseline gauze or any other material. A large pad of gauze is simply placed on the surface of it and a plaster cast is applied. The cast is split throughout its length and when the patient returns to bed the limb is elevated.

Wound Closure—Secondary Suture or Skin-grafting.—After a few days it will be obvious from the general condition of the patient, from the pulse and temperature chart, and from the appearance of the wound when the plaster is removed in the operating theatre, that it is healing without infection. If it is allowed to heal by granulation (*Fig.* 678) there is not only danger of late secondary infection but the scar becomes fibrotic, broad, and adherent, and in



Fig. 678.—A wound should not be allowed to heal by granulation. If no skin has been destroyed secondary suture should be performed. If, as in this case, skin has been destroyed, early skin-grafting should be performed.

regions where the underlying tissues are inelastic, as, for example, the subcutaneous surface of the tibia, healing is delayed by many weeks or months. The wound should therefore be closed. If no skin was destroyed by the original injury it should be closed by secondary suture; the skin margins are dissected from the granulations, undercut, and brought together by silkworm or nylon sutures. If, however, there has been actual destruction of skin no attempt must be made to pull the margins together under tension by strong mattress sutures. The destroyed skin must be replaced by split skin-grafts cut from the inner aspect of the thigh.

WINNETT ORR TREATMENT OF INFECTED FRACTURES

If the wound does not heal by first intention, and there is actual infection, it is a grave mistake to attempt secondary suture. In these circumstances no part of the wound should be sutured. It must be laid widely open with free drainage and saucerization of every part of it down to the bone. The cavity is lightly packed with sterile gauze which has been impregnated with sterile

vaseline. The skin is protected with a generous layer of vaseline and vaseline-gauze, displacement of the fracture is reduced, and the limb is enclosed in plaster. If any part of the skin over which pus will flow has been inadequately protected, a purulent dermatitis will develop, with severe burning pain.

The temperature chart must be watched carefully. The fever should subside within three or four days, so that the temperature ranges from subnormal to 99° or 99·5° F. If the temperature rises acutely over 100° F. it means that pus is pocketing under tension. The wound must be reopened for drainage of the pocket. This should be the only indication for changing the plaster. Discharge of pus from the ends of the plaster and the revolting smell of retained discharges are of no significance provided that there is no febrile reaction.

The plaster and vaseline pack are changed in four or five weeks, and any sequestra which have separated are removed. The treatment is continued with a routine of two-monthly changes of plaster until the wound is completely granulated and epithelialized and for several months longer until the fracture is united.

GAS GANGRENE

Every compound fracture sustained on the roads, in pasture lands, or wherever there may be infection from cattle manure, must be suspected of gas-gangrene infection, especially when there is severe muscle or cellular tissue injury, and the emergency operation of wound excision was unduly delayed or imperfectly performed. The bacteria, being anaerobic, can develop only in avascular tissue. The three typical signs are: (1) Swelling, possibly at some distance from the wound, which on palpation is found to crepitate and to be due to gases liberated in the muscles and subcutaneous tissues; (2) Serous discharge from the wound; (3) A typical pungent smell which once recognized is never forgotten.

Immediate operation is of the greatest urgency. The organism is anaerobic, and if all dead tissue is removed, and every infected region is so freely drained that the tissues regain their normal blood-supply and their normal oxygenation, the infection may be controlled and the limb saved. All stitches are removed, and the wound is extended in the long axis of the limb well beyond the limits of infection until it is even ten or more inches in length. Other longitudinal incisions may be added. Any muscle which is already infected and gangrenous is removed in its entirety, great care being taken not to damage the blood-supply to adjacent tissues and muscles. If the gas-gangrene infection is controlled, secondary suture of the granulating wound may be performed in ten to fourteen days. If it is not controlled, immediate guillotine amputation is imperative in the attempt to save the life of the patient.

AFTER-TREATMENT OF WOUNDS

"*Injuries which are most important to industry are most neglected by surgeons.*"

This surprising observation is true. The man-power of the country is largely uninfluenced by success or failure in the treatment of cerebral tumours and other major problems which have commanded much surgical interest, but it is profoundly influenced by the treatment of simple wounds of the hand which are generally regarded as unworthy of special skill. Of all industrial accidents which incapacitate men from work, and cost over £5,000,000 a year in compensation payments alone, more than half are injuries of the fingers and hand. In two-thirds of these cases the disability is due to infection of trivial wounds. Moreover, the additional loss of time due to wound infection in men and women who never actually cease work is no

less than one million man-hours a year.* The surgical challenge is grave because very often infection is due not to the original injury but to the treatment of it.

Danger of Secondary Cross-infection.—Primary infection of a wound is due to early contamination and failure of wound excision. Secondary infection is due to recontamination in the course of after-treatment. Bacteria may be transferred to the wound from the nose and throat of a surgeon, nurse, or dresser, from the skin of a dresser, or from the wounds of other patients treated in the same department. The danger of cross-infection is greatest in hospital casualty departments and industrial dressing stations where a large number of wounds are dressed each day. On the average a quarter of such wounds are frankly septic, and another quarter, though apparently clean, are no less important a source of potential infection to other wounds because they are bacteriologically contaminated (so-called ' silent infection '). Surgeons and nurses who are meticulous in the aseptic technique of operating theatres often fail in the casualty follow-up department. The patient may be allowed to rest his hand on a table (thus contaminating the table top), while a nurse takes off soiled bandages and dressings with her fingers (thus contaminating her skin), then placing the dirty dressings in a shallow dish (thus contaminating the air), taking a clean dressing by hand from the sterile drum (thus contaminating the contents), mopping discharge and debris from the wound with swabs held by hand (thus re-contaminating her skin), and doing the whole of it without using a mask (thus contaminating everything). In such circumstances it is quite certain that the wound of the next patient will be infected with bacteria from the first, and that re-infection of wounds will continue throughout the day with a steadily mounting bacterial flora.

No-touch Technique of Wound Dressing.—It is unreasonable to expect the full aseptic ritual of an operating theatre in the casualty redressing department, but cross-infection can be controlled almost completely by a simple no-touch technique. The steps to be taken by the surgeon or nurse who is dressing the wound must follow a definite plan :—

1. Cover nose and mouth with a mask (which stays in position throughout the redressing session).

2. Wash hands and dry on a clean towel (for a long session wear rubber gloves which can be washed between each case with soap and water, or with antiseptic, without damage to the dresser's skin).

3. Take from the sterilizer, with sterile lifters, a dressing bowl, two pairs of dissecting forceps and a pair of scissors.

4. Take from sterile drums, with the sterile dissecting forceps, mops, gauze dressing and bandage sufficient for the case ; place them in the sterile bowl.

5. By means of another pair of forceps and scissors (which are kept in 10 per cent dettol), remove the outside bandage and soiled dressings by no-touch technique.

6. Drop the soiled dressings into a deep bin from which dust cannot scatter, and replace the forceps and scissors in dettol.

* A Medical Research Council unit found that, on the average, patients in factories attended the dressing station four times for the treatment of a clean wound and eleven times for the treatment of an infected wound. Allowing no more that a quarter of an hour loss of working time for each dressing, the total loss was 1¾ hours more in the case of a septic wound than a clean one. In a factory of 6000 workers this meant a loss of 1000 working hours. There are 6,000,000 workers in the factories of Britain, so that the total loss must be at least one million hours.

7. Clean the wound with mops, using the two pairs of sterile dissecting forceps and no-touch technique ; use only the sterile scissors for snipping off dead skin or for cutting dressings ; apply gauze dressing with no-touch technique ; apply the bandage.

8. Wipe over the glass surface of the table on which the limb has been resting with a swab of 2 per cent lysol or 10 per cent dettol held in forceps.

9. Replace the dressing bowl, two pairs of dissecting forceps, and scissors in the sterilizer , rewash hands or gloves ; prepare for next case.

CHAPTER LXVII

GENERAL PRINCIPLES IN THE TREATMENT OF FRACTURES

By Sir REGINALD WATSON-JONES

THERE are three principles of fracture treatment, all of equal importance, which must be in the mind of the surgeon from the first day of injury until the last day of recovery :—

1. *Reduction.*—To correct displacement perfectly and maintain replacement of the fragments, always using X-ray control.

2. *Immobilization.*—To fix the fragments completely and without interruption until the fracture is firmly united.

3. *Functional Activity.*—To preserve movement in joints which need not be immobilized, by the patient's own active exercise, but never by passive stretching. To maintain the tone of muscles even in the parts immobilized, and to encourage use of the limb, as far as possible, throughout the period of immobility.

REDUCTION OF DISPLACEMENT

Manipulative Reduction.—The ' setting ' of fractures is not a special art dependent on hereditary skill. The technique consists simply in inspecting radiographs to see where the fragments lie, replacing them by direct pressure or by traction, X-raying to see that the object has been achieved, and repeating the routine " manipulate, fix, X-ray " as often as may be necessary. Occasionally manipulative reduction may fail owing to anatomical difficulties or to undue delay in instituting treatment, and operative reduction is necessary.

Reduction must be effected by guarded measured strength rather than by sudden jerking force. This is important in fractures of the shafts of the long bones where considerable leverage is possible ; it is particularly important in greenstick injuries, which must be reduced by gentle moulding, taking care not to convert the injury into a more difficult complete fracture. In fractures near the ends of the long bones, especially when impacted, much more force may be necessary. Frequently in fractures of the ankle, and sometimes in other fractures, the radiograph will show that the fragments lock when fully reduced, so that over-reduction is impossible.

Manipulation under Anæsthesia.—No displaced fracture should be manipulated without an anæsthetic ; to do so is unfair to the patient and unfair to the surgeon. The patient may permit one sudden movement which he does not fully expect, but he will certainly not allow any further manipulation, and no fracture can always be perfectly reduced by one sudden movement. Even old and fragile patients can withstand two or three minutes of gas anæsthesia with safety.

In the very rare cases where general anæsthesia is inadvisable owing to constitutional disabilities, local novocain anæsthesia may be used. Ten minutes should elapse after injecting the novocain into the fracture hæmatoma to allow

complete diffusion of the anæsthetic before the fracture is manipulated. Most surgeons prefer not to use local anæsthetics as a routine in all cases. Anæsthesia is not always perfect, and there is particular difficulty in impacted fractures where diffusion of the anæsthetic is difficult.

Standard of Reduction.—How perfectly must the fragments be replaced? Is an anatomical 'hair line' reduction necessary? The standard of end-result must be a limb clinically indistinguishable from normal—one which has normal function and which looks normal. The alinement must always be perfect, and there must be no rotational displacement. Slight lateral displacement may be of no significance in fractures of the shafts of the humerus and of the femur, but if lateral displacement exceeds a certain minimum, bony thickening impairs the cosmetic result, particularly in subcutaneous bones such as the tibia. Furthermore, when there is marked lateral displacement reduction may be unstable. X-ray examination is therefore essential after every every manipulation, and the surgeon must be satisfied that the position, though not necessarily anatomically perfect, is compatible with perfect function and appearance.

Ideal Time for Reduction.—The fracture which is seen within about half an hour of the injury should be reduced under anæsthesia and immobilized at once. If it is feared that subsequent swelling may be of such severity that a complete encircling plaster cast would be dangerous, a plaster slab may be applied over half to two-thirds of the circumference of the limb and held in place by a bandage which can be cut at once if required The encircling cast is completed the following day.

If the fracture is reduced and plaster applied when the limb is already severely swollen, redisplacement very often occurs a few days later as the swelling subsides and the plaster becomes loose. In this event it may be better not to anæsthetize the patient unnecessarily, but without preliminary manipulation to immobilize the fracture by a plaster slab and put the patient to bed with the limb elevated. Two or three days later the swelling will have subsided and the fracture is then manipulated under anæsthesia and completely immobilized.

This routine of delayed reduction should not be applied to dislocations, nor to any fractures where the displaced fragments may exert pressure on nerves or vessels. Badly displaced supracondylar fractures of the elbow should be reduced at whatever stage they are seen, and whatever the degree of swelling.

Subsequent Check Radiographs.—If a fracture has been reduced and plaster applied over a swollen limb, a check radiograph is essential seven to ten days later before the new plaster is applied, in order to be sure that the fragments have not become redisplaced. Every time that splints are adjusted or plaster reapplied, a further radiograph must be taken through the new plaster, however unlikely it may appear that the position has been altered; slight but important changes in the position of the fragments commonly occur during the reapplication of plaster.

Certain fractures, particularly fractures of the lower shaft of the radius with radio-ulnar dislocation, fractures of both bones of the forearm, fracture-dislocations of the cervical spine, and fractures of the shaft of the tibia, are prone to redisplacement even despite a satisfactory initial reduction and closely fitting plaster casts. These fractures must be X-rayed again every second or third week, whether the plaster has been changed or not.

It has been said of fracture treatment that "bones are filled not with red marrow but with black ingratitude". This is no longer true if treatment is

controlled, but if a surgeon fails to exercise detailed control of every stage of treatment, black ingratitude is his just reward

Danger of X-ray Screening.—Manipulation of fractures under the direct visual control of X-ray screening is dangerous to patients and very dangerous to surgeons and their staffs. One young surgeon within twelve months of adopting this technique suffered X-ray dermatitis of the hands, warty pigmentation and ulceration of the skin, replacement of his nails by rough, irregular, broken talons, and amputation of one finger. It was impossible for him to scrub up and his career as a surgeon was finished. Another victim, after longer exposure, lost all eight fingers and one thumb, together with most of his nose and lips, owing to X-ray cancer.

Repeated manipulations under one continuous anæsthetic can be controlled no less effectively by taking a series of ordinary radiographs, and using modern methods of rapid film development, the surgeon and his staff protecting themselves from scattered rays during the exposures. Each pair of films should be ready for inspection within three or four minutes.

IMMOBILIZATION OF FRAGMENTS

The repair of fractures takes place by the development of a delicate cellular granulation tissue between the fragments which calcifies to form callus. Tearing of this granulation tissue delays repair; the slightest shearing or rotation strain interrupts the continuity of the growing tissue and causes continued decalcification of the fragments.

If movement continues a fibrous gap develops, and the final process of recalcification occurs, not in a continuous callus between the fragments, but across the bone ends which become densely sclerosed so that non-union is established. Operative treatment by drilling or bone-grafting is then necessary in order to break up the sclerosis before immobilization will succeed in promoting union.

The more complete the immobilization the more rapid is the union. Plaster casts are therefore preferable to splints, and the casts must be carefully moulded to the contour of the limb. There must be no bulky wadding or thick layers of wool beneath the plaster; as a rule it may be applied directly to the skin or over a single or double layer of stockinette. *Complete and absolute immobilization must be continued until the fracture is united, and even if the average period has been exceeded there must still be no interruption of the immobilization.* Many factors account for slow repair and delayed union; they do not cause non-union if the immobilization is suitably prolonged, but if immobilization ceases non-union becomes established.

Fractures unite more slowly in adults than in children. A fracture of the shaft of one of the forearm bones is usually united in six weeks in a child, but not until ten weeks in the adult.

Union is delayed by infection; even a trace of infection may add several weeks to the duration of repair, and if there is severe infection, union may occur only after six, twelve, or eighteen months. If the blood-supply of one fragment is cut off by the fracture all repair must take place from the other fragment and union may not be complete until twelve to eighteen months after the injury. There are other unknown factors which account for very marked variation in the rate of repair in apparently identical fractures.

The accepted periods of immobilization must therefore be recognized as minimal periods, to be exceeded in any case where clinical and radiographic tests show a slower rate of repair. Most fractures are united in children in two

months and in adults in three months. Fractures of the lower limb weight-bearing bones must be immobilized for the whole of this time; in the upper limb a shorter period of protection is necessary, particularly if the fracture lies near the joints so that leverage strains are reduced.

Minimal Periods of Immobilization of Fractures and Dislocations in Adults

Upper limb dislocations :—	
Shoulder, elbow, carpal semilunar, finger-joints ..	2 to 3 weeks
Upper limb fractures—near joints :—	
Colles's, supracondylar, neck of humerus ..	4 to 5 weeks
Exceptions.—Clavicle, 3 weeks; carpal scaphoid, 8 to 10 weeks	
Upper limb fractures—shafts of long bones :—	
Humerus, radius, ulna	6 to 10 weeks
Lower limb dislocations and fractures of weight-bearing bones :—	
Os calcis, fracture-dislocation of ankle, shaft and tuberosities of tibia, shaft and condyles of femur ..	10 weeks
Exception —Neck of femur, 4 to 12 months	
Spine—crush fractures and fracture-dislocations .	3 to 6 months

FUNCTIONAL ACTIVITY

No joint must be unnecessarily immobilized. Complete fixation of the fracture is essential, so that immobilization of the joints immediately above and below the injury cannot be avoided, but no other joint must be covered by splints, plaster, strapping, or bandage. *It is not enough that these joints are left free; it is the surgeon's duty to see that they are actively mobilized by the patient's own exercise.*

Stiffness of the Fingers.—Recovery should be complete after a Colles's fracture of the radius within about two months of the injury. If the finger-joints

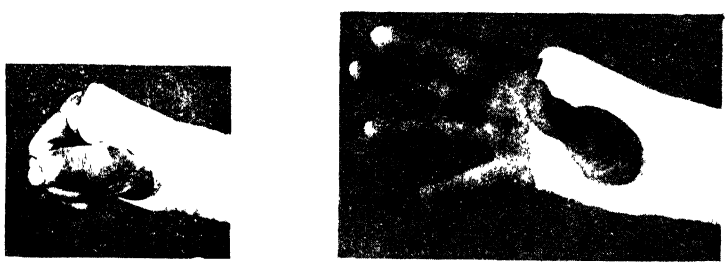


Fig. 679.—Full finger exercises must be practised although the fractured wrist is immobilized in plaster.

have been allowed to stiffen it will be at least twelve months before the patient can use the hand, and the limb may even be permanently crippled. This stiffness may develop within a few days, especially if the fingers are swollen and œdematous. The patient believes that swelling indicates a very severe injury, and that aggravation is to be avoided by guarding against the slightest movement of any part of the limb. Exactly the opposite treatment is urgently indicated:

the more swollen the fingers the more imperative is active exercise. The patient must flex the interphalangeal joints by bending the fingers tightly into the palm, flex the metacarpo-phalangeal joints by reaching towards the front of the wrist with the finger-tips, extend all the joints until the fingers are fully spread, and repeat the exercises for at lease five minutes every hour of the day (*Fig.* 679).

In every upper limb injury the first step when the patient recovers from the anæsthetic is to teach him finger exercises. He must be seen daily until movements are perfect, and any patient who through anxiety or lethargy fails to regain movement rapidly must be referred to a massage department—not for massage, but for daily supervision of the exercises. If the swelling of the fingers is so severe that movement is difficult the patient must be admitted to hospital, the limb elevated, and exercises supervised every hour.



Fig 680.—Exercises for the shoulder whilst the limb is encased in plaster.

Finger exercises are equally important in fractures of the hand, wrist, or forearm in plaster; fractures of the elbow or shoulder in a collar-and-cuff sling; fractures of the humerus in a frame; or fractures of the clavicle in bandage or strapping. Many healthy men have been permanently incapacitated from work by a simple fracture of the clavicle treated by Sayre's strapping which had bound the fingers and hand flat on the chest wall for only two or three weeks.

The Danger of Passive Movement.—It is of vital importance that the exercise should be done by the patient himself, and that there should be no stretching or passive movement of any type.

Passive stretching not only causes unnecessary pain, but it has exactly the opposite effect to that which is intended. The stretching injures the joints, tears the capsule, increases the exudation, and aggravates the adhesion formation. If stiffness of the fingers is threatening, the one way to make certain that the stiffness will be serious or even permanent is to force the joints.

Stiffness of the Shoulder.—In fractures of the hand, wrist, and forearm, shoulder exercises are also important. Several times a day the shoulder must be

fully externally rotated, fully abducted, and internally rotated, by lifting the arm with its plaster until the hand is behind the neck, over the opposite ear, and in the small of the back (*Fig.* 680)

Functional Use of the Upper Limb.—As a rule no sling should be worn after the first day or two. In many cases the patient may use the limb for dressing, eating, and for light household duties. This activity prevents stiffness of the fingers, and it maintains the tone of the muscles within the plaster, promotes a normal circulation, and minimizes adhesion formation round the immobilized joints so that subsequent recovery is more rapid (*Fig.* 681).

Wasting of the Quadriceps.—In lower limb injuries the thigh muscles waste very rapidly, especially when the knee-joint itself is injured. This wasting occurs so quickly that many months of treatment may be required to regain the losses of only two or three weeks. No injured knee-joint should be immobilized without at the same time teaching the patient 'quadriceps drill'. Smooth rhythmic contraction and relaxation of the muscle is continued for five or ten minutes every hour of the day. The muscle must be braced as tightly as possible and in doing so the knee-joint must be *fully* extended. It is only during the last two or three degrees of extension movement that the vastus internus comes into play and this muscle will continue to waste rapidly and seriously despite leg-raising exercises unless the knee-joint is braced quite straight.





Fig. 681.—The range of wrist movement possible immediately the plaster is removed after six months' immobilization for a fracture of the scaphoid. Functional activity and finger exercises have prevented adhesion formation round the joint despite immobility

Rigid Clawing of the Toes.—Toe exercises are no less important when the foot and leg are immobilized in plaster, than finger exercises in upper-limb plasters. The toes must not be immobilized in the clawed position, or rigid clawing of the toes and rigid transverse flat-foot will cause persistent disability. The plaster must be moulded under the transverse arch, and if a platform of plaster is left under the toes, it must be bent down sufficiently to allow the metatarso-phalangeal joints to be flexed.

Functional Use of the Lower Limb.—In many fractures and dislocations of the foot and ankle, patients may safely walk with the limb immobilized in closely fitting plaster casts. With certain fractures weight-bearing may begin within two or three days, but as a rule, especially when there was marked swelling of the foot at the time that the original plaster was applied, weight-bearing is deferred for two or three weeks until the new plaster has been applied. The exercise maintains the tone of the leg muscles, it minimizes disuse decalcification of the bones, and it prevents circulatory stasis with resulting œdema and adhesion

formation. Even after union of the fracture, the patient who has a swollen, heavy, œdematous foot with decalcified bones and a painful stiff ankle cannot undertake the walking exercise necessary to overcome these disuse changes. In such cases, if the foot is immobilized in plaster, so that the patient can walk several miles a day, the range of ankle movement increases steadily despite immobility of the joint.

Prevention of Disuse Œdema.—After prolonged recumbency there is always a tendency to swelling of the foot and leg when the upright position is resumed. This is particularly marked if the limb has been in plaster so that the circulation has become accustomed to a rigid external support. When the support is suddenly lost, severe œdema develops during the daytime, and if left uncontrolled it may continue for many months. Massage treatment is quite ineffective in controlling it. As soon as the plaster is taken off, a semi-rigid or elastic dressing must be applied. *There must be no interval between removal of the plaster and the application of elastic support.* If, in error, an interval has been allowed, so that the leg is already swollen, the patient must be put to bed for two or three days with the foot elevated before the dressing is applied.

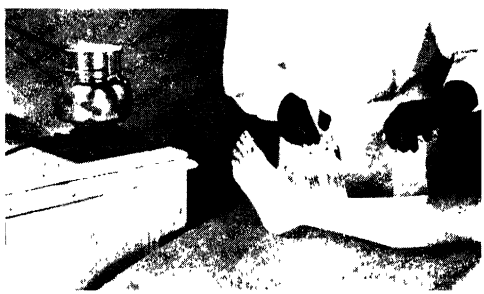


Fig. 682.—Application of Unna's paste to prevent recurrent œdema after removal of plaster.

Ordinary crêpe bandages may be used to control this swelling, but they tend to slip, and if the patient applies the upper turns of the bandage more tightly than the lower turns, the œdema is aggravated. An elastic stocking, though useful, is expensive. Elastic adhesive strapping such as Elastoplast is very irritating and often causes a pustular eruption or even generalized dermatitis; it should not be applied directly to the skin, but only over a layer of stockinette. Unna's zinc-gelatine paste is non-irritant and relatively cheap. The cubes of gelatine are placed in a pot surrounded by water which is boiled until the gelatine melts to form a smooth paste. The paste is painted on to the leg with a wide brush, and covered with a soft bandage spirally applied. Two or three layers of alternate paste and bandage complete the dressing (*Fig.* 682). It must extend from the web of the toes to just below the knee.

Proprietary bandages are now available already impregnated with zinc-gelatine paste. Viscopaste is rather harsh, but icthopaste, which must first be softened by immersion in hot water for five or ten minutes, is very satisfactory. The dressing is retained until the muscle tone and circulation of the leg is restored; the patient's report that the dressing is no tighter at the end of the day than it was at the beginning shows that the tendency to œdema has subsided. In the adult protection is necessary for at least five weeks, and sometimes for several months.

No plaster, strapping, or firm bandage should ever be applied to the thigh, knee, or upper leg with the lower leg and ankle left unsupported; œdema of the unprotected lower leg is inevitable. If a plaster spica for the hip ends at the level of the lower calf, it must be extended to the toes by a Viscopaste bandage. If a knee-joint which is tending to swell is firmly bandaged or strapped, the bandage must extend over the calf, leg, and ankle to the foot.

CHAPTER LXVIII

COMPLICATIONS OF FRACTURES

By Sir Reginald Watson-Jones

Every patient with a fracture or dislocation must be examined at least once daily for several days after the injury in order to confirm that. (1) reduction is complete; (2) there is no undue friction at the margins of the plaster; (3) bandages or strappings are not too tight; (4) the circulation is normal, (5) there is no undue œdema of the fingers or toes; (6) the patient is practising exercises adequately.

If the patient has not been admitted to hospital explicit instructions must be given that he is to report the following day, and *if there is pallor, cyanosis, numbness, tingling, or immobility of the fingers or toes, he is to return at once whatever the hour of the day or night.* When the danger of complications is over, the patient is examined once weekly until recovery is complete.

LOCAL COMPLICATIONS

Œdema.—During the first two or three days after injuries of the wrist and ankle there is usually swelling of the fingers and toes, especially when local swelling is prevented by a plaster cast. If the circulation is brisk, and there is no cyanosis or anæmia, the swelling is of little significance. The limb must be elevated until it has subsided. Active exercises to prevent joint stiffness are even more important than usual, and patients must be disillusioned of the belief that " the fingers are too swollen to move ".

Gangrene.—When there is not only swelling but also impairment of the circulation, the position is much more serious. If any limb is encased in plaster or splints the circulation must be tested frequently by compressing the tip of each digit, and seeing that the area made anæmic rapidly flushes with blood when pressure is released. If the return of blood is slow the test is repeated every few minutes. If the digit remains blue, or is actually cold and pallid, the plaster must be cut at once. It is not always necessary to remove any part of the plaster, but it must be cut longitudinally throughout its length, every turn of plaster and bandage being divided until skin is exposed in the gap. The gap must then be filled with wool, firmly bandaged in position, in order to prevent blistering of the exposed skin. If the circulation is still not restored the whole of the front half of the plaster must be removed, the back half being relied upon to prevent redisplacement of the fracture. If pressure is not released and the vascular obstruction is not relieved, gangrene may develop and necessitate amputation.

Volkmann's Ischæmic Contracture.—Occasionally in fractures of the elbow and forearm, even when all external pressure has been relieved, the limb remains pallid or blue and the radial pulse is weak or absent. Compression of the brachial artery in the antecubital fossa, or injury to the walls of the brachial, radial, or ulnar arteries, must be suspected. The surgeon

must not await the development of contracture of the fingers before establishing the diagnosis; if he does he will be too late and there will be permanent crippling; he must diagnose Volkmann's ischæmia by the pallor or cyanosis of the fingers.

If the circulation is not restored within six to eight hours the flexor muscles of the forearm die and are replaced by fibrous tissue which shortens so that the fingers contract at the interphalangeal joints. If the wrist is flexed so that the muscles are relaxed, the finger contracture is released; if the wrist is dorsiflexed there is increased tension on the forearm muscles and the contracture is increased. The contracture may occur in a localized form, affecting only one or two fingers. It must be looked for in all forearm and elbow injuries during the first few days, especially when there has been circulatory impairment, by testing the ability of the patient to extend the fingers fully (*Fig.* 683). The fully developed contracture causes serious and permanent crippling, and may be associated with paralysis of the ulnar and median nerves.



Fig 683.—Testing for Volkmann's ischæmic contracture in a fracture of both forearm bones immobilized in plaster.

These serious consequences can be avoided only by prompt treatment during the first few hours. The surgeon must first satisfy himself that there is no pressure on the artery.

Pressure may arise from: (1) Tight bandages, strapping, or plaster. Encircling bandages must be cut, and if there is an encircling plaster the front half must be removed. (2) Flexion of a swollen elbow-joint. In elbow fractures the only safe position may be 20° or 30° below the right angle. (3) Displacement of a supracondylar fracture, the vessels being stretched over the lower end of the shaft. The displacement must be reduced, and the position maintained by a posterior plaster slab

If all these factors can be excluded and there is still pallor or cyanosis and absence of the radial pulse, the artery has been damaged and immediate operation is urgently necessary. It may be found that the artery is not actually severed but is in spasm, which is often relieved by simple exposure of the vessel and cleaning of its walls with a moist saline swab. If the artery is partly or completely severed a segment of it must be excised in order to remove all vasoconstrictor nerves which are causing vasospasm of the collateral vessels.

If finger contraction is already developing, shortening of the flexor muscles should be minimized by splinting the fingers in extension.

Thrombosis.—Thrombosis due to injury to the veins sustained at the time of the accident, or during manipulative or operative reduction, is rare. Femoral thrombosis may complicate hip injuries, and subclavian or axillary thrombosis may occur in injuries of the shoulder. The limb should be elevated, and firm elastic pressure applied by crêpe bandages or zinc-gelatine paste.

Nerve Lesions.—Injuries to the nerves are usually sustained at the time of the original injury. Primary nerve lesions are particularly common in injuries of the elbow, humerus, and shoulder; in most cases the paralysis is incomplete and due to simple bruising of the nerve-trunk. Secondary nerve lesions may arise in injuries of the elbow-joint from passive movement of the joint causing friction of the nerve-trunk over irregular bone.

Pressure Sores.—These may develop from undue pressure over bony prominences by splints, bandages, or plaster.

Plaster sores may be due to: (1) Pulling one turn of the plaster bandage too tightly; (2) Careless moulding of the plaster; (3) Application of a plaster slab which instead of being wet and sloppy has begun to harden, so that it does not adapt itself smoothly to the contour of the limb; (4) Movement of a joint during the setting of the plaster so that a ridge is formed; (5) Before the plaster has firmly set, allowing it to rest on a hard surface so that it is flattened over a bony prominence (especially the back of the heel in leg plasters, and over the sacrum in trunk and hip plasters); (6) Pushing coins, heads of knitting needles, small wads of wool, or other foreign bodies down between the plaster and the limb; (7) Delay in repairing a crack in the plaster near the joint, so that there is friction from the broken margins.

The patient may complain of persistent localized discomfort and pain. In other cases the skin and subcutaneous tissues become anæmic and anæsthetic, and there is no complaint of pain. The first sign may then be the typical smell of accumulated secretions and discharge. The pressure sore can usually be localized because the overlying plaster becomes warmer than elsewhere. *Œdema of the toes or fingers recurring after the initial œdema has subsided means almost certainly that there is a pressure sore.* If the sore is near the end of the plaster the digits become red and inflamed. Finally the sloughing is recognized by the staining of the overlying plaster, or by a purulent discharge from the end of the plaster.

As soon as a pressure sore is suspected, a window must be cut in the plaster. The gap should afterwards be filled with a pad of wool firmly bandaged into position.

Purulent Dermatitis.—When plaster is applied directly to a limb without padding, the skin usually becomes dry and scaly. Some patients have a more susceptible skin and a dermatitis develops which is similar to intertrigo dermatitis, or to the skin irritation sometimes seen beneath adhesive strapping. Staphylococcal infection of the hair follicles and sweat glands supervenes, and if the condition is ignored a severe and extensive purulent dermatitis develops. The first sign is itching and irritation of the skin, and later there is severe burning pain. At the first sign of irritation, a small window should be cut, and talcum powder liberally applied and blown under the margins of the plaster every day. In severe cases it may be necessary to apply a new plaster after cleaning the skin, freely dusting it with talcum powder and applying a layer of stockinette.

Skin Blistering.—This is very common during the first twenty-four hours in the region of severe elbow, leg, and ankle fractures. The blisters are due to traumatic œdema and exudation into the cuticle, the exudate sometimes being hæmorrhagic. They can develop only where the skin is unsupported. If splints are used they appear between the splints and not beneath them; they never develop beneath a complete encircling plaster. The blisters should be emptied by pinching the overlying cuticle, and talcum powder dusted over them. Plaster may then be applied in the usual way.

If a plaster is cut down owing to circulatory difficulty, or a window is cut for a suspected pressure sore, the gap should be filled with a firm pad of wool bandaged into position. If this is not done, there will be blistering or œdema of the uncovered area of skin, and sores may develop round the margins of the window.

Myositis Ossificans.—This is due to the ossification of subperiosteal hæmatomata, and occurs most commonly in children, where the periosteum is easily stripped, and after dislocations, where ligaments and muscles are avulsed with their periosteal attachments. It is most common at the elbow-joint, but it may also occur at the shoulder,

hip, knee, or ankle. The complication may be avoided by prompt reduction of dislocations, and by avoiding all passive stretching which interferes with the reattachment of the periosteum to the bone.

Joint Stiffness.—Stiffness of the joints from adhesion formation is to be avoided by active exercises and early functional activity. If any stiffness does develop, it must be overcome by the patient's own exercise and not by massage or stretching.

Stiffness of the elbow-joint is very commonly due to passive stretching. When a child is seen with an elbow injury, the parents must be warned at once that the recovery of movement may be slow, but that it will be most rapid and most complete if it is allowed to develop at its own rate. *No elbow injury should be treated by massage; there must be no single stretching movement; the patient must not be allowed to carry buckets of water or heavy weights with the object of straightening the joint.* The range of movement should be estimated and recorded week by week by means of an angle measurer (*Fig.* 684). If the fracture has been perfectly reduced the movement will steadily increase. If the range remains stationary or decreases, the surgeon knows that some type of force or passive stretching is being permitted.

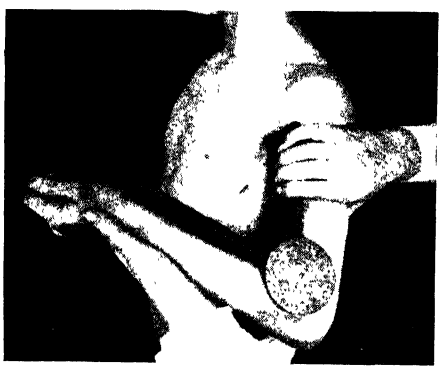


Fig 684.—The range of joint movement must be measured accurately and recorded

The stiff elbow should seldom be manipulated under anæsthesia with the object of regaining mobility. If the range of movement is actually measured, it will often be found that manipulation usually delays recovery, and does not accelerate it. Exactly the same is true of stiff finger-joints. The stiff finger usually becomes stiffer as the result of manipulation under anæsthesia.

The harmful effects of passive stretching and manipulation under anæsthesia are most obvious in the elbow and finger-joints, but the same principle applies to all joints. Movement is regained more rapidly by the patient's own exercise than by passive stretching or by manipulation.

Delayed Union of Fractures.—At the conclusion of the usual minimum period of immobilization, union is tested clinically by 'springing' the bone, and it is estimated radiographically. If the fracture is not firmly united, plaster is reapplied for a further four to six weeks, and union is again tested. In cases of delayed union this routine is repeated as long as may be necessary up to twelve months or longer, or until it is decided that operative treatment is essential.

Established Non-union of Fractures.—If a fracture with delayed union has not been immobilized continuously for a long enough period established non-union develops. The fractured surfaces become sclerosed. An operation is then necessary to refreshen the surfaces and to implant bone-grafts. The surgeon may decide to use cancellous bone chips cut from the crest of the ilium, or an onlay bone-graft cut from the subcutaneous surface of the tibia. Both areas should be prepared for operation as well as the injured limb.

GENERAL COMPLICATIONS

Rise of Temperature.—An increased temperature is not uncommon for a day or two after severe fractures, even though there is no compound injury and no infection. The febrile reaction disappears as the blood-clot undergoes absorption.

Hypostatic Pneumonia.—This may occur in old people, especially those who are somewhat emphysematous. It is due to congestion, and its onset is favoured by keeping these patients on their backs. The rule, therefore, in treating fractures in elderly people should be never to allow them to remain flat on the back unless there is some very special reason to the contrary. They should be well propped up with pillows. The first symptoms are usually cough, slight dyspnœa, and possibly some cyanosis and signs of consolidation at the lung bases. Stimulants and expectorants must be given, and since there is often cardiac failure as well as pulmonary congestion, digitalis and strychnine are of value

Delirium Tremens.—This is a form of mania occurring in alcoholic subjects, especially when suddenly deprived of stimulants of which they have usually partaken freely. The earliest symptoms are restlessness and inability to sleep. Tremors and twitchings of the tongue and hands are followed by hallucinations, frequently of the reptilian type, delirium, and mania Attacks may be aborted by the judicious administration of alcohol, and hypnotics should be given

Fat Embolism.—This is an occasional cause of death after fracture The emboli consist of fat globules which may be liberated from the medulla of the fractured bone, or be derived from the fat of blood-plasma broken down from the normal state of emulsification Localized fat emboli in the lungs give rise to the symptoms of bronchopneumonia, but more often they are scattered throughout the body and embolism of the brain gives rise to cerebral irritation, coma, and death on the third or fourth day

CHAPTER LXIX

FRACTURES AND DISLOCATIONS OF THE UPPER LIMB

By Sir REGINALD WATSON-JONES

FRACTURES AND DISLOCATIONS OF THE CLAVICLE

Fractures of the Clavicle occur most commonly in the middle third of the bone. There is usually overriding of the fragments, the inner being displaced upwards by the pull of the sternomastoid muscle, and the outer displaced downwards and forwards by the weight of the arm. The fragments can only be re-alined and replaced by pulling the whole shoulder girdle upwards and backwards.

The difficulty of maintaining perfect replacement of the fragments is shown by the fact that over a hundred different methods have been described. Fortunately, however, these fractures almost invariably unite firmly, and the only ill effect of imperfect reduction is slight bony thickening at the site of injury. On the other hand, over-zealous attempts to maintain anatomical reduction by immobilization of the shoulder for many weeks are a common cause of serious stiffening of the shoulder-joint. The articular cartilage and capsule have often been bruised by the injury which fractured the clavicle, and if the joint is immobilized for more than two or three weeks in patients over forty years of age, the stiffening will sometimes remain permanently.



Fig. 685.—Fracture of the clavicle immobilized by figure-of-8 bandage over large axillary pads. The limb is supported in a triangular sling for ten days.

The figure-of-8 bandage is simple and effective. The patient sits on the front of a stool, the operator standing behind with one foot on the stool and his knee between the patient's shoulder-blades. A large pad of wool is placed in front of each shoulder, extending into the axilla. Several long bandages five or six inches wide are then applied in the form of a figure-of-8, passing in front of the shoulders under the axillæ, and crossing between the shoulder-blades. With each turn of the bandage the shoulder-girdles are pulled backwards and upwards as strongly as possible without compressing the axillary vessels (*Fig.* 685). The bandages may be stitched together to prevent slipping, or alternatively they should be re-applied every second or third day for the first fortnight. For the first ten days the shoulder is elevated by a triangular sling tied over the opposite side, but after that time it is left free for exercises. The finger-, wrist-, and elbow-joints must be exercised frequently from the first day. The figure-of-8 bandage may be discarded after three weeks when there is clinical evidence of union ; there is

no necessity to wait for radiographic evidence of union, which is much more delayed.

Occasionally the fracture is comminuted and a small fragment is tilted out of position, so that a subcutaneous spur develops. Attempts should be made to replace these fragments by direct pressure, *after* the main fracture has been reduced by the figure-of-8 bandage. Even if these attempts fail, operative reduction should still not be contemplated. The sharpest of spurs usually becomes absorbed and rounded, and if any symptoms do remain, it is better to remove the spur after union of the fracture than to attempt open reduction. The only indication for operation in recent fractures is the exceedingly rare complication of compression of the brachial plexus or subclavian vessels by displaced fragments.

Dislocation of the Acromio-clavicular Joint.—If the ligaments of the acromio-clavicular joint are torn, the weight of the arm displaces the shoulder-girdle and acromion downwards below the level of the outer end of the clavicle.



Fig. 686.—Acromio-clavicular dislocation. A, Reducing the dislocation. Strapping is applied in such a way as to elevate the humerus and scapula, and pull down the clavicle. B, Correctly strapped. C, Incorrectly strapped. Reduction is only stable if the strapping lies over the clavicle itself, and not over the point of the shoulder.

Incomplete dislocations (subluxations) are common; more rarely the acromion lies entirely below and in front of the clavicle. The dislocation is easily reduced by elevating the whole arm and shoulder-girdle, but the weight of the limb tends to reproduce the displacement.

A small pad of wool is placed in the axilla, and the wrist is slung from the neck by a collar and cuff with the elbow at the right angle. A pad of adhesive felt or adhesive sorbo rubber is placed below the elbow to protect the bony prominence of the olecranon and the ulnar nerve, and a second pad is placed over the outer end of the clavicle. These two points are then pulled together by strips of brown strapping, four or five feet long, applied as tightly as possible. While the strapping is being applied, the humerus is pushed upwards to elevate the scapula and the acromion, and the clavicle is pulled downwards (*Fig.* 686, A). The strapping is easily stretched by the weight of the limb, so that five or six layers should be used one on top of the other. It is a frequent mistake to apply the strapping over the top of the humerus and the shoulder-joint itself, instead of over the clavicle and supraclavicular triangle (*Fig.* 686, B, C).

The strapping must be tightened every second or third day. The original strapping need not be disturbed, but other layers should be applied on top. It is retained for at least three weeks, throughout which time the finger- and wrist-joints are constantly exercised.

DISLOCATION OF THE SHOULDER-JOINT

Dislocation of the shoulder-joint seldom occurs before the age of 20. The capsule is torn on its under surface and the head of the humerus lies below the glenoid fossa, or in front of the glenoid beneath the coracoid process.

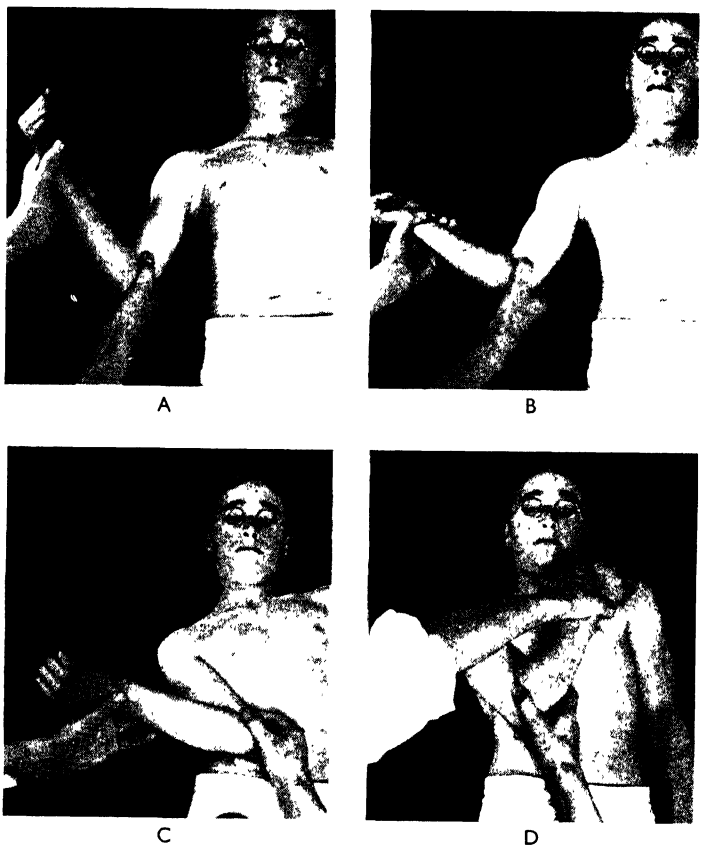


Fig. 687.—Kocher's method of reducing a dislocation of the shoulder. A, Traction is applied; B The humerus is slowly externally rotated; C, It is adducted across the chest; D, It is internally rotated.

The limb must be examined carefully for nerve injuries. The deltoid muscle is often paralysed by injuries to the circumflex nerve, the posterior cord, or the outer trunk of the plexus. The examiner palpates the muscle belly with one hand, and instructs the patient to attempt abduction movement against the resistance of his other hand over the patient's elbow. If the nerve-supply is uninjured the muscle is felt contracting even although the shoulder is not actually moved.

Method of Reduction.—The head of the humerus is held in its inwardly displaced and inwardly rotated position by the tension of the subscapularis. To reduce the dislocation this muscle must be stretched slowly and gradually by Kocher's manipulation. The patient lies on a couch and the surgeon stands at his side. For a dislocation of the right shoulder, the surgeon takes the elbow in his right hand and the wrist in his left (*Fig.* 687). Strong, smooth traction is applied to the humerus by pulling with the right hand. The arm is then very slowly and gently externally rotated, by moving the wrist outwards, until the normal limit of 90° external rotation is reached. Keeping the limb in full external rotation, the limb is adducted across the chest. Finally the limb is internally rotated and the hand brought over to the opposite shoulder. The manipulation is performed so smoothly that the head of the humerus glides into position, and the surgeon does not know at which stage the dislocation was reduced. There should be no click or sudden jerk. It is essential that the accuracy of reduction should be confirmed, not only clinically, but also be radiographic examination.

If the dislocation is not reduced by Kocher's manipulation at the first attempt the method first described by Hippocrates should be used. The surgeon grasps the wrist with both hands and places his stockinged foot between the upper arm and chest. With knees and elbows straight he leans backwards and thus applies traction. He slowly externally rotates the limb and then adducts it over the leverage of his foot. The manipulation is essentially the same in the two manœuvres but more power is available by the Hippocratic method and there is no greater danger of injury to the axillary artery or nerves; indeed, the danger may be less and there is certainly less danger of fracturing the neck of the humerus by direct traction than by forcible external rotation of the limb.

Testing for Ruptured Supraspinatus Tendon, and After-treatment.—As soon as the dislocation has been reduced, the patient should be asked to abduct the shoulder to the right-angled position. If he is unable to do so, and yet the deltoid muscle is contracting normally, the loss of power is due to avulsion of the supraspinatus tendon and the limb must be immobilized in an abduction frame or plaster spica (*see below*). If the patient can abduct the shoulder normally, the tendon is intact, and the limb is immobilized by the side for three weeks by a collar-and-cuff sling and body bandage. Immobilization for a shorter period than three weeks predisposes to recurrent dislocation. The fingers, hand, and wrist must not be covered, and these joints are exercised constantly. After three weeks the patient regains movement at the elbow and shoulder-joint by his own exercise. There must be no passive assistance by a masseuse, no forcible stretching, and no manipulation under anæsthesia for the breaking down of adhesions. These measures increase the stiffness and delay recovery.

Dislocation with Fracture of the Tuberosity.—Radiographs may show that a large fragment of the great tuberosity has been torn off at the time of the dislocation. As a rule the fragment is in perfect position when the dislocation is reduced and treatment is continued as for an uncomplicated dislocation. If, however, the post-reduction radiograph shows that the tuberosity is still displaced upwards, the limb must be immobilized in a plaster spica in the abducted position.

Dislocation with Avulsion of the Supraspinatus.—The tendon retracts away from its point of insertion, and if the arm is immobilized in the usual position by the side, active abduction movement is permanently lost. There is no necessity to operate in order to bring the tendon down to the raw surface of bone; it is simpler to bring the raw bone surface up to the retracted tendon. As soon as the diagnosis has been established, a frame is applied with the limb in abduction and external rotation. This position

must be maintained very rigidly, and the patient never permitted to lower the arm, even momentarily, until complete repair of the tendon is proved by the recovery of active abduction and the ability to hold the limb 30° or 40° above the level of the frame. If the necessary treatment is instituted promptly, repair should be complete within two or three months, but if there has been delay, immobilization for three to six months may be necessary. In delayed cases operative suture may be preferable.

Dislocation with Paralysis of the Deltoid.—If there has been an injury to the circumflex nerve, or to one of the cords of the brachial plexus, the paralysed deltoid muscle must be relaxed by abducting the shoulder on a frame. If the patient's arm is firmly bandaged to the frame but the trunk part is loose and can slide down, there is a danger that the joint may be re-dislocated. For this reason some surgeons defer the application of the frame for two or three weeks. This delay is not necessary if the frame is skilfully applied. At least seven or eight 6-in. bandages must be used to fix the trunk part of the frame and to hold it up, the turns of bandage being hitched under every hook, screw, and bar, and passed over both shoulders (*see Fig.* 692).

FRACTURE OF THE GREAT TUBEROSITY OF THE HUMERUS

Contusion Fractures.—As a result of a direct fall on the shoulder the great tuberosity may be comminuted. A large fragment of bone is separated but not



Fig. 688.—Contusion fracture of the great tuberosity of the humerus without displacement



Fig. 689.—Avulsion fracture with displacement

displaced (*Fig.* 688). There is no necessity to use an abduction frame. The arm may be supported in a sling for ten days, and the limb should then be used for all ordinary purposes. Full movement of the shoulder is regained in two to three months.

Avulsion Fractures.—A small flake of bone is pulled off the tuberosity by traction of the supraspinatus muscle. The fragment may be retracted so that it lies above the head of the humerus (*Fig.* 689). The limb must be immobilized in a frame or plaster spica, in the position of 90° abduction and at least 60° external rotation, for two to three months, until it can be raised actively to 30° or 40° above the level of the frame. Throughout this time exercises must be practised for every other joint of the limb.

FRACTURE OF THE NECK OF THE HUMERUS

Three types of fracture must be distinguished : (1) Contusion crack fractures ; (2) Adduction fractures ; and (3) Abduction fractures (*Fig.* 690).

Contusion Crack Fractures.—The injury follows a fall on the outer aspect of the shoulder, and the crack across the neck of the humerus is often associated with a comminuted fracture of the tuberosity. Complete immobilization is not necessary. The limb should be supported in a sling for two or three weeks, throughout which time the finger-, wrist-, and elbow-joints are exercised. As soon as the swelling and bruising of the shoulder have begun to subside, active exercises are practised.

Adduction Fractures.—These occur equally commonly in adults and in children, and the fragments are impacted in such a way that the shaft is adducted on the head. If the displacement is not corrected, abduction movement is permanently limited by a degree corresponding with the degree of angulation. In elderly patients this is unimportant and the impaction should not be broken down by manipulation. Treatment is carried out exactly as for contusion crack fractures.

In younger patients the displacement is reduced by traction on the limb in the abducted position, so that the adduction angulation is corrected. The limb is immobilized on a frame, in right-angled abduction, for 4 to 5 weeks.

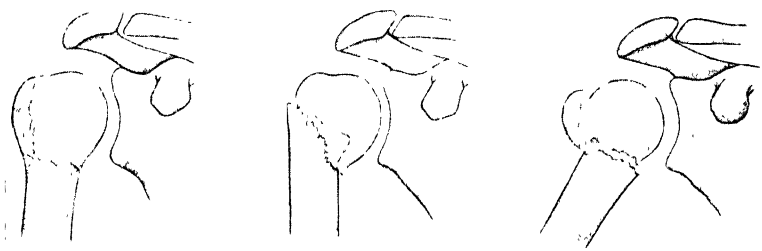


Fig. 690.—Fractures of the neck of the humerus A, Contusion crack fracture. B, Adduction fracture, C, Abduction fracture

Abduction Fractures.—These fractures occur less commonly in children than in adults. The shaft is slightly abducted on the head and the great tuberosity is pinched off by compression between the head and the outer margin of the shaft. In most cases the displacement is of minimal degree, and there is no necessity for manipulative reduction. The injury is treated in the same way as simple crack fractures by protection in a sling for two or three weeks, followed by active exercises.

In a few cases the degree of abduction displacement at the time of the injury is so extreme that the shaft is driven inwards beneath the head and completely detached from it. There is no apposition between the fractured surfaces, and the loose head is fully abducted and externally rotated by the unopposed pull of the muscles inserted into the tuberosity. The displacement must be reduced by adducting the shaft across the chest, and pushing the upper end of the shaft outwards, by means of a hand in the axilla, until the fractured surfaces engage. The arm is then brought to the side and immobilized by the side for about four weeks before active shoulder movements are begun.

If the manipulation fails to secure complete engagement of the fractured surfaces the proximal fragment remains fully abducted and externally rotated. In this event the shaft of the humerus must also be abducted and externally rotated. It must be recognized, however, that the original displacement was produced by abduction, and that if an ordinary frame is used the shaft will continue to lie

under the head. If it unites in this position it may prove impossible to bring the arm down to the side, and a most serious deformity results. *If an abduction*



Fig. 691.—Abduction frame with arm traction for fractures of the shaft and certain fractures of the neck of the humerus.

fracture is treated in the abducted position, continuous traction is essential, and a special traction abduction frame must be used (*Fig.* 691). The frame is adjusted



Fig 692.—Applying an abduction frame. To prevent the frame from sliding down the trunk, it must be firmly bandaged over both shoulders.

so that the limb is in abduction, external rotation, and forward flexion, and special care must be taken that the frame does not slide down the trunk (*Fig.* 692).

Frequent check radiographs are necessary. The frame is jointed so that elbow movements may be practised, and the forearm, wrist, and finger-joints must be regularly exercised.

STIFFNESS OF THE SHOULDER FROM PERIARTICULAR ADHESION FORMATION

Fractures and dislocations, or simple contusions and sprains of the shoulder, are often followed by adhesion formation between the plications of the joint capsule, which causes limitation of external rotation and abduction movement. *It is the limitation of external rotation which is of significance.* The normal shoulder-joint cannot be abducted beyond a right angle if the humerus is held internally rotated; outward rotation is an essential component of abduction movement. Every upper limb which is supported in a sling is immobilized with the shoulder in full internal rotation. The resulting limitation of outward rotation may be demonstrated with the elbow to the side and the forearm and hand directed forwards. Normally it is possible to rotate the limb outwards through almost 90°, so that the forearm and hand point sideways. If this movement is completely limited, it is a waste of time to practise abduction exercises; external rotation exercises must first be practised, by keeping the elbow to the side and turning the forearm more and more outwards. The patient must also try to reach the back of his neck. As this movement recovers, he endeavours to reach over the top of the head to the opposite ear. He may then practise crawling up a wall with his finger-tips, marking the level reached, and endeavouring to reach a higher level every day. The exercises must be performed by the patient himself five minutes hourly throughout the day. Many patients require encouragement and stimulation, *but there must be no passive stretching by a masseuse or relative. The exercises must be done smoothly, without sudden jerking or forcible movements. The patient must not hang by the affected arm from overhead beams or parallel bars so that body-weight exerts passive stretching.* Whenever possible, manipulation under anæsthesia must be avoided. Forcible manipulation is the last line of treatment, to be applied only when actual measurements show that movement is no longer increasing despite regular active exercise. If a manipulation is inevitable, only one group of adhesions should be broken at a time. If too much is done, the reaction is so severe that the movement cannot be retained, and the joint may even become stiffer. After manipulation, passive stretching by a masseuse must again be avoided. *Passive stretching of a stiff shoulder-joint is the most common cause of permanent stiffness.*

FRACTURE OF THE SHAFT OF THE HUMERUS

Fractures of the shaft of the humerus which are adequately reduced show little tendency to redisplacement. For this reason it is usually sufficient to use a simple collar-and-cuff sling, with three or four gutter splints (*see Fig.* 673) or two plaster slabs, to immobilize the fragments and prevent angulation. It is true that gutter splints or a plaster slab do not afford absolute immobility of the fragments, but in most fractures of the shaft of the humerus the tendency towards union is so strong that firm union still takes place in five or six weeks, and more complete immobility is unnecessary. Occasionally, however, the blood-supply of one fragment is impaired and union is very slow. At the fifth week, far from union being complete, clinical examination shows that it has scarcely begun. Unless the fracture is more completely immobilized, slow

union will be complicated by non-union. A complete shoulder plaster spica must be applied, closely moulded to the limb, absolute immobility being maintained for many weeks or even months, until clinical tests show firm union. The shoulder- and elbow-joint are then mobilized by the patient's own active exercise.

Musculospiral Palsy.—If the musculospiral nerve has been damaged, stretching of the extensor muscles of the forearm must be prevented by supporting the wrist in moderate dorsiflexion. A long cock-up splint which immobilizes the finger joints in the fully extended position must not be used, because it so often causes serious stiffness of the fingers, and this may prove even more disabling than the paralysis itself. If there is no sign of recovery of the nerve lesion within two or three weeks, exploration is advisable, because the nerve-trunk has sometimes been severed by the sharp bone fragments and nerve suture is essential.

SUPRACONDYLAR FRACTURES OF THE HUMERUS

Types of Fracture.—There are two types of supracondylar fracture—the usual type where the lower fragment is displaced backwards, and the less common type in which it is displaced forwards. In the more usual variety the line of fracture runs obliquely upwards and backwards; the displacement is reduced by applying traction to the limb, and while traction is maintained flexing the elbow. In this position the fragments lock securely (*Fig.* 693). In the opposite type the fracture line is oblique downwards and backwards. If the elbow is flexed the displacement is increased, and the fragments lock only in the extended position (*Fig.* 694). It is obviously wrong to treat all supracondylar fractures with the elbow flexed. The common type must be treated in this position, but the opposite type must be treated in the opposite position.

Importance of Perfect Reduction.—Accurate reduction with complete correction of the tilting of the lower fragment is of the utmost importance. The axis of this fragment determines the position of the forearm, and the range of movement of the elbow. If the fragment unites with forward tilting, extension of the elbow will be permanently limited by a corresponding degree. If the fragment unites with backward tilting, there will be a greater range of extension than normal, and flexion will be permanently limited. If lateral tilting remains uncorrected, the carrying angle of the forearm is altered and there is obvious deformity. These angulations do not undergo correction with subsequent growth of the bone. The absorption of bony spurs may make them less conspicuous in the radiograph, but the limitation of movement, and the deformity of the elbow with alteration of the carrying angle, persist into adult life.

Supracondylar Fracture with Backward Displacement.—The most important part of the manipulative reduction is traction applied in the long axis of the limb. In the common type with backward displacement, while traction is maintained, the elbow is gradually flexed to almost 45° above the right angle. Lateral displacement is then corrected. An assistant holds the limb by the wrist, keeping the elbow flexed, and the surgeon applies direct lateral pressure with one hand over the shaft of the humerus and the other hand on the opposite side of the limb over the displaced fragment itself. The circulation is at once tested, and if the swelling of the joint is so severe that 45° of flexion has compressed the radial artery or the veins, the elbow must be extended until the pulse and venous return are normal. A plaster cast is applied over the back of the limb and lightly bandaged into position, taking care to avoid the slightest pressure over the front of the joint. The limb is slung from the neck by a collar-and-cuff.

Immediate radiographic examination is essential, and if the displacement is not completely corrected, the fracture is at once remanipulated. Full ether anæsthesia should be used, with a portable X-ray machine in the plaster-theatre, so that three or four or more manipulations may be performed if necessary.

Supracondylar Fracture with Forward Displacement.—If the fracture is of the opposite type, traction is applied and the limb is extended until the elbow is quite straight. Lateral displacement is corrected as before, and a plaster cast applied from below the shoulder to just above the wrist. While the patient is

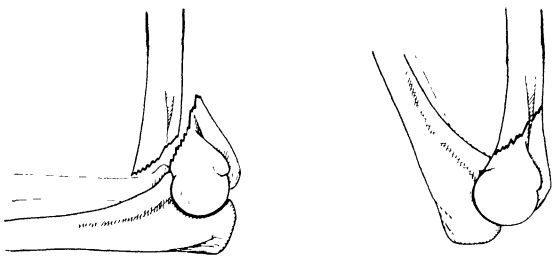


Fig. 693.—Supracondylar fracture of the usual type, with backward displacement of the small fragment. Reduction is stable only if the elbow is flexed.

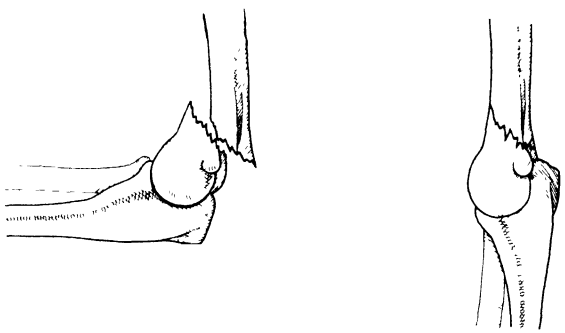


Fig. 694.—The less common type of supracondylar fracture, in which there is forward displacement of the lower fragment. Reduction is stable only if the elbow is fully extended.

up and about the limb hangs by the side, but swelling of the fingers and hand must be avoided by elevating the limb on cushions as soon as he sits or lies down.

After-treatment.—If the joint was severely swollen at the time of reduction, a check radiograph seven days later is very important. It may be necessary to apply a new plaster cast to avoid recurrence of displacement. The finger-joints must be moved actively at once, and gentle shoulder exercises should begin after seven to ten days. The elbow is immobilized for four weeks, and the patient is then allowed to regain movement by his own exercises. There must be no massage, no passive stretching, and no carrying of heavy weights. (*See* VOLKMANN'S CONTRACTURE, NERVE LESIONS, MYOSITIS OSSIFICANS, JOINT STIFFNESS.)

FRACTURE OF THE EXTERNAL CONDYLE OF THE HUMERUS

This injury occurs usually in children of five to fifteen years of age. A perfect recovery can be achieved, but failure to apply the correct treatment leads inevitably to non-union, to an appalling deformity, and sometimes to ulnar paralysis supervening ten to twenty years later. The separated fragment includes the capitellum and outer part of the trochlea; the external lateral ligament and the extensor muscle origin remain attached to it. The tension of the muscle tilts the fragment out of the elbow-joint, and rotates it so that the fractured surface is directed outwards (*Fig.* 695). Sometimes it turns completely upside down, and the articular surface of the fragment lies opposite the fractured surface of the shaft of the humerus. Under these circumstances bony union is obviously impossible, and a weak fibrous union results, with a completely unstable elbow-joint.

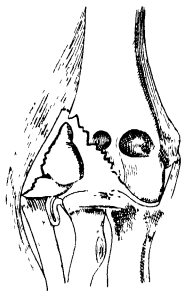


Fig. 695.—Fracture of the external condyle of the humerus. The condylar fragment is tilted out of the joint by the pull of the extensor muscles.

As years go on, the forearm bones become displaced more and more to the outer side of the humerus, until the carrying angle may be as much as 60° or 70°. Gradual stretching of the ulnar nerve round the inner side of the elbow accounts for the delayed ulnar palsy.

The displacement is easily seen in the anteroposterior radiograph (*Fig.* 696). In children, where the epiphyses are not yet fully ossified, it must be recognized that the fragment shown in the radiograph is merely the ossific nucleus of a very much larger cartilaginous fragment.

Manipulative Reduction.—This may be possible within a few days of the injury. An assistant holds the limb by the wrist with his other hand on the inner aspect of the elbow, and gently opens the joint on the outer side so that the limb is in slight cubitus varus. The surgeon places one or both thumbs beneath the fragment and pushes it upwards and inwards, tilting it into the joint. The elbow is then flexed, and the two condyles of the humerus are strongly compressed laterally so that the fragment is firmly pressed into its bed. Reduction is usually stable, but a plaster cast may be used in addition to a collar-and-cuff sling. The after-treatment is the same as for supracondylar fractures.



Fig. 696.—Displacement of external condyle epiphysis which is tilted and rotated so that its flat surface is no longer in contact with the humerus.

Operative Reduction.—If the fragment is not perfectly replaced, the joint must be opened on the outer side, the fragment replaced, and held in position by catgut suture. There is no necessity to peg or screw the fragment to the humerus.

FRACTURES OF BOTH CONDYLES OF THE HUMERUS (T AND Y FRACTURES)

This injury consists of a high supracondylar fracture, with a second vertical fracture line extending into the joint, separating both condyles. It is sometimes comminuted, and usually occurs in elderly patients from a fall on the point of the elbow.

The displacement is reduced by traction and direct lateral compression of the fragments. A plaster cast is applied, well moulded to the inner and outer aspects of the joint, in order to prevent recurrent tilting of the fragments with distortion of the joint surface. As a rule the elbow is held in right-angled flexion and the limb is suspended by a collar-and-cuff sling. In some cases the flexed or right-angled position tilts the condylar fragments forwards so that extension movement of the joint would remain limited. In this event the cast must be applied with the elbow fully extended. Since the injury occurs in elderly patients, it is particularly important to preserve full finger and shoulder movements. Only if a plaster cast has been used, in addition to a collar-and-cuff sling, can early shoulder exercises be practised with safety.

If the fracture is so comminuted that the joint surface is completely broken up, operative treatment may sometimes be advisable. Unfortunately open reduction and fixation with plates, screws, or wire seldom avoids the penalty of serious permanent stiffness of the joint, and it may be better to perform an immediate excision-arthroplasty

FRACTURE OF THE INTERNAL EPICONDYLE OF THE HUMERUS

The internal epicondyle of the humerus may be fractured by direct violence, but more often the epicondyle or its epiphysis is avulsed by the common flexor group of muscles (*Fig.* 697). Slight displacement of the fragment is of no significance, and operative treatment is not necessary; union of the fragment may be

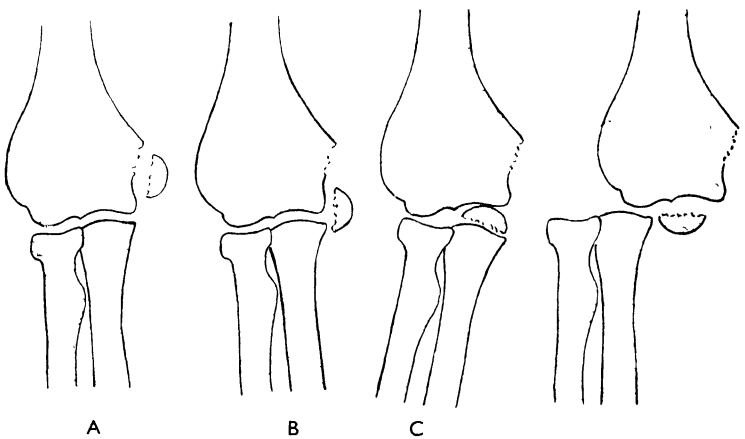


Fig. 697.—Separation of the epiphysis of the internal epicondyle. A, Minimal displacement; B, Marked displacement—operative fixation is usually advisable; C, Inclusion within the elbow-joint—operative replacement is imperative; D, Displacement associated with dislocation of the elbow-joint—care must be taken in reducing the dislocation not to include the epiphysis within the joint.

fibrous and not bony, but this does not usually impair the functional result. If the fragment is widely displaced, or rotated away from the humerus, it should be replaced through a short incision and fixed with catgut sutures. The associated traumatic synovitis of the joint necessitates immobilization by a collar-and-cuff sling for three weeks, and movement is then regained by the patient's own exercise. The recovery of full extension is sometimes a slow process, and even twelve months may elapse before movement is normal. Passive methods,

or manipulation under anæsthesia, must be avoided because they delay the recovery still more.

Inclusion within the Elbow-joint.—If the fragment is displaced into the elbow-joint its immediate replacement is imperative. In early cases it may be dislodged from the joint by manipulation, but in other cases operation is necessary. The fragment should not be pinned or nailed into position; any foreign body other than absorbable catgut causes irritation of the elbow-joint, with recurrent exudation and dense adhesion formation.

Ulnar Palsy.—Since the epicondyle is displaced by the stretching open of the inner side of the joint there is frequently a coincident traction injury of the ulnar nerve, with paralysis which is usually incomplete. Transposition of the nerve from the irregularly thickened post-condylar groove to the front of the joint is sometimes necessary.

DISLOCATION OF THE ELBOW-JOINT

As a rule both radius and ulna are dislocated backwards, either directly backwards, backwards and outwards, or backwards and inwards. The injury is often associated with avulsion of the internal epicondyle or its epiphysis. It is important to recognize this complication before reducing the dislocation, in order to avoid imprisoning the small fragment within the inner side of the joint. In other cases there may be a comminuted fracture of the head of the radius. Forward dislocation of both radius and ulna together with a fracture of the olecranon is a less frequent injury.

Reduction and After-treatment.—Backward dislocations are easily reduced by applying traction to the forearm and gradually flexing the elbow. The wrist is suspended from the neck by a collar-and-cuff sling, and the joint is immobilized for three weeks; throughout this time movements of the fingers and shoulder must be practised. Radiographs *must* be taken after manipulation to confirm the accuracy of reduction, to be sure that the internal epicondyle is not displaced within the joint, and to exclude fracture of the head of the radius necessitating operative treatment (*see* below). Movement of the elbow is regained by the patient's own gentle exercise, with no massage, no passive stretching, and no weight-carrying. The range of movement should be measured and recorded week by week.

Myositis Ossificans.—This complication is due to ossification of a hæmatoma beneath periosteum which has been avulsed by muscles or capsule (*see* p. 523). It is most commonly seen after dislocation of the elbow, usually when passive stretching has been employed.

The first sign of the complication is the radiographic evidence of a cloudy shadow in the front of the joint. The shadow gradually becomes more dense and consolidated, but since the hæmatoma is continually absorbing, the final bony mass is much smaller than the original shadow.

In the treatment of myositis ossificans, the absolute immobility sometimes recommended is neither necessary nor advisable. The tearing away of periosteum and the hæmatoma formation are the result of passive stretching, not of active exercise. The only treatment necessary is to prohibit passive stretching. Recovery is no more rapid if active exercise is prohibited and the joint completely immobilized in plaster. On the other hand, complete immobility allows consolidation of the adhesions which have also occurred from the passive stretching, and stiffness and limitation of extension are then inevitable.

FRACTURES OF THE HEAD OF THE RADIUS

Fractures of the head of the radius may appear insignificant but they are of considerable gravity. If treated inexpertly even simple marginal chips may cause serious incapacity. The injury usually follows a fall on the outstretched hand, and is often overlooked. The diagnosis is based on the tenderness over the head of the radius, limitation of extension of the elbow, and pain on radio-ulnar movement.

Crack Fractures without Displacement.—These require rest by means of a triangular sling, or collar-and-cuff, for two or three weeks, followed by active exercises. The fracture involves the joint surfaces of the elbow, and passive stretching is disastrous. Stretching for only three or four weeks often causes permanent limitation of extension movement.

Displaced Marginal Fractures.—If a marginal sector of the head of the radius is displaced so that the radio-humeral joint surface is broken up and irregular, early operative removal of the head of the radius is advisable. It will often be found that the articular surface of the capitellum opposite the head of the radius is also damaged and loose fragments may be separated. The ideal time for operation is within the first ten days, but when the fracture occurs as a complication of dislocation of the elbow-joint it is wise to defer the operation for three weeks, by which time the avulsed ligaments, tendons, and periosteum will be sufficiently healed to prevent myositis ossificans.

Comminuted Fractures.—If the whole head of the radius is comminuted, there is breaking up of the radio-ulnar as well as of the radio-humeral joint surfaces. Unless the head of the radius is removed within the first two or three weeks, there will be permanent limitation of pronation-supination movement as well as of extension movement.

Post-operative Treatment.—After operation treatment is continued as for fractures of the head of the radius without displacement. The recovery of movement may be very slow, but the temptation to accelerate recovery by massage, stretching, or manipulation under anæsthesia must be rigidly avoided. However slow recovery may be, it will be still more slow if these measures are permitted, and permanent limitation of extension movement will result.

FRACTURE OF THE OLECRANON

Fractures of the olecranon process extend into the sigmoid notch and involve the elbow-joint surface. If the gap between the fragments is not closed and a smooth joint surface restored, stiffness of the elbow and painful movement remain. If the fragments are not immobilized in perfect apposition for at least four to six weeks, fibrous union will result, with impairment of active extension of the elbow against resistance.

Manipulative Treatment.—An attempt should be made to secure perfect apposition by manipulation. The elbow is fully or almost fully extended and firm pressure applied over the detached fragment, pushing it forwards and downwards into the angle from which the triceps has pulled it. A plaster cast is applied from below the shoulder to just above the wrist. The limb must be elevated whenever possible to avoid gravitational œdema of the fingers and hand.

Operative Treatment.—If manipulation fails to secure close apposition of the fragments and to restore a smooth joint surface, operative reduction and fixation by catgut suture is necessary; or alternatively, the detached fragment is excised and the triceps stitched to the ulna. Wire, screws, and other irritant and non-absorbable foreign

bodies should be avoided. After the fragments have been sutured, it is usually safe to flex the elbow to about 30° below the right angle. The limb is immobilized in plaster for six weeks, throughout which time full finger and shoulder exercises are practised. Elbow movement is restored by the patient's own exercise

Fractures of the Olecranon with Forward Dislocation.—Occasionally after a fall on the back of the forearm the olecranon is fractured and both forearm bones are dislocated forwards. The ulnar nerve may be damaged by traction over the lower end of the humerus. The dislocation is easily reduced by applying traction, extending the elbow, and pressing backwards on the front of the upper forearm. The fracture of the olecranon is then treated in the usual way.

FRACTURES OF THE SHAFTS OF THE RADIUS AND ULNA

One or both of the forearm bones may be fractured in any part of the shaft. If a fracture of the radius lies above the insertion of the pronator radii teres, the proximal fragment is fully supinated by the unopposed action of the supinator brevis and the biceps. The distal fragment must therefore be held in a similar position, and the limb is immobilized in full supination. If the fracture of the radius lies below the insertion of the pronator radii teres, the proximal fragment has both supinator and pronator muscles attached to it. The limb must then be immobilized in the position midway between full supination and full pronation. As a rule the elbow is held at the right angle

Method of Reduction.—Overriding and angulation of the fragments is reduced by strong and prolonged traction. Counter-traction should be arranged by passing a sling of calico bandage over the front of the arm just above the flexed



Fig 698.—Reduction of fracture of shafts of both forearm bones

elbow. An assistant takes the patient's fingers in one hand and the thumb in the other, and pulls steadily for several minutes. If the fingers are moist and slippery, adhesive plaster is applied so that a firmer grip is secured. If the injury is several days old, traction may be necessary for fifteen minutes, or even longer, before reduction is perfect. The surgeon applies direct pressure to the fragments and moulds them into position. An unpadded plaster cast is then applied from the upper arm just below the shoulder to the knuckles, not extending into the palm beyond the oblique skin creases. The calico bandage sling used for counter-traction must be entirely removed before the plaster is completed, so that no pressure remains over the vessels in the antecubital fossa. The cast is carefully

moulded to the forearm and wrist, because redisplacement sometimes occurs even in unpadded plasters. (*Fig.* 698.)

After-treatment.—Reduction must be confirmed by X rays, and check radiographs taken every second week for the first two months. It is usually necessary to apply a new plaster two to three weeks after reduction when the swelling has subsided. During the first few days the hand is elevated with the fingers pointing to the ceiling in order to minimize reactionary swelling. The circulation and movements of the fingers must be carefully watched, because of the danger of Volkmann's contracture (*see* p. 521). If there is cyanosis or pallor of the fingers, or difficulty in fully extending them, the plaster is at once cut longitudinally from the front of the wrist to above the elbow. When the circulation is again normal the plaster may be repaired. The average minimal period of immobilization is six weeks in children and ten weeks in adults. Full movements of the fingers and shoulder are practised throughout.

Non-union of the Shaft of the Ulna.—Non-union is sometimes seen in fractures of the shaft of the ulna at the junction of the middle and lower thirds, but it is always due either to inadequate immobilization or to immobilization for too short a period. In some cases a below-elbow plaster cast which does not prevent rotatory movement of the fragments has been relied upon. In other cases a complete cast above the elbow has been replaced after six or eight weeks by a below-elbow plaster. The union which had developed during the first few weeks was broken down by the rotatory movements subsequently permitted. The complete cast from the upper arm to the knuckles must be retained until there is radiographic evidence of union of the fracture.

Fractures of the Upper Third of Both Bones.—When the fracture lies high in the forearm the flexed position of the elbow may tend to produce a similarly flexed position of the fragments—a backward angulation. In these circumstances the elbow should be fully extended and plaster applied with the limb in this position.

Fractures of the Upper Shaft of the Ulna with Dislocation of the Head of the Radius.—*In every fracture of the upper shaft of the ulna the surgeon should suspect that there is also a dislocation of the head of the radius.* The dislocation is often overlooked, and a very serious permanent disability then remains. The combined injury—the Monteggia fracture-dislocation—is one of the most difficult of all bone injuries and none except the most experienced should embark upon the treatment of it. The case should be transferred at once to an expert.

Fracture of the Lower Shaft of the Radius with Inferior Radio-ulnar Dislocation.—This is a relatively common injury, and there is a strong tendency to redisplacement, the radius angulating towards the ulna, and the inferior radio-ulnar joint again dislocating. It must be reduced by traction on the radius applied through the thumb. The limb is immobilized with the wrist deviated as far as possible to the ulnar side. The plaster must be very closely moulded round the radius and wrist-joint, and carried well down the radial side of the hand over the thumb and index metacarpals. A hook of metal is incorporated in the plaster, extending beyond the thumb, and skin traction is applied by strapping on the thumb attached to the hook (*see Fig.* 707). Frequent check radiographs are imperative.

The use of traction wires or steel pins penetrating both forearm bones and incorporated in the plaster is not recommended, but operative fixation of the radius by a vitallium transfixion screw may be needed.

COLLES'S FRACTURE OF THE RADIUS

Method of Reduction.—It is possible to correct both backward and outward displacement by one twisting movement which pronates the lower fragment, but it is more satisfactory to correct each displacement separately by two distinct



Fig. 699.—Reduction of Colles's fracture. Correction of backward displacement.



Fig 700.—Reduction of Colles's fracture Correction of radial displacement.

manœuvres. To reduce a right Colles's fracture, the surgeon grasps the lower fragment in his left hand, securing a grip between his thenar eminence on the back of the fragment and his finger-tips on the front (*Fig.* 699). By counter-pressure with his other hand on the front of the forearm, the fragment is tilted and pushed forwards as strongly as possible. A new grip is then taken to correct the radial displacement. The surgeon places his right thenar eminence over the patient's radial styloid process, and his finger-tips over the ulnar side of the joint, and with his other hand on the opposite side of the limb the radial fragment is tilted and pushed inwards towards the ulna (*Fig.* 700). It is impossible to over-correct the displacement however strongly the surgeon manipulates.



Fig. 701.—Reduction of Colles's fracture. While the plaster is setting the radial concavity is reproduced by the fingers of the left hand and the lower fragment is pushed forwards and inwards with the right hand.

An assistant holds the limb, taking the patient's thumb in one hand and fingers in the other, and maintains strong traction. The surgeon applies a dorsal plaster slab directly to the skin, from the back of the knuckles to just below the fold of the elbow. An encircling plaster bandage may also be applied. The plaster must extend over the radial side of the thumb metacarpal to the base of the thenar eminence, and over the front of the wrist-joint to below the scaphoid tubercle, but not actually into the palm. *While the plaster is setting, the surgeon must again grasp the wrist and mould the plaster very closely round the radius, reproducing the normal concavity of the lower end, and pushing the carpus and lower*

radial fragment forwards and inwards (*Fig.* 701). Unless the plaster is closely moulded to the bone, redisplacement will occur and the fracture will unite with radial deviation.

After-treatment.—The hand is lightly bandaged or strapped to the dorsal plaster. There must be nothing in the palm except strapping or bandage, and full finger and shoulder exercises are practised at once (*see* p. 517). If the fingers are swollen the limb is elevated until the œdema has subsided. A sling may be worn for 24 to 48 hours; the arm is then put through the sleeve of the clothes and used in the ordinary way for light activities. The plaster must be retained for five weeks. If the limb was very swollen when the fracture was reduced, a new plaster is necessary seven to ten days later. Wrist and forearm movements recover by the patient's own activity within a few weeks of removing the plaster.

Displaced Lower Radial Epiphysis.—The same injury sustained in children causes a backward and outward displacement of the lower radial epiphysis. The clinical signs, method of reduction, and after-treatment are the same as for Colles's fracture. The injury is to be regarded as a fracture adjacent to the epiphysial line. It seldom causes arrested growth of the radius such as occurs after compression of the epiphysial disc.

Comminuted Colles's Fracture.—The lower fragment of the radius may be comminuted and the wrist-joint surface broken up by the fragmentation. Comminution must not be accepted as an excuse for failure to reduce. Irregularity of the joint surface makes it still more imperative to secure perfect reduction, so that joint movement will be smooth and painless. Spreading of the fragments is corrected by compression between the operator's two hands in both the antero-posterior and the lateral axes. It is usually possible to secure a perfect reduction and to restore a smooth articular surface.

Fracture of the Radial Styloid.—The same manipulative manœuvre is used in fractures of the base of the radial styloid process. This is a common backfire injury, and since the fracture extends into the joint, accurate reduction is essential. Direct compression manipulation is also used to reduce posterior and anterior marginal fractures of the lower end of the radius.

Spontaneous Rupture of Thumb Tendons.—The extensor pollicis longus tendon lies in a groove on the back of the lower end of the radius. A sharp spicule of bone in this groove may cause fraying and spontaneous rupture of the tendon. In posterior marginal articular fractures, and comminuted Colles's fractures, the patient should therefore be warned not to practise too energetic movement of the thumb during the first three weeks. Actually the complication usually occurs in overlooked fractures, where wrist movements are permitted as well as thumb movement.

Reversed Colles's Fracture.—In more uncommon cases the lower fragment of the radius is displaced forwards and not backwards. The displacement is reduced by pushing the fragment backwards and dorsiflexing the wrist. The fracture line is usually oblique, and the displacement cannot be over-reduced however strongly it is manipulated. A plaster cast is applied in the usual way and the wrist immobilized for five weeks.

FRACTURE OF THE CARPAL SCAPHOID BONE

Fracture of the scaphoid bone is a very frequent injury in boys and young men. If it is properly treated perfect recovery is possible within two or three months. If treatment is delayed the incapacity period is prolonged to six or twelve months. If the wrist is not immobilized at all non-union is inevitable,

the wrist is permanently weakened, and arthritis with a very serious disability may supervene several years later. Early diagnosis is therefore of great importance. Unfortunately the injury is often regarded as a sprain and the fracture is overlooked.

Diagnosis.—Sprain of the wrist is almost an unknown injury. Nearly every so-called sprain is actually a fracture. *Every patient who injures the wrist and complains of pain and tenderness over the radial side of the joint, must be assumed to have sustained a fracture of the scaphoid until radiographs prove otherwise.* The radiograph may show only the very finest hair-line crack. The crack may be obvious only when seen through a magnifying lens. Nevertheless, this is a complete fracture and it must not be ignored. If the bone is not immobilized, even the finest crack will gradually widen until a gap appears (*Fig.* 702) and non-union develops. If a fracture of the scaphoid is suspected three radiographs must be taken, including an oblique view as well as the classical antero-posterior (*Fig.* 703) and lateral views. If the crack does not appear even in the oblique view, the surgeon must still not be satisfied. A further series of three radiographs must be taken two weeks later. If there is any fracture, it will show clearly after this interval.

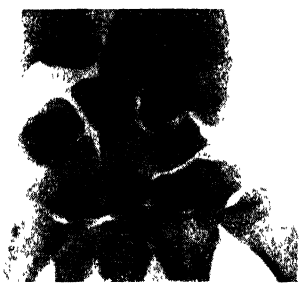


Fig. 702.—Two-months'-old fracture of the carpal scaphoid bone; there is cavitation at the site of fracture.

Treatment.—The wrist must be completely immobilized until there is radiographic evidence of union. Every single shearing movement of the fragments retards the process of repair, and if the movement is repeated often enough the fracture will never unite. A cock-up splint does not afford sufficient immobilization. A plaster slab must be moulded to the limb from the metacarpal heads to the upper forearm, extending far enough round the radial and ulnar margins to prevent side-to-side movements of the hand. The wrist is in slight dorsiflexion and the thumb in opposition. The plaster extends round the radial side of the index and thumb metacarpals, and must not fall short of these metacarpal heads. The slab is then secured by encircling turns of plaster bandage which are very closely moulded in the palm of the hand so that wrist movement is completely limited. The plaster must not extend beyond the skin creases of the palm.



Fig 703. — Recent fracture of the carpal scaphoid bone Although it is a hair-line crack, complete immobilization is essential.

The patient must report at once if the plaster shows signs of cracking at the wrist, and he must not allow it to become wet. With these reservations he may undertake any activity, and may even return to work.

Duration of Immobilization.—Most fractures of the tubercle of the scaphoid are united in four weeks, and most recent fractures of the wrist in eight to ten weeks. *If the fracture is not united at that time, strict immobilization must be continued until it is united.* If occasional movements have been permitted, it may be necessary to continue for three or four months. If there

was any delay in the institution of immobilization, six to twelve months may be required.

If the fracture is near the proximal pole, repair is often slow, because the blood-supply of the proximal fragment is impaired; immobilization may be required for twelve to eighteen months. If the surgeon is prepared to continue immobilization as long as each individual case requires it, bony union can be secured in every recent fracture of the scaphoid. Even if it is necessary to immobilize the wrist for from six to twelve months, the circulation and functional activity can be maintained so easily by finger movement that the joint does not stiffen. Only when half the scaphoid is deprived of blood, so that avascular necrosis supervenes, does any serious stiffness occur.

DISLOCATION OF THE SEMILUNAR (LUNATE) BONE

Clinical Signs.—The semilunar bone is dislocated forwards into the very confined space beneath the anterior annular ligament. This space is already almost fully occupied by the flexor tendons of the fingers and the median nerve. The typical clinical signs are, therefore, immobility of the semiflexed fingers, median paralysis in 50 per cent of cases, and swelling and painful limitation of wrist movement, with no obvious deformity.

X-ray Diagnosis.—The radiographic appearances are quite typical, but are often misinterpreted. In the lateral view it is evident that the head of the os



A B

Fig. 704.—Dislocation of the carpal semilunar bone. A, In a lateral view the cup of the semilunar is tilted forwards and the os magnum lies behind it. B, The antero-posterior view. The normal quadrilateral-shaped shadow of the lunate is now triangular.

magnum no longer lies in the cup of the semilunar (*Fig.* 704, A), but is displaced behind it. As a rule the semilunar is tilted so that its cup is directed forwards instead of downwards. This 90° tilt accounts for the different shape of the X-ray shadow in the antero-posterior view (*Fig.* 704, B). Whereas normally the bone outline is quadrilateral, when it is dislocated it appears triangular.

Method of Reduction.—Manipulative reduction is seldom difficult. The surgeon presses over the front of the semilunar with one thumb. With the other hand grasping the patient's fingers he applies strong traction to the remainder of the carpus, pulling the os magnum* away from the radius and gradually flexing the wrist so that the head of the os magnum is pulled into the cup of the semilunar (*Fig.* 705).

If the dislocation is of one, two, or three weeks' duration, sustained and prolonged traction may be necessary. An assistant takes the patient's thumb in one hand and the fingers in the other, and pulls steadily for five or ten minutes.

* Os magnum = Os capitatum.

After the traction has been maintained for some time the surgeon presses with both thumbs over the front lip of the semilunar and tilts it back into its socket. It is always difficult to be sure whether the dislocation is reduced or not, and a portable X-ray machine should be used in the fracture theatre.

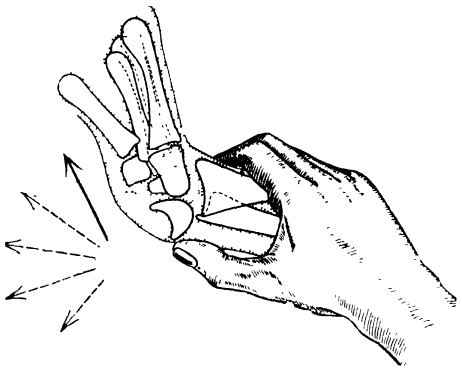


Fig. 705.—Manipulative reduction of dislocation of the semilunar.

After-treatment.—The wrist is immobilized by a dorsal plaster cast, in 45° of palmar flexion, for seven days. The plaster is then changed, no anæsthetic being used, and immobilization is continued with the wrist in the mid-position for a further two weeks.

Dislocation of the Semilunar with Half of the Scaphoid.—Fracture of the waist of the scaphoid may be combined with dislocation of the semilunar which carries the proximal half of the scaphoid with it. The distal half of the scaphoid remains attached to the os magnum and other carpal bones, and is displaced backwards and to the radial side. The dislocation is easily reduced in the usual way. The wrist is then immobilized for as many weeks or months as may be necessary to secure bony union of the fractured scaphoid.

Operative Treatment.—Old unreduced dislocations of the semilunar, or of the semilunar and half the scaphoid, should be treated by operative excision of the displaced bone. Operative reduction is not advisable, because if the dislocation is of long standing the blood-supply of the displaced bones is so impaired that avascular necrosis supervenes, with stiffness of the wrist

FRACTURES OF THE METACARPALS

The metacarpals may be fractured at the base, in the middle of the shaft, or at the neck. There is usually no displacement and the hand is simply immobilized for four weeks by a dorsal plaster cast similar to that used for fractures of the carpus. The finger-joints must be left free for movement. The old method of strapping the fingers over a roll of wool or bandage in the palm must not be used.

If there is angulation of a fracture of the shaft or neck of the metacarpal, with displacement of the metacarpal head forwards into the palm, the displacement must be reduced. This must not be attempted by hyperextension of the metacarpo-phalangeal joint because the manœuvre will fail and immobilization of the fingers in this position causes permanent stiffness. The metacarpo-phalangeal and proximal interphalangeal joints are flexed to the right angle; if the phalanx is then thrust backwards, the metacarpal head is pushed backwards and the angulation thereby corrected. The finger is immobilized with both joints flexed 90°.

BENNETT'S FRACTURE-DISLOCATION OF THE THUMB

In this injury a marginal fragment is broken off the base of the thumb metacarpal. This fragment, however, remains in its normal position, and it is the metacarpal itself which is displaced. The base of the metacarpal is partly or completely dislocated from the trapezium, and lies to the radial side of the carpus (*Fig.* 706). If it is unreduced, abduction movement of the thumb is

lost, the span is reduced, the thumb is greatly weakened, there is an ugly deformity, and arthritis of the carpo-metacarpal joint may supervene.

The oblique articular surface of the trapezium coincides with the line of fracture and forms a sliding plane. Reduction is therefore unstable and traction on the thumb is usually essential. The dislocation is reduced by strong firm pressure over the prominent base of the metacarpal. A dorsal plaster cast is applied

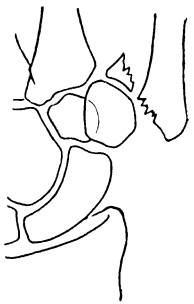


Fig. 706.—Bennett's fracture-dislocation of the thumb metacarpal.



Fig. 707.—Plaster cast with thumb traction for Bennett's fracture-dislocation.

closely moulded over the base of the metacarpal. A strong wire loop is incorporated in the plaster and skin traction applied (*Fig.* 707). The traction is maintained for two or three weeks and immobilization is continued for a total period of five weeks.

INJURIES OF THE FINGERS

The finger-joints are the most important joints of the upper limb; a workman with completely stiff fingers is very little better off than a workman with an amputated arm. These joints are particularly susceptible to injury, they very readily stiffen, and even minor sprains may cause months of incapacity. Every finger injury must therefore be treated with great respect, and if serious and possibly permanent incapacity is to be avoided certain principles of treatment must be observed:—

1. *The injured finger must be immobilized for at least two or three weeks.* This applies even to joint sprains.

2. *The finger must be immobilized in the flexed position.* This is the position in which reduction is usually most stable; it is the position in which the injured finger will stiffen least; and it is the only position which will allow bending movement of the other fingers. If one finger is held fully extended it is quite impossible to bend the others.

3. *Every finger except the injured one must be left free from splints, strapping, or bandage.* There must be no restriction of any sort to full movements of the normal fingers.

4. *The patient must move every uninjured finger throughout its normal range many times a day.* It is not enough to 'waggle' the finger in the middle range of movement. The limits of flexion and extension must be reached.

5. *Passive stretching and manipulation must never be permitted.* Massage is a waste of time; if the fingers are stiff active exercise is the essential measure; if the fingers are swollen elevation of the limb will relieve the swelling.

Sprains of the Finger-joints.—The joint is acutely painful and swollen. Radiographs may show small bony chips detached from the joint margin by

avulsion of the capsule. In other cases the capsule itself is torn. Many finger sprains have been actual dislocations, spontaneously reduced at the moment of injury. The joint should be immobilized in moderate flexion for two or three weeks by a collodion-gauze dressing. Collodion is painted on the skin and ribbon gauze bandaged over it. Four or five alternate layers of collodion and gauze complete the dressing, which dries to form a splint sufficiently rigid and less bulky than plaster. Recovery after interphalangeal joint strains is sometimes slow, and it may be many months before the joint thickening has finally subsided and movement fully recovered.

Dislocation of the Fingers.—Dislocations are usually due to hyperextension injuries. A triangular fragment may be chipped from the base of the distal phalanx. Reduction is easily accomplished by traction and flexion of the joint. The finger is immobilized for three weeks by a small plaster cast with all joints flexed at least 30° to 40°. Reduction is sometimes unstable, and check radiographs must be taken seven days after reduction. If the detached fragment is a fairly large one and carries one-third or more of the articular surface of the joint, there is a strong tendency to recurrence of the dislocation. This injury is comparable with Bennett's fracture-dislocation of the thumb, and should be treated in traction.

Dislocation of the Thumb.—Dislocations of the metacarpo-phalangeal joint of the thumb are also produced by hyperextension, and are sometimes difficult to reduce because the tendons of the short thenar muscles slip round the sides of the metacarpal head. The sesamoids may be interposed between the two articular surfaces. If manipulative reduction fails, operative reposition is necessary.

Fracture of Phalanges.—These usually occur in the shaft of the bone. The proximal fragment is flexed and the distal fragment tilted backwards (forward angulation). The displacement is reduced by traction and flexion of the joints. The digit is immobilized by a small plaster cast. If the fracture is oblique and there is considerable overriding, traction may be necessary.



Fig. 708.—Application of plaster cast for mallet finger. A small slab is moulded to the flexor surface by means of ribbon-gauze bandage. While it is setting the surgeon holds the terminal joint in full hyperextension. This is a very difficult plaster to apply and much practice is needed. Try it first on a normal finger.

Mallet Finger.—The extensor tendon is avulsed from the base of the terminal phalanx with or without a small flake of bone. The terminal joint is flexed and although passive extension is possible, active extension is lost. Failing suitable treatment a severe mallet-finger deformity develops. The whole of the power of the extensor tendon is then concentrated on the proximal interphalangeal joint. A hyperextension deformity at this joint is therefore added to the flexion deformity at the terminal joint. The finger must be immobilized by a plaster cast, with the proximal interphalangeal joint flexed and the terminal joint hyperextended for at least six weeks (*Fig.* 708).

CHAPTER LXX

FRACTURES AND DISLOCATIONS OF THE BONES OF THE FACE, SPINE, AND PELVIS

By Sir REGINALD WATSON-JONES

FRACTURES OF THE BONES OF THE FACE

Nasal Bones.—The nasal bones or cartilages and the nasal septum may be fractured by direct violence, and even minor degrees of displacement cause serious disfigurement. Asymmetry due to lateral displacement should be corrected by direct pressure over the fragments. An instrument such as a pair of straight artery forceps covered with thin rubber tubing may be inserted into the nostril to correct lateral deviation of the septum and to elevate depressed fragments. Reduction is usually stable; it is seldom necessary to use any splint, and the nose should not be plugged.

Malar Bone.—Fractures of the zygomatic arch and malar bone are usually depressed; if the fragments are not elevated facial disfigurement persists. There is sometimes anæsthesia of the cheek and lip from compression of the infra-orbital nerve. Replacement can be effected by an elevating instrument inserted through a half-inch incision placed within the hair margin above and behind the zygomatic arch.

FRACTURES AND DISLOCATIONS OF THE LOWER JAW

Fractures of the Lower Jaw.—Almost every fracture of the body of the jaw is compound into the mouth, and frequent antiseptic mouth-washes are necessary. A fluid diet is prescribed, and soft foods may be taken after a week or ten days. When there is no displacement of the fragments, the jaw is supported by means of a four-tailed bandage for about ten days. If the fragments are displaced and occlusion of the teeth is inaccurate, the co-operation of a dental surgeon should be sought. After reduction of displacement the jaw may be immobilized by: (1) an interdental splint cemented on to the teeth; (2) wires secured round the teeth which fix upper and lower jaws together; (3) transfixion pins driven into each fragment and fixed to each other by a stainless steel or vitallium plate.

Dislocation of the Lower Jaw.—This may be bilateral, when both condyles slip forward on to the articular eminences, or may be unilateral, when one condyle slips forwards and pushes the jaw and chin towards the opposite side. To reduce the dislocation the operator stands in front of the patient, and, with his protected thumbs passed into the mouth, presses the angle of the jaw downwards, at the same time raising the chin with his fingers outside the mouth. The jaw is supported by a four-tailed bandage kept in position for two or three weeks, the patient meanwhile being fed on fluids and soft foods.

FRACTURES OF THE SPINE

Types of Fractures (*Fig.* 709).—There are three types of flexion fracture: (1) simple wedge compression of one or more vertebræ; (2) comminuted fracture

of one vertebral body due to more localized and acute angulation ; (3) fracture-dislocation.

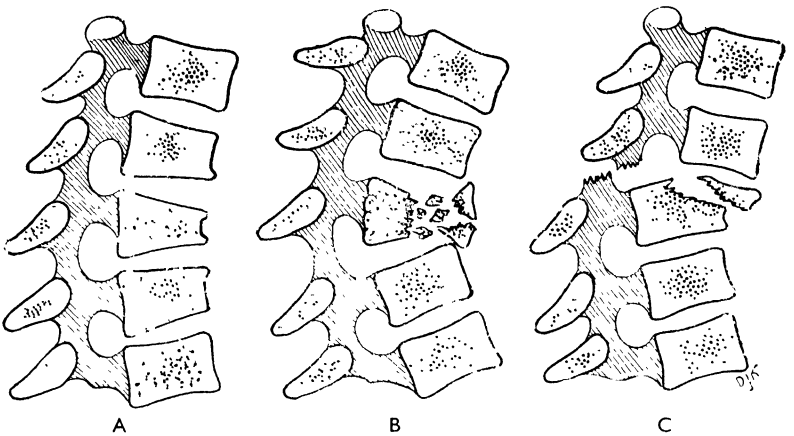


Fig. 709.—Three types of crush fracture of the spine. A, Wedging of one or more vertebral bodies, B, Comminuted fracture of a vertebral body, C, Fracture-dislocation

Diagnosis.—The important clinical sign is abnormal prominence of one spinous process. The deformity may not be obvious on inspection, but is easily felt when the examining finger passes down the line of spinous processes. The patient usually, but not always, complains of pain in the back. Every patient who falls, even from a moderate height in the sitting or standing position, and has pain in the back, should be radiographed even if abnormal prominence of a spinous process cannot be detected.

X-ray Examination.—The lateral radiograph discloses the injury more clearly than the antero-posterior film. Even the slightest wedging of a vertebral body must be accepted as a complete fracture.

If the spine is not immobilized in hyperextension the wedging will steadily increase and a deformity develop. This is described as 'Kummell's disease'. If a crush fracture is suspected on clinical grounds, but there is no evidence of it in the lateral radiograph, further films must be taken with the spine flexed. If the diagnosis is still in doubt the radiographic examination should be repeated two or three weeks later.

Principles of Treatment.—No fracture is more easily reduced than a fracture of the spine, but the omission of apparently trivial details may lead to failure. Compression of the vertebral body is corrected by the tension of the anterior common ligament attached to its upper and lower margins. The spine must therefore be immobilized in the position of hyperextension. *It is not enough to extend the spine ; reduction is perfect only if it is hyperextended to the normal limit.* Unless there is actual tension on the anterior common ligament, reduction will be imperfect, and wedging and redisplacement will recur.

Method of Reduction and Immobilization.—No anæsthetic should be used. Morphine ¼ gr. is given fifteen minutes before reduction is begun. The patient is rolled on to his face, so that when he is lifted the spine will be extended and the dangerous movement of flexion avoided (*see* p. 504). A double layer of stockinette 8 in. wide is pulled over the trunk and fixed over the shoulders and

in the perineum. Each anterior superior iliac spine is protected by adhesive felt, and a larger piece of felt, 4 × 6 in., applied over the spinous processes at the level of fracture. Two tables, one ten or twelve inches higher than the other, are placed end to end with a space between them slightly greater than the length of the patient's trunk. The patient is then lifted into position so that his head and arms are resting on the edge of the higher table (*Fig.* 710). The lower table supports the lower limbs to the level of the upper thigh, but must fall short of the symphysis pubis by several inches. The pelvis must be entirely free of support so that it can tilt forwards, and the whole trunk must sag between the two tables. There must be no sling or hammock to support the abdomen and chest.

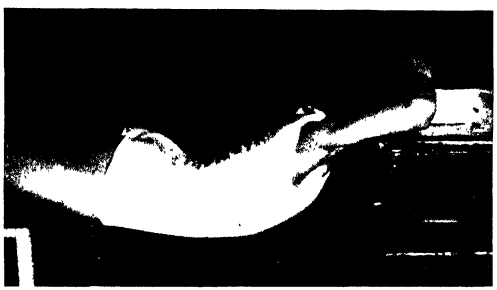


Fig. 710.—Reduction and plaster fixation of a crush fracture of the lumbar spine. The pelvis is entirely clear of the lower table and there is no ventral sling, so that the lumbar spine is fully hyperextended.



Fig. 711.—An efficient plaster jacket extending from the clavicles to the symphysis pubis.

Plaster is at once applied, and successive layers are rubbed into each other firmly. This degree of pressure is sufficient to complete the reduction; there must be no manipulation and no forcible thrusting over the kyphos. The plaster must extend from the groin to the clavicles (*Fig.* 711). A small area may be cut out in the midline between the two clavicles to prevent pressure on the larynx. Sufficient plaster is also cut from the groins to permit flexion movement of the hips, and from below the axillæ to allow free movement of the arms. A window must be cut over the spinous processes at the site of injury; this window should be slightly smaller than the piece of felt already applied, and the felt is not removed. Only in this way can pressure sores be avoided.

A common mistake is to carry the jacket anteriorly no higher than the nipple line. If this is done it is still possible for the patient to flex the upper dorsal spine, and to transmit movement to the region of the fracture. Unless the plaster is intact from the clavicles to the symphysis pubis, redisplacement will occur.

After-treatment.—Until the plaster is thoroughly dry the patient lies with pillows beneath the concavity in the arch of the spine. The position is then changed every few hours during the day, to avoid hypostasis and congestion of the lungs. The patient may sit up at once, and if there is no nerve complication, walking may be resumed within a day or two. Exercises are taught to maintain the tone of the spinal and abdominal musculature.

Lying on the face with the arms by the side, the head and shoulders are slowly raised from the bed and lowered again. Each hip is slowly hyperextended with the

knee straight, and as the patient becomes more expert both hips are simultaneously hyperextended. The patient should resume normal activities, wearing normal dress over the plaster jacket. The victim of spinal injury understands that "his back is broken" and has difficulty in believing that complete recovery is possible. Psychological disturbances and the tendency to exaggeration and malingering are minimized if normal activity is resumed at an early stage.

It may be necessary to cut a window in the plaster over the upper part of the abdomen. The elderly man with emphysema of the chest and calcification of the rib cartilages breathes mainly with the diaphragm and the abdominal wall. If a rigid plaster is applied over the abdomen, there may be serious respiratory distress, which is promptly relieved by a window six to eight inches in diameter over the upper half of the abdomen. A window may also be necessary to relieve flatulence and abdominal distension. It is not advisable, however, to cut such a window as a routine, because it may weaken the jacket.

Duration of Immobilization.—The plaster jacket usually becomes loose after two or three weeks, and a new jacket must then be applied, again with the spine in hyperextension. The first degree of hyperflexion fracture, where there is simple wedge compression of one or more vertebral bodies, must be immobilized in plaster for four months. If the jacket is discarded earlier deformity will recur. Comminuted fractures unite still more slowly and six months of immobilization is necessary. The third type, where there is a fracture-dislocation, should also be immobilized for four to six months.

It is inadvisable to use a posterior spinal support after the plaster is discarded. If the fracture is firmly united the support is obviously unnecessary, and if it is not firmly united the plaster has been discarded too early. A spinal support will not prevent recurrence of deformity. After removal of the plaster movement of the spine is regained by the patient's own exercise. It is seldom necessary to manipulate the spine, and full movements should be regained within about two months of discarding the jacket.

FRACTURES AND DISLOCATIONS OF THE CERVICAL SPINE

Subluxation of the Cervical Spine.—Crush fractures of vertebral bodies seldom occur in the cervical region, but subluxation of one interarticular joint



Fig. 712.—Application of plaster for subluxations and fractures of the cervical spine. The neck is hyperextended over a spinal rest made of wood nailed to a wooden table. Plaster is applied, and the patient is then slid off the spinal rest.

is a frequent injury. There is often pressure on the adjacent nerve-root causing pain, tingling, or numbness in one or both arms. Immobilization by means of a plaster jacket is essential. A piece of ½-in. wood, 3 in. wide, is nailed to a wooden

table so that it projects one foot from the end, and is padded with wool to form a rest. The head is held by an assistant, with the cervical spine in full extension and neutral rotation (*Fig.* 712). The arms are held in the abducted position, and plaster is applied from the crest of the ilium over the trunk, neck, and head. The jaw and forehead must be included in the plaster so that flexion movement of the neck is prevented. The patient's comfort is greatly increased by cutting a window over each ear. Immobilization is continued for not less than two months.

Fracture-dislocation of the Cervical Spine.—The reduction and immobilization of fracture-dislocations usually calls for skeletal traction from the skull, but such treatment is beyond the scope of this work.

SPINAL FRACTURES WITH PARAPLEGIA

Recoverable and Irrecoverable Paralysis.—Fractures and fracture-dislocations of the cervical, dorsal, or lumbar regions may be associated with injury to the spinal cord or cauda equina and paralysis of the lower limbs, bladder, and rectum. The cord injury may be a simple contusion, a compression by the bony walls of the spinal canal, or an actual severance of the nerve-fibres. If the cord is severed, no recovery is possible whatever treatment is undertaken. On the other hand, paraplegia due to simple compression will recover if the compression is relieved.

Treatment.—During the first ten days the types cannot be distinguished by neurological tests. In all cases, therefore, immediate steps should be taken to relieve pressure. This can be done by reducing the fracture. The spine must be hyperextended at once. Complete anæsthesia below the level of the lesion makes it difficult to avoid decubitus sores, but with careful nursing an ordinary hyperextension plaster jacket or plaster bed may be used.

One of the most important considerations is the relief of retention of urine. Before passing a catheter the house surgeon should consult the views of the surgeon in charge of the case. Most surgeons consider that a high suprapubic cystotomy is advisable, but catheterization with tidal drainage is sometimes used (*see* p. 250). Few surgeons advocate repeated catheterization because infection of the paralysed bladder is then almost inevitable. The patient should be given urinary antiseptics at once, even before infection has developed.

Prognosis.—The prognosis in fracture-dislocations of the upper dorsal region is poor, because the cord has usually been severed. In cervical injuries the outlook is better, and in lumbar injuries which involve the medullated fibres of the cauda equina and not the cord itself, recovery from paralysis is possible in about 40 per cent of cases.

FRACTURES AND DISLOCATIONS OF THE PELVIS

The bone injury is often unimportant, but the associated injury to soft tissues may be serious or even fatal. Injuries to the urethra, the bladder, and the rectum must be excluded.

Injuries to the Urethra or Bladder.—If injury to the urethra or bladder is even suspected, arrangements should be made immediately with the surgeon in charge of the case to carry out the necessary investigation in the operating theatre. Sounding of the urethra and similar procedures should not be carried out except in an operating theatre where asepsis can be assured and if necessary operation undertaken immediately. If urgent relief of retention of urine is needed before these facilities are at hand, catheterization is still contra-indicated; the bladder,

if full, should be emptied by suprapubic aspiration. In cases of rupture of the urethra, the patient must not under any circumstances even attempt to pass urine.

Injuries to the Rectum.—These are rare, and are usually caused by a fracture of the coccyx. In most cases nothing more than a slight laceration exists, but in more severe injuries extensive operations may be required.

Treatment of the Bone Injury.—The common injuries to the pelvis are fractures of one or both pubic rami, slight separations of the symphysis pubis, and fractures of the body of the ilium. No special treatment is necessary other than recumbency for three or four weeks. Fracture boards are placed beneath the mattress, and the pelvis is surrounded with a firm wide binder or a many-tailed bandage. No attempt need be made to secure complete immobilization, and there is no necessity for a plaster spica or plaster jacket. As soon as the tenderness has subsided, the patient may sit up, and recovery should be complete within about two months.

Disruption of the Pelvis.—The one injury which requires special treatment is unilateral disruption of the pelvis, where there is a fracture in the anterior segment involving the pubis or pubic rami, and a second fracture or dislocation



Fig. 713.—Three types of fracture-dislocation and disruption of the pelvis.

in the postero-lateral segment involving the ilium or sacro-iliac joint (*Fig.* 713). This injury follows compression of the pelvis in its antero-posterior axis. One half of the pelvis is rotated outwards, carrying with it the corresponding lower limb. Radiographs show wide displacement of the fragments of the pubis, but much less obvious displacement of the sacro-iliac joint.

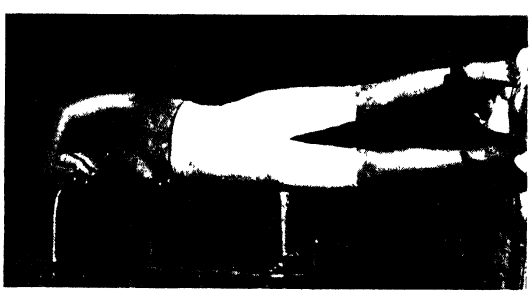


Fig. 714.—Fracture-dislocation of the pelvis. The dislocation is reduced and plaster applied in lateral recumbency.

While the patient lies on his back, gravity and the weight of the lower limb maintain the outward rotation of the dislocated half of the pelvis. A dislocated pelvis is like a partly opened oyster: when laid on the hinge at the back, gravity

keeps the two halves apart, but when laid on one side the two halves close. Similarly with the dislocated pelvis, if the patient lies on one side the two halves of the pelvis fall together.

A plaster table or any form of pelvic rest is used with the perineal post removed. The patient is placed on his uninjured side, with the trochanter lying on the pelvic rest and the two lower limbs held one above the other by an assistant. Pressure may be applied over the crest of the dislocated ilium, pushing and rotating it downwards and forwards. Accuracy of reduction is confirmed by palpating the pubic bones through the lower abdominal wall and in the perineum.

A radiograph should be taken before the plaster is applied. The iliac crests are protected with adhesive felt, and a double plaster spica applied (*Fig.* 714). The pelvic rest is cut out and the defect repaired.

To prevent redisplacement within the plaster, the spica must be carefully moulded to the pelvis and trunk. A new plaster is usually necessary in three or four weeks. Immobilization is continued for ten weeks, and throughout this time the patient should lie on one side and not on the back.

When the displacement is of minor degree, it may be necessary only to nurse the patient on his side on a firm mattress with fracture boards. If the pelvic disruption is complicated by injuries to the bladder and urethra, simple lateral recumbency should be adopted at once. A plaster spica freely cut away from the perineum and abdomen must be applied as soon as possible, because separation of the pubic bones tranferes with repair of the bladder.

CHAPTER LXXI

FRACTURES AND DISLOCATIONS OF THE LOWER LIMB

By Sir REGINALD WATSON-JONES

DISLOCATION OF THE HIP-JOINT

TRAUMATIC dislocation of the hip-joint was at one time very rare but with the increasing hazards of collision of motor vehicles and crash landing of aircraft it has become increasingly common.

Method of Reduction.—The object of the manipulative procedure is to flex the hip and rotate it so that the femoral head lies just below the acetabulum



Fig. 715.—Reduction of a traumatic dislocation of the hip. The femoral head is rotated to the neutral position and lifted into the acetabulum.

and then to lift the head into the acetabulum. Reduction is easily accomplished by gentle manœuvring; forcible manipulation and vigorous traction are unnecessary and dangerous. The anæsthetized patient is laid on blankets on the floor so that the surgeon can more easily hold the limb. An assistant kneels by the patient and steadies the pelvis with both hands. The surgeon stands over the hip, and with both hip-joint and knee-joint flexed to a right angle, he slowly rotates the limb from the position of deformity into neutral rotation, and then lifts it with firm steady traction (*Fig.* 715). This simple procedure will usually reduce all types of dislocation.

If it fails, the surgeon again applies traction to the flexed hip, and circumducts the limb through the position opposite to that of the deformity, into neutral

extension, so that it lies by the side of its fellow. In the dorsal dislocation where the hip is adducted and internally rotated, it is flexed, traction is applied, the hip is moved into abduction and external rotation, and then into the neutral position. In the anterior dislocation where the hip is abducted and externally rotated, it is flexed, traction is applied, the hip is moved into adduction and internal rotation, and then brought down to the side of its fellow limb.

It is obvious that the limb must not be moved too forcibly or too suddenly into the position opposite to that of the deformity, or the head of the femur will slide right past the acetabulum into the opposite type of dislocation.

Marginal Fracture of the Acetabulum.—Marginal fragments of the acetabulum which are displaced with the head of the femur are often replaced fairly accurately when the dislocation is reduced, but it is sometimes necessary to perform an operative reduction.

Avascular Necrosis of the Femoral Head.—The blood-supply of the femoral head is carried almost entirely through vessels in the capsule of the joint. The nutrient and periosteal vessels of the shaft extend no higher than the neck of the femur. When the hip is dislocated the capsule is torn, the vessels are damaged, and the blood-supply of the head is endangered. If the vessels are completely torn or thrombosed, avascular necrosis supervenes The articular cartilage undergoes degeneration, and a stiff, painful, arthritic hip results

Evidence that this complication will arise may be seen in radiographs taken about six weeks after injury. If the head of the femur has no blood-supply, it cannot undergo disuse decalcification, so that the head remains dense whereas adjacent bones decalcify

After-treatment.—The whole of the treatment of traumatic dislocation should be governed by the danger of avascular necrosis. Further capsular injury must be avoided by very gentle manipulation, and by immobilization of the joint in a plaster spica for two months. Although in many cases early movement would not redislocate the joint, it interferes with repair of the soft tissues and may cause further thrombosis of capsular vessels. The patient must not resume weight-bearing earlier than from two to three months after injury.

If the complication does arise, there must be no weight-bearing until revascularization is as complete as possible. Active movement may be permitted after two months, but no weight should be borne within six months. The only alternative is to perform an arthrodesis of the hip-joint two or three years after injury, when the arthritis has fully developed.

FRACTURE OF THE NECK OF THE FEMUR

Every elderly patient who after slight injury to the hip complains of pain, or is found to lie with the limb in external rotation, must be assumed to have sustained a fracture of the femoral neck until antero-posterior and lateral radiographs prove otherwise.

Fracture of the neck of the femur is sometimes a terminal event in the lives of old and fragile patients. Hypostatic bronchopneumonia and bedsores, or even the simple shock and general disturbance, may cause death within a week or two. In such cases the patient's condition is too frail for active treatment of the fracture. It must be explained to the relatives that general measures are more important than local treatment, and although the fracture will fail to unite, the patient is encouraged to sit up in bed at once. If he survives, weight-bearing is resumed with a bucket-topped calliper in two or three weeks. With modern surgical developments the number of patients who are too ill or too feeble for active treatment of the fracture is increasingly small.

Three types of fracture must be distinguished: (1) abduction cervical fractures; (2) adduction cervical fractures; and (3) basal fractures (intertrochanteric and pertrochanteric).

Abduction Cervical Fracture.—This is a high cervical or subcapital fracture with true impaction (*Fig.* 716). The femoral shaft and neck are abducted



Fig. 716.—Abduction fracture of the neck of the right femur.

in relation to the proximal fragment in the coxa valga position. Moreover, the fracture lies in a relatively horizontal plane (*Fig.* 717). It follows, therefore, that weight-bearing and muscle pull impact the fragments more closely and do not give rise to shearing stresses. These fractures always unite by bone whether

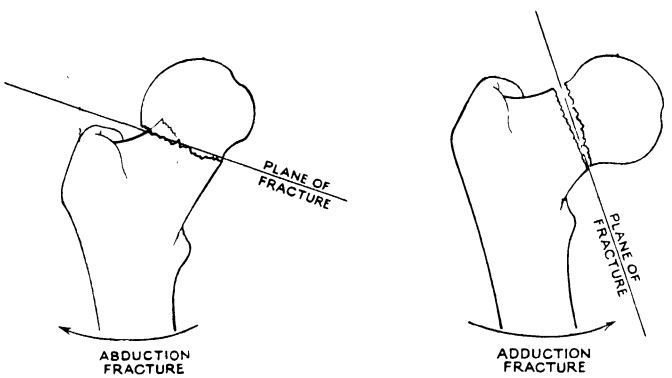


Fig. 717.—A, In abduction injuries the fracture is in the relatively horizontal plane. Muscle retraction (M), and weight-bearing (W) impact the fragments and bony union occurs spontaneously. B, In adduction fractures there is shearing stress from muscle retraction and weight-bearing. Non-union occurs unless perfect immobility is secured by a nailing operation.

immobilized or not. No operation is indicated. The only treatment necessary is rest in bed for about six weeks with a shoe and cross-piece to prevent rotation strain. The knee-joint must not be allowed to stiffen, and even hip exercises are safe. Recovery should be complete within about three months.

Adduction Cervical Fracture.—In this injury the distal fragment is adducted, the plane of fracture is relatively vertical, and the line of force of muscle pull and weight-bearing is more or less parallel with the fractured surfaces, so that there is shearing strain (*Fig.* 718). Even if the fragments appear to be impacted, continued shearing strain prevents bony union, and there is progressive decalcification of the neck of the femur until it is entirely absorbed. The displacement must be corrected, the fragments impacted in slight abduction, and

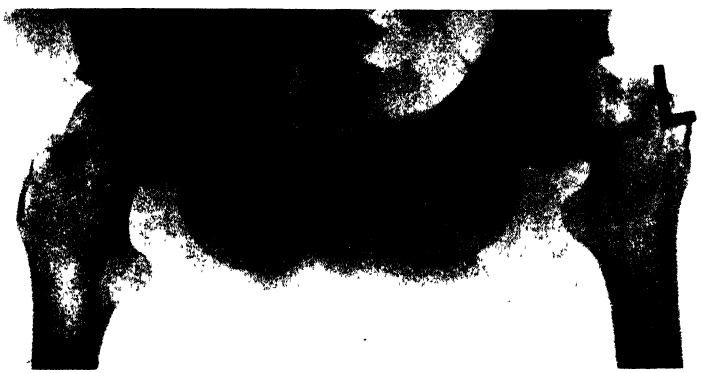


Fig. 718.—Adduction fracture of the neck of the left femur.

immobilization maintained for many months. Union is often slow, and may be unsound even after twelve months. A plaster spica is therefore less satisfactory than a three-flanged stainless steel nail driven through the neck of the femur into the head.

After inserting the nail, a shoe is worn with a cross-piece of wood nailed to the heel to prevent rotational strains (*see Fig.* 676, p. 508). The patient sits up at once and is encouraged to move freely in bed. Knee exercises are practised from the first day; the patient must lie on one side, so that the knee-joint can be flexed fully without moving and straining the hip. The arthritic knee-joint of an elderly patient lying flat in bed becomes stiff within a few days, and the pain and discomfort of movement during the first days after operation must be overcome by constant encouragement and stimulation.

Weight-bearing should not be resumed until from two to three months after operation. If there is radiographic evidence of avascularity of the head, weight-bearing should be deferred still longer, in order to minimize the danger of avascular necrosis.

Basal Fractures.—If the fracture lies along the intertrochanteric line, it may still be possible to perform the nailing operation with complete success. If the fracture lies below the intertrochanteric line, the bone on the distal side of the fracture is too thin to afford a secure grip for the nail. In these cases a nail must be used with an attached plate which is screwed to the shaft of the femur. Alternatively the limb is immobilized in a plaster spica in abduction and slight internal rotation.

DISPLACED UPPER FEMORAL EPIPHYSIS

This injury, like high fractures of the femoral neck, is liable to interfere with the blood-supply of the femoral head. Forcible manipulations and open operations are

therefore to be avoided. In acute displacements of a few days' duration, reduction by gentle abduction and internal rotation of the limb and immobilization in a plaster spica or abduction frame may be safe, but in long-standing displacements even this degree of trauma precipitates avascular necrosis and stiffness of the hip. In such cases the deformity should be reduced gradually by traction. Weight-bearing should not be resumed until the epiphysial line has fused. This usually involves at least six months of recumbency.

FRACTURE OF THE SHAFT OF THE FEMUR

The essentials of treatment are to preserve full length, and to prevent rotation or angulation of the fragments; accurate apposition of the fragments is less important. Since the muscles of the thigh are so long-bellied and powerful that there is a strong tendency to overriding and shortening, traction on the limb throughout the period of immobilization is essential.

Fractures of the Middle Two-thirds: Fixed Traction Method.—The best routine treatment of shaft fractures is immobilization in a Thomas knee splint with skin traction.

General or local anæsthesia is used. The foot and ankle are held by an assistant, who pulls strongly and steadily on the limb so that he can elevate it without damaging the soft tissues by the sharp bone fragments. Three-inch wide brown holland strapping, warmed to make its surface adhesive, or " one-way stretch Elastoplast strapping ", is applied on each side of the limb from just above the malleoli to the level of the fracture. The outer strip is centred a fraction behind the midline and the inner strip in front, so that the limb will lie slightly more in internal than in external rotation. *The extension strapping must not be bound to the limb by circular or spiral turns of adhesive strapping, but by soft bandage.* If strapping is applied in a spiral or circular manner, pressure sores will result in later weeks when it slides down the limb. For the same reason the malleoli, ankle, and back of the heel must be protected by thick pads of wool under the extension tapes, and the encircling bandage must stop short two or three inches above the malleoli.

The ring of the splint is then threaded over the limb (*Fig.* 719). If the ring of the splint is too big a pad of wool or felt is fixed between the outer part of the ring and the outer aspect of the thigh so that the inner part of the ring lies snugly against the adductors and does not encroach on the perineum. The limb is supported in the splint by means of a wide metal gutter splint held in position by strong bandage slings placed at the top and bottom. The normal forward curve of the lower shaft of the femur must be preserved by keeping at least two-thirds of the limb in front of the side bars and only one-third behind, and by a pad of wool on the gutter splint just above the femoral condyles in the upper part of the popliteal space.

To the lower free end of the extension strapping, strong linen tapes are secured by firm knots. The outer tape is passed over the outer bar of the splint, the inner tape under the inner bar, the padded ring of the splint is pushed well up against the ischial tuberosity, and the extension tapes are tightened and fastened securely over the cross-bar at the end of the splint. While the patient is still under the anæsthetic, and after traction has been applied, the fragments are manipulated into good apposition by direct pressure. Radiographic control is used. Aluminium gutter splints are then bandaged into position, one twisted splint lying on the outer side from the region of the trochanter to the front of the patella, and a straight gutter splint on the inner side. These splints control alinement and apposition; the traction controls only length.

AFTER-TREATMENT.—As the traction continues, the extension tapes gradually slide down the limb and become slack; it is necessary to tighten them several times a day. Moreover, the counter-pressure of the ring of the splint makes it difficult to avoid pressure sores in the adductor region and groin. Both these difficulties are easily met by the simple device of fastening the end of the splint to the foot of the bed, which is raised twelve inches. The patient is then partly suspended from the foot of the bed by the extension tapes, so that the slightest

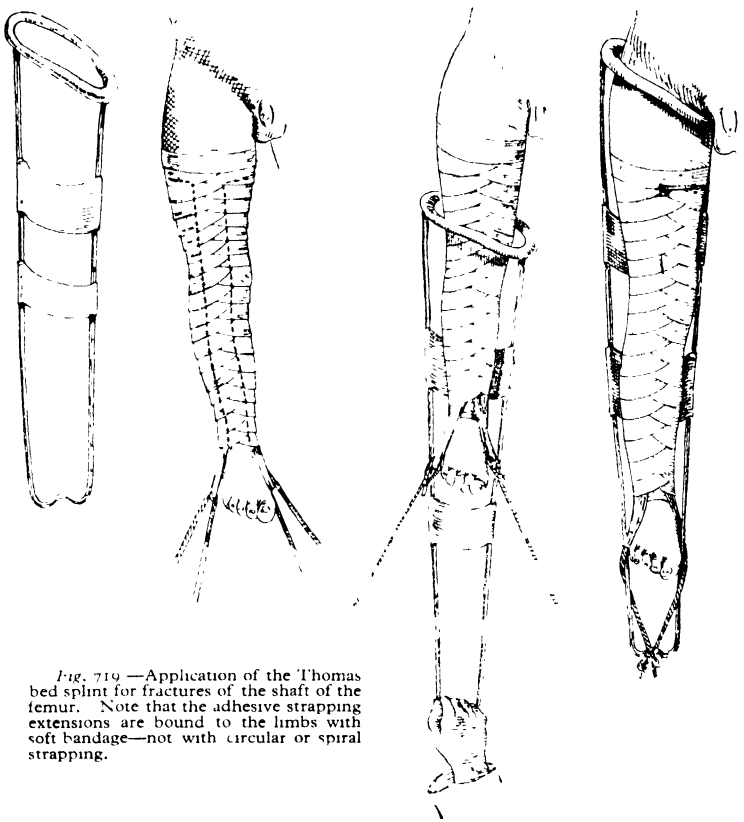


Fig. 719.—Application of the Thomas bed splint for fractures of the shaft of the femur. Note that the adhesive strapping extensions are bound to the limbs with soft bandage—not with circular or spiral strapping.

degree of slack is at once taken up. It is only necessary to tighten the tapes once a day or once every other day. The patient tends to fall away from the ring of the splint and pressure in the groin is reduced. The counter-pull of the patient's body-weight increases the traction, and if the shortening is not fully reduced the traction is increased merely by raising the foot of the bed still more.

The position of the fragments is confirmed radiographically, with a portable X-ray apparatus, every second or third week. Throughout the period of immobilization the patient must practise toe and foot exercises; for five minutes every hour of the day the foot is dorsiflexed, inverted, everted, and circumducted. There is no need for a foot support on the splint. After a few weeks

the thigh muscles should be exercised by smooth rhythmic contraction and relaxation (' quadriceps drill ').

After ten weeks the degree of union is estimated clinically. If immobilization has been imperfect, or the fracture has been compound and infected, or for any other reason union is delayed, immobilization and traction in recumbency are continued for a longer period. When the fracture is clinically firm, and is no longer tender, and the callus shown in the radiographs is calcifying, the Thomas splint is replaced by a calliper splint which is worn day and night.

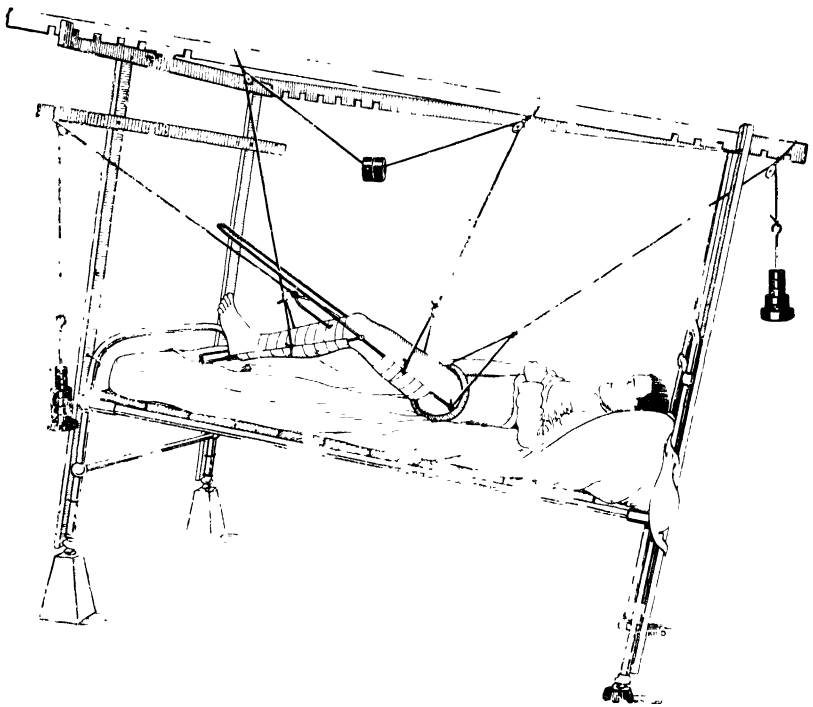


Fig. 720.—Balanced traction and suspension for fracture of the shaft of the femur. The traction pin is in the tibial tuberosities—*not the femoral condyles*. Great care is necessary to avoid overpull and distraction of the fragments.

Weight-bearing in the calliper splint is resumed when union of the fracture is consolidating. A zinc-gelatine dressing is applied to the leg and a crêpe bandage over the knee to prevent recurrent œdema; if œdema is not prevented, the stiffness of the knee- and ankle-joints will be difficult to overcome. The calliper is taken off three times a day for non-weight-bearing knee exercises. It is finally discarded about six months after injury, when there is final consolidation of the fracture. Weight-bearing knee exercises are then practised from five to ten minutes hourly throughout the day. The range of knee movement is measured every second week; the joint should not be manipulated under anæsthesia until it is found that movement is no longer recovering by the patient's own exercise.

Fractures of the Middle Third: Balanced Weight-traction Method.—If the fracture is several weeks old, or if for any other reason satisfactory reduction is not secured by the 'fixed' skin-traction method, balanced weight-traction may be used. A Steinmann pin is driven through the tibial tubercle, and a stirrup fixed to the pin. Infection of the pin track must be avoided, (*a*) by taking all aseptic precautions in the insertion of the pin, and (*b*) by fixing the pin securely so that it cannot rotate or move in its track through the bone. A plaster bandage may be used, encircling the limb and incorporating the pin and stirrup. A Thomas splint with a Pearson's flexed-knee attachment is guided over the limb and suspended from an overhead beam with weights (*Fig.* 720). A cord from the tibial pin stirrup passes over a pulley at the foot of the bed to a 20-lb. weight. The foot of the bed is raised on blocks. The position of the fragments must be checked radiographically, and if necessary the weight may be increased.

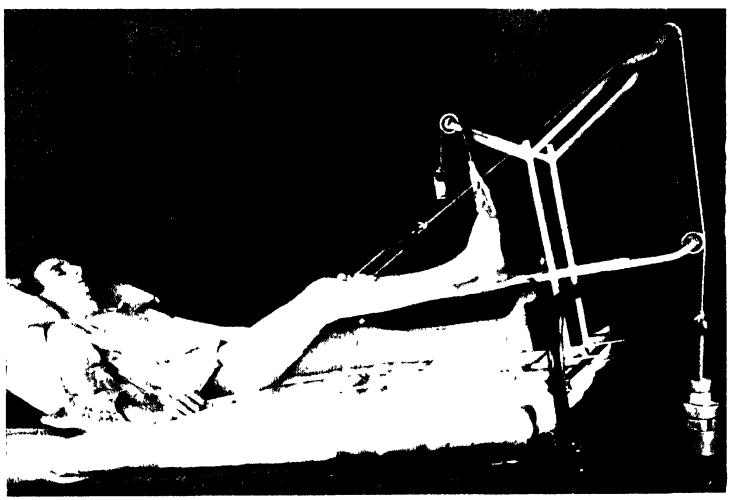


Fig. 721.—Supracondylar fracture of the femur treated in the Bohler-Braun splint with skeletal traction from a tibial pin. The angle of the splint is above the level of the knee-joint. The foot of the bed is raised about 18 in. Light vertical traction on the foot prevents pressure sores behind the heel. A block of wood below the normal foot adds to the patient's comfort.

It is most important to avoid excessive weight and distraction of the fragments. The slightest overpull, even if it causes no more than a third of an inch of distraction of the fractured surfaces, and even if corrected within a few days, adds many months to the necessary period of immobilization. A fracture of the femur which would otherwise unite in two or three months, may then unite only after ten or twelve months. Excessive traction is now the commonest cause of slow union of fractures. Half an inch of shortening due to underpull is far less serious than half an inch of lengthening with slow union due to overpull.

Fractures of the Lower Shaft—Supracondylar.—At this level the small lower fragment is tilted backwards by the pull of the gastrocnemius muscle, especially if the tension on this muscle is increased by keeping the knee straight and the ankle dorsiflexed. If this is not corrected, the fracture unites with backward angulation and genu recurvatum. The knee must be flexed 45° and special care taken to support the back of the supracondylar region. The fracture may be treated on a Braun's splint (modified by Bohler, *Fig.* 721), with tibial skeletal traction. The traction pin must be securely

fixed by incorporating it in plaster. From 10 to 15 lb. weight extension is used. The foot of the bed is raised 1 to 2 ft. It must be raised enough to balance the traction weight on one side, and the patient's body-weight on the other. The angle of the Braun's splint lies just behind the supracondylar region—not behind the knee-joint—so that the fragments are supported and backward angulation is prevented. Adhesive strapping is applied to the foot with slight vertical traction to prevent pressure sores behind the heel. This technique often fails to correct the backward tilting, and it may be necessary to drive a second pin through the femoral condyles, so that the fragment can be pulled forwards. After reduction, the two pins are incorporated in a plaster spica. This is better than using a Braun's splint and balanced traction, because a supracondylar pin which can twist and slide in its track may cause infection of the joint, infection of the fracture, or stiffness of the knee due to suprapatellar adhesions.

Stiffness of the Knee-joint after Fracture of the Femur.—Attempts have been made to avoid stiffness of the knee by permitting early movements of the joint after plating the fracture, or by encouraging movement while using supracondylar skeletal traction. Very often the only effect of these measures has been to convert temporary stiffness into permanent stiffness. The adhesions between the capsular plications of the joint and between the muscles of the thigh which result from immobility alone, are easily overcome within two to six months by the patient's own exercise. Recovery is facilitated and accelerated by instituting regular quadriceps drill within a few weeks of fracture while the limb is still immobilized. Only when immobility is complicated by such factors as are enumerated below does the stiffness resist the patient's exercises and often remain permanently.

1. *Operative Reduction.*—It is difficult to expose the shaft of the femur without some injury to the muscles of the thigh, and if there is infection of the operation wound the muscles become densely adherent to each other and to the fracture.

2. *Supracondylar Skeletal Traction.*—After a few weeks the pin track usually becomes the site of a low-grade infection causing serous exudation. This is most common when the pin is allowed to rotate in its track, or when movable ice-tong callipers are employed. If this serofibrinous exudation and infection does arise, the suprapatellar synovial pouch becomes densely adherent, and it is unlikely that the knee-joint will ever flex beyond 90°. There is no necessity to use supracondylar skeletal traction. Traction from the tibial tubercle is equally effective and is safe; the criticism that tibial traction causes stretching of the ligaments of the knee is unfounded, except in cases where excessive traction has been used.

3. *Recurrent Œdema of the Knee.*—If the knee is allowed to swell day by day the adhesions which are daily soaked in serofibrinous exudation steadily increase in density, and permanent stiffness may result.

4. *Early and Repeated Manipulation or Passive Stretching.*—The tearing of adhesions by over-vigorous methods produces fresh serofibrinous exudation and increases the adhesion formation. The joint should not be manipulated until all swelling and œdema have subsided, until the circulation is restored, and until steady recovery of movement by the patient's own exercise has ceased.

DISPLACED LOWER FEMORAL EPIPHYSIS

The epiphysis is usually displaced forwards in front of the lower end of the shaft, and tilted by the gastrocnemius muscle exactly as in supracondylar fractures. To reduce the displacement the knee-joint is flexed to a right angle, the head of the tibia is pulled away from the femur, and the epiphysis is pulled back to its normal position by traction on the leg. The limb is immobilized by an anterior plaster cast

with the knee flexed about 130°. Pressure on the popliteal vessels and nerves by tight bandage or plaster, or by acute flexion of the swollen knee, must be avoided. Immobilization is continued for six weeks, and movement of the knee-joint is then restored by the child's own active exercise.

RUPTURE OF THE EXTENSOR APPARATUS OF THE KNEE

Avulsion of the Quadriceps.—The radiograph shows no bone change, and for this reason the injury is sometimes overlooked. Loss of active extension against gravity with tenderness at the upper margin of the patella in elderly patients is sufficient to establish the diagnosis. It is usually possible to feel the gap between the muscle and the bone. If the quadriceps is not stitched back, ossification occurs in the hæmatoma between the retracted muscle and the patella, giving rise to the condition described as " myositis ossificans of the quadriceps ". The muscle should be firmly stitched with catgut mattress sutures. As a rule, no external splintage is necessary ; active flexion movements may begin at once and weight-bearing exercises are resumed in a few weeks. A full range of movement should be regained within four to six months.

Fracture of the Patella with Displacement.—When the patella is fractured by muscular action it must be recognized that the fracture is only a part of the rupture of the extensor tendon ; there is also a rupture of the quadriceps expansion on each side of the bone. The upper fragment is retracted by the quadriceps muscle, and the aponeurosis from the front of the patella falls inwards over the fractured surfaces. Unless operative treatment is carried out fibrous union results, and because there is a gap between the patellar fragments with lengthening of the quadriceps tendon, full active extension is permanently lost.

The skin must be carefully prepared for 48 hours. If there are skin abrasions which might be infected, operation should be deferred. At operation the fragments of the patella are sutured with catgut or stainless steel wire and the quadriceps expansion is repaired. A plaster cast is applied with the knee almost fully extended. Weight-bearing may be resumed within a few days. The plaster cast is removed after six or eight weeks. Flexion movement of the knee is regained by active exercises practised for a few minutes hourly throughout the day.

Excision of the Fractured Patella.—In comminuted fractures with serious damage to the articular surface the bone fragments should be excised before the quadriceps tendon is repaired. Active knee movements are begun within three or four weeks, and weight-bearing may be resumed within five or six weeks.

Avulsion of the Ligamentum Patellæ.—The ligament must be stitched back to the bone. Since the injury occurs in younger patients, there is no danger of permanent stiffness of the knee. It is therefore quite safe to immobilize the joint in extension by a plaster cast for eight weeks.

Avulsion of the Epiphysis of the Tibial Tubercle.—After minor injuries the degree of separation of the epiphysis is minimal and may not be obvious in the radiograph ; this is the condition known as Schlatter's disease. The knee should be immobilized in plaster in the position of full extension for eight weeks. When the displacement is more marked, the epiphysis must be replaced by manipulation or operation. The fragment is firmly pressed back to the tibia and the knee is immobilized in a closely fitting plaster cast for eight weeks.

Fracture of the Patella without Displacement.—Crack fractures may occur from a direct blow over the bone. The fracture may lie transversely, or

one of the angles of the patella may be separated by an oblique crack. This injury is quite different from the other type of patellar fracture ; in this case there is no rupture of the quadriceps expansion. Operative treatment is unnecessary. It may be advisable to immobilize the knee by a posterior plaster slab for a few weeks. After a more severe contusion the whole bone may be comminuted and crushed, and excision of the patella is often advisable.

DISLOCATION AND ALLIED INJURIES OF THE KNEE-JOINT

Traumatic Dislocation of the Knee.—The lateral and crucial ligaments are torn or severely stretched, and the head of the tibia is displaced backwards, forwards, or laterally. Manipulative reduction usually offers no difficulty. The joint must be immobilized in a plaster cast from the toes to the groin for not less than ten weeks. Ultimate recovery depends on the tone of the thigh muscles. Even if the ligaments remain lax, if muscle control is perfect there will be little or no disability. No trace of wasting of the muscles must be permitted, and from the first day after reduction quadriceps drill is practised for five minutes hourly. Weight-bearing may be resumed within a few days. After the plaster is removed it is inadvisable to use a knee cage because it encourages wasting of the quadriceps. Muscle redevelopment is still the most important treatment.

Rupture of the Internal Ligament of the Knee.—Minor sprains of the internal lateral ligament are treated by regular quadriceps drill, strapping of the joint until the effusion has subsided, and raising the inner border of the heel and sole of the shoe ¼ in. to prevent valgus strains of the knee. Standing or walking in bare feet or in uncorrected shoes is not permitted for at least six weeks. Recovery may be accelerated by injecting 5 to 10 c.c. of 1 per cent novocain into the tender part of the ligament.

When rupture of the ligament is complete and there is marked lateral instability of the knee, treatment should be carried out as for dislocation of the knee-joint.

Rupture of One or Both Crucial Ligaments.—This should also be treated as for dislocation of the knee-joint. Maintenance of normal volume and tone of the quadriceps muscles is imperative.

Fracture of the Tibial Spine.—A severe rotation strain of the knee through the tension of the anterior crucial ligament may avulse the tibial spine from the head of the tibia. The small fragment of bone is tilted forwards and outwards by the crucial ligament and external semilunar cartilage which remain attached to it. There is then a bony block to the terminal 20° of extension of the joint. The fragment must be replaced by open operation and the knee immobilized by a posterior plaster slab for six weeks. Quadriceps exercise is practised throughout, and weight-bearing is permitted after a few days.

FRACTURE OF THE TIBIAL TUBEROSITY

A severe abduction strain of the knee may not only rupture the internal lateral ligament, but also crush the outer tuberosity of the tibia. As a rule the tuberosity is split vertically by the impact of the outer margin of the external femoral condyle (*Fig.* 722). A lateral marginal fragment is displaced outwards, and the tuberosity itself is comminuted and depressed. The displacement must be reduced to correct the knock-knee deformity and to restore the smoothest possible articular surface. While strong traction is applied in the long axis of the limb, the tibial tuberosities are laterally compressed either manually or by a compression clamp. The knee is held in as much varus as possible,

and a closely fitting plaster cast is applied from the toes to the groin. The ligamentous rupture is no less important than the bone injury. Regular quadriceps exercise must be instituted at once, and the immobilization continued for not less than ten weeks. Usually a new cast is necessary in four to six weeks, after the swelling has subsided, before weight-bearing is resumed. The inner border of the heel and sole of the shoe is raised ¼ in., and the patient is not allowed to stand or walk except in the corrected shoe for several months. Development of the quadriceps muscle must continue throughout every stage of the treatment.

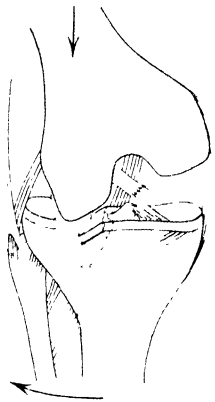


Fig. 722.—Comminuted fracture of the external tuberosity of the tibia due to severe valgus strain. The crucial and internal lateral ligaments are ruptured.

FRACTURES OF THE SHAFTS OF THE LEG BONES

Fractures without Overriding.—Greenstick and subperiosteal crack fractures of the shafts of the tibia and fibula occur fairly commonly in children. Similar fractures may occur in adults where there is no serious loss of apposition but merely slight angulation of the fragments. A plaster cast is applied with the limb hanging over the end of a table in the line of gravity. Angulation and rotatory displacement are corrected. When

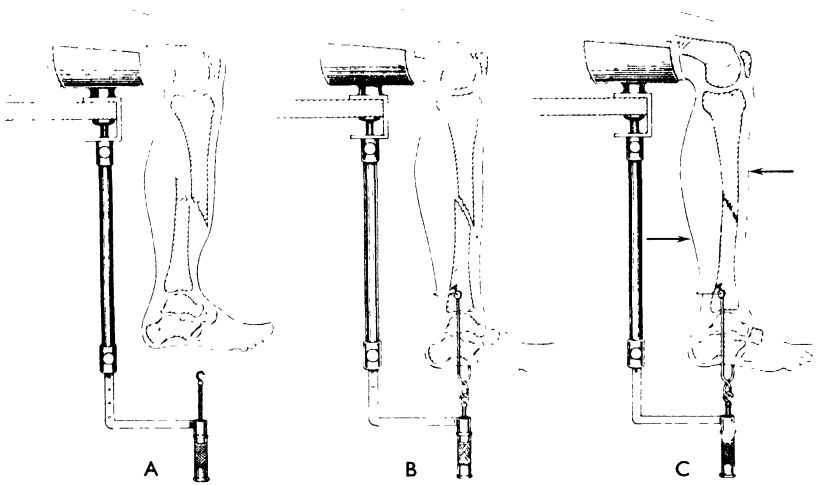


Fig. 723.—Watson-Jones tibial traction apparatus. A, Before reduction. B, After applying traction. C, Traction and antero-posterior pressure combined.

the plaster from the toes to the tubercle of the tibia is hard, the knee is almost fully extended and the cast is continued to the groin.

Fractures with Overriding.—When the fractures are complete and the fragments are disengaged, simple manual reduction is more difficult. Some form

of tibial traction apparatus should be used (*Fig.* 723). A pin is driven through the tibia about 1 in. above the ankle-joint, a stirrup is fitted to the pin, and screw traction employed until full length is restored and the fragments are in apposition. The position is checked by radiographs taken with a portable apparatus, and a cast is applied from the toes to the knee (*Fig.* 724). When it is hard, the plaster is extended to the groin with the knee slightly flexed. Care must be taken that rotation displacement is completely corrected, so that the toes and patella point in the same direction.

Wedging the Plaster.—Radiographs must be taken through the plaster, and if there is the slightest angulation of the fragments this is corrected by wedging.

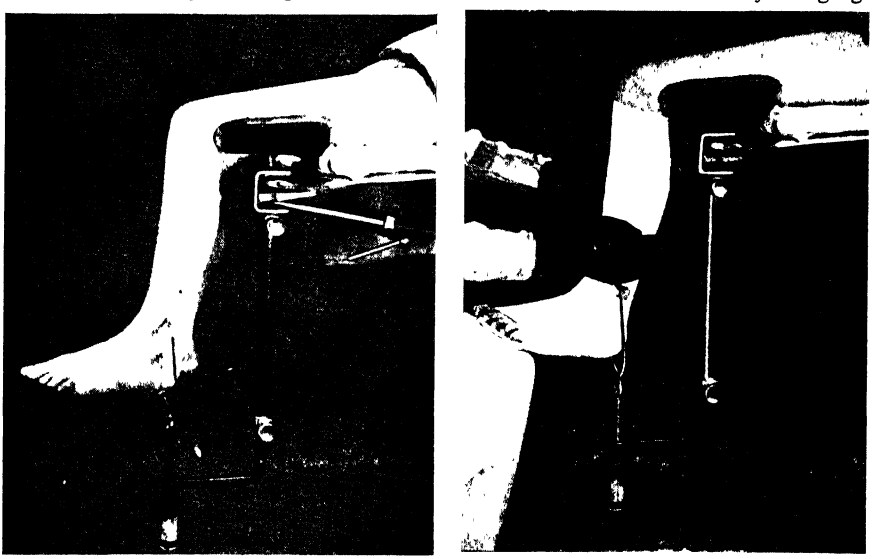


Fig. 724.—Application of plaster for fractures of the shafts of the leg bones.

A linear cut is made round two-thirds of the plaster at the level of the fracture on the concave side of the angle. A very short gas anæsthetic may be given; the linear division is opened to a wedge and a small block of wood placed between the two cut edges (*Fig.* 725). The block of wood must be exactly opposite the angle—in front of the leg for backward angulation, on the inner side for outward angulation, half-way between the two for combined backward and outward angulation, and so on. Another radiograph is taken and the degree of correction may be increased or decreased by inserting larger or smaller blocks of wood. When the alinement is quite perfect the gap in the plaster is filled and reinforced. The wedging method allows absolute control and accurate correction of minor degrees of angulation. Caution is necessary when more severe angulation is corrected. Gross wedging may so increase the pressure of the plaster on the limb, even a considerable distance above and below the level of the wedge, that pressure sores may develop unless this possibility is borne in mind and discomfort relieved by cutting windows.

AFTER-TREATMENT.—If the toes are swollen the limb is kept elevated. Regular toe exercises, especially flexion at the metatarso-phalangeal joints, must be

practised to prevent rigid hyperextension contracture and rigid transverse flat-foot. If the limb was already swollen when the plaster was applied, a new cast is necessary three weeks later. In all cases check radiographs should be taken three weeks and six weeks after reduction, because there is frequently a tendency to redisplacement within the plaster.

After ten weeks the union may be tested clinically. If there is tenderness over the fracture, and elasticity or pain when the fracture is strained, a new cast is applied, again from the toes to the groin. As a rule, at this stage weight-bearing is safe. A pad of Sorbo rubber is fixed to the heel and the foot of the plaster is covered with a cloth boot or galosh. Union is tested at four-weekly

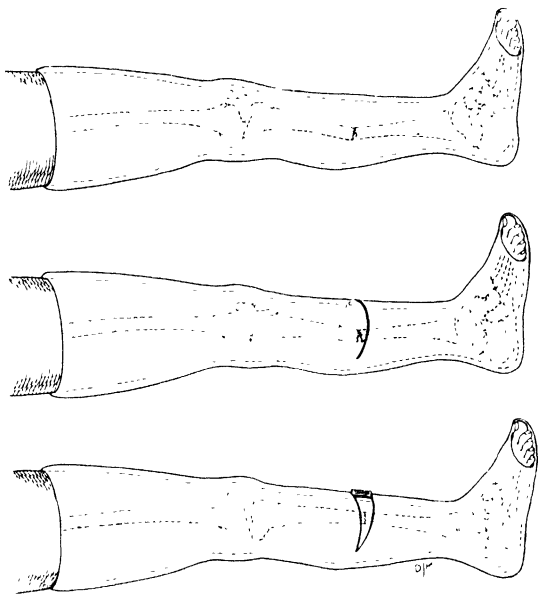


Fig. 725.—Angulation of fragments corrected by wedging the plaster.

intervals and immobilization is continued by walking plasters until union is firm. Occasionally it is necessary to continue immobilization for several months.

When the plaster is removed, a Viscopaste or Unna's paste dressing is at once applied to prevent recurring œdema. Active exercises are practised for the knee- and ankle-joints. Very rarely a gentle manipulation of the ankle is necessary to relieve adhesion formation.

Oblique Fractures with Overriding.—When the line of fracture is oblique or spiral, the fragments are relatively unstable, and there may be a tendency to redisplacement. In such cases continuous skeletal traction may be advisable for the first five or six weeks. The fracture is reduced by the tibia traction apparatus and plaster is applied from the toes to the lower thigh. The traction pin is not withdrawn, but is incorporated in the plaster, and a stirrup is attached; the limb is supported in a Braun's splint, and about 5 lb. weight extension is maintained (*Fig.* 726). *The greatest care must be taken to avoid excessive traction.* Distraction of the fragments even for a few days usually delays union for many months.

When it is intended to leave the traction pin in the bone for several weeks, it should be driven through the lower shaft of the tibia 1 in. above the ankle-joint, and not through the os calcis. If a traction pin is left in the os calcis the sero-fibrinous exudation which will probably develop along the pin track binds down

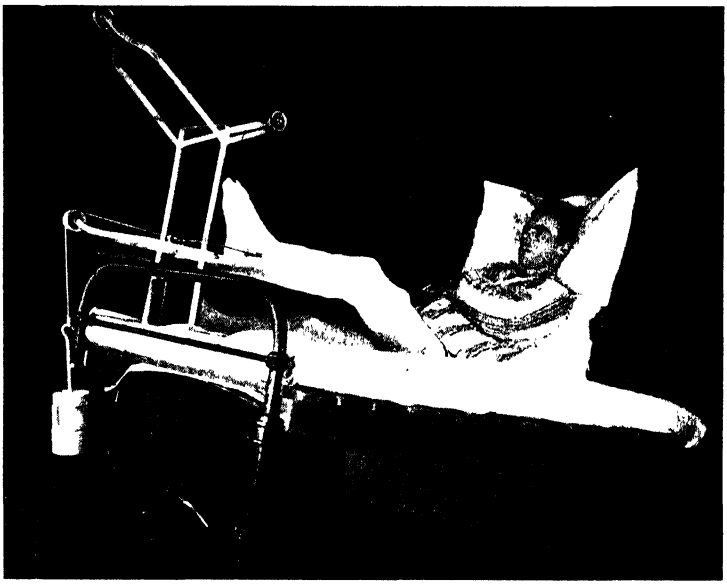


Fig. 726.—Skeletal traction for overriding fractures of leg bones. Since the traction must be continued for several weeks, the pin is driven through the shaft of the tibia and not through the os calcis. Distraction of the fragments due to overpull must be rigidly avoided

the subastragaloid synovial and capsular reflections, and may cause permanent stiffness of this joint. After six weeks, when the fracture is beginning to unite, a new unpadded plaster is applied, the traction pin is withdrawn, and treatment is continued as for horizontal fractures.

SPRAINS OF THE ANKLE AND DISLOCATION OF THE ANKLE-JOINT

The layman believes that it is worse to sprain an ankle than to fracture it. If all ankle sprains are treated by simple strapping and early weight-bearing this is true, for a certain proportion of ankle 'sprains' which show no bone injury in ordinary radiographs are actually dislocations of the joint. Two types of injury to the external lateral ligament of the ankle must be distinguished.

A simple sprain is a tearing of a few fibres of the ligament by inversion strain. There is swelling, œdema, and ecchymosis below the external malleolus, pain on inversion movement, but no instability of the joint. This is a relatively minor injury, and if adhesion formation is prevented recovery should be complete within a few weeks. On the other hand the anterior and middle bands of the external lateral ligament may be completely ruptured. The swelling, œdema, and ecchymosis below the external malleolus are still more severe, and the ligamentous injury is then so complete that on inversion movement of the foot the

astragalus tilts within the joint, and there is obviously excessive mobility. Ordinary antero-posterior and lateral radiographs show no abnormality, but radiographs taken with the foot in maximum inversion show that the astragalus* is subluxated, or even dislocated from within the tibio-fibular mortice. Unless the joint is completely immobilized in plaster, for at least ten weeks, recurrent dislocation is inevitable. When the patient walks over rough, irregular surfaces, and the foot is suddenly inverted, there is no ligamentous protection, the astragalus again dislocates, the ankle gives way, and the patient may even fall to the ground.

Sprain of the External Ligament of the Ankle.—If the ankle is already swollen, the limb is firmly bandaged over wool and elevated until the swelling has subsided. The foot and lower leg are then strapped with Elastoplast or brown holland strapping, applied from the inner side of the sole of the foot, across the outer side of the joint on to the leg, so that the ankle tends to be everted. Non-weight-bearing exercises are practised at once, but only within the limit of pain. After a few days weight-bearing should be resumed. The strapping is retained for at least two to three weeks. If there is still swelling or œdema, an elastic anklet must be worn. Recurrent œdema aggravates the tendency to adhesion formation, and must be prevented by elastic support and active exercise.

If after two or three months there is still pain below the external malleolus on plantar flexion and inversion movement, and the radiograph shows no evidence of subluxation or dislocation of the astragalus on inversion, it is evident that adhesions have formed. The joint should be manipulated under anæsthesia, and the patient must practise regular active exercise until recovery is complete.

Complete Rupture of the External Ligament of the Ankle (Dislocation of the Ankle-joint).—A plaster cast must be applied from the toes to just below the knee, with the heel slightly everted. No anæsthetic is necessary. If there is already severe swelling, a new plaster is necessary in two to three weeks. Weight-bearing in the plaster may be resumed at once. The plaster is retained for ten weeks, and if clinical examination shows normal stability of the joint, weight-bearing is then permitted with a Viscopaste dressing which is worn until the tendency to œdema has subsided. If there is still instability of the ankle, shown by rocking of the astragalus on inversion movement, or by subluxation of the bone shown in radiographs taken in maximum inversion, an outside crooked elongated heel should be worn for several months, or even if necessary an inside iron and outside T-strap.

If, through failure to recognize this condition, or through inadequate treatment, recurrent dislocation is allowed to occur, new ligaments must be constructed from free fascial grafts or from the peroneus brevis tendon.

FRACTURES AND FRACTURE-DISLOCATIONS OF THE ANKLE

Varieties.—Four types of malleolar fracture must be distinguished: (1) External rotation fractures; (2) Abduction fractures; (3) Adduction fractures; and (4) Fractures due to vertical compression.

1. In the first type of injury the foot is externally rotated in relation to the leg. External rotation injuries produce spiral fractures of the external malleolus at the level of the tibio-fibular joint. There are three degrees of displacement (*Fig.* 727). Relatively minor force results in a subperiosteal fracture of the external malleolus without displacement. If the injury is more severe, the

* Astragalus = talus.

internal lateral ligament or a fragment of the internal malleolus is avulsed from the tibia, and there is outward displacement of the astragalus and foot. In the third degree there is not only fracture of both malleoli with outward

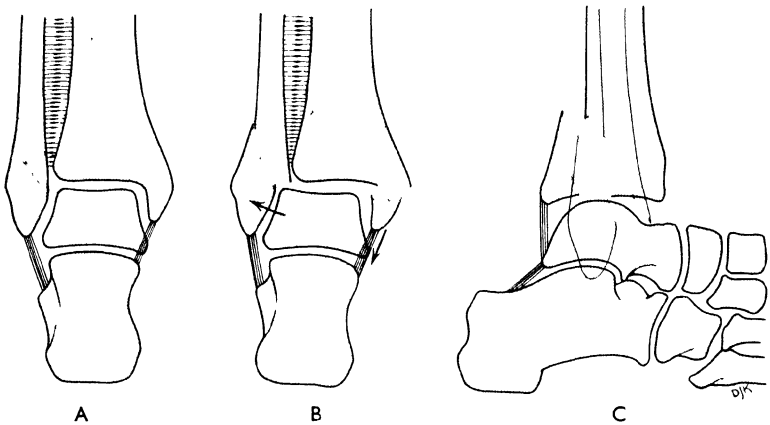


Fig. 727.—External rotation fractures of the ankle. A, 1st degree—Fracture of the external malleolus without displacement B, 2nd degree—Bimalleolar fracture with outward dislocation C, 3rd degree—Trimalleolar fracture, with outward and backward dislocation.

dislocation, but also fracture of the posterior margin of the tibia with backward dislocation.

2. Abduction injuries cause transverse fractures at any level in the lower two-thirds of the fibula. There are again three degrees of displacement: (1)

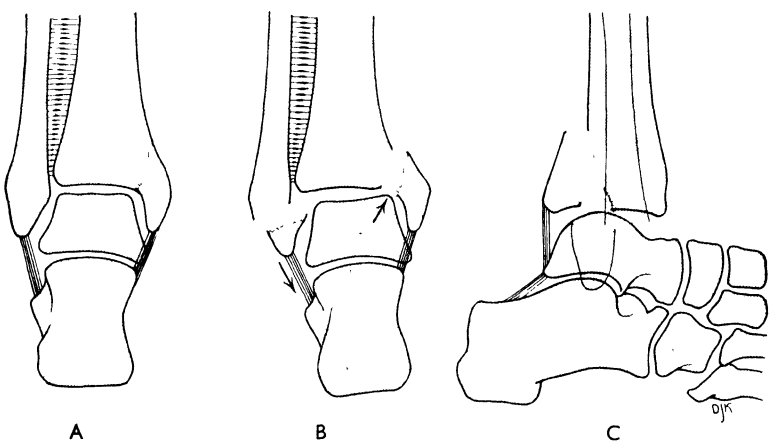


Fig. 728.—Adduction fractures of the ankle. A, 1st degree—Fracture of the internal malleolus without displacement. B, 2nd degree—Bimalleolar fracture with inward dislocation. C, 3rd degree —Trimalleolar fracture with inward and backward dislocation.

Fractures of the external malleolus with no displacement; (2) Bimalleolar fractures with outward dislocation; (3) Trimalleolar fractures with outward and backward dislocation. The only difference between these injuries and

external rotation fracture-dislocations is that the inferior tibio-fibular ligament is often torn so that special care must be taken that there is no redisplacement within the plaster. A new plaster cast must be applied after two or three weeks and immobilization should be continued even longer than the usual period of ten weeks.

3. Adduction fractures are due to forcible inversion of the foot, which drives the astragalus against the internal malleolus. There are again three degrees of displacement (*Fig.* 728). The least serious injury is the subperiosteal fracture of the internal malleolus without displacement. This fracture is easily distinguished radiographically from avulsion injury of the internal malleolus due to abduction. The abduction injury avulses a relatively small flake. The adduction injury compresses the malleolus at its base, and the line of fracture runs almost vertically upwards from the inner angle of the ankle-joint. If the injury is more severe, the external lateral ligament, or a fragment from the external malleolus, is avulsed and the foot is dislocated inwards. Still more gross violence causes fracture of both malleoli, and of the posterior margin of the lower end of the tibia, with inward and backward dislocation of the foot.

4. The fourth type is usually due to a fall from a height, so that the foot is driven forwards and upwards. There is an anterior marginal fracture of the tibia and forward dislocation of the ankle-joint (*Fig.* 729). Sometimes the lower end of the tibia and both malleoli are extensively comminuted.

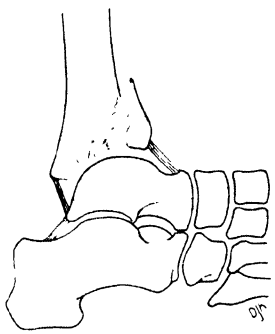


Fig. 729.—Anterior marginal fracture of the ankle with forward dislocation.

Fracture of the External Malleolus without Displacement.—There is tenderness, œdema, and slight ecchymosis over the external malleolus, and the radiographs show a subperiosteal crack fracture without displacement. Some surgeons treat these cases by the simple protection of strapping, but it is better to apply a walking plaster for a few weeks, and then to use ichthopaste dressing to control œdema.

Fracture of the Internal Malleolus without Displacement.—A walking plaster is applied for a few weeks, followed by an elastic dressing to control œdema.

Bimalleolar Fracture with Outward Dislocation.—In this injury there is an actual or potential outward dislocation of the foot. Even if there is no evidence of outward dislocation in the initial radiograph, if further radiographs taken in maximum eversion show that the astragalus displaces outwards, plaster immobilization for not less than ten weeks is essential. With the limb hanging over the end of a table, an unpadded plaster cast is applied from the toes to just below the knee, with the foot at right angles to the leg, and neutral to inversion and eversion (*Fig.* 730, A). Whilst the plaster is hardening, the surgeon supports the forefoot with his knee to keep it at right angles to the leg, and he uses both hands to push the astragalus inwards as far as possible towards the internal malleolus. In the case of a fracture of the left ankle, his left hand is placed over the lower shin, and his right hand over the outer side of the ankle and heel (*Fig.* 730, B). Firm steady inward pressure is applied over the malleolus itself; it is usually quite impossible to over-reduce. No

attempt should be made to maintain the position by twisting the foot inwards, adducting the forefoot, and inverting the heel; all the force will be expended on the tarsal joints.

Trimalleolar Fracture with Outward and Backward Dislocation.—This is again reduced by direct pressure over the malleoli and heel, and not indirectly by twisting the forefoot. The limb hangs over the end of the table so that the knee is flexed and the calf muscles relaxed. For a fracture-dislocation of the right ankle the surgeon places his right hand over the front inner aspect of the lower shin, and his left hand over the outer aspect of the ankle, with his fingers curved round the back of the heel. The foot is pulled strongly forwards and pressed strongly inwards. An assistant steadies the foot by holding the toes while the plaster cast is applied. This must be done as quickly as possible, and before the plaster has begun to harden the surgeon again takes the same grip and holds it strongly and firmly until the plaster has set. When there is a posterior



Fig. 730.—Reduction and plaster fixation of abduction fracture-dislocation of the ankle A, Application of the plaster. B, While the plaster is hardening, the forefoot is supported by the surgeon's knee and the astragalus is pushed strongly inwards. C, The transverse arch must be moulded up and the metatarso-phalangeal joints flexed. Note the sorbo heel in position before the final turns of plaster are applied.

marginal fracture of the tibia, reduction is often unstable, and backward dislocation may recur while the plaster is hardening. It is usually impossible to over-reduce, however strong the pressure which is applied.

Accuracy of reduction must be confirmed radiographically. If the astragalus is even slightly tilted or displaced outwards, or there is the least trace of backward displacement, the plaster must be removed and a new cast applied. Reduction and immobilization should be carried out as soon as possible after injury. If the limb is already swollen, a new unpadded plaster is necessary in two to three weeks.

AFTER-TREATMENT.—Immobilization for at least ten weeks is essential. If the plaster is removed earlier, displacement will recur. Check radiographs are taken during the third and sixth weeks. With a Sorbo rubber heel and a plaster boot the patient is encouraged to walk. If the limb was already swollen at the time of reduction, weight-bearing must be deferred until the new cast is applied after two to three weeks. During the last six weeks the patient should

walk about five miles a day. After ten weeks the plaster is removed and radiographs are taken in the oblique axis to determine the degree of union of the external malleolus. If the patient is heavy and the firmness of union is doubtful, plaster immobilization should be continued for a few weeks longer. This is preferable to the use of an inside crooked heel, or outside iron and inside T-strap.

As soon as the plaster is removed a zinc-gelatine dressing is applied to prevent œdema. Protection is usually necessary for six weeks. If there is still a tendency to recurring œdema, an elastic stocking is worn. Exercises are practised to regain full movements of the ankle and tarsal joints. Manipulation for adhesions is rarely necessary.

Adduction Fractures and Fracture-dislocations.—The principles of treatment are exactly the same as in abduction fractures and fracture-dislocations. Fractures with actual or potential inward dislocation, or with inward and backward dislocation, must be immobilized in plaster for ten weeks. The astragalus is replaced by strong outward pressure applied over the internal malleolus and inner side of the heel. Imperfect reduction is often seen, surgeons are so often impressed by the fallacy that because the everted position of the foot is a position of weakness, the inverted position must be one of strength, that they hesitate to push the heel outwards strongly enough. If the astragalus is allowed to remain tilted either outwards or inwards, there will be persistent pain and ultimately arthritis of the joint. The only position of strength is the normal position, and this is attained in adduction fractures only by very strong outward pressure on the heel (*Fig.* 731). It is practically impossible to over-reduce.



Fig. 731.—Reduction of an adduction fracture-dislocation of the ankle. While the plaster hardens, the astragalus is pushed strongly outwards.

Anterior Marginal Fractures with Forward Dislocation.—A large fragment is broken off the front of the lower end of the tibia, and displaced with the astragalus and other tarsal bones forwards and upwards The more the foot is dorsiflexed the more it dislocates forwards. It must be reduced by pushing the tarsus backwards and downwards, and immobilized in plaster with the foot in moderate plantar flexion. Reduction is often unstable and it is necessary to use operative reduction and internal fixation. Occasionally the joint is so severely damaged that early arthrodesis is advisable.

DISPLACED LOWER EPIPHYSIS OF THE TIBIA

Abduction strains of the ankle-joint in children may cause outward displacement of the lower tibial epiphysis. Reduction, immobilization in plaster, and after-treatment are carried out as for abduction fractures in adults. Adduction fractures may also occur, and these are more serious because the inner half of the lower tibial epiphysis is crushed and its growth is therefore arrested. The outer half of the epiphysis and the lower fibular epiphysis continue to grow and gradually force the foot into the inverted position. The deformity must be corrected by osteotomy, or prevented by operative fusion of the undamaged part of the epiphysial lines.

FRACTURES OF THE ASTRAGALUS (TALUS)

Fracture of the Neck of the Astragalus is of importance because the true nature of the injury is so often overlooked. Unless radiographs are examined with great care the injury appears to be a simple fracture without displacement, whereas in fact there is almost invariably a dislocation of the posterior half of the subastragaloid joint, and unless this is corrected, painful stiffness of the foot persists as a serious permanent disability. The clue to the displacement lies in the fact that when the body of the astragalus is separated by fracture from the other tarsal bones, it always tilts into the plantar-flexed (equinus) position. If the foot is not held in a similar degree of equinus, but is immobilized in the usual right-angled position, there is no normal apposition between the body of the astragalus and the head of the bone in front, nor the os calcis beneath. The foot must be fully plantar-flexed and, as a rule, everted; it must be immobilized in plaster in this position for six or eight weeks. After that time, when the fracture is uniting, a new walking plaster is applied in as much dorsiflexion as can be secured without straining the site of fracture. Two or three weeks later a third plaster is applied with the foot in the right-angled position. This is discarded after several weeks.

Fracture of the Astragalus with Dislocation of the Body is a surgical emergency. The body is dislocated backwards and lies under tightly stretched skin behind the internal malleolus. If it is not reduced promptly the skin sloughs. Every effort should be made to reduce the dislocation by manipulation, but operative reduction is sometimes necessary. Excision of the body of the astragalus and total astragalectomy are to be avoided.

FRACTURES OF THE OS CALCIS (CALCANEUS)

The weight of a patient falling from a height on to his heels frequently crushes one os calcis or both. The bone is spread laterally, so that the heel feels unduly broadened. The subastragaloid joint is usually involved, causing pain and limitation of inversion or eversion movement of the heel. The back of the os calcis is displaced upwards. If this remains uncorrected, the power of the calf muscles is reduced by the relaxation of the tendo Achillis.

Accurate reduction is possible only by skeletal traction from a pin driven through the back of the os calcis. An ordinary tibia traction apparatus may be used (*see Fig.* 723). The lateral spreading must be reduced by strong compression between the surgeon's two hands, or by a Thomas's wrench or special clamp (Böhler's compression clamp). A cast is applied, the plaster is well moulded on each side of the os calcis. If the articular surfaces are seriously fragmented and comminuted, early arthrodesis of the subastragaloid and mid-tarsal joints is advisable.

FRACTURES OF THE METATARSALS

The shafts of the metatarsals may be fractured by a direct crushing injury, or indirectly by twisting strains sometimes sustained almost spontaneously after strenuous marching. The base of the 5th metatarsal may be fractured by the pull of the peroneus brevis tendon during a sudden inversion strain of the foot. If these fractures are not immobilized in plaster, union is delayed, callus may be excessive, and the disability period is prolonged. An unpadded plaster cast in which the patient may walk at once should be retained for six weeks. Recurrent œdema is prevented by the subsequent use of a zinc-gelatine bandage.

Marked displacement of the fragments should be corrected by manipulation. This is particularly important in fractures of the necks of the metatarsals, where imperfect reduction always causes permanent disability. It may be necessary to use traction by means of a pin or wire through the pulp of the toes attached to a ' banjo splint ', which is incorporated in the plaster. The traction is continued for three weeks.

FRACTURES OF THE TOES

The most common injury to the toes is a comminuted fracture of the terminal phalanx of the great toe due to crushing by a weight. Serious displacement of the fragments is rare, but there is extreme swelling and ecchymosis. The disability period may be greatly reduced by trephining the toe-nail and evacuating the subungual hæmatoma (*see* p. 312). Otherwise, the nail becomes loose and ultimately comes off. The toe should be protected for a week or two by means of a collodion gauze dressing. A heavily soled boot is the best splint. If necessary, the toe-cap may be cut out, and it is sometimes advisable to fit a metatarsal bar in order to avoid weight-bearing through the great toe.

Fracture of the great toe is one of the most common of industrial injuries, and it is unfortunate that a protective boot, with metal reinforcement of the toe-cap, has not been more generally introduced as a preventive measure.

CHAPTER LXXII

THE TREATMENT OF TUBERCULOUS JOINTS

By F. P. FITZGERALD

A TUBERCULOUS joint is a local manifestation of a systemic infection, and general treatment is consequently of great importance. This consists of rest, good food, fresh air, and sunlight.

THE HIP

The surgeon's aim is to relieve pain, arrest inflammation, control bone destruction, and prevent deformity. If these ends are to be achieved, the joint must be kept at rest with the limb in extension. Muscle spasm round the hip-joint is the chief agent which keeps up irritation and causes deformity. It can be controlled by traction.

The Application of a Strapping Extension.—

Materials (*Fig.* 732).—

1. A strip of strapping or flexible adhesive plaster is cut to the required length. This length is obtained by measuring the limb from the perineum along the inner



Fig. 732.—Extension equipment. 1, Knock-knee splint, for outer side of knee; 2, Back knee-pad, to prevent genu recurvatum; 3, Six-inch linen bandage; 4, Liston splint, to prevent pelvic tilt; 5, Weight hanger and weights; 6, Cord; 7, Extension spreader.

aspect of the leg to 4 in. below the heel, and up the outer aspect of the limb to the greater trochanter.

2. A wooden spreader, 3 in. by 3 in., perforated in the centre for the extension cord, or a wooden shoe to which the strapping and extension cord are fixed and which prevents rotation.

3. Extension cord.

4. Weights, 3 to 8 lb., depending upon the weight of the patient and the amount of muscular spasm.

5. A pulley, the position of which can be altered in either the vertical or horizontal plane.

6. A Liston's long splint, which can be fixed to the end of the bed.

7. Blocks to elevate the foot of the bed.

8. A knee-pad with tapes.

9. An aluminium or wooden gutter splint, reaching from mid-thigh to mid-calf, for the lateral aspect of the limb.

10. A heel-rest, two pieces of adhesive felt, and gauze bandages.

11. A right-angled back splint with transverse cross-piece to prevent rotation.

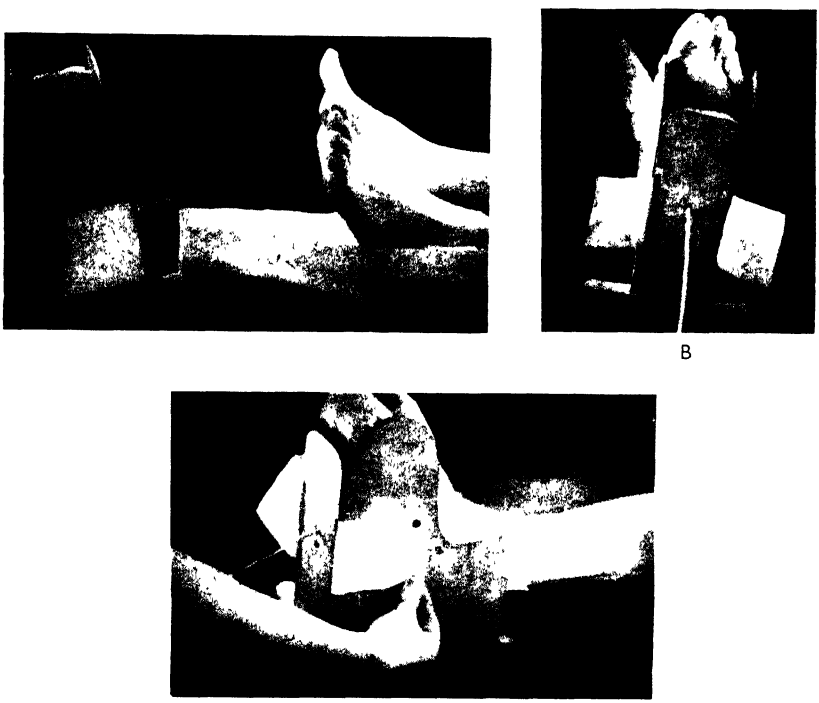
Method.—The extension is applied along the inner and outer aspects of the limb. The strapping is freed from creases by nicking the edges obliquely

(*Fig.* 733), the small pieces of felt are placed over each malleolus, and the strapping attached to the wooden shoe with drawing pins (*Fig.* 734, A, B, C). The



Fig. 733.—Application of strapping to leg. Note, the upper end is divided into three strips. The edges are nicked to enable the plaster to adhere evenly.

knee-pad, which prevents hyperextension and consequent stretching of the ligaments, is tied in position behind the knee. The gutter splint, used to avoid genu valgum, is bandaged firmly into position along the outer aspect of the limb. The right-angled back splint is fixed along the leg and foot. The Liston splint



B

C

Fig. 734.—A, Extension spreader showing cord holes and strapping slits. B, The cord is in place. The strapping has been passed through the slits. C, The strapping is being fixed to the wooden sides with drawing pins.

is laid along the sound side of the patient. It is held in position above by a many-tailed bandage, and below by a flannel bandage. Straps may be used instead. The splint is attached to the foot of the bed and prevents tilting of the pelvis (*Fig.* 735). The cord is passed through the hole in the spreader or wooden

shoe and knotted several times on the proximal side. After twenty-four hours the weights, on a special weight hanger, are attached and the foot of the bed elevated on blocks (*Fig.* 736).

The Line of Pull.—When the extension has been applied and the end of the bed elevated by means of the blocks, the line of pull must be regulated. If the hip is in a position of deformity, the pull must, at first, be in the line of this deformity—that is, if the hip is flexed and adducted, the pulley must be raised and moved nearer to the middle of the foot of the bed. Steady traction in this plane will



Fig. 735.—The knock-knee splint is fixed along the outer side of the knee. The Liston splint is held by the body belt

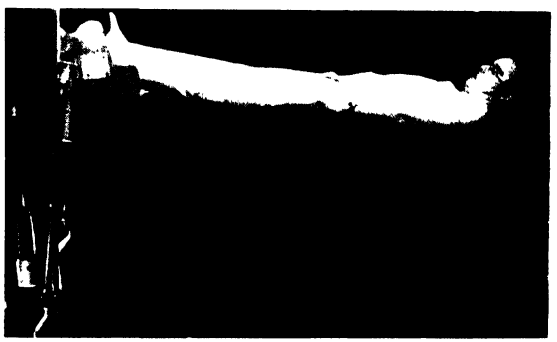


Fig. 736.—The complete extension in place. Note the bed is raised on blocks to provide a counterpoise to the weight

overcome the muscular spasm. Gradually the line of pull can be altered until the desired position is obtained, with 10° abduction, a few degrees of flexion, and without rotation.

Abduction Frames.—In the majority of cases the above method of immobilization is satisfactory. Some patients, however, complain of severe shooting pains in the hip, especially at night. Others are so unruly that something further is necessary to keep them quiet. In these cases, the patient should be nursed on a Jones's double abduction frame (*Fig.* 737). In fixing a child to

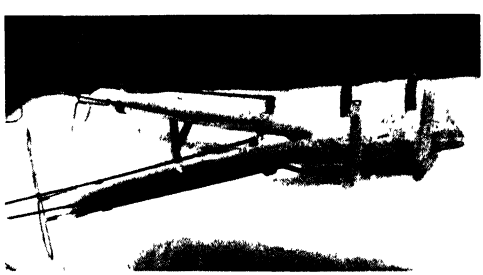


Fig. 737.—Jones's double abduction splint for use in preventing 'night cries' or wherever extra fixation is indicated

such a frame, extensions are applied to both lower limbs and are fixed to the ends of the frame.

When ordering a frame, the following measurements are necessary :—
1. Circumference at nipple line.
2. Distance from nipple line to greater trochanter.
3. Distance from greater trochanter to lateral malleolus.
4. Circumference at umbilicus.
5. Distance between the anterior superior iliac spines.

Stages of Treatment.—

Active Stage.—Adequate immobilization, with proper general treatment, is all that is necessary unless complications occur. This stage lasts for not less than two years.

Special care : During this period it is necessary to reapply the extension when it slips ; to watch carefully for pressure sores, especially at the malleoli and the heel ; and to examine the child at weekly intervals for the development of an abscess If an abscess develops it is aspirated under aseptic conditions, the needle being inserted through healthy tissue. The pus is sent for examination —direct film, guinea-pig inoculation or culture on special egg medium. It is a mistake to inject any antiseptic into the abscess cavity after the aspiration. The



Fig. 738.—Sidden's operating plaster spica

blood-sedimentation rate is estimated regularly. Serial radiographs are taken at three-monthly intervals. The active stage is complete when : (*a*) There is no muscular spasm produced by passive movement ; (*b*) The last four radiographs show no further bone destruction ; and the fluffy appearance has given place to the clear outline again ; (*c*) The sedimentation rate is normal.

Quiescent Stage.—The disease is now quiescent locally and generally, but as the child has been in bed for a long time, the condition of the heart and muscles is below normal. This stage consists of getting the child up in a short, walking plaster spica (*see Fig.* 652) for three months. The plaster splint prevents the development of deformity, guards the hip from sudden strain, allows the head of the femur to be forced into the acetabulum, and encourages free movements at the knee-joint.

Operative Stage.—In this stage the child is put into an operating plaster spica (*Fig.* 738), and an extra-articular arthrodesis of the hip performed. The child is kept in bed in this cast for four months. Any residual deformity can be corrected later by a subtrochanteric osteotomy.

Convalescent Stage.—The patient is allowed up in a short walking spica, which is worn for from six to twelve months, or until the fusion of the joint is beyond doubt. When this plaster has been removed no splint of any kind is used, for the disease is arrested.

End-results of this Treatment.—These are extremely good. There is no chance of the deformity recurring, the disability is surprisingly small, and the patients are able to walk with scarcely a limp. Recrudescence is most unlikely as the fibrous ankylosis has been converted into bony ankylosis. If the joint is not arthrodesed, and, instead, a hip-splint is fitted at the end of the quiescent stage, deformity is almost certain to occur.

THE KNEE

Treatment in Children.—

Active Stage.—The knee is treated by extension in a Thomas splint until the disease is quiescent. *Method*: Strapping is applied to the leg as above and



Fig. 739.—The strapping tapers towards the malleoli and is fixed to a simple wooden spreader by narrow webbing and a buckle.

fixed by tape and buckle to a spreader. An extension cord is attached to the spreader (*Fig.* 739). The limb is then passed through the ring of the Thomas splint. Limb and splint are bandaged together (*Fig.* 740). The exact duration of the extension depends on the appearances of serial radiographs. Abscess formation and pressure sores should be watched for and treated.

Quiescent Stage.—A walking calliper is worn until the age of sixteen. This prevents deformity and does not hinder growth.



Fig. 740.—Tuberculous knee treated by extension in a Thomas splint, showing method of supporting the splint and keeping the heel off the bed. Note the 'Spanish turn' rod between the extension cords to increase traction

Operative Stage.—The knee is arthrodesed by excision of the joint surfaces. It is immobilized in a few degrees of flexion by a long plaster spica (p. 495).

Convalescent Stage.—A skin-tight walking plaster is applied from groin to toes, and weight-bearing is encouraged. Bony union may take six months or longer, and is determined clinically and radiologically.

Treatment in Adults.—Mild early cases and late cases with much bone destruction and sinus formation are treated by arthrodesis as above. When the local condition is acute, with marked swelling, conservative treatment in a Thomas splint is employed until the reaction subsides. Operative measures are then indicated. Amputation is rarely necessary.

THE ANKLE AND FOOT

In children the condition is best treated by immobilization in plaster until serial radiographs show no further bone destruction. If abscess formation is suspected, a window is cut for observation. Then a moulded leather stocking with steel struts is worn for two years. In adults amputation is indicated.

THE SHOULDER

Treatment in Children.—

Active Stage.—The joint is immobilized in a plaster spica (*see Fig.* 643). It is fixed at 30° in front of the coronal plane and abducted to 90° until the disease is quiescent.

Quiescent Stage.—Fixation is discarded. No attempt is made to prevent adduction.

Operative Stage.—At the age of sixteen years the joint is arthrodesed. It is fixed in a plaster spica as in the active stage until bony union occurs.

Treatment in Adults.—Acute cases are treated conservatively until quiescent. Otherwise the joint is arthrodesed in 45° of abduction.

THE ELBOW AND WRIST

When the elbow or wrist is involved, the treatment consists of immobilization in plaster until radiographs show no further destruction of bone. The elbow is fixed above or below a right angle depending on the patient's occupation. The wrist should be in slight dorsiflexion, the forearm being in the mid position in both cases. A moulded leather splint reinforced with steel is worn in either case for two years after the plaster has been removed.

The Elbow.—In children, the limb is immobilized in plaster extending from the axilla to the palm. The elbow is fixed at 90° and the forearm in the neutral position. When the disease is quiescent, a moulded leather splint from the axilla to above the wrist is worn.

In adults, similar treatment is usually necessary, but in selected cases the joint may be excised.

The Wrist.—The joint is fixed in plaster in slight dorsiflexion and ulnar deviation until quiescent. A moulded leather splint reinforced with steel is then supplied. In selected cases the wrist may be arthrodesed by a bone-graft. When multiple sinuses are present amputation is indicated.

THE SPINE

Stages of Treatment.—

Active Stage.—The initial treatment of a tuberculous spine depends on the age of the patient. If an adult, he should be treated in a plaster bed (*see Fig.* 667) until the disease is quiescent. If a child, an angulated Bradford frame should be used until the disease is quiescent, usually at the end of two years.

The Bradford frame (*Fig.* 741): This is a rectangular splint made from gas-piping, with a split canvas 'mattress' stretched between the sides. The division in the canvas is for nursing purposes.

Measuring the frame: It is important that the frame should be measured accurately, as otherwise sagging will occur. The length of the frame is equivalent to the height of the patient with 12 in. added to this measurement. The width is the distance between the axillæ. The frame is angulated at the level of the lesion, so that the maximum convexity is in contact with the apex of the kyphosis. The angulation is 10° at first. This is increased at monthly intervals up to 30°, so that the spine is hyperextended.

Special care: Radiographs are taken at three-monthly intervals. The blood-sedimentation rate is estimated regularly. Attention is paid to pressure points. It is most important to examine for the development of a psoas abscess; this is done by weekly *deep palpation* in the lateral part of the iliac fossæ. A psoas abscess should not be allowed to 'point'. It is aspirated, while still deep, with



Fig. 741.—Position of patient on Bradford frame. The angle of the patient is at the level of the lesion. The angulation can be moved gradually.

a trocar and cannula, the latter being adapted for a syringe. *Technique* (*Fig.* 742): The skin is drawn inwards towards the middle line with the left hand. The trocar is then inserted close to the medial side of the iliac crest and passed deeply into the abscess. The syringe is attached, and pus withdrawn and passed into a sterile specimen jar. The cannula is then withdrawn and the skin allowed to move back so that the perforation is on the outer side of the iliac crest. It is

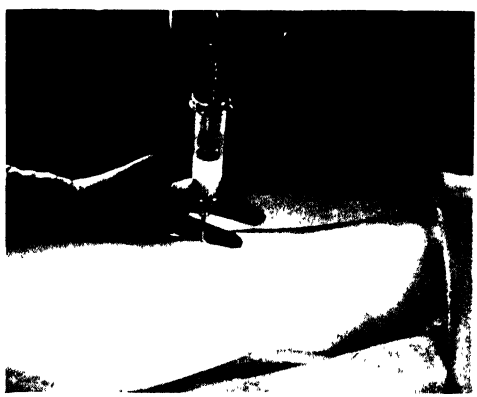


Fig. 742.—Aspirating a psoas abscess. Asepsis is essential

sealed by wool and collodion. Pus is sent for pathological examination. Routine urine examination is necessary. Prolonged dorsal decubitus is an occasional cause of hæmaturia, pyelitis, and urinary calculus. In the absence of any organic lesion, such as renal tuberculosis, the patient is nursed in the prone position for a few days or if in a plaster bed he is 'turned out' and allowed to lie face downwards (*see Fig.* 668). The angle of the frame is diminished before the child returns to the extended position. When the last three radiographs show no more bone destruction and the sedimentation rate is normal, the active stage has been completed and the Bradford frame may be discarded.

Quiescent Stage.—While the child is on the frame the diseased vertebræ are prevented from falling together by the hyperextension. As the result of treatment the bones are no longer soft, and since they must be brought into apposition if bony union is to occur, the patient is now nursed face downwards in an anterior plaster shell. This position favours three things: the apposition of the vertebral bodies, the development of the back and leg muscles, and the formation of compensatory curves above and below the lesion. This stage lasts for three months.

At the end of three months the very difficult question of a spinal graft has to be faced. If on radiological examination the diseased vertebral bodies have even outlines, have come into apposition fairly accurately, and show no sign of cavitation or sequestrum formation, the child may be allowed up without a spine graft, but a spinal support (*see* p. 590) should be worn for two years If, on the other hand, these features are absent, an Albee type of spinal fusion must be performed.

Operative Stage.—A plaster bed is made a month before operation. Three days' skin preparation is necessary for the leg from which the tibial graft is to be taken. The blood is typed in case a transfusion is necessary. For the following four months he is nursed in the plaster bed.

Convalescent Stage.—A spinal support is worn for two years.

CHAPTER LXXIII

ORDERING SURGICAL APPLIANCES AND SPLINTS

By W. H. TUCK

IT is the practice of most surgeons and doctors to send the patient to a qualified appliance maker when a surgical appliance is prescribed; this is essential when the patient requires a spinal support or some other complicated appliance. When this procedure cannot be followed many firms supply self-measurement forms. In the absence of both of these facilities, the measurements required will be found in the text that follows.

It is important to give a detailed prescription, and where the measurements are not taken by the maker, care must be exercised to ensure that the tape-measure encircles the anatomical area in the correct position and without undue tension.

LEG INSTRUMENTS

Refer to *Fig.* 743 for all measurements.

Below-knee Instruments.—Record the circumference (5) and the length from (5) to the base of the foot. State if the steel support is to be worn on the outside (*Fig.* 744), the inside, or on both sides of the leg; whether it is to be made with joints at the ankle or not, and whether a T-strap is required.

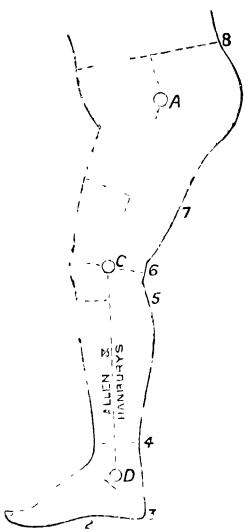


Fig. 743.—Key for measurements for lower-limb appliances.

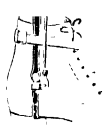


Fig 744.—Outside steel support to below the knee

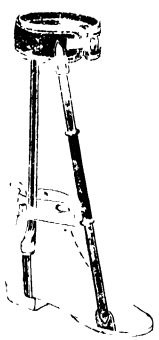


Fig 745.—Outside steel support with uplifting toe spring

Drop-foot Appliance.—A strap can be added to the calf band with a short spring attached to a D ring on the centre of the boot, or to the outer or inner side, to give the correction required (*Fig.* 745).

An efficient type of drop-foot appliance is a below-knee instrument with a joint at the ankle fitted to a flat socket in the patient's boot, with a toe-raising spring attached from the joint to the calf band (*see Fig.* 744).

Thomas's Knee Splint (*Fig.* 746).—In the case of a swollen knee where the knee circumference proves larger than the thigh, a half ring is advisable with a leather strap round the front of the thigh. State which leg, and if Pearson's knee-flexion attachment is required. Measurements required :—

Circumference of thigh at perineum (obliquely).
Circumference of knee.
Length from perineum to base of foot.
Centre knee to base of foot.

Walking Calliper.—The same measurements as for the knee splint are required. The patient's boots must accompany the measurements for a socket

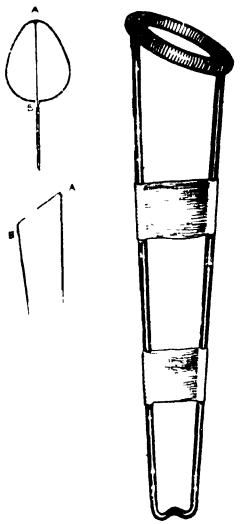


Fig. 746.—Thomas's knee splint.

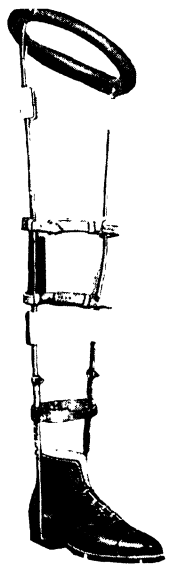


Fig. 747.—Walking calliper.

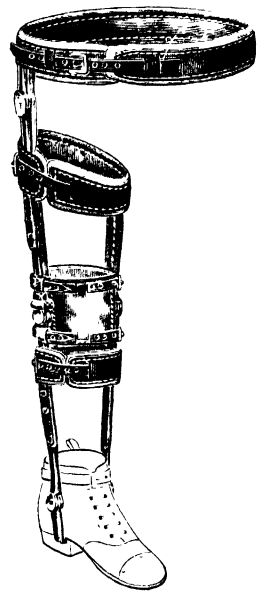


Fig. 748.—Walking instrument for infantile paralysis

to be added to the heel. It is often advisable to raise the heel of the opposite boot a quarter-of-an-inch in order to give clearance when the patient is walking. State if the calliper (*Fig.* 747) is to be weight-bearing or weight-relieving.

Walking Instrument to the Thigh.—Such an instrument is used to support a leg that is paralysed. It can be fitted with a locking knee-joint, and uplifting toe springs can be added if required. Measurements required :—

Circumference of thigh at perineum.
Circumference of knee (**6**).
Circumference above the calf (**5**).
Length, perineum to ground.
Length, perineum to knee.
Length from knee (**C**) to base of foot.

The patient's boot must be sent for sockets to be fitted.

Walking Instrument to Thigh with Pelvic Band (*Fig.* 748).—If a pelvic band is required to obtain external rotation of the foot to the above

appliance, give the circumference of pelvis (B), length from great trochanter (A), to centre of knee (C), in addition to the above measurements. A moulded leather thigh bucket can be fitted in place of the thigh band. Should this fitting be required a plaster cast of the thigh and lower buttock is necessary, in order to give a good mould of the tuber ischii.

Jones's Abduction Frame.—Measurements required :—

Circumference at nipple line.
Circumference at umbilicus.
Distance between the anterior superior iliac spines.
Length of line from nipple to top of great trochanter.
Great trochanter to external malleolus

State which leg is to be abducted.

Genu Valgum Splints.—There are various types of knock-knee splints. The gutter type of night splint, fitted with the necessary straps, is efficient.

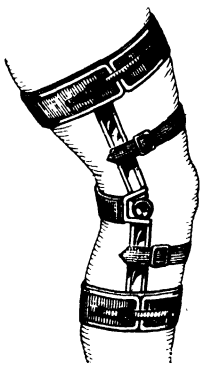


Fig. 749.—Marsh's knee cage

Measurements required :—

Circumference of pelvis (B)
Circumference of thigh
Circumference of knee (6).
Circumference above calf at (5).
Length, pelvis (B) to great trochanter (A)
Length, great trochanter (A) to knee (C).
Length, knee (C) to base of foot

For day wear a knock-knee brace can be supplied with a posterior bar between the thigh and calf bands around which the knee-cap passes to prevent hyperextension of the knee. The pelvic band is fitted with front and back straps. Measurements required : As above.

The patient's boots must be sent, in order to fit outside sockets and inside T-straps. It is most essential to adjust the back pelvic strap correctly to obtain the necessary eversion of the feet.

Knee Cage (Jointed) (*Fig.* 749).—State whether for left or right knee, the degree of movement required, and the amount (if any) of limitation from full extension. Tracing taken down each side of limb extending to about 7 in. above and 6 in. below mid-patella. Measurements :—

Circumference of limb 7 in. above mid-patella.
Circumference of limb 3 in. above mid-patella.
Circumference of limb at mid-patella.
Circumference of limb 3 in. below mid-patella.
Circumference of limb 6 in. below mid-patella.

Night Shoes.—For congenital talipes equinus varus order short night shoes with each foot set in valgus and calcaneus. If the night shoe is for a calcaneus deformity, order the foot-piece to be set in an equinus position. For flexion deformity of the knees, a long night shoe with a front knee-cap is recommended. Measurements required :—

Short night shoe .—
Circumference above calf (5).
Length, (5) to base of foot.
Long night shoe :—
Circumference at thigh.
Circumference at knee
Length, perineum to centre knee (C).
Length (C) to base of foot.
Outline of feet for both types of splints.

SURGICAL BOOTS

Measurements should be taken according to the diagram (*see Fig* 743), with an outline of the patient's feet. Circumference at (1), (2), (3), and (4). Give height of upper required. If the deformity is severe a plaster cast taken with the foot at right angles is advised. Give a full prescription of the wedges, cork, or socket required. Note: if the foot is paralysed, a boot laced to the toe will prove helpful.

For Flat Feet.—Inside or valgus wedges are added in various thicknesses from $\frac{1}{8}$ in. to $\frac{1}{4}$ in. to the heel only, or to the sole and heel according to the deformity. In the case of a spasmodic flat foot it has proved satisfactory to 'float out' the heel of the shoe on the inner side (*Fig.* 750), and to extend the heel forward if the arch of the shoe becomes flat; this is called 'elongating the heel'. It is not uncommon to find the patient walking very badly on the outer border of the shoe after an inside wedge has been added to the heel, and the stiffener becoming trodden over. To compensate this the heel should be floated out on the outer side, thus retaining the wedged position and giving an even balance to the heel.

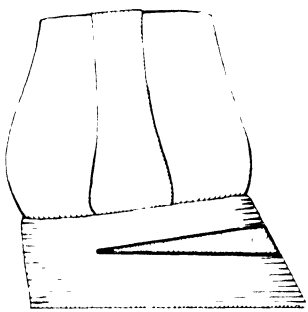


Fig. 750.—A 'float-out' heel with a wedge inserted on the inner side



Fig. 751.—Metatarsal bar fitted to the patient's shoe.

For hospital out-patients, inside cork heel wedges, which can be fitted immediately, are of great assistance. These can be obtained in various sizes from most appliance makers.

Metatarsal bars for metatarsalgia can be fitted to the sole of the foot behind the level of the metatatarsal joints; this bar can be concealed between the sole and the upper or fitted on the sole (*Fig.* 751).

Arch Supports.—Give tracing of foot, size of shoe worn, and (in the case of a female) type of shoe worn. Ready-made supports are seldom satisfactory. For pes planus, a valgus support of felt and leather, or cork and leather usually proves satisfactory. In cases of advanced flat feet the arch should be supported with an apparatus reinforced with metal.

H. Spitzy (of Vienna) has introduced a support for children consisting of an insole with a marble, or similar hard substance, fitted under the longitudinal arch. This has the effect of giving discomfort when the child walks on the inner border, and therefore encourages the foot to hold a corrected position without wedging or support.

Metatarsal Supports.—A sponge-rubber pad fitted on an insole behind the metatarsal heads is very satisfactory. This can be incorporated with a valgus support, if required.

A different type of support which is becoming more widely used is the Letterman foot corrective support. This consists of a plastic material covered with a fabric material. The support is heated in an electric oven (*Fig.* 752). It is

then fitted inside the patient's shoe (*Fig.* 753). The patient walks about for approximately ten minutes until the plastic material becomes firm, and after minor adjustments a perfect support is obtained (*Fig.* 754). This support has proved most satisfactory in cases of flat feet, metatarsalgia, spurs on the os calcis, and painful heels. This support can be fitted by an appliance maker, or a surgeon who has the necessary equipment.

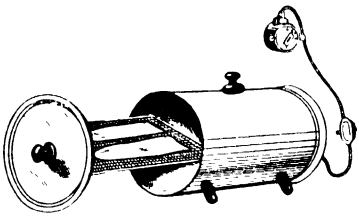


Fig. 752.—The Letterman foot supports are heated in an electric oven

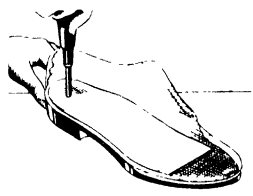


Fig. 753.—While still warm, the supports are fixed in the patient's shoe

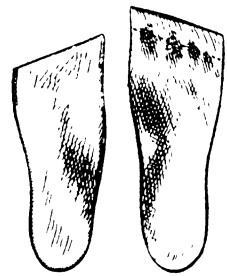


Fig. 754.—After the patient has walked about in the shoe for ten minutes, a perfect support is obtained. A, The heated Letterman support before the patient has walked about on it. B, Afterwards

ELASTIC HOSIERY

Hosiery can be supplied in cotton or silk. When ordering state whether for right or left limb. Measurements to be given according to chart (*Fig.* 755). Give length, circumferences, and detail of stocking required.

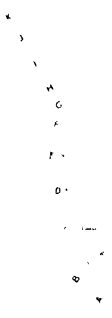


Fig. 755.—Chart for ordering elastic stockings.

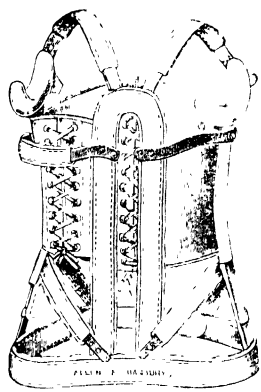


Fig. 756.—Full spinal support for scoliosis



Fig. 757.—Spinal collar

SPINAL SUPPORTS

Fig. 756 shows a full spinal support as used for scoliosis. It is advisable to take a plaster cast of the patient with the spine in extension for all spinal supports, but it is essential if a moulded leather or a celluloid jacket is required. Measurements required :—

For double or single lateral curvature.

Circumference at axilla, waist, and round hips
Depth from axilla to waist line, and hips to waist line
Position of curvature.
For angular curvature add length from centre of curvature to pelvic line.

Spinal Collar.—Made in moulded leather or poroplastic felt (*Fig.* 757) it can be reinforced with steel supports if required. A negative plaster case should be provided, showing length of back and front sections.

State if it is to be used with a posterior spinal support or to be worn independently.

Circumference at the base of the neck.
Depth of front, taken from the point of the jaw to the sternal notch.
Depth at back as required in accordance with the nature of the injury.

ARM SPLINTS

Robert Jones's Humerus Splint.—Measurements required :—

Vertical circumference at axilla.
Circumference of elbow and wrist
Length of axilla to elbow.
Length of elbow to wrist.

Arm Abduction Splint.—Measurements required :—

Circumference of chest, waist, forearm, and wrist.
Length, axilla to pelvis.
Length, axilla to elbow.
Length, elbow to wrist
Sketch of hand.
State whether left or right.

CRUTCHES

Take measurements while the patient is standing in his boots or shoes.

French Pattern (*Fig.* 758) :—
Length from axilla to ground
Length from axilla to hand grip



Fig. 758.—Crutch (French pattern)

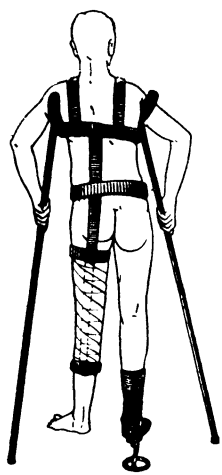


Fig. 760.—A patten in use

Fig. 759.—Forearm type of crutch

Forearm Crutches (*Fig.* 759).—This type can usually be supplied with a spring arm or in light tubular material. Measurements required :—
Length with the wrist flexed to the desired position, the hand pointing towards the ground.

When ordering crutches remember that a patten (*Fig.* 760) may be required on the boot of the sound leg.

ABDOMINAL BELTS

Fig. 761 shows the type of support particularly suitable for patients with a pendulous abdomen. It is fitted with elastic sections over the hips, and buckles and straps designed to give good lower abdominal uplift. Perineal straps or suspenders can be added if required.

For cases with a ventral hernia, or where support to a moveable kidney is required, suitable pads are fitted.

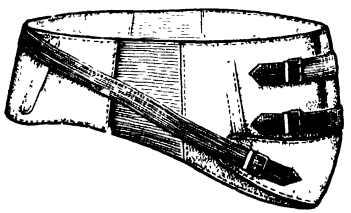


Fig. 761.—Standard abdominal belt

With the patient standing record the following measurements:—

Circumference just below the waist at A
Circumference at the fullest part of the abdomen at B
Circumference at hips at C
Depth of front, A–C
Depth at sides.
Depth at back.
If a pad or pads are required
State if for male or female

Fig. 762.

The Curtis Abdominal Support is indicated especially in cases of visceroptosis (*Fig.* 763).

Instructions for measuring. With the patient supine, stretch a piece of calico approximately 12 in. by 36 in. firmly across the lower abdomen, and on it with a crayon pencil mark the position of the umbilicus. Draw a line from the umbilicus to a point half an inch inside the anterior superior spine. Continue the measurement by following the inner line of Poupart's ligament, then across the symphysis pubis and along the opposite ligament to the other anterior superior spine; and thence coming back to the umbilicus.

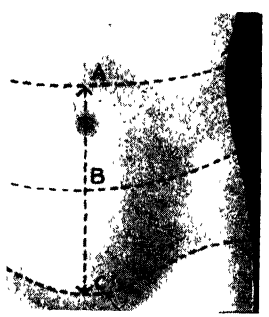


Fig. 762.—Measurements for an abdominal belt.

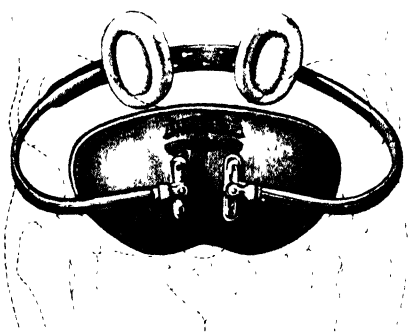


Fig. 763.—The Curtis Support.

In cases of hernia carefully define the actual area of the orifice by marking it on the calico sheet. The tracing so formed represents the size of the front plate.

Take a circumference measurement passing the tape measure just below the greatest hollow of the back and just below the anterior superior spines in front.

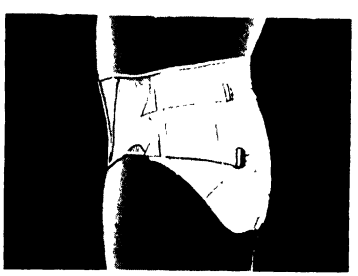


Fig. 764.—Sacro-iliac corset.

The instructions given above are applicable to all ordinary cases. When the abdominal wall is loose and pendulous, there may be difficulty in locating the points mentioned, and judgement is called for to avoid the prescription of a plate larger than is really necessary. In all such cases, endeavour to control the abdominal wall at its point of greatest convexity.

Indicate the general build of the patient and any peculiarities pertaining to the abdominal wall, the hips, or the back.

Lumbo-sacral or Sacro-iliac Corsets are made of strong canvas (*Fig.* 764) or similar material, with a special fulcrum over the sacro-iliac region. Sometimes pads and an extra steel support are incorporated. The measurements required are similar to those for an abdominal belt, but special attention must be given to the depth at the back. State whether the corset is required for a male or a female patient, in order that perineal straps or suspenders can be fitted.

TRUSSES

There are three types of trusses in general use —

The Spring Truss properly shaped to the contour of the body, having a spring of the correct tension and fitted with a pad of suitable dimensions, is the most efficient truss for controlling an inguinal hernia

The Elastic Band Truss is seldom satisfactory and should be applied only in mild cases or for use in bed following the removal of a spring truss for the night.

The Celluloid-covered Truss enables the patient to bathe without damage to the appliance.

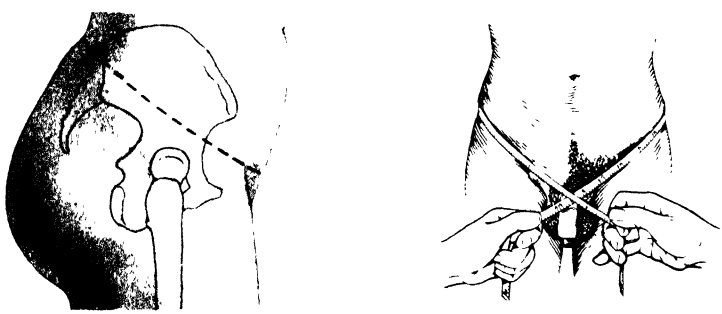


Fig. 765.—Measuring for an inguinal truss.

When a truss has to be ordered through the post, the following measurements and particulars should be given.

Whether inguinal or scrotal hernia.

Right, left, or double.

Male or female and approximate age

Size of hernia

Strength of spring required (with due regard to occupation and if patient is troubled with a cough).

Circumference of the body taken next the skin whilst standing, at a point below the iliac crests (*Fig.* 765).

Bag Truss for Irreducible Scrotal Hernia.—A special bag support (*Fig.* 766) can be provided to meet cases of a scrotal hernia which cannot be reduced.

In addition to the measurement described on p. 593 give length over the shoulder back to front for the braces and provide a paper pattern of scrotum as a guide for size of bag.

Belt for an Umbilical Hernia in a Child (*Fig.* 767).—Rubber is preferable as it remains more firmly in position, is easily sponged, and readily adjustable for correct tension. State circumference of body taken next the skin in a line with the umbilicus.

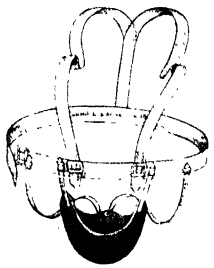


Fig. 766.—A bag truss for an irreducible scrotal hernia.

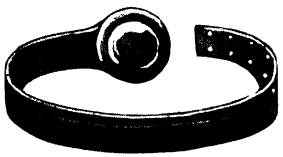


Fig. 767.—Child's rubber umbilical belt

Umbilical Belt for an Adult.—An elastic webbing belt 4 in. or 5 in. in depth fitted with a soft pad about 3½ in. in diameter will usually be found to be suitable.

Suprapubic Drainage Apparatus.—There are various types of appliances, but those illustrated are in general use. The apparatus illustrated in *Fig.* 768 is made of stout red rubber and fitted with a detachable moulded rubber shield.



Fig. 768.—Suprapubic belt.

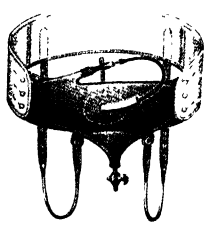


Fig. 769.—Millin's suprapubic belt.

The bag is fitted with a non-return valve and a screw outlet cap ; it has a capacity of 18 oz.

Terence Millin's apparatus (*Fig.* 769) has the rubber urinal incorporated in front, avoiding the necessity of a bag being fastened to the leg.

When ordering either of the above, state the size and type of the catheter to be used and give the circumference of the body at the hips.

Colostomy Belts.—The measurements required are the same as those detailed for an abdominal belt. State whether the belt is for a male or a female.

The position of the stoma should be shown in a diagram, and its distance from the umbilicus measured.

The St. Mark's Hospital pattern for a left inguinal colostomy is satisfactory when the patient has good control. It is made in coutil, with a stout red rubber front which overlies the colostomy opening, and thus prevents leakage.

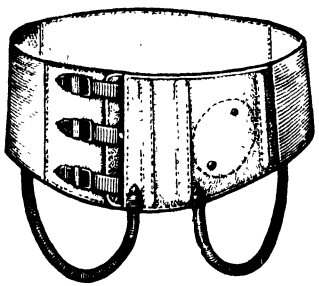


Fig. 770.—Colostomy belt.



Fig. 771.—Cup for colostomy belt.



Fig. 772.—Cup and bag.

The type of belt shown in *Fig.* 770 can be used with a cup (*Fig.* 771) when the fæcal matter is of solid consistency or small in amount. When there is little control the cup and bag type of receiver (*Fig.* 772) is recommended.

CHAPTER LXXII

GENERAL ANÆSTHESIA

By J. L. HOPKINS

The first duty of the anæsthetist is to make an examination, with a view to forming an assessment of the most suitable anæsthetic for the patient. The lines upon which the examination is made are as follows :—

1. The respiratory system is investigated and any abnormalities duly noted and, if gross, reported.

2. The temperature.

3. The cardiovascular system must be examined and the systolic and diastolic blood-pressure taken. The pulse pressure—that is, the difference between the systolic and diastolic pressure—should be noted. The cardiovascular stability of a patient may be estimated by Moots' Law, which states that

$$\frac{\text{pulse pressure}}{\text{diastolic pressure}} \quad \frac{1}{2} \text{ or } 50 \text{ per cent in a normal individual.}$$

Any figure above 75 per cent, or below 25 per cent indicates a high anæsthetic risk.

4. A clinical examination of the urine.

5. Clinical signs of anæmia call for a blood-count and a hæmoglobin estimation.

The second duty is to arrange for suitable premedication to be given at the proper time (*see* Chapter *XI*).

The third duty (in the anæsthetic room) is to make sure that :—

1. The patient has not had a meal recently. The safe interval is four hours for an adult and three hours for a child.

2. False teeth have been removed and the position of loose teeth and dental bridges noted.

3. In the case of out-patients, the neck must be quite unconstricted, e.g., the collar and tie must be removed ; also the bladder must be empty.

Other points to which the anæsthetist may well direct his attention are :—

In female patients, to avoid masking cyanosis, lipstick and rouge should be removed.

An artificial eye has proved a source of perplexity to an unobservant anæsthetist.

SIGNS OF ANÆSTHESIA

The progressive paralysis produced by anæsthetics is divided into four stages :

1st Stage (syn. the stage of induction ; the stage of conscious excitement). —During this period the patient feels the hypnotic effect of the anæsthetic and commences to lose consciousness.

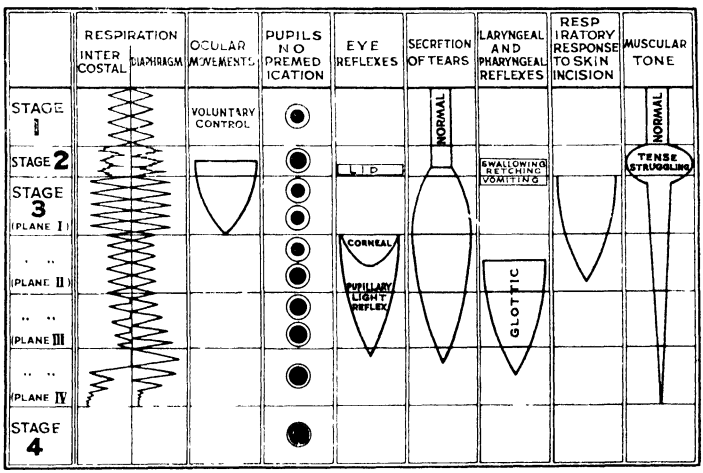
2nd Stage.—This is the period of unconscious excitement. During this stage some individuals become violent. The pulse becomes rapid, but remains strong. The pupils are widely dilated, but react to light. Cough and vomiting reflexes are still present. Breathing is irregular ; holding the breath is a common

cause of prolongation of this stage. The time occupied by the second stage is inversely proportional to the amount of breath-holding and unsatisfactory respiratory excursions. When it ends, the second stage does so gradually.

3rd Stage.—This is characterized by the respirations becoming more regular and quieter. Comparatively noisy respirations and roving eyeballs are indications of light anæsthesia. The signs of full surgical anæsthesia are :—

a. Automatic respiration.
b. Eyeballs fixed in a central position.
c. Pupils medium to large in size and reacting to light.
d. Complete muscular relaxation, the jaw being quite relaxed.

THE STAGES OF ANÆSTHESIA



4th Stage.—This is the stage of respiratory paralysis It must be recognized early and the anæsthetic stopped until the patient returns to the third stage. The signs are .—

a. Respirations become shallow, irregular, and sighing in character.
b. Pupils are dilated and the reflex to light is lost.
c. Pulse becomes more rapid and the blood-pressure falls.
d. There is pallor or a mild degree of cyanosis.

If a Boyle's or similar apparatus is being used, the anæsthetic vapour should be cut off and the bag emptied and then filled with oxygen. Now, with the expiratory valve closed, gently squeeze the bag rhythmically until automatic respirations are regained. If this simple method of artificial respiration cannot be employed, some other method must be used.

An overdose of the anæsthetic must be distinguished from shock due to the operation.

Shock may occur at any time during an operation, and must be reported to the surgeon at once. Grossly, shock can be recognized when a patient who was

Pink Warm and Dry	becomes	Pale Cold and Moist

It cannot be stressed too strongly that it is better to set up unnecessarily the apparatus for an intravenous drip saline or plasma infusion than to wait until it is obvious to all that such measures are required urgently.

ANÆSTHETIC AGENTS

Ethyl Chloride (C_2H_5Cl) is highly inflammable and is used by spraying on to a Schimmelbusch mask (*Fig.* 773) covered with 8 to 10 layers of gauze or a piece of white lint. This is a quick-acting anæsthetic and is useful for inducing anæsthesia in children and for short surgical procedures such as extraction of teeth and the incision of an abscess. The dose of ethyl chloride is 3 c.c. to 5 c.c. for a child, and 5 c.c. to 7 c.c. for an adult. During the first few breaths the vapour should be weak; the strength of the vapour is increased gradually. In this way laryngeal and masseter spasm can be avoided and anæsthesia achieved without cyanosis.

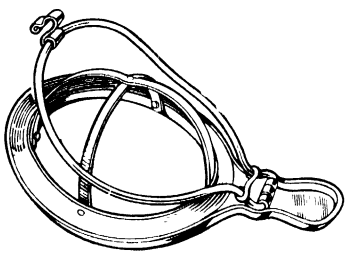


Fig. 773.—Schimmelbusch's mask.

Signs of anæsthesia :—

1. Automatic respiration.
2. Flushed face and jaw relaxed.
3. Medium-sized pupil

Ethyl chloride is a potent and rapidly-acting anæsthetic. The anæsthetist must be vigilant in watching for signs of danger, which are :—

1. Pallor.
2. Shallow respiration with gasping.
3. Widely-dilated pupils which do not react to light.

If the patient stops breathing, or the airway becomes obstructed, the mask must be removed immediately and the administration withheld until breathing is satisfactory, because a sudden inspiratory gasp may be fatal if ethyl chloride is inhaled at this stage.

Chloroform ($CHCl_3$) is a volatile liquid which is not inflammable. It is a powerful and very toxic anæsthetic agent. It is used in such weak concentration that it is pleasant to take and it is not irritating. All that is required for the administration of chloroform is a drop bottle and a Schimmelbusch mask covered with eight layers of gauze or a single layer of lint. The chloroform is dropped on to the mask three or four drops in each quadrant in turn; in this way the whole mask is kept uniformly saturated with the liquid. This procedure is kept up steadily until respirations become regular and automatic in character and the other signs of surgical anæsthesia are present. The amount of chloroform dropped on the mask subsequently should be just sufficient to maintain a constant level of anæsthesia.

Chloroform and Ether Mixture.—The same care must be given to the administration of chloroform and ether mixture as to pure chloroform. The commonest mixture used is two parts of chloroform and three parts of ether (C_2E_3). The mixture must be made immediately before use. Usually C_2E_3 is used for induction and is followed by open ether anæsthesia. The change over is made as soon as respirations become quiet and regular. A fresh mask should be used when the open ether is substituted for the mixture.

Ether ($C_2H_5OC_2H_5$) is a weaker anæsthetic than chloroform, consequently a much higher concentration of it is required. Open ether is a safe and well-tried

method of anæsthesia; it is one which beginners should strive to master. When the induction has been completed by means of ethyl chloride, C_2E_3 mixture, or intravenous pentothal sodium, a pad of Gamgee tissue with a 3-in. slit cut down the middle is placed over the patient's face. The slit in the Gamgee tissue is stretched so that the patient may breathe through it. A Schimmelbusch mask, covered with eight layers of gauze, is placed on top, and this in turn is covered with another piece of Gamgee tissue which has been slit in the middle and stretched. Through this hole the ether is poured on to the mask. The amount of ether should be just sufficient to keep the gauze damp. When the requisite level of anæsthesia has been attained only sufficient ether to maintain that level is allowed.

Full doses of ether do not produce toxic effects on the myocardium; nevertheless, the liver and kidneys are adversely affected by a prolonged ether anæsthesia.

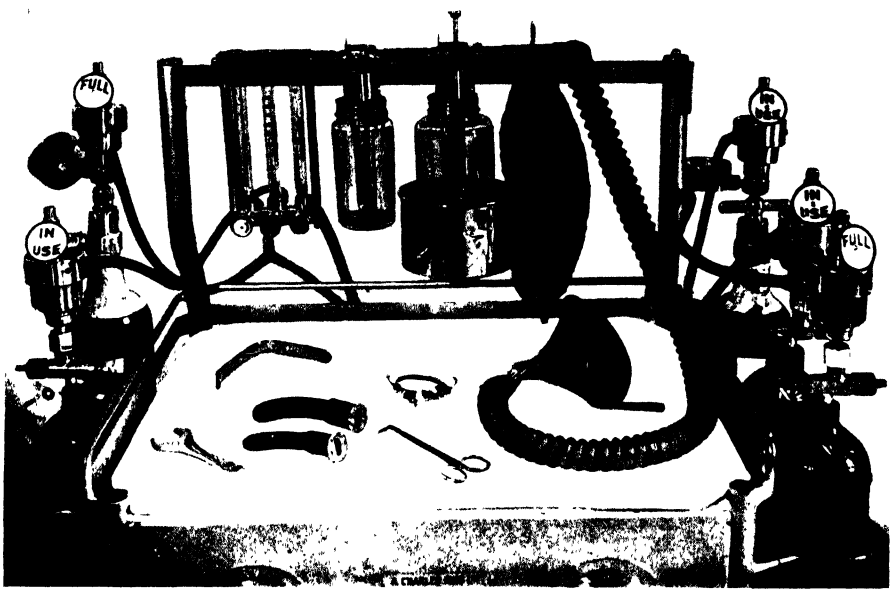


Fig. 774.—Boyle's anæsthetic machine, showing flow-meters for oxygen, carbon dioxide, and nitrous oxide, re-breathing bag, and unkinkable tubing to the facepiece

Nitrous Oxide (N_2O) is a weak anæsthetic, and when used without other agents is suitable only for short minor operations. Nitrous oxide and oxygen, if preceded by a basal narcotic such as avertin or pentothal, may be used for operations which do not call for much muscular relaxation. When considerable muscular relaxation is necessary, nitrous oxide and oxygen must be supplemented, usually by ether. In order to obtain even light anæsthesia with nitrous oxide and oxygen it is necessary to reduce the oxygen in the mixture to about 10–12 per cent; this entails sub-oxygenation of the patient's tissues. It is important to know that anoxæmia is not tolerated well by: (1) Children;

(2) Elderly persons ; (3) Those with cardiac incompetence ; (4) Anæmic patients. In these cases it is far safer to increase the percentage of oxygen and to employ ether as an adjuvant.

The apparatus in most common use for the administration of nitrous-oxide–oxygen–ether anæsthesia is the Boyle (*Fig.* 774). This is a continuous-flow machine fitted with a bag for partial re-breathing. By this is meant that the gas–oxygen mixture flows continuously to the patient while part of each expiratory breath escapes through the valve in the facepiece, and part passes into the re-breathing bag, so that carbon dioxide is accumulated. The amount of partial re-breathing is controlled by altering the rate of flow of the gases. Before commencing to administer N_2O–O_2 with any apparatus the two following points are of fundamental importance :—

1. See that a well-fitting facepiece (*Fig.* 775) is available

2. Examine the cylinders to make sure that plenty of nitrous oxide is available and that there is an abundant supply of oxygen.

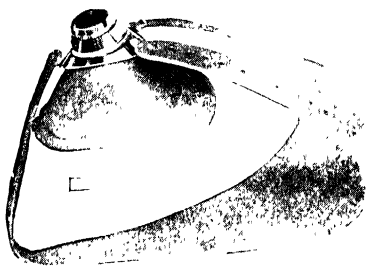


Fig. 775.—Facepiece with harness fixing attachment.

Oxygen must always be available during the administration of an anæsthetic. A spare cylinder which is full must always be at hand. If a cylinder of oxygen runs out, replace it by a full one immediately, and *never leave an empty oxygen cylinder where it may be used again by mistake.*

If by chance the oxygen supply runs out during an operation, the mask must be removed and anæsthesia continued by means of open ether until the oxygen supply is replenished.

Induction.—Commence by using nitrous oxide alone. The rate of flow should be 6–8 litres per minute with the expiratory valve on the facepiece open. (N.B.—It is the top or widest part of the bobbin or rotometer that indicates the amount of gas flowing into the machine). When the bag becomes fully distended, the volume of nitrous oxide can be reduced to about 4 litres per minute. When the respirations become regular and a mild degree of cyanosis appears, oxygen is turned on at the rate of 500 c.c. per minute. Should ether be required to supplement the mixture, it is now added, but the ether vapour should at first be very weak or laryngeal spasm will occur. As the patient becomes tolerant to the ether vapour, the flow of oxygen can be increased until the patient's colour becomes bright pink. Thenceforth the only change in the mixture is to increase or decrease the strength of the ether vapour if necessary. When Boyle's machine is in use, this is done by moving the lever on the ether bottle gradually between the ' off ' and the ' on ' position.

It is during the period of increasing the strength of the ether vapour that the beginner experiences trouble, notably cyanosis due to laryngeal and masseter spasm. When the patient becomes blue, with his teeth clenched and the breathing stertorous, the antidote is to shut off the ether and the nitrous oxide and to increase the oxygen ; as a result of the oxygenation the breathing soon becomes quieter and the colour improves. Nitrous-oxide–oxygen mixture is now resumed and ether vapour is added very cautiously. Time expended in increasing the strength of the ether vapour very gradually is well repaid. As soon as the jaw

is sufficiently relaxed, an airway (*Figs.* 776, 777) should be inserted. In an edentulous patient the airway is easy to introduce, consequently it can be passed soon after the patient has been rendered unconscious.



Fig. 776.—Waters' metal airway



Fig. 777

Divinyl Ether $(C_2H_3)_2O$ is a powerful anæsthetic (commonly known by the proprietary name, Vinesthene) with a rapid action. It is so volatile that it cannot be used on an open mask and some form of well-fitting mask with a bag attached must be used.

Goldman's bag (*Fig.* 778), which consists of a metal chamber containing a piece of marine sponge situated between the bag and the facepiece, is the most convenient. Three c.c. of divinyl ether are poured on to the sponge. With the bag half filled with air, the facepiece is accurately adjusted and the patient is told to breathe into the bag. As soon as the patient is rendered unconscious the facepiece is removed. Approximately 1½ minutes of excellent anæsthesia is obtained in this way. This is an excellent anæsthetic for dental extractions in children, because the vapour is not irritating and does not produce vomiting.



778.—Goldman's bag

Trichlorethylene or Trilene is a non-irritating, non-inflammable anæsthetic which is generally employed as an adjuvant to nitrous-oxide–oxygen anæsthesia. Among its advantages are that a high percentage of oxygen may be combined with it and recovery of consciousness is rapid. Other advantages are that trilene can be used in the presence of diathermy and in the X-ray room without fear of an explosion.

The usual method of administering trilene is to pour it into the bottle labelled 'chloroform' of a Boyle's machine. In these circumstances it is negligent to omit to change the label to 'Trilene' for many reasons. Trilene has a variety of uses. When this anæsthetic agent is in use two axioms must be in the administrator's mind:—

a. Trilene must never be pushed until it produces muscular relaxation because at that concentration there is a grave danger of ventricular fibrillation.

b. Trilene must never be used with a CO_2 absorber. Products of the disintegration of trilene coming on contact with soda lime result in a poisonous compound.

Cyclopropane (C_3H_6).—As an anæsthetic, cyclopropane is as powerful as chloroform. This gas is highly inflammable. Owing to the high cost of cyclopropane it is used only in a closed-circuit machine. Even when combined

with as much as 80 per cent of oxygen, cyclopropane has powerful anæsthetic properties.

Induction.—The bag of a closed-circuit apparatus is half filled with oxygen. The anæsthetic mask is accurately placed on the patient's face. The cylinder of cyclopropane is now turned on and the gas is allowed to pass into the circuit at the rate of 300 c.c. per minute. During the whole of this period the patient's basal oxygen requirement varies from 250 c.c. to 300 c.c. per minute. Using this mixture, respirations remain quiet and the colour good. By induction with cyclopropane and oxygen, full surgical anæsthesia can be expected in from two to five minutes.

Maintenance.—From 200 c.c. to 300 c.c. per minute of oxygen must be allowed throughout the anæsthetic, but the cyclopropane is shut off when the desired level of anæsthesia has been attained.

This is not an anæsthetic for a beginner to employ.

THE CLOSED-CIRCUIT TYPE OF ANÆSTHETIC MACHINE

Because some anæsthetic gases (e.g., cyclopropane) when expired from the lungs are chemically unchanged, it follows that they can be used over and over again, provided the excess of CO_2 in the expired mixture is removed. This is the reason for the inclusion of a CO_2 absorber (*Fig.* 779) in a closed-circuit apparatus. Essentially the CO_2 absorber is a canister containing soda lime granules over which the exhaled gases must pass and the CO_2 is absorbed by

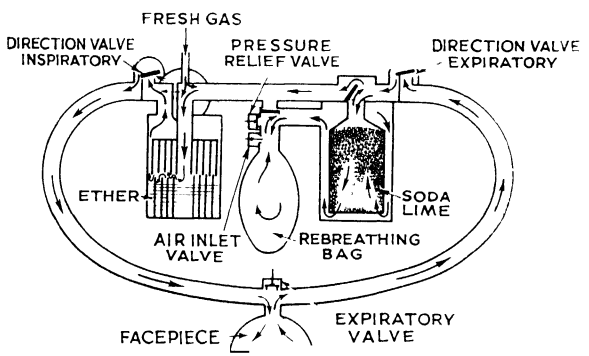


Fig. 779.—Coxeter-Mushin CO_2 absorber.

the granules. In spite of the fact that the gases pass in and out of the patient's lungs without change, and the CO_2 is absorbed, the tissues must be supplied with oxygen. The basal oxygen requirement of the body is about 250 c.c. to 300 c.c. per minute, therefore this amount must be admitted to the circuit throughout the anæsthetic. The closed circuit has the great advantage of reducing the respiratory heat loss and water vapour loss ; also the quiet respiration calls for less exertion on the part of the patient.

ENDOTRACHEAL INTUBATION

This expedient for conveying the anæsthetic vapour directly into the trachea is particularly valuable in the following circumstances :—

1. Operations on the head and neck, particularly those where there is a risk of blood, pus, or other debris entering the respiratory passages.
2. Certain thoracic operations.
3. Upper abdominal operations. The quiet respirations consequent upon the perfect airway minimize the respiratory movements.

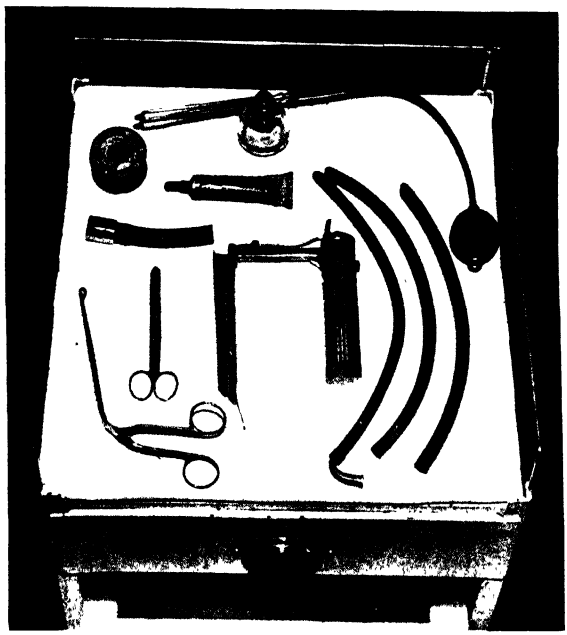


Fig. 780.—Endotracheal trolley lay-out showing Cocaine spray, Endotracheal tubes with metal angle piece, Magill's laryngoscope, Magill's introducing forceps, Scissors, Connecting tubing, Tube of lubricant, Strapping, ½ in. wide.

Technique.—Before commencing the anæsthetic, all the necessary apparatus for intubation (*Fig.* 780) must be in readiness within easy reach. A tube of a suitable size is chosen and the extremity is smeared with vaseline or liquid paraffin; some anæsthetists prefer 1 per cent nupercain in lanoline. The passage of the tube is facilitated by spraying the nasal mucous membrane with 10 per cent solution of cocaine before commencing the anæsthetic.



Fig. 781.—Nasal catheter.

Intubation may be nasal or oral according to the nature of the operation. Nasal intubation is carried out when the patient is deeply anæsthetized (except by the very experienced who can intubate under light anæsthesia) and the jaw well relaxed. With the patient's chin held forward and his head kept steady in the midline, the well-lubricated tube (*Fig.* 781) is passed gently down the nose.

Expired air can be felt issuing from the tube as it is being advanced towards the larynx. When the tube has been passed to its full extent, the expired air can

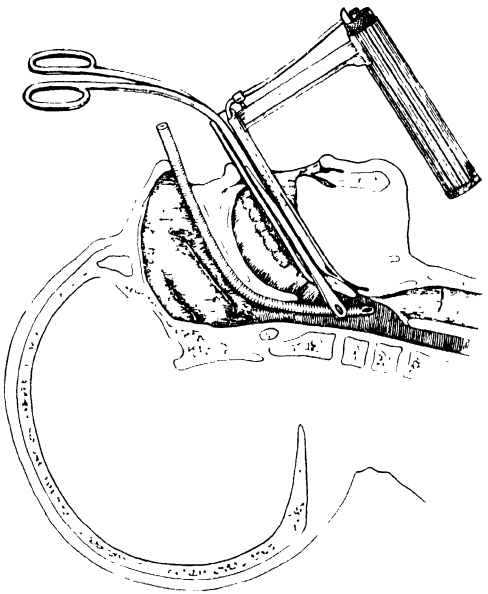


Fig. 782.—Intubation. Shows the tube, passed through the nose, being seized by forceps passed through a laryngoscope, for introduction into the larynx.

still be felt coming out of the end; it is now unquestionably within the trachea. The machine is connected with the tube and the anæsthetic continued through

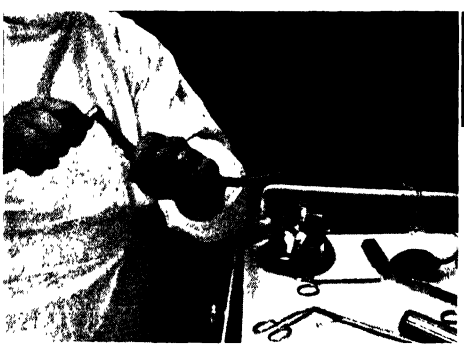


Fig. 783.—Correct way to connect the angle piece to the nasal catheter.



Fig. 784.—Insertion of the nasal catheter.

it. When the tube is being advanced towards the larynx, if neither expired air can be felt nor breath-sounds heard, the end of the tube is not in the air passage. A faint sucking noise is heard when the tube has been passed into the œsophagus.

In such circumstances the tube is withdrawn until the breaths can be felt and heard issuing from it; it is then advanced once more with the head slightly extended. After two or three unsuccessful attempts to intubate blindly, no more time should be wasted.

Intubation under Direct Vision.—A laryngoscope is introduced and the epiglottis lifted forwards; the vocal cords come into view. The end of the tube lying in the pharynx is grasped by the forceps about 1 in. from the end



Fig. 785.—Packing the pharynx



Fig. 786.—Tube in situ connected to the gas and oxygen apparatus

and guided between the cords (*Fig.* 782). The steps of nasal intubation are shown pictorially in *Figs.* 783–786. Oral intubation by direct vision is impossible unless the patient's jaw is well relaxed. The laryngoscope is introduced and the tongue and epiglottis lifted forward to expose the vocal cords; the tube is then passed between them. When the laryngoscope is withdrawn, a dental prop should be inserted between the teeth to prevent the tube being bitten.

After having passed an endotracheal tube it may be necessary to pack off the pharynx or post-nasal space. On no account should the length of gauze used for packing the pharynx be used dry, as this is liable to cause pharyngitis. The gauze should be moistened with liquid paraffin or saline solution. The endotracheal tube is attached to the anæsthetic machine by a Magill angle-piece.

CARE OF THE PATIENT

During anæsthesia the first care of the anæsthetist is to see that a good airway is maintained by inserting a rubber or metal airway, if necessary. More trouble is caused through neglecting to maintain a good airway than by anything else. Constant attention must be paid to the respiration, as this is the surest guide to the depth of anæsthesia. Alteration of rhythm or volume of the respiratory excursions calls for investigation to determine whether the anæsthesia is too light or too deep.

Cyanosis indicates that the patient is receiving an insufficient supply of oxygen. This may be due to:—

1. An impaired airway. If this is due to the tongue falling back it can be corrected by holding the jaw forward, or inserting an airway.

2. Laryngeal spasm due to irritation of the larynx. This is minimized by reducing the strength of the irritating vapour and giving an additional supply

of oxygen until the spasm is released. When the spasm has passed off is the time to deepen the anæsthesia.

Observation of Rate and Volume of Pulse.—It is the duty of the anæsthetist to observe the pulse constantly in order that he may be in a position to assess the general condition of the patient. He will then be able to estimate the degree of shock which may develop during any operative procedure, and in good time organize appropriate measures to combat it.

Other Duties of the Anæsthetist.—The care of the patient during his transit to and from the theatre, and on to and off the operating table comes under the domain of the anæsthetist. Care must be taken to ensure that the patient is moved gently from trolley to table, and that he is placed in the correct posture according to the requirements of the surgeon. The positioning of the arms is most important. With the patient lying on his back, the arms should be straight down the patient's side; if the bridge of the operating table is to be raised, the hands are placed upon the patient's chest. In the prone position the arms are extended above the head and the ends of the two pyjama sleeves pinned together, or the wrists secured to each other by means of a bandage.

Complications of Intubation.—

1. *Bleeding from the Nose.*—From time to time the passage of the tube down the nostril causes bleeding. All blood must be swabbed out of the pharynx before attempting to proceed with the intubation.

2. *Damage to Teeth.*—This is liable to occur when intubation is attempted by direct vision with the jaw incompletely relaxed.

3. *Nasal Infection.*—Infection of the accessory nasal sinuses has been known to follow nasal intubation in patients suffering from rhinitis.

4. *Tube passed into the Bronchus.*—This may occur if the tube is too long. The tube should be cut suitably and a suitable length is one which reaches from the upper border of the patient's ear to 1½ in. below the thyroid cartilage.

5. *Kinking of the Tube.*—The most probable site of the kinking is just inside the nose, where the metal angle-piece joins the rubber tube. Kinking results in an impaired airway, and cyanosis results.

CHAPTER LXXV

INTRAVENOUS ANÆSTHESIA

By J. L HOPKINS

INTRAVENOUS anæsthesia has become popular because of the simplicity of its administration, its efficiency, and the pleasantness and speed of its stage of induction. The drugs employed belong to the barbiturate group, and are used in solution. The two members of this group in common use are sodium pentothal and sodium evipan.*

Indications.—

1. As a method of inducing anæsthesia before a general inhalation anæsthetic is administered.

2 As a single dose. This gives light anæsthesia suitable for procedures which do not require more than about ten minutes to complete.

3. Intravenous anæsthesia given continuously, with or without local anæsthesia, is particularly valuable when an anæsthetic via the respiratory passage is contra-indicated or carries a high risk.

Contra-indications.—

1 Impaired liver function. Barbiturates are detoxicated in the liver.

2 Toxic patients, because of delay in elimination of the drug.

3. Low blood-pressure. These drugs tend to lower the blood-pressure still further

4 Impaired renal function. Renal disease *per se* is not a contra-indication. It is when the excretory powers of the kidneys are seriously impaired that it is dangerous to administer an intravenous anæsthetic.

5. In young children. Considerable difficulty in venepuncture is sure to result from the small size of the veins. In addition, respiratory depression is apt to occur when an intravenous anæsthetic is given to a patient under 3 or 4 years of age.

6. In cases where there is threatened obstruction to respiratory passages, e.g. Ludwig's angina.

Premedication is not necessary or desirable for short, single-dose intravenous anæsthesia when the patient is expected to return home an hour or two after regaining consciousness. In other circumstances morphine (gr. $\frac{1}{6}$) or omnopon (gr. $\frac{1}{3}$) given one hour beforehand is of advantage, for the anæsthesia is thereby slightly prolonged, slightly deeper, and the tendency to muscle twitching is reduced. If inhalation anæsthesia is to be superimposed on the intravenous, then the rules for ordinary premedication should be observed (*see* Chapter XI). It is important to note that other barbiturates such as nembutal or sodium soneryl should never be given as premedication for the intravenous anæsthetics,

* Sodium evipan was formerly manufactured in Germany. Since the outbreak of war licence to manufacture has been granted to British firms, and the drug is put up under such names as Cyclonal (May & Baker), Narcommal (Roche), etc.

because the resulting respiratory depression is liable to become dangerously severe. For this reasonal so morphine should not be given to old patients.

Preparation of the Solution.—Sodium pentothal in solution is unstable; it is therefore supplied in powder form in ampoules. The requisite amount of distilled water is also supplied in ampoules. Thus the solution can be made immediately before use by opening an ampoule of the powder, opening an ampoule of the distilled water, and by means of a syringe fitted with a wide-bore needle, drawing up the water and transferring it to the ampoule containing the powder. Sodium pentothal is put up in two doses: (1) 0·5 g. of powder and 10 c.c. of distilled water; and (2) 1·0 g. of powder and 20 c.c. of distilled water. The strength of the solution of sodium pentothal, as made up according to these instructions, is 5 per cent. Evipan and the other British-made equivalents are used in a 10 per cent solution.

Technique of Administration.—Before it is decided to use intravenous anæsthesia an examination of the patient's veins is advisable. The median



Fig. 787.—Intravenous anæsthesia being administered via Edwards's vein seeker

basilic vein in the antecubital fossa is usually chosen, but if this is unsuitable, a search for a better vein can be made in the region of the ankle or on the dorsum of the foot. Varicose veins are unsuitable because the blood is stagnant. In the case of small or difficult veins the use of an Edwards's vein seeker (*Fig.* 787) is a great help. The technique of Edwards's vein seeker is described on p. 37.

The patient should always be placed in the recumbent position for this form of anæsthesia, because a fall in blood-pressure is to be expected. When an arm is selected for the injection it should be placed on an arm-rest, or firmly on the table, and fully extended. Constriction is applied above the vein, either by means of a piece of rubber tubing used as a tourniquet or pressure exerted by an assistant's hand; only sufficient pressure is required to make the vein stand out prominently. During the injection the arm or leg must be held quite still, otherwise the needle may be dislodged from the vein and the solution injected into the perivenous tissues. Extravasation of these drugs into the tissues is liable to cause an inflammatory reaction which may give rise to serious trouble; considerable necrosis sometimes results.

The needle is inserted well into the lumen of the vein and the plunger of the syringe slightly withdrawn; blood should then pour into the syringe. The

assistant releases the pressure on the upper arm, and the injection is commenced. The rate of injection is 3 c.c. in the first fifteen seconds, and this amount usually produces sleep. A pause of about 15 to 20 seconds is now advisable, and the patient's reaction to the drug is noted. The injection is then continued at the rate of 1 c.c. every 5 seconds until the required depth of anæsthesia is attained. The amount of pentothal necessary for any particular operation varies widely in different individuals. Each patient must be assessed on the dose needed to produce sleep.

CONTINUOUS PENTOTHAL ANÆSTHESIA

The following résumé includes some examples where this form of anæsthesia can be employed with advantage. There are many occasions where an anæsthetic via the respiratory passages is contra-indicated or undesirable, for

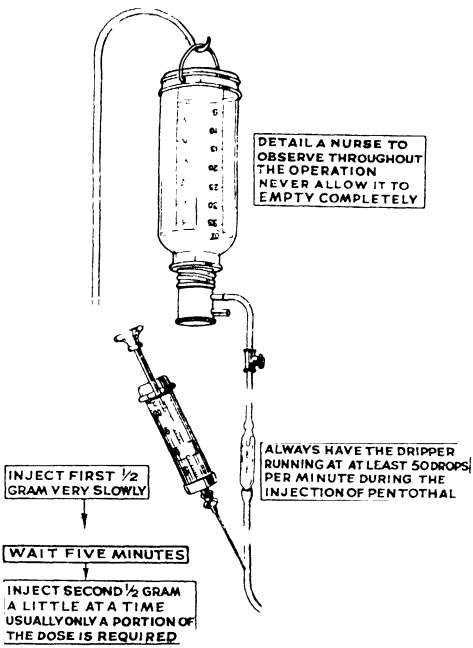


Fig. 788.—Symposium of essential details of administering an intravenous anæsthesic agent into the tubing of a continuous intravenous drip saline apparatus.

instance, if the patient has phthisis. Prolonged intravenous anæsthesia can also be used to supplement local anæsthesia. Very small, repeated doses—just enough to keep the patient asleep—can be given from time to time if an Edwards's vein seeker (*see Fig.* 787) is in place.

Continuous pentothal anæsthesia can be given through the tubing of an already instituted intravenous drip saline infusion. Before attempting the injection the screw clamp must be adjusted so that there is a steady flow (not a drip) of saline solution through the interceptor. The rubber tubing not far from the cannula is cleansed with spirit and 0·5 g. of sodium pentothal in a 5

per cent solution is injected very slowly into the lumen of the rubber tubing to produce the initial anæsthesia (*Fig.* 788). Subsequently anæsthesia is maintained by the use of a 2½ per cent solution injected as required. Whenever an injection of anæsthetic is given the screw clamp must be turned on as described above. When the injection of the anæsthetic is completed, the drip must be adjusted to about 40 drops per minute unless there is some indication for giving more. While this form of anæsthesia is in progress, it is a wise precaution to deliver a steady stream of oxygen to the patient by means of a lubricated catheter passed down the nostril to the base of the tongue. Throughout the anæsthetic attention must be paid to depth and regularity of the respirations and a good airway maintained. Some experience of pentothal anæsthesia is essential before the beginner uses the continuous method.

OVERDOSAGE

Death from pentothal anæsthesia is fortunately rare. *The great danger is injecting even a comparatively small dose too quickly.* The chief complication is respiratory depression, and if this becomes extreme, oxygen under slight positive pressure must be given immediately, preferably by using the re-breathing bag (*see* p. 599). The airway must be clear. Artificial respiration may be necessary. Give 3 c.c. of coramine intravenously or (better) 2–5 c.c. of 0·3 per cent solution of picrotoxin, also intravenously.

Other complications.—Muscular twitchings and jactitations of the limbs do not, as a rule, occur during pentothal sodium anæsthesia, but are sometimes observed during the early stages of evipan anæsthesia. Hiccup may occur when the drug has been injected too quickly and this can be controlled, to a large extent, by CO_2 inhalations.

CHAPTER LXXVI

THE TREATMENT OF ACUTE POISONING

By H. L. MARRIOTT

SERIOUS cases of acute poisoning are desperate emergencies ; there is not a moment to lose. Because of the urgency of the situation it is necessary that the house surgeon confronted with a case of acute poisoning should be equipped with a clear knowledge as to what to do and how to do it.

The subject of toxicology is usually presented in relation to each of the individual poisons considered in turn. For each poison the symptoms are detailed and the treatment indicated. Since there are very many poisons, the reader is apt to gain the impression that the subject is complicated, and he tends in consequence to feel that he can never hope to remember indefinitely what to do except in regard to the commonest poisons

This chapter will present the treatment of poisoning in regard to poisons considered *as a whole*. Principles of treatment will be laid down which are applicable to *any* case of poisoning whatever, even if the nature of the poison is unknown. To apply these principles, all that must be known is : (1) That the case is one of poisoning ; (2) The route of entry of the poison ; (3) The chief effects which the poison is producing in the particular patient.

1. That the case is one of poisoning is almost always indicated immediately to the doctor by those who summon him or who bring the patient to him. In an experience of several hundred cases of acute poisoning, the author can only recollect two in which this was not true. It is, however, important to remember that, rarely, a case of acute poisoning may not be presented as such. Poisoning should be suspected in instances of inexplicable coma or intense vomiting or diarrhœa. In any case of coma due to poisoning, there may be sugar, albumin, or blood in the urine, and there may be an extensor plantar response.

Although the fact that the case is one of poisoning is almost always clear, yet it is not unusual for the precise nature of the poison to be unknown. The patient may have inadvertently swallowed some household substance of unknown composition, or he may have been seen to drink from a bottle which is now empty, or he may have been found beside an empty bottle or glass. This difficulty does not matter from the point of view of the general principles which are about to be stated. They are framed to overcome it, and in the rest of this chapter very few poisons will be mentioned by name.

2. The route of entry of the poison is also usually communicated to the doctor. If there is any doubt about it, the assumption should be that the poison has been swallowed.

3. The effects of lethal importance produced by poisons are usually immediately manifest, as will be explained later.

In the following pages the principles and methods of treatment will be discussed in detail. At the end of the chapter they are compressed into a short summary, which conveys the essentials of treatment in *any* case of acute poisoning, and which is all that need be memorized.

The aims of immediate treatment of any case of acute poisoning are two only: (I) Removal of the poison from the body if this is possible, or, if not, its conversion into an inert form; (II) Counteraction of such effects of the poison as are immediately endangering life.

I. REMOVAL OR NEUTRALIZATION OF POISONS

In the vast majority of cases poisons enter the body by being either inhaled or swallowed. It is very uncommon for introduction into the body to be by unusual routes, such as injection, through the skin or wounds, or via the rectum or urogenital tract.

Inhaled Poisons.—Inhaled poisons are put first because of the great frequency of carbon monoxide poisoning, which in Great Britain and America causes more deaths than all other poisons combined.

Removal of gaseous poison is essentially a matter of inducing a great increase in breathing, so that the poison can be washed out of the system. The promotion of increased breathing is most effectively achieved by inhalation of 7 per cent of carbon dioxide mixed with 93 per cent of oxygen. The breathing, owing to the stimulation of the respiratory centre by the carbon dioxide, is greatly increased within a minute or two.

Administration of the carbon dioxide and oxygen mixture is most simply achieved by use of an ordinary bag and face-piece, as used for nitrous oxide administration. The mixed gases are obtainable in cylinders. In carbon monoxide poisoning* the use of carbon dioxide and oxygen inhalation has enormously reduced mortality, and it is almost true to say that no carbon monoxide case should die if treated before life is quite extinct.

The inhalation of carbon dioxide and oxygen cannot take place if the patient's air-passages are obstructed, or if breathing has ceased or has almost ceased. Obstruction of the air-passages and depression of respiration are common in gas poisoning. Hence in such cases, clearance of the airway and the application of artificial respiration may be essential preliminary measures.

The airway may be obstructed from falling back of the patient's tongue in unconsciousness, or from the presence of aspirated fluid in the trachea and bronchi. Obstruction from prolapse of the tongue may be relieved by pulling the patient's tongue or jaw forwards. If traction is made on the tongue, it should always be gentle, and care should be taken that the organ is not injured by dragging it over the lower teeth. If traction is rough, very serious swelling of the tongue may follow within a few hours. When an instrument is used to pull upon the tongue, it should be a tongue clip or safety-pin and never crushing forceps.

When the air-passages are obstructed by fluid, it is necessary to turn the patient into the prone position and to raise the pelvis, so that he is sloping head downwards. The fluid can then run out by gravity.

Artificial respiration is described in Chapter II. In acute poisoning Shafer's method is desirable because of the advantages of the prone position.

* In suspected cases a diagnosis may be made by spectroscopic examination of the blood. A very dilute solution of the blood is made with distilled water. This solution has a bluish-red or cherry-red tint in contrast to the yellowish-red colour of a similar dilution of oxyhæmoglobin. The spectrum of carboxyhæmoglobin (CO-Hb) shows two bands closely resembling in position and character the corresponding ones of oxyhæmoglobin, but the bands of the former are distinguished by the fact that they are not altered by the addition of a few drops of ammonium sulphide, whereas those of the latter are changed to the single band of ' reduced ' hæmoglobin (*see* p. 75).

The removal of inhaled poisons, summarized in tabular form, thus consists in :—

a. Maintenance of the patient's airway
b. Artificial respiration } when needed.

c. Administration of a mixture of 7 per cent of carbon dioxide and 93 per cent of oxygen to all cases.

In carbon monoxide cases administration of the carbon dioxide and oxygen mixture should be maintained until the patient is thoroughly recovered. These patients tend to relapse, and the medical attendant and the nurse must be ready to reinstitute treatment for a period of twenty-four hours.

Swallowed Poisons.—The removal of swallowed poisons is best achieved by washing out the stomach. Emetics should only be used if a stomach tube is not available. Gastric lavage must be very thorough. At least two gallons of water should be used, a pint at a time, so that the stomach is washed out again and again and no poison whatever left behind. Lavage with one or two pints may be useless, because enough poison to kill the patient may remain in the stomach.

Gastric lavage should never be omitted because the patient has vomited or because some hours have elapsed since the poison was taken. If a patient has swallowed poison the stomach should be washed out, even if he seems perfectly well.

The only swallowed poisons in which lavage or emetics are contra-indicated are the corrosive acids and alkalis, because of the danger of perforation. These corrosives are the strong acids (sulphuric, nitric, and hydrochloric) and the strong alkalis (caustic soda, caustic potash, and strong ammonia). Carbolic acid, carbolic disinfectants, and oxalic acid are corrosive, but not sufficiently so to make gastric lavage dangerous.

In the author's opinion the neutralization of the corrosives constitutes the only instance in which swallowed antidotes are of much practical importance. In the case of all the other swallowed poisons, complete removal of the poison by thorough lavage is of more importance than theoretical attempts to render it inert. Precious time may be lost before the commencement of lavage through fussing over the question of an antidote.

It is not implied that neutralizing antidotes are completely valueless, but that they are of minor importance. A list of them will be found on p. 616. In a particular case, if the antidote is instantly at hand, it may be administered, added to the water used for the wash-out. No time, however, should be wasted over it if it is not readily available.

Technique of Gastric Lavage.—The apparatus required for gastric lavage is as follows :—

1. A Jaques' rubber stomach tube. For adults the tube should not be less than ½ in. in diameter, i.e., No. 23 to 30 of the English catheter gauge. These tubes are commonly made either 30 or 60 in. in length. The longer tube is preferable, as it obviates the necessity for the interposition of a glass connexion and further tubing. For children of 2 years and under, No. 15 is convenient. Stomach tubes used for gastric lavage should be fairly stiff, as too flexible tubes are difficult to introduce. Before the tube is passed, the distance to which it should be passed should be marked by the insertion of a safety-pin through the wall, but not the lumen, of the tube. For adults the pin should be inserted 20 in. from the tip of the tube, for infants of 2 years or less, 10 in. Before lavage the tube is

passed so that the safety-pin lies just outside the lips. During lavage the pin provides a convenient indication that the tube is being maintained in position.

2. A funnel of enamelled iron or glass.
3. Two mouth gags.
4. A tongue clip or a large safety-pin.
5. Two jugs, preferably of 1-pint and 4-pint sizes.
6. A pail.
7. Several newspapers to spread on the floor.

The most important consideration in washing out the stomach is to place the patient in a proper position. He must be so placed that his respiratory tract is not liable to be invaded by influx of fluid from the mouth. Whenever gastric lavage is performed, the mouth tends to fill with fluid vomited or regurgitated around the tube and also with saliva. Unless the patient is in such a position that the mouth and pharynx are on a lower level than the larynx, the fluid must run by gravity into the larynx, trachea, and bronchi; the only safeguard is the cough reflex, and this may be abolished in cases which are comatose.

Attempts to wash out the stomach with the patient in an unsuitable position, such as lying on the back or sitting up, produce in conscious patients great coughing and spluttering, while in unconscious patients immediate death from drowning or later death from bronchopneumonia may result.

The best position in general practice for the patient is lying prone (*Fig.* 789) on a couch, bed, or table, with the face projecting over its end and supported looking down towards the floor. The operator sits or kneels on the floor while passing the tube. In the prone position conscious patients experience only the discomfort of the passage and presence of the tube, without the addition of suffocation. Struggling children should be wrapped round and round with a blanket pinioning the arms. It is much easier to hold down a struggling patient in the prone than the supine position, quite apart from the fact that his fighting is less ferocious when he is not literally contending for his life.

The patient having been placed in the prone position, any false teeth should be removed and gags inserted on each side of the mouth. If possible, one assistant should be delegated to make the control of the gags his sole concern.

The end of the stomach tube should be lubricated with glycerin or liquid paraffin and then passed into the mouth in the middle line till it touches the posterior wall of the pharynx. The tube should then be pushed swiftly down the œsophagus into the stomach. The distance to which it is to be passed has already been mentioned. Introduction of the tube should be rapid, bold, but not rough; it is no use expecting conscious patients to swallow it.

When the tube has been passed, tepid water should be poured through the funnel into the stomach. When a pint has been introduced ($\frac{1}{4}$ to $\frac{1}{2}$ pint in children), it should be syphoned back by inverting the funnel into the pail. The first pint should be set aside for possible subsequent analysis.

The wash-out should continue, a pint at a time, until sixteen pints have been used. The volume of the returned fluid should be checked at the end, to make sure that no fluid has been lost. Loss of an appreciable quantity suggests perforation of the stomach, which would necessitate surgical intervention.

Emetics.—The only indication for the use of emetics is lack of a stomach tube. The emetic which is most certain in action is apomorphine hydrochloride, of which $\frac{1}{10}$ gr. administered by hypodermic injection will usually produce vomiting

within five minutes. Other emetics are zinc sulphate, ammonium carbonate, or powdered ipecacuanha; the dose of each is 30 gr. Convenient household emetics are a tablespoonful of salt or mustard powder. An oral emetic should be administered in half a tumbler of warm water and drunk quickly.

Neutralization of Corrosives.—As has already been stated, the corrosive acids are strong sulphuric, nitric, and hydrochloric acids; the corrosive alkalis are caustic soda, caustic potash, and strong ammonia.

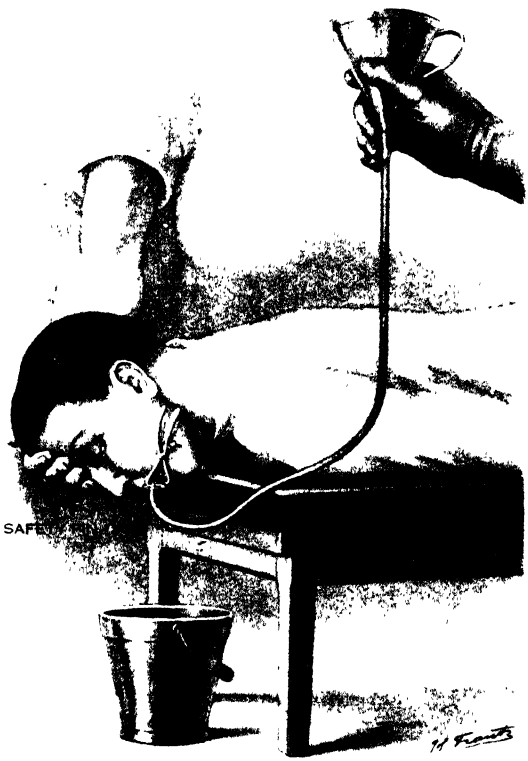


Fig. 789.—Washing out the stomach. For the sake of clarity, the operator's hand holding the tube and the assistant's hand holding the gag are not shown. The head must on no account be raised higher than shown.

The neutralizing agent should be administered in a pint of water (¼ to ½ pint in children), which serves to dilute the poison. More than a pint may dangerously distend the corroded stomach. For neutralizing the corrosive acids the best agent is magnesia (magnesium oxide), either mag. ox. lev. or mag. ox. pond.; four tablespoonfuls of the powder should be used. If magnesia is not readily obtainable, chalk, soapsuds, whitewash, ceiling plaster, or washing soda may be used. For neutralizing corrosive alkalis, 3 oz. of vinegar or the juice of half a dozen lemons should be employed.

Antidotes.—The following is a reference list of antidotes, with the amounts which should be added to two gallons of water. As has already been stated, they are, in the author's opinion, of minor importance.

Antimony	Tannic acid, 180 gr. (12 g.)
Arsenic	Add sodium carbonate to 2 fl. oz. of liquor ferri perchloridi till effervescence ceases. Filter, and use all the precipitated ferric hydroxide.
Atropine	Potassium permanganate, 60 gr. (4 g.)
Barium salts	Magnesium sulphate, 2 oz. (60 g.)
Cocaine	Potassium permanganate, 60 gr. (4 g.)
Cyanides	Potassium permanganate, 60 gr. (4 g.)
Iodine	Thin starch paste.
Lead salts	Magnesium sulphate, 2 oz. (60 g.)
Opium	Potassium permanganate, 60 gr. (4 g.)
Oxalic acid	Magnesium oxide, 4 oz. (120 g.)
Phenol	Magnesium sulphate, 2 oz. (60 g.)
Phosphorus	Copper sulphate, 15 gr. (1 g.)
Silver nitrate	Salt, 2 oz. (60 g.)

Poisons Entering the Body by Unusual Routes.—

Injected poisons cannot be directly removed or neutralized. If the patient is seen within a few minutes of the injection it may be possible, in the case of a limb, to prevent carriage of the poison to the rest of the body by the application of a sphygmomanometer cuff applied tightly enough to obstruct the venous return.

Poisons entering the body through the skin, wounds, rectum, or urogenital tract should be removed mechanically by swabbing away or by lavage.

II. COUNTERACTION OF SUCH EFFECTS OF THE POISON AS ARE IMMEDIATELY ENDANGERING LIFE

Although there are many poisons, each with individual peculiarities of action, yet the modes of mechanism by which they produce death are few. This fact forms part of the foundation of this attempt to simplify the treatment of acute poisoning.

If all the poisons are considered in turn and their lethal effects analysed, there results a list of only five common modes by which life is primarily endangered. Stated in order of frequency these are: (1) Asphyxia; (2) Depression of the central nervous system, i.e., coma; (3) Dehydration and dechloridation; (4) Pain and shock; (5) Excitation of the nervous system, i.e., violent delirium or convulsions.

Often two or more of these effects occur together and react upon one another. From a practical point of view it is fortunate that, with the exception of some cases of asphyxia, all are instantly evident and require no diagnostic skill.

It will be noticed that circulatory failure is not included in the list. Circulatory failure is the almost invariable final cause of death in poisoning, but it is consequent upon one or more of the above effects and not due primarily to poisoning of the cardiovascular system. Later complications, such as bronchopneumonia, nephritis, and hepatitis, do not concern the question of immediate treatment.

Not only are the five primary lethal effects of acute poisoning readily recognized, but they are also very amenable to treatment. In fact, it is true to say that very few cases of acute poisoning should die if seen before they are moribund.

1. Asphyxia.—This is the most frequent cause of death from poisoning. Its treatment is so urgent that relief of asphyxia should precede even removal of the poison. For this reason the treatment of asphyxia will be found to be put first in the final summary.

CAUSES.—Asphyxia may be caused by :—

a. Obstruction of the Patient's Air-passages.—A common cause is obstruction of the glottic aperture by the tongue having fallen back in a supine comatose patient. Œdema of the glottis may follow the inhalation of irritant gases or liquids, but is a rare occurrence.

Obstruction of the air-passages by fluid is relatively common. The fluid may be : (i) Inhaled vomit or saliva in unconscious patients ; (ii) Inflammatory exudate, following the inhalation of irritant gases or liquids ; (iii) Non-inflammatory transudate, when secondary circulatory failure is occurring.

b. Alteration in the Alveolar Epithelium.—This may follow the inhalation of irritant gases or irritant liquids, and result in serious interference with the normal diffusion of oxygen and carbon dioxide across the epithelium.

c. Interference with the Capacity of the Blood to Carry Oxygen.—The only important example of this class, but itself intensely important, is carbon monoxide.

d. Inadequate Respiratory Movements.—This common cause of asphyxia in acute poisoning is generally due to toxic depression of the respiratory centre, and occurs notably in severe carbon monoxide poisoning and in poisoning by the many depressants of the nervous system. It is also seen in severe poisoning by the irritant gases in the later stages. Very rarely, inadequate respiratory movements are caused by spasm of the respiratory muscles, e.g., in strychnine poisoning.

DIAGNOSIS.—Asphyxia should be diagnosed as being present in acute poisoning in all carbon monoxide cases and in all other cases with blue lips. The nature of the breathing is an unreliable criterion, for it may vary from the most violent respiratory efforts (" fighting for breath ") to the feeblest gasps, depending upon the influences operating in the particular case.

TREATMENT.—The principles of treating asphyxia are simple :—

a Maintenance of the patient's airway
b. Artificial respiration } when needed.

c. Administration of oxygen to all cases, with the addition of carbon dioxide to cases breathing feebly or due to gas poisoning.

The principles are, in fact, the same as for the removal of inhaled poisons, and the practical details have already been discussed. The best method for administration of oxygen or oxygen and carbon dioxide for short periods is by the ordinary nitrous oxide bag and face-piece. For longer administrations, the oxygen tent or nasal catheter is desirable. (*See* pp. 196, 197.)

2. Depression of the Nervous System : Coma.—The poisons which tend to cause coma are alcohol, the anæsthetics, the very many analgesic and narcotic drugs, carbolic acid and the carbolic disinfectants, and certain other poisons.

Coma is usually accompanied by some degree of asphyxia, either from obstruction of the airway or from feeble breathing. Conversely, severe asphyxia, as in carbon monoxide poisoning, so depresses the central nervous system that coma ensues.

In practice, acute alcoholism is the most frequent cause of toxic coma. Alcoholic coma may be quite deep when the patient is ' dead drunk '. There is often a history obtainable that the patient has recently been drinking heavily. The breath smells of alcohol. The pupils are usually moderately dilated and react sluggishly to light. A full bladder can often be palpated. All cases of acute alcoholism that are in coma should be treated in hospital and not consigned to the police station until they have come round. Such cases are seriously

poisoned. Further, a case of coma from some other cause may often on first inspection appear to be due to simple drunkenness. If the patient's coma is not deep, he may be left to sleep it off. If, however, he is deeply unconscious, it is advisable to wash out the stomach and to institute the other measures for the treatment of coma which are about to be described.

TREATMENT.—In the treatment of toxic coma there are two drugs of pre-eminent value, namely, strychnine and coramine. In regard to both it is desirable to administer relatively large doses, as the comatose patient tolerates and requires much larger doses than the patient who is not unconscious. In ections of strychnine, $\frac{1}{8}$ gr. hypodermically, and coramine, 5 c.c. to 15 c.c. intravenously or intramuscularly, should be administered immediately and repeated every one, two, or three hours according to the severity of the case.

In toxic coma the intracranial pressure usually rises, and some of the poison is usually excreted into the cerebrospinal fluid. For these reasons lumbar puncture is of value and should be performed immediately and at eight-hourly intervals thereafter as long as the coma continues. The technique of lumbar puncture is described on p. 394. The puncture should be controlled by a manometer, and the pressure of the fluid reduced, by allowing some to escape, until it is 120 mm. with the patient in the lateral recumbent position.

If coma is prolonged for many hours or days, the patient may become dehydrated from lack of fluid intake and from sweating. Such dehydration is dangerous in itself and also because it has the effect of preventing urinary excretion of the poison. The latter effect is very serious in barbiturate poisoning, since excretion of barbiturates occurs almost entirely by the urine. Hence in all cases of coma prolonged beyond eight hours, continuous administration of fluid per rectum or intravenously should be instituted.

The essential treatment of coma is thus :—

a. Strychnine, $\frac{1}{8}$ gr. (8 mg.) hypodermically, and coramine, 5 c.c. to 15 c.c., intravenously or intramuscularly—administered at once, and repeated as often as hourly if necessary.

b. Lumbar puncture—immediately, and eight-hourly as long as the coma lasts.

c. If coma is prolonged beyond eight hours—continuous rectal or intravenous saline.

3. Dehydration and Dechloridation.—Many poisons produce intense vomiting and often severe diarrhœa. The result is great loss to the body of water. The loss may be so great that the patient may lose a stone in weight in a few hours. In such cases water is not the only substance lost to the body. There is also great loss of inorganic salts, particularly sodium chloride.

Dehydration and dechloridation produce the picture of collapse. At first the patient complains of intense thirst and often of cramp in the limbs. Later he becomes delirious and then comatose. The skin is cold and clammy. The subcutaneous tissues are lax, and in consequence the expression becomes sunken. The blood-pressure falls and the pulse is rapid and feeble. The output of urine becomes extremely scanty.

TREATMENT.—The remedy for dehydration and dechloridation is the administration of water and salt. It must be realized that adult patients presenting the picture of dehydration have a fluid deficit of at least a gallon. They therefore require this amount of fluid, plus the amount of fluid which is lost during the process of administration.

Administration by mouth is best when practicable. Even vomiting patients should be encouraged to drink freely, and the amounts ingested and vomited should be recorded, to determine if any fluid is being retained. The best fluid for oral administration is half-normal saline (i.e., 0·425 per cent, or 40 gr. to the pint) sweetened with glucose and flavoured with lemon or orange. If the patient's condition appears to be serious, immediate intravenous administration of normal saline (0·85 per cent, or 80 gr. to the pint) is necessary. The saline should be administered by the continuous drip method, the technique of which is described in detail on p. 40.

As has been stated, the dehydrated patient's requirement of fluid is considerable. At the same time, waterlogging must be avoided, and observation should be kept for the development of œdema, particularly in the lung bases. It is desirable to establish a urinary output of not less than half a pint, or 300 c.c., every six hours. In comatose cases a catheter must be kept in the bladder.

4. Pain and Shock.—Pain in poisoning is met with principally in poisoning by the corrosive acids and alkalis, the gastro-intestinal irritants, the irritant gases, and strychnine. In corrosive poisoning the pain is so intense that it alone causes a considerable degree of shock, although probably the principal factor in the production of collapse is dehydration and dechloridation from the incessant vomiting.

TREATMENT.—Pain should be relieved by an immediate injection of at least ¼ gr. (16 mg.) of morphine.

5. Excitation of the Nervous System : Violent Delirium or Convulsions.—A number of poisons act principally as deliriants or convulsants, but with the exception of alcoholic delirium tremens, such states arising from acute poisoning are rarely encountered in practice. Neither delirium nor convulsions present any difficulty in diagnosis—they are only too obvious. Delirium indicates a cerebral effect. Convulsions, however, may be due to cerebral, medullary, spinal, or even muscular stimulation, depending upon the site of action of the particular poison involved.

TREATMENT.—Recent developments in the use of barbiturates have caused a great advance in the treatment of delirium and convulsions due to poisoning. Different workers have used different barbiturates, but all have testified to their efficacy. In the treatment of maniacal or convulsed patients it is necessary to use larger doses than are employed to obtain basal anæsthesia in normal individuals.

In the writer's experience pernocton has been extremely satisfactory. Pernocton is a 10 per cent aqueous solution of the sodium salt of the secondary butyl-brom-allyl barbituric acid. It may be administered intravenously or intramuscularly. The intravenous route has the advantage that quicker action is secured and the dose may be directly regulated by the effect produced. The disadvantage of this route lies in the difficulty of intravenous injection with a violent or convulsed patient. The intravenous injection should be given, drop by drop, at a rate not exceeding 1 c.c. per minute as timed by a watch, until the patient has passed into a quiet sleep. From 2 to 8 c.c. may be required, depending upon the body-weight of the patient and the intensity of his excitation. If the intramuscular route is employed, 1 c.c. per 20 lb. of body-weight (as determined by rough guessing of the patient's weight) should be administered. If this amount is not effective within a quarter of an hour, half the original dose should be injected.

The pernocton sleep usually lasts for several hours. If the patient becomes violent or convulsed upon awakening, a fresh injection may be given.

SUMMARY OF THE TREATMENT OF *ANY* CASE OF ACUTE POISONING

The practitioner should put the following three questions to himself and act instantly upon the answers evoked :—

I.—Is the Patient Asphyxiated or Suffering from Poisoning by a Gas ?

If so : *a.* Maintain airway } if
b. Artificial respiration } needed
c. 7 per cent carbon dioxide and 93 per cent oxygen for all cases, except non-gas cases which are already breathing more vigorously than normal, who need oxygen only.

II.—If the Poison was not Gaseous, how did it Enter the Body ?

If swallowed : Gastric lavage, unless it is known to be a corrosive acid or alkali.

If corrosive : Neutralize.

Other routes : Wash away poison if practicable.

III.—Is Life Endangered by any of the Four Following :

1. *Coma ?*

If so : *a.* Strychnine $\frac{1}{8}$ gr. (8 mg.) hypodermically and coramine 5 to 15 c.c. intravenously or intramuscularly—at once, and repeated as often as hourly if necessary.
b. Lumbar puncture—immediately, and eight-hourly as long as coma lasts.
c. If coma prolonged beyond eight hours—continuous rectal or intravenous saline.

2. *Dehydration and Dechloridation ?*

If so : Water and salt until relieved—half-normal saline by mouth if practicable, or, if not, normal saline by intravenous drip.

3. *Pain ?*

If so : Morphine $\frac{1}{4}$ gr. (16 mg.) for an adult.

4. *Delirium or Convulsions ?*

If so : Injection of pernocton—either 1 c.c. per minute intravenously till patient sleeps, or an intramuscular injection of a dose of 1 c.c. per 20 lb. of body-weight.

CHAPTER LXXVII

MEDICO-LEGAL REPORTS

By D. C. NORRIS

THE house surgeon is often asked to furnish a report about a case under treatment at the hospital. He should make sure before doing so that the patient consents to this—some hospitals have a rule that no such report may be given until a form is filled in and signed by the patient, giving his authority for the disclosure of the facts of the case (which are, of course, confidential). It is often required that the fee should be paid in advance. If the patient is unable, owing to his condition (e.g., mental defect) to give a valid consent, this should be sought from his nearest relative or other authorized agent.

Workmen's Compensation Acts.—These Acts provide that workmen shall be paid certain sums in respect of loss of earnings due to accidents at work. It is important to remember that the benefits provided are very limited, and do not include any payments in respect of disfigurement, pain and suffering, out-of-pocket expenses, or costs of treatment, such as would be recoverable in an action at Common Law. If the workman is able to earn as much as he did before the accident he is not entitled to be paid anything under these Acts. Neither has he any right to claim a ' lump sum ', since the Acts provide only a right to weekly payments. The employer is allowed, in certain cases, to redeem his future liability by payment of such a ' lump sum ', and this may also be paid by agreement with the workman in discharge of future liability. All such agreements must be ratified by a County Court, otherwise they are not binding on either party.

The Acts provide that when a workman claims compensation the employer has a right to have the workman medically examined at all reasonable times by a doctor selected by the employer ; the workman has a right to require that his own doctor shall be present at such an examination, but this right is seldom claimed, because the employer is not bound to offer a consultation fee, so that if the workman insists on his own doctor attending, the workman must pay his doctor's fee. The workman has no right to insist on his solicitor being present at the examination, or on its being carried out at his solicitor's office. If the workman refuses or obstructs the examination he is liable to forfeit his claim to compensation.

If the employer wishes (otherwise than by agreement with the workman) to reduce or terminate payments of compensation, he has to serve a notice on the workman to that effect, accompanied by a medical certificate stating that the workman is no longer disabled, or no longer wholly disabled, as a result of the accident, and the doctor is obliged to state the grounds on which he forms such an opinion. Such a certificate should be as brief and as clear as possible, thus :—

1. In cases in which the workman is no longer disabled :—

" This is to certify that I have to-day examined A. B., of (workman's address), in respect of injuries sustained by him on or about (date of accident), and that

in my opinion the said A. B. is fit to resume his ordinary work as (state workman's occupation). The grounds on which I form this opinion are as follows: The injured part has healed soundly. There are no signs or symptoms of disability for the work of (state workman's occupation)."

2. In cases in which partial recovery has been attained:—

Certificate begins with particulars of workman and of accident, as above, and continues as follows: ". . . in my opinion the said A. B. is now fit to undertake work not entailing (here follows a statement of what it is that the workman cannot do, e.g., raising the right arm above shoulder level, lifting weights exceeding 28 lb., prolonged standing, climbing ladders, etc.). The grounds on which I form this opinion are as follows: The fracture has healed, but with some deformity and restriction of movement in the injured limb. There are no signs or symptoms of disability for work of the kind herein suggested."

The expression "Fit for light work" should *never be used* because it cannot possibly be defined. ("Fit for work" is just as meaningless—it evokes the question, Fit for *what* work?).

3. In cases in which the workman has recovered from the effects of the accident, but remains disabled by some independent condition, e.g., heart disease, which has nothing to do with the accident:—

Certificate begins as above, with particulars of workman and date of accident, and continues as follows: ". . . in my opinion, the said A. B. is no longer disabled as a result of such injuries. The grounds on which I form this opinion are as follows: There are no signs or symptoms of disability due to such injuries. The said A. B. is now disabled on account of (state cause of present disability, not related to accident)."

If the workman wishes to dispute such a certificate he must do so within ten days, and serve on the employer a counter-certificate from his own doctor, who must likewise state the grounds on which he forms his opinion.

Disabled Persons (Employment) Act, 1944.—This Act has not yet (May, 1945) been brought into operation, but already, in anticipation of its enforcement, the Ministry of Labour has introduced a new form of medical certificate (R.D.1) which should be carefully studied by every doctor who is liable to be called upon to complete a certificate in connexion with the effort of a disabled person to obtain employment as provided by this Act. Form R.D 1 is designed to get over the difficulty due to the fact that very few doctors are sufficiently familiar with industrial processes to be able to say whether or not a particular man is fit to do a particular job. This Form sets out briefly to analyse the patient's functions, and to give information about his physiological capacities —strength of grip, range of movement, ability to run, jump, endure extremes of temperature, etc. This information, it is hoped, will enable the Disablement Rehabilitation Officer (who is supposed to be familiar with the physiological requirements of industry in the district) to assign the patient to suitable work. Copies of the Form can be obtained at any Labour Exchange, and it is recommended that any doctor who is often called upon to use it should take an early opportunity of meeting his local Disablement Rehabilitation Officer at the Exchange and establishing friendly contact with him—this will greatly facilitate the operation of this important Act.

Arrangement of Reports.—Insurance companies sometimes send a printed form, with a request that the doctor will complete this by entering answers to a series of questions. This form of report is particularly useful in life assurance

examinations, and other cases in which presumably healthy persons are to be examined; but in cases of injury or illness it is usually better for the doctor to construct his own report, in which irrelevant material can be omitted, and the salient features of the case given their proper emphasis. It makes for clarity if the matter is arranged under cross-headings, such as History of Accident, Previous Medical History, Present Complaints, Condition on Examination, and Opinion. *Diagrams are often useful, to illustrate loss of amputated parts, restriction of movement in joints, size and position of scars, and outline of fragments in cases of fracture.* If separate documents are to be sent—e.g., prints of radiographs, copies of pathological reports, etc.—it is advisable to give a list of these in a covering letter, in case they should become mislaid. *Original documents, e.g., X-ray negatives, reports signed by the pathologist, etc., should not be sent out of the hospital; care should, however, be taken that copies are accurate and legible, and include the full name of the patient and the date of examination.*

Doubtful Cases.—

The house surgeon may be in doubt as to some important aspect of the case, e.g., whether the condition found is due to the accident, or as to the diagnosis. Such doubts should, if possible, be resolved before a report is sent, but in no case should they find expression in a vague or ambiguous report. If the difficulty is such as could be resolved by some further tests or observations, then these should be undertaken if possible, or at least should be indicated in the report. Thus, it is unsatisfactory to say, "He is making a good recovery, although the fracture has not yet healed soundly"; the doctor should suggest a further examination at such a time as would probably enable him to give a final opinion as to whether bony repair has been secured or not. It is useless to report that a patient is "either a malingerer or a neurotic"—a definite opinion should be expressed, giving the grounds on which this is formed, or some further tests suggested which would resolve such a doubt. If information is then provided that the patient has been seen to engage in a strenuous game, it would be justifiable to report: "In view of the information furnished by you, and of my own examination of this case, I am of the opinion that A.B. is fit to resume his ordinary work."

The Doctor in the Witness Box.—If a case is taken to Court, the doctor may be asked to attend and give evidence. Sometimes this request is made informally, as by a telephone message or letter, which the doctor is at liberty to disregard if he so desires, although courtesy would suggest that he should say so if he does not wish to be called as a witness. His attendance at Court may be enforced by handing him personally a document called a 'Subpœna', which is an order of the Court, and which cannot be disregarded without making the doctor liable to proceedings for 'Contempt of Court', which might entail a fine or even imprisonment. The service of a subpœna should be accompanied by an offer of 'Conduct Money'—usually one guinea—which is intended to pay the witness's travelling expenses to the Court. Once the doctor has accepted the subpœna and the conduct money, he is bound to go to Court, but he need not give evidence unless his fees for doing so have been paid. If this has not been done, he should say so to the Judge before taking the oath; once this has been taken the witness is bound to give evidence, whether he has received his fees or not, and some excuse may afterwards be made for not paying him—e.g., the client's lack of means.

Although the witness swears to tell "the truth, the whole truth, and nothing but the truth", this phrase has a narrow, technical meaning. Actually, he will seldom be allowed to tell all he knows, but only to answer questions briefly—usually by saying "Yes" or "No" to the questions set by Counsel. These questions are often very skilfully devised, so that while the doctor is led to reply

to each question quite correctly, the general inference which Counsel seeks to draw from the whole series of answers may be very different from the true opinion of the witness. If a doctor thinks he is being unfairly treated, or that a wrong construction is being put on his evidence, he should say so to the Counsel calling him, or in the last resort he may make a protest to the Judge. It is a bad mistake to lose one's temper in the witness box; this is likely to lead to one's evidence being discredited.

The rules of evidence exclude not only everything which is irrelevant, but also all that is 'inadmissible', such as hearsay; thus a doctor will not be allowed to quote the observations of an eminent consultant with whom he saw a case, although such an opinion might be most important, and quite clearly relevant, the proper way to bring in such evidence is to call the consultant himself as a witness.

When he attends Court, the doctor should remember that he is at the service of justice, and should place himself unreservedly in the hands of Counsel, who is an officer of the Court, and should do to the best of his ability what is required of him. He should not be offended if the case turns out to be such that medical evidence is of little or no value, so that he may spend a good deal of time at Court without being called upon at all to give evidence; he should console himself with the reflection that he is entitled to his fees whether he is put into the witness box or not, so long as he actually attends Court when summoned to do so.

Preservation of Records.—A doctor who sends a medico-legal report should always keep a copy of it, together with all correspondence relating to the case, as legal proceedings arising out of the case may continue for months or even years.

As any case admitted to hospital, especially if it be one of injury by accident, is liable to be the subject of legal proceedings, in which the hospital notes may have to be produced in Court for the inspection of the judge and of Counsel, the house surgeon should always take care that these notes are as complete and as clear as possible, not only to the writer himself, but to anyone else who may have occasion to make use of them.

CHAPTER LXXVIII

ASSESSMENT OF INCAPACITY

By H. E. GRIFFITHS

IN order to determine the period of incapacity for work following an accident it is necessary not only to have a thorough knowledge of the physical and mental effects of the injury, but also an understanding of the exact nature of the work.

Incapacity for work may be due to a variety of different causes, the most important of which are :—

Pain	may incapacitate	for any form of work
Tenderness		e.g., a blacksmith—tender palm
Loss of touch		dressmaker
Weakness		labourer
Loss of joint movement		acrobat
Loss of joint stability		steel erector
Deformity		soldier
Mutilation		waiter
Loss of agility		barge hand
Loss of dexterity		watchmaker
Loss of working speed		typist
Loss of special sense		policeman
Loss of power of concentration		bookkeeper
Loss of memory		teacher
Loss of confidence		barrister
Irritability		receptionist
Giddiness		scaffolder
Fear		night watchman

Physical and mental attributes required in different kinds of work include :—

Muscular strength	by a	quarryman
Power of muscular endurance		timber porter
Manual dexterity		carpenter
Agility		professional cricketer
Speed of action		bottler
Muscle co-ordination		weaver
Self-confidence		salesman
Power of concentration		costing clerk
Good memory		commercial traveller
Amiability		private secretary

The conditions under which work is performed may affect the ability to work. For example, exposure to cold and wet may completely incapacitate a labourer with deficient circulation in one or more of his extremities, though the same man might be able to work quite satisfactorily inside a warm factory.

" Nature is prodigal in her gifts ", and in no occupation is physical perfection required, unless, perhaps, in that of an artist's model. It follows, therefore, that capacity for work may be restored before full recovery from an injury has taken place.

Table I.—PROBABLE PERIODS OF INCAPACITY FOLLOWING OPERATIONS

OPERATION	PROBABLE PERIODS OF INCAPACITY IN WEEKS			
	Class 1 (Heavy)	*Class 2 (Light)*	*Class 3 (Highly Skilled)*	*Class 4 (Sedentary)*
For Inguinal hernia	12	6	6	6
Femoral hernia	16	8	8	6
Umbilical hernia	12	6	6	6
Ventral hernia	12–16	6–8	6–8	6–8
Varicocele	8	4	4	4
Hydrocele	8	4	4	4
Appendicitis	12	6	8	6
On Stomach	12–16	8	12	8
Gall-bladder	12–16	8	10	8
Kidney	16–26	8–12	12	8–12
Spleen	26	12–16	12–16	12–16
Urinary bladder	12–16	8	8	8
For Ruptured urethra	8–10	6	6	6

Table II.—PROBABLE PERIODS OF INCAPACITY FOLLOWING OPERATIONS FOR SUTURE OF NERVES

NERVE	PROBABLE PERIODS OF INCAPACITY IN WEEKS			
	Class 1 (Heavy)	*Class 2 (Light)*	*Class 3 (Highly Skilled)*	*Class 4 (Sedentary)*
Median	104 +	52 +	104 +	52
Ulnar	52 +	26	52	4
Musculospiral	78	26–52	52	26
Sciatic	104 +	104 +	*	*
External popliteal	52 +	26 +	*	*
Internal popliteal	52 +	26 +	*	*

* Not necessarily incapacitating for work, but may interfere with travelling

Table III.—PROBABLE PERIODS OF INCAPACITY FOLLOWING OPERATIONS FOR SUTURE OF MUSCLES AND TENDONS, ETC.

[illegible]	PROBABLE PERIODS OF INCAPACITY IN WEEKS			
	Class 1 (Heavy)	*Class 2 (Light)*	*Class 3 (Highly Skilled)*	*Class 4 (Sedentary)*
Suture of—				
Supraspinatus	26	13	16	6
Biceps	26	12	16	6
Extensor longus pollicis	12–16	12	16	3–12
Flexors of fingers	12	6–8	12–16	6–8
Extensors of fingers	8–12	6–8	8–12	6–8
Quadriceps extensor	12–16	8	6–8	6–8
Tendo Achillis	12–16	8	6–8	6–8
Removal of cartilage—				
Internal semilunar	12–16	8	6–8	6
External semilunar	12–16	8	6–8	6

Table IV.—PROBABLE PERIODS OF INCAPACITY FOLLOWING FRACTURES

BONE	PROBABLE PERIODS OF INCAPACITY IN WEEKS			
	Class 1 (Heavy)	*Class 2 (Light)*	*Class 3 (Highly Skilled)*	*Class 4 (Sedentary)*
Clavicle	8–10	5	7	5
Scapula	10–12	8	10	6
Humerus, neck	20–26	12	20–26	12
,, shaft	16–20	12	20	8–12
,, supracondylar	16–20	12	20	8–12
Radius, head	8	6	8	4
,, shaft	12	8	12–16	8
Ulna, olecranon	12–16	8	12–16	8
,, shaft	8–12	6–8	8–12	6–8
Radius and ulna	12–16	10	20–26	10
Colles's fracture	10–12	6–8*	12*	6*
Scaphoid (carpal)	12–26	*	*	*
Semilunar (dislocation)	12–16	*	*	*
First metacarpal (Bennett)	10–12	6	12–16	6
Metacarpals	8–12	6–8	12–16	6
Phalanges	6–10	6	12–16	*
Pelvis	12–16	8–12	8–12	8–12
Femur, neck	—	26	12	12 +
,, shaft	39–52	16–20	16	16
,, condyles	39–52	16–20	16	16
Patella	16–20	8–12	8–12	8
Tibia, head	39–52	16–20	16*	16*
,, shaft	26–39	12–16	12*	12*
Tibia and fibula, shafts	26–39	12–16	12*	12*
Malleolus, including Pott's fracture	16–26	10	10*	10*
Fibula, shaft	6–8	4	4*	4*
Astragalus	20–26	12–16	12*	12*
Os calcis	26–104	26–52	26–52*	26*
Metatarsals	12–20	8–12	8*	8*
Phalanges—				
Great toe	8–12	6–8	6*	6*
Other toes	4–6	3	3*	3*
Vertebræ—				
Bodies:				
Cervical	20–26	10–12	26	10–12
Thoracic and lumbar	39–104	26–52*	26–52*	26–52*
Pedicles	39–104	26–52*	26–52*	26–52*
Spinous processes:				
C. 6, 7 and D 1 (digger's fracture)	3–6	3*	3*	3*
Dorsal and lumbar	8–12	6–8	6–8*	6–8*
Transverse processes (lumbar)	8–12	6–8	6–8*	6–8*
Sacrum	26–39	12–16	12–16	12–16
Coccyx	8–12	6	6–12	6–12
Mandible	8–16	8*	8–12*	8*
Ribs	8	3	4–6	3*
Skull†				

* After immobilization of the fracture with plaster-of-Paris or otherwise, the patient may be able to return to work before union has been secured.

† Details in fractured skulls cannot be given because the incapacity is due entirely to the brain injury, which varies very considerably in different cases.

The task of the determination of capacity for work after injury is that of an estimation of the restoration of function in relation to the requirements of the work. For example, in the case of a labourer who had a fracture of the femur two years ago which is now firmly united with one inch of shortening, capacity for work will depend on: whether he is relatively free from pain; whether the limb is strong and supple; whether there is sufficient joint movement to allow him to bend and pick up loads and to climb ladders; whether his joints are sufficiently stable to give him a sense of security when working on scaffold boards, etc. The fact that he may have a slight limp from the shortening of the leg is not an indication of incapacity; the fact that he may have about 15° loss of flexion of the knee-joint is not evidence of incapacity. If, on the other hand, the man had been a waiter instead of a labourer, the limp caused by the shortening would probably prevent his resuming work in his old trade.

In *Tables I–IV* (pp. 626, 627) an attempt is made to give a rough guide to the periods of incapacity which may be expected after certain injuries or operations in otherwise uncomplicated cases. For example, it is assumed that the patients are able to get proper nourishment and that they are not obsessed with thoughts of compensation or litigation.

Four general classes of work are considered —

1. Heavy manual work.

2. Light manual work, i.e., work which, having regard to the age, sex, and physique of the patient, places no great strain on the muscular system either by the employment of sudden force or by prolonged usage.

3. Highly skilled manual work, i.e., work requiring considerable training in order to acquire the necessary dexterity, e.g., watchmaking, typing.

4. Sedentary work of the office type

Operations on Nerves.—In the hands of the expert a fairly high percentage of successes may be obtained after immediate suture of divided nerves, but under present conditions in the treatment of industrial injuries delayed suture is more frequently seen, and less than 25 per cent of cases are successful *Table II*, therefore, can only be considered as a guide to those cases in which suture proves successful.

CHAPTER LXXIX

THE RELATIONSHIP OF THE HOUSE SURGEON TO HIS CHIEFS, HIS PATIENTS, AND THE NURSING STAFF

By J. A. EAST

A. TO HIS CHIEFS

THE house surgeon has certain fundamental duties towards his chiefs, and to a great extent it is on the proper discharge of these that his future progress depends. Loyalty is most desirable; most people dislike hypercritical juniors. It should be borne in mind that often the house man is not in full possession of facts; consequently, he may not appreciate the reasons of his chief's judgement regarding a particular case. It is right and proper that the house surgeon should discuss the whys and wherefores of diagnosis and treatment with his seniors, but this should never be done in front of the patient or his relatives.

The house surgeon should exercise initiative and resourcefulness, but the unnecessary assumption of responsibility often brings regret. The chief should be informed of all serious complications, and, as far as possible, he should be told of day-to-day progress in cases giving rise to anxiety

The radiologist and pathologist should be furnished with necessary information so that their data may be correctly evaluated. In cases of special difficulty a personal discussion with the radiologist or the pathologist is of great help. It should be remembered that the final responsibility for diagnosis and treatment rests with the chief in charge of the case, and if it transpires that an error in diagnosis has been made it is irrelevant to attribute the blame to the radiological or pathological departments

B TO HIS PATIENTS

It is unwise for the house surgeon to give technical explanations to patients and their relatives, they are rarely able to comprehend these, and so often they paint gruesome and inaccurate pictures around ill-understood technical phrases. They should be told about the condition in simple terms, and it is essential that the house surgeon's explanations should tally with those of his chief. Conflicting views always lessen the patient's confidence in his medical advisers.

How much to tell the patient himself is a difficult problem. The patient's relatives should be told the truth and, when necessary, the full gravity of the situation must not be minimized. As far as possible a true prognosis should be given them, but if one must err, it is better not to be too sanguine. Relatives are more amenable if they have been prepared for the worst, and if the issue is more favourable than was expected they are all the more grateful. The patient should never be told that he is suffering from cancer or incurable disease. A direct question, as far as possible, should be evaded, and in any case terms like 'growth' should be used. 'Cancer' is a word that is dreaded, and it is unkind and unnecessary to employ it.

When a patient is suffering from venereal disease he should be told about it, its complications, and its effects on his family. Thus, fully comprehending its

dangers, there can be no excuse for the patient not following the advice given in every detail.

Nothing about these diseases should be told to the relatives. If the patient wishes them to know he must tell them himself. On the other hand, it is the doctor's duty, if possible, to find out if the patient's family is also infected. In the case of syphilis, he should endeavour to get a Wassermann reaction performed on the patient's marital partner and children.

C. TO THE NURSING STAFF

By DAME ELLEN MUSSON

Close co-operation between the Medical and Nursing Staff is essential if the full benefit of medical or surgical treatment is to be attained. To prescribe such treatment is the duty of the Medical Officer. It is the province of the Sister to see that his orders and directions are skilfully carried out and the patients efficiently nursed. The general management of the ward or department is also her responsibility.

In no place is the maxim that " manners makyth man " more true than in a hospital. Courtesy and consideration when shown to each other by the Medical and Nursing Staffs lead to loyal co-operation, and help to maintain the happy and peaceful atmosphere which is necessary for the patients' complete recovery. A domineering autocratic bearing with an absence of good manners has the reverse effect.

Punctuality on the part of everyone is necessary to the smooth working of the complicated machinery of a hospital and of the hospital wards. No Resident Medical Officer can expect smooth working conditions if he ignores this fact and is erratic and unreliable in the performance of his duties.

A nurse, by reason of her continuous attendance on the patients, has greater opportunities for detailed observation than has the Medical Officer in his periodic visits. Many nurses thus acquire something which almost amounts to 'instinct' in regard to their patients. An experienced Ward Sister is able to help a Resident Surgical Officer not only by her knowledge of the methods most favoured by the Visiting Medical Staff and by her knowledge of the idiosyncrasies of individual patients, but also by reason of this acquired 'sense' which often warns her of changes in a patient's condition before such are apparent to a newly qualified Medical Officer. A wise man, who takes advantage of his opportunities when holding a hospital post and works in close and friendly collaboration with the Sisters, will often reap great benefit from their riper experience.

CHAPTER LXXX

HOSPITAL ADMINISTRATION

By H. H. MacWilliam

THE out-patient who said to the house surgeon " It is the likes of me what put that white coat on you " spoke with a measure of truth. The hospital exists for the sake of the patients. This should be the guiding principle of the medical administrator, who must also remember that he is primarily a doctor.

The Medical Staff.—The reputation of a hospital depends more upon the acumen of its staff than upon any other single factor. An imposing building, latest equipment, and elaborate special departments are excellent attributes, but they are of secondary importance in consolidating a hospital's reputation It is the duty of the administrator to promote harmonious association and co-operation among the staff. An atmosphere of goodwill and loyalty and the absence of jealousy and excessive rivalry indirectly results in the efficient treatment of the patients. Each member of the staff should be given his due position and demarcation of function, so that there can be little opportunity for one member to encroach on the sphere of another. If misunderstandings arise, the administrator should arbitrate.

In general, responsibility should be placed where it properly lies, and credit for achievement should be distributed similarly. Most individuals do their best work when they act on their own volition, and as long as this does not interfere with the work of others, freedom of action should be allowed. It is too much for every member of the staff to expect to do as he likes, but at least he should like what he is doing. Energy and originality in the staff should be encouraged.

It is often wise to introduce changes gradually ; few administrative problems are urgent. There should be full discussion of the whole staff on matters of general policy, and suggestions from any member should be given proper consideration. Always, the aim in view should be to act in well-balanced unity.

Contacts with the General Public.—All members of the public coming to the hospital must be treated with consideration and courtesy. Minor hospital officials must not be allowed to display the insolence of office ; on the other hand they should preserve a certain dignity. Jokes and levity are out of place, for they are liable to be misunderstood by outsiders.

Letters must be answered promptly. Copies should be made and filed with the case-sheets, if the inquiry refers to a patient. Care should be taken to spell names correctly, and if reference numbers have been given in letters they should be noted in the replies. Letters to doctors about patients should give all the information that may be useful. If the diagnosis arrived at in the hospital differs from that made by the general practitioner, always remember that the facilities of the hospital make accurate diagnosis much easier. Never yield to the temptation to crow over the mistake of a fellow practitioner.

Admission of Patients.—Every hospital has its own regulations about the classes of cases to be admitted and the areas from which they may be expected,

but all require that the patient who comes for admission should be attended to promptly. Nothing damages the reputation of a hospital more than publicity concerning an ill person kept waiting unnecessarily.

All the particulars required—name, age, address, religion, date, time, and so on, must be fully, accurately, and legibly recorded.

The medical examination cannot be expected invariably to result in an exact diagnosis, but it should discover the category to which the patient belongs, so that he may be sent to the correct ward. If a surgical case, handicapped with a medical label, is sent to a medical ward, a tragedy may result. A fundamental point at this early stage is to recognize a really ill patient, and particularly if there is any need for immediate further professional advice. In this connexion the hospital resident should not be too proud to take into consideration the opinion of the nursing staff. Experienced sisters can often perceive better than a newly-qualified doctor whether a patient is gravely ill.

'*Drunk or Dying*': This is a well-recognized perplexity. That the patient's breath smells of alcohol is no criterion. If, after due deliberation, you come to the conclusion that the patient is inebriated, do not be content with writing on the record paper 'C_2H_5OH'; record all the observations which led you to the diagnosis.

Infectious Cases: If there is doubt about the diagnosis, consult with a colleague before the patient leaves the receiving room. By taking this precaution the spread of infectious disease may be prevented.

The house surgeon who refuses to admit a patient frequently assumes heavy responsibility. The usual excuse for refusing a case is shortage of beds. It is difficult to believe that any hospital worthy of the name cannot make a bed for such a case as a perforated duodenal ulcer or a patient with a tourniquet around his leg. Transfer of such cases can seldom be justified. If it appears likely that the patient cannot be admitted, it is much better to send him on at once, after conducting an examination in the ambulance, rather than to keep him waiting in the Casualty Department.

Visiting.—Visitors disturb the work of a ward, and are sometimes regarded as a nuisance. Nevertheless, it must always be remembered that the happiness of patients depends very much on the facilities for seeing their relatives and friends. For ordinary patients who are not dangerously ill it is well to have a short period of visiting, say half-an-hour, every day. An arrangement such as this can be fitted in the ward routine and causes less disturbance than long visiting hours, even if they are less frequent. When a patient is dangerously ill the relatives must be allowed to come whenever they wish, but the time they actually remain with the patient must be regulated by the doctor or the sister-in-charge, who will take into consideration the best interests of the patient.

In the Wards.—An excellent method of judging the efficiency of a hospital is to inspect a representative group of case-sheets. It is hardly possible to exaggerate the importance of the dated record and progress notes. When a patient has been in hospital for a long time or suffers from chronic disease, it is a good standing rule to have recorded and initialed that the patient has been examined periodically, even if no new facts were discovered. As soon as a diagnosis is made it should be entered in the appropriate space on the case sheet. This is particularly important in the case of notifiable infectious diseases.

Operations.—No operation may be performed without the consent in writing of the patient. In the case of minors, that is, persons under 21 years of age,

unless the condition is extremely urgent, authority must be obtained from a parent or guardian.

This rule often causes considerable inconvenience because firstly many persons under 21 years of age lead lives of independence and are not in close contact with their parents, and secondly, the urgency or otherwise of an operation is sometimes a matter of opinion.

A good case can be made for taking 16 as the critical age because the Ministry of Health Order 1930 covering the administration of Poor Law Hospitals, following long-established precedent, takes 16 as the age at which a person ceases to be a child, but the fact remains that a surgeon who accepts the signature of a person under the age of 21 must be prepared to defend his action.

It is wise to adopt the form of permission suggested by the Medical Defence Union.

It is advisable to obtain the consent of the husband before performing an operation upon his wife, althought there is no obligation to do so unless the operation is one which might cause sterility or interfere with marital relations.

Births.—All births, both live and still, must be notified to the Medical Officer of Health. The child is born alive if it breathes or shows other signs of life after separation from the mother. If a period of gestation of less than 28 weeks results in a *dead* fœtus, the case is one of abortion or miscarriage. The distinction formerly made between abortion and miscarriage has been abandoned.

Maternity benefit under the National Health Insurance is paid in respect of all live births and for stillbirths after 28 weeks' gestation. It sometimes happens that a feeble newborn child dies before it is seen by a doctor. In such cases it is wise to notify the Coroner, and to abide by his instructions.

Mistaken identity of newborn babies is not unknown, and it is advisable to have standing rules designed to prevent such errors. Before the child is removed from the labour bed a strip of adhesive strapping bearing the name should be attached to its skin As soon as convenient this is replaced by two labels in the form of tapes On each is written in marking ink name, religion, and date of birth. One tape is placed around the ankle and the other around the wrist. It is important to have *two* labels, in case one should become detached. When the tape labels are fixed, the temporary strapping is removed, and the identity checked by a second nurse.

Abortions.—There is little doubt that many abortions are induced by criminal action. If the patient herself is at fault, it is no part of the doctor's duty to report the matter to the police, although the Coroner must be informed should she die. If the abortion is known to be the work of a professional abortionist, the doctor who hides the fact carries a heavy responsibility ; other lives are at stake. He should persuade the patient to allow information to be given to the police. Should the patient be in danger of death, it is of cardinal importance that a dying declaration be made, and the doctor who takes no steps to obtain this evidence may incur grave culpability.

Attempted Suicide.—Attempted suicide is a crime. The facts must be reported to the police. Full contemporary notes must be made of all circumstances including the method of obtaining the drug or weapon. The hospital may be at fault in allowing access to poisonous drugs. In many instances the action of the patient can be attributed to a disordered mind and he can be transferred to a ward for the insane As a rule, if it can be avoided, the police are reluctant to take action.

Dangerous Drugs.—Narcotic drugs should be ordered only for the benefit of the patient; they should never be given for administrative or nursing convenience. Orders for Schedule I drugs must be signed—initials are not sufficient.

Signing Certificates.—In legal circles it has been said that a doctor will sign anything; there are some grounds for this assertion. All certificates should be read carefully to make sure that the statements certified are within one's knowledge, and are true. A certificate is true only for the time at which it is signed; never certify to-day something which you expect will be true to-morrow. Never sign blank certificates, leaving the blanks to be filled in by someone else. A facsimile rubber stamp must only be used under the hand of the principal. If it is for open use, the words 'per pro' must be embodied in the stamp.

Information about Patients.—Anything that is discovered about a patient is confidential and must not be divulged without his consent. It is generally assumed that the patient will allow information which is required for medical reasons to be passed on, so letters to doctors are written freely, but in all other cases consent must be obtained, and if the information is required for legal purposes, the consent of the patient or his legal adviser should be in writing.

The inquiries of outsiders, such as employers of labour, should be carefully scrutinized, especially if the inquirer feels that for any reason he occupies a privileged position in relation to the hospital and gives an assurance that any information supplied will be treated as confidential.

Even to relatives information should not be given without thought. A simple inquiry from a husband about his wife may be made with a divorce in view

In cases which are of public interest the Press may be informed of the general condition of the patient, but details of injuries or diseases must not be given without permission.

For answering telephone inquiries it is well to adopt a list of approved terms, if only to avoid the constant repetition of the word 'comfortable'.

The distinction between a dangerous illness and a serious illness should be appreciated.

A dangerous illness is one in which there is clearly risk of the patient dying. A serious illness is one which causes considerable incapacity but does not necessarily involve risk of death. All dangerous illnesses are serious, but all serious illnesses are not dangerous.

Discharge of Patients.—A patient must be allowed to take his discharge whenever he wishes to do so. If he selects an inconvenient time an effort to persuade him to stay is permissible, but he cannot be compelled to give reasonable notice of his intention to depart unless the hospital is administered under the Poor Law. If he is medically unfit to go, he should be asked to sign an acknowledgement that he is leaving against medical advice, but again it must be remembered that he cannot be compelled to sign such an acknowledgement. If he refuses to sign, it is a good practice to have a witness that he has been advised, but refuses, to stay in hospital.

Before discharging a patient it is necessary to see that all his notes are completed and in order. A letter to the patient's doctor may be written at this time, but if this is not the custom of the hospital care should be taken that all the material required to answer an inquiry from the doctor is available. Before discharge the patient should be reasonably fit to cope with the conditions he will meet outside. The efficiency of hospitals is judged too often by the average length of stay of the patients, but this is not always a good criterion.

Transferring Patients to other Hospitals.—Too often an urge to transfer a patient is not inspired by zeal for his welfare. To transfer a patient is not an achievement—rather is it the admission of incapacity of some kind on the part of the hospital. Every transfer is a potential source of dissatisfaction. Complaints may come from the patient, his friends, or the receiving hospital. It is common prudence to refrain from transferring a case which may place some member of the hospital staff in an unfavourable light; the hospital's dirty linen should be washed in the hospital's own laundry.

If, after full consideration, a decision to move the patient is reached, make sure that proper arrangements are made for his transfer. See that his relatives are given adequate notice, and, above all, pass on to the receiving hospital the information you yourself would expect to be given in similar circumstances.

CONTROL OF INFECTIOUS CASES

Some of the infectious diseases do not arouse so much alarm as formerly. Erysipelas, for example, is not considered more infectious than any septic surgical condition and cases are commonly treated in general medical wards, but on the other hand some of the diseases which are not notifiable are taken very seriously. A streptococcal sore throat, an infected nasal sinus, or a discharging ear may set up a virulent infection in a surgical or maternity ward. A resident doctor must never fail to report sick when suffering from a condition of this kind. Fortitude is misplaced if it puts patients in danger.

Children should not be admitted to a large ward without undergoing a period of quarantine. On the admission of a child the parents should be asked about infectious diseases it has had and the information gained should be entered on the case sheet

Measles.—If a child shows any sign suspicious of measles, it must be isolated at once. As soon as the diagnosis is made (and it is well to be on the safe side), all contacts who have not previously had the disease must be given a protective injection. The most effective material is serum from someone who has recently had measles 10–15 c.c. should be given intramuscularly. If this cannot be obtained, serum from an adult who has had measles at any time may be used in doses of 20–25 c.c.. Placental extract also may be used in doses of 10 c.c. Towards the end of the first incubation period, the susceptible contacts must be kept in bed and frequently examined. On the development of any signs they must be isolated. Immunizing sera may cause a prolongation of the incubation period. At the end of the second quarantine period the same procedure must be carried out if there have been any fresh cases. The ward must be closed to all children who have not had measles.

Whooping-cough, like measles, is very infectious in the early stages, and often infection is spread because the doctor waits for the whoop before making a diagnosis. A paroxysmal cough is usually sufficient evidence. Unfortunately, there is no protective serum.

Mumps is frequently troublesome because of the length of the incubation period. The diagnosis is frequently made in error.

Diphtheria, Scarlet Fever, Whooping-cough, Mumps, and Chicken-pox must be dealt with by the same methods of isolation as measles. If a case of diphtheria should occur in a ward, throat and nasal swabs should be taken by the doctor from all contacts and sent for examination. All positive cases are isolated as soon as the reports are received. Some people give antitoxic serum 1000 units to all

contacts; others rely on early diagnosis and treatment of cases developing the disease.

Isolation.—Infections are usually spread by droplets, ward dust, or fairly close contact, either directly or through the medium of a third party. It follows from this that, given sufficient space, patients suffering from various diseases can be nursed in general wards by 'bed isolation', but this demands a high standard of nursing and imposes a great strain on all the attendants. In general, material is cheaper than personnel, so every hospital should have sufficient isolation wards or cubicles, properly furnished, and equipped with plumbing on a lavish scale.

If one is obliged to use bed isolation, strict instructions must be given. Ample space must be allowed; there should be at least 10 ft. between the patients. The floor of the wards should be treated with oil to prevent flying dust. Each bed must have a separate washing bowl, soap, nailbrush, and thermometer.

Everything taken to the patient should be free from infection and everything brought away should be sterilized as soon as possible.

If the patient is suffering from diphtheria or a disease of the typhoid group, all nurses should have been immunized.

All feeding utensils must be sterilized after use

Coats for the doctors and nurses hang by each bed These are put on before making any contact with the patient.

In normal times gloves are freely used

On coming away from the patient, the coat is first removed, and the hands are then well washed. Coats are to be worn when removing sanitary utensils to the sluice. The coat is afterwards removed at the bedside and the hands disinfected.

Respiratory Infections.—Infants, and particularly premature infants, are very susceptible to respiratory infections and every effort should be made to protect them. In hospital all infants up to at least 9 months old should be nursed with cot isolation technique as a general routine and not merely when there is known to be infection in the ward. All nurses and doctors should be free from infections such as colds. Masks are worn all the time a nurse is in the ward Coats are provided for each cot.

A nurse before coming to attend to a child washes her hands and then puts on a coat. On completion of her task she removes the coat and carefully washes her hands before passing to another cot

Visitors must wear masks and coats and must not be allowed to touch the children. Nursing mothers must use the same precautions as the nurses.

Deaths.—In some hospitals it is the rule that a resident should be summoned. In large hospitals it is difficult to keep to this rule, and it is probably unnecessary. It is essential that the sister should make a note on the case-sheet stating the date and the time of the death. This entry must be signed. The case-sheet is then sent to the hospital administrative office, sometimes with a special death notification form. From the office a notification is sent to the relatives.

The body is left in the ward for an hour. It is then washed and dressed in a shroud. A card stating name, age, and religion of the deceased, with the date of death, is sewn on to the shroud. A similar card is prepared for attachment to the mortuary shell. As this arrangement does not prevent the risk of confusion when a post-mortem examination is performed, a name label must be attached to one ankle. The body is then conveyed to the mortuary under the supervision

of a nurse. An undertaker should not be allowed to remove the body without the written order from the administrative office. When the undertaker arrives, the body is identified by a nurse after it has been placed in the coffin. If a nurse is not available, identification must be furnished by a relative.

An objectionable activity of some undertakers is the employment of touts to give early information of deaths. These touts make efforts to bribe minor hospital officials, and they are very difficult to detect.

Post-mortem Examinations.—It is to the benefit of all concerned that everything possible should be learnt about fatal cases. The American Medical Association lays down a rule that, if the hospital is to be approved for intern training, post-mortems must be performed upon a minimum of 20 per cent of subjects.

Permission for the post-mortem must be obtained from a near relative. While not a legal obligation, failure to obtain permission leads to a great deal of unpleasantness. If good reasons are put to the relatives with clarity and sincerity, more often than not consent is given. One must be able to assure relatives that there will be no delay in issuing the death certificate or the removal of the body, and that there will be no discernible disfigurement. The promises must be fulfilled meticulously.

Medical Care of the Nursing Staff.—Nurses and others on joining require a careful medical examination with a case-sheet similar to that used for patients. The previous medical history must be recorded. An X-ray examination of the chest should be made, and the hæmoglobin should be estimated. These examinations should be repeated every six months. The weight should be recorded every quarter. Those who have not had diphtheria or typhoid or paratyphoid should be given a course of immunizing injections, unless tests have shown them to be immune. If they have not been vaccinated, this must be carried out. Under the National Health Insurance regulations a nurse is under no obligation to select a doctor on the staff of the hospital as her panel doctor, although the convenience of the arrangement is so obvious that she generally does so. If a nurse wishes to consult a doctor, she must be allowed to do so without the consent of a senior member of the nursing staff.

CHAPTER LXXXI

CERTIFICATION OF DEATH AND REPORTING TO THE CORONER

By W. BENTLEY PURCHASE

DEATH CERTIFICATES

A REGISTERED practitioner who has attended a patient in his last illness is required by law to certify the cause of the death " to the best of his knowledge and belief ". When completing the form it is essential for the doctor to state when he last saw the deceased and whether he saw the body after death. It is necessary to set out the cause of death clearly, and ambiguous terms such as ' syncope ', ' coma ', ' respiratory failure ', etc., must be avoided.

The form provides for a main cause of death, and this is often sufficient, e.g., carcinoma of the stomach. It also allows a secondary contributory cause to be inserted, thus :—

I. (*a*) Intestinal obstruction ; (*b*) Carcinoma of pelvic colon (opn.—colostomy).
II. Chronic bronchitis.

The secondary or associated cause should be recorded only if it does really contribute to the death.

If a doctor for some reason notified a death direct to the Coroner, he should place his initials at the back of the certificate, and this will intimate to the Registrar that such notification has been given.

REPORTING A DEATH TO THE CORONER

It must be appreciated that while it is a doctor's duty, if he can, to issue a death certificate, it is the Coroner's duty to inquire into certain deaths reported to him. In theory it is permissible for a doctor to issue a certificate even in a case of death by violence, e.g., ' cut throat ', but under these circumstances it is incumbent upon the Registrar of Deaths to refer the certificate to the Coroner. Such a procedure only leads to delay ; it is obviously more convenient to all concerned for the doctor to report direct to the Coroner or, more often, to the Coroner's officer. The latter is usually a police officer. In cases of doubt the local police station will always assist in getting in touch with the nearest Coroner.

Once the Coroner is informed of a death, the entire responsibility of certification rests with him. He may take one of three courses :—

1. After inquiry, but without necropsy or inquest, decide that the death resulted from natural causes : in this case he gives permission to the Registrar of Deaths to accept a certificate issued by the doctor in attendance during the last illness.

2. Make inquiry and order a necropsy (for which he pays), and on the findings : (*a*) Issue a certificate himself ; (*b*) Hold an inquest.

3. Hold an inquest with or without a necropsy.

Cases to be Reported to the Coroner.—These are : (1) Sudden (i.e., unexpected) death—cause unknown. (2) Violent or unnatural death, including

poisoning or suspected poisoning, overdosage of drugs, etc. (3) Deaths of all lunatics. (4) Deaths of all foster-children.

'Unnatural' Deaths.—It is necessary to consider more fully the 'unnaturalness' of a death. Deaths due to violence or accident call for no comment; nevertheless it must be understood that the passage of time has no bearing on the necessity for reporting to the Coroner. A man may die from injuries received many years previously, but it is just as necessary to report the matter to the Coroner. Although the lapse of time precludes a criminal charge, it makes not the slightest difference to the fact that death was due to unnatural causes.

Unnatural deaths embrace those due to, or accelerated by, alcohol, drugs, self-neglect, or neglect by others. Even old war wounds come under this category; thus it is important to realize that a death which is expected, and the cause of which is understood, does not necessarily become natural.

War Casualties.—Deaths (civilian and service) which result from war operations are subject to special temporary provisions. They need not be reported to the Coroner unless there be some doubt as to the cause of death (as there well may be if there be no external indication, e.g., blast injury of lungs), or unless there is reason to think that some cause other than war operations has led to the death (e.g., coronary thrombosis during an air raid, or injuries sustained by a fall while seeking shelter in a raid).

Provision is also made for the deaths of persons killed in war operations and subsequently unidentified or wrongly identified, to be reported to and investigated by the Coroner; this procedure extends to the cases in which no part of the body remains.

Death during Anæsthesia or as the Result of Operation.—An anæsthetic may not necessarily render a death unnatural, e.g., a patient with intestinal obstruction may die on the way to hospital, in the lift up to the theatre, or on the table after the commencement of the anæsthetic. Under such circumstances death may be natural and due entirely to the condition causing the intestinal obstruction.

It used to be said that if a patient died on the operating table the fact should be communicated to the Coroner, whereas if death took place after the patient had once returned to the ward, no such notification was necessary. This is entirely inaccurate. The point to be decided is the cause of death, and the person to decide it is the Coroner on the information supplied to him.

In conclusion, it is better to err on the side of reporting a case unnecessarily rather than to omit to do so. In cases of doubt as to the cause of death, where relatives refuse a necropsy, the doctor cannot complete the certificate of death conscientiously. If this matter is reported to the Coroner, he may arrange for a post-mortem examination to be made at his order.

Payment of Fees by Coroner.—By statute a doctor who makes a necropsy at the Coroner's order is entitled to two guineas: if he gives evidence as well, he is entitled to three guineas; for giving medical evidence only, with no necropsy, the fee is one and a half guineas. In a few districts the Coroner is empowered to pay a fee varying from 3s. 6d. to 10s. 6d. to a doctor for providing a written report upon a case without necropsy or evidence in court.

CHAPTER LXXXII

DEATH CERTIFICATION IN SCOTLAND

by SYDNEY SMITH

IN Scotland the form of death certificate is simpler than that used in England and requires the doctor to state (*a*) the primary cause of death, and (*b*) the secondary causes, in order. This certificate must be sent to the Registrar within seven days of the death according to the law, but it is customary to hand it to a relative of the deceased to take to the Registrar

In no circumstances should a death certificate be given in duplicate, nor should a certificate be signed in blank for the relatives to fill up. Certificates should never be given :—

1. Without personally seeing the body, even when the medical practitioner has been constantly in attendance.

2. In any case where he has not been in attendance during the illness, even though he were present at the death.

3. In sudden deaths from unknown causes.

Death from an Accident.—When a person dies directly or indirectly from an accident, or when there is reason to suspect that death is not due to natural causes, a certificate may require to be given in England *and* the case reported to the Coroner. In Scotland in any of these circumstances a legal official known as the Procurator Fiscal should be notified, and no death certificate should be issued unless authorized by him

If the practitioner has any reason to believe that there is any suspicion about the cause of death, it is his common law duty to inform the Procurator Fiscal, apart altogether from his duties as a medical practitioner.

Post-mortem Examinations.—No post-mortem should be performed in any case of accident or where there is any suspicion of foul play, without instruction from the proper authority. Though the performance of such autopsy is not illegal (if without intent to impede or prevent subsequent investigation), it is most inadvisable, as it may hinder the proper administration of justice. When once a case is in the hands of the judicial authorities it may not be examined in any way without authority.

If there is doubt as to the cause of death and the relatives refuse to allow an autopsy the doctor may refuse to give a certificate of death.

Unnatural Deaths.—In the investigation of sudden death or death from unnatural causes, the procedure in England and Scotland differs, inasmuch as in England a public Coroner's inquiry is held, whereas in Scotland the inquiry is of a private nature carried out by the Procurator Fiscal. In either country, such an inquiry may lead to proceedings in various courts of law, and it is desirable that the medical man should have some knowledge of these

Death Under Anæsthetics or as a Result of Operation.—An anæsthetic may not necessarily render a death unnatural, e.g., a patient with intestinal

obstruction may die on the way to hospital, or on the table after the commencement of the anæsthetic. Under such circumstances death may be natural and due entirely to the condition causing the intestinal obstruction.

It is sometimes said that if a patient dies on the operating table the death should be considered to be due to the anæsthetic, but that if death takes place after the patient has returned to the ward it should not be so attributed. This is quite wrong. The point to be decided is the cause of death, and the person to decide it is the Procurator Fiscal or the Coroner on the information supplied to him.

It is better to err on the side of reporting a case unnecessarily rather than to omit to do so.

Suicide.—Scottish Law is quite different from English Law with reference to suicide. In English Law, suicide, or self-murder, or *felo de se*, is regarded as a peculiar instance of malice directed to the destruction of a man's own life. An attempt to commit suicide is a misdemeanour at Common Law, and is punishable by fine or imprisonment, provided that the accused was sane at the time of the attempt. In so-called " suicide pacts ", if one of the parties survives and the other dies, the survivor may be charged with murder. The doctrine of *felo de se* has never been part of the Law in Scotland, and an accessory to a suicide cannot be charged with any crime. Nor is it a crime in Scotland to attempt to commit suicide, although the circumstances may lead to proceedings on a charge of " breach of the peace ".

INDEX

PAGE

ABDOMEN, adhesive plaster dressing after operations on - - (*Figs* 352–356) 299
— bandage for - - - - (*Fig* 333) 291
— burst, post-operative - - - - 273
Abdominal aorta, digital compression of - 3
— belts, ordering of - - (*Figs.* 761–764) 592
— cases, lower, management of (*Figs* 251–261) 220–225
— corset after pancreatic operation - - 219
— distension, aspiration in - - - 387
— operations, complications after (*Figs* 304–306) 270–275
Abduction fracture of ankle - - - - 572
— — neck of femur - (*Figs.* 716, 717, A) 558
— — — humerus - - (*Fig* 690, C) 531
— frame for fractured humerus (*Figs.* 691, 692) 532
— — in tuberculous hip - - (*Fig* 737) 580
— splint, arm, ordering of - - - - 591
Abortion, criminal - - - - - - 633
— induction of - - - - - - 339
— perforation of uterus during evacuation of 338
— treatment of - - - - - (*Fig.* 443) 338
Abrodil in retrograde pyelography - - 150
Abscess(es), alveolar, acute - - (*Fig.* 598) 450
— axillary - - - (*Fig* 472) 355
— Bartholin - - - - - - 341
— breast - - - (*Figs* 469–471) 353
— cavities, chronic, injection of radio-opaque media into - - (*Figs* 157–161) 147
— cavity, exploration of - - (*Fig.* 465) 351
— cervical, deep - - - (*Fig* 468) 352
— development of, in pelvic inflammation - 269
— formation in tuberculous joint - 581, 582
— ischiorectal - - - - (*Fig* 473) 356
— localized, removal of drainage tubes in - 113
— of nasal septum - - - - (*Fig* 535) 408
— peri-apical - - - (*Fig* 597) 449
— peritonsillar - - - - - 404
— peri-urethral - - - - - 464
— popliteal - - - - - - 355
— prostatic, complicated by retention - - 249
— psoas, in tuberculous spine - (*Fig* 742) 584
— retropharyngeal - - - - - 405
— stitch - - - - - - - 274
— treatment of - (*Figs* 465–473) 351–356
Acapnia after tracheotomy - - - - 415
Accident, death from - - - - - 640
Acetabulum, marginal fracture of - - 557
Acetarsol in vaginitis - - - - - 265
Acetic acid in irrigation of empyema - - 203
— — lotion in burns of eye - - - 436
— — for washing out bladder - - 251
Aceto-acetic acid and acetone, tests for - 74
Acetone bodies in urine - - - - - 74
Acetylcholine inadvised in paralytic ileus 271, 272
— for post-operative flatulence - - - 270
Achlorhydria in fractional test-meal - - 383
Acid burns of eye - - - 436
— poisoning, treatment of - - - 613
Acidification of urine - - - - - 236
Acidogenic diet in acidification of urine - 236
Acidosis, post-operative - - - - 275
— pre-operative treatment of - - - 93
Acriflavine for bladder washes - - 251, 252
— as urinary antiseptic - - - - 237
Acromio-clavicular joint, dislocation of (*Fig* 686) 527
Actinomyces fungus in urine - - - - 85
Adalin as hypnotic - - - - - 115
Adaptor, syringe - - - (*Fig* 28) 29
Adduction fracture of ankle (*Figs.* 728, 731) 572, 575
— — neck of femur - (*Figs.* 717, B, 718) 559

PAGE

Adduction fracture of neck of humerus (*Fig.* 690, B) 531
Adenoids, removal of - - (*Figs* 538, 539) 411
Adenotome - - - - (*Fig.* 538) 411
Adhesions, articular - - - - - 476
— complicating sprains - - - - 475
— in connexion with arthritis - - - 477
— — muscles, tendons, or fasciæ - - - 477
— peri-articular - - - - - 476
— — causing shoulder stiffness - - - 533
Adhesive plaster in after-treatment of abscess 352
— — bandage in carbuncles - - - 358
— — — for varicose ulcer (*Figs* 494, 495) 376
— — — — veins - - - 372, 374, 375
— — in prevention of bed-sores (*Fig.* 478) 361
— — removal of - - - (*Fig.* 340) 295
— — technique in bandaging (*Figs* 340–376) 295–307
— — in treatment of bed-sores - - - 362
Adrenal cortical extract in burns - - 17, 18
Adrenaline in anaphylactic reactions - 55, 66
— burns of mouth - - - - - 27
— and cocaine in reducing paraphimosis - 318
— in epistaxis - - - - - - 411
— hæmorrhage from tooth socket - - 454
— injection into heart in white asphyxia 12, 13
— in pleural shock - - - - 387
— post-operative hæmatemesis - - 211
" Aeris " pump for wound drainage (*Fig* 204) 176
Aero-otitis - - - - - - - 422
Agranulocytosis due to sulphonamides - 277, 280
Air embolus, precautions against, in blood transfusion - - - - 55
— — — — saline infusion - - - 55
— replacement in aspiration of empyema - 280
— — of pleural effusion - - (*Fig* 506) 388
Airway in anæsthesia - (*Figs* 776, 777), 601, 605
— clearance of, in carbon monoxide poisoning 612, 620
Albargin irrigation in gonorrhœa - - 463
Albucid - - - - - - 276
— in Meibomian cyst - - - 430
Albumin in urine, tests for - - - 72
Albuminuria, benign - - - - - 71
— contra-indicating blood transfusion - - 54
— febrile - - - - - - 72
— organic - - - - - - 72
— orthostatic, urine in - - - 68
— plasma-protein deficit in - - - 229
— toxic - - - - - - 72
Alcohol test-meal - - - - - 383
Alcoholic coma - - - - - - 617
Alcoholism, unconsciousness due to - - 185
Alkali poisoning, treatment of - 613, 615
Alkaline burns of eye - - - - 436
— diuretic in gonorrhœa - - - 461
— lotion for blepharitis - - - - 432
— — lid margins - - - - 430
— 'tide' - - - - - - 71
— treatment of acute pyelitis - - - 238
Alkalinization of urine - - - - - 237
— — in cystitis - - - - - 255
Alkalosis, pre-operative treatment of - 93
Alkaptonuria - - - - - - 69
Allantoin for wound healing - - 180
Allen's bougie - - - - (*Fig* 276) 246
Allergic rhinitis - - - - - - 410
Alum alcohol in prevention of bed-sores (*Fig* 478) 361
Aluminium acetate in exterior otitis - - 421
Alveolar abscess, acute - - (*Fig.* 598) 450
— epithelium, alteration to, in poisoning - 617
Ambulatory plaster treatment of sprained ankle 474

PAGE

Amino-acids of casein, total, intravenous injection of - - - - - - 180
Ammoket in acidification of urine - - - 236
Ammonia burns of eye - - - - - - 436
Ammonium benzoate in acidification of urine 236
— carbonate as emetic - - - - - 615
— — pre-operative expectorant - - - 118
— chloride in acidification of urine - 236, 238
— — for bruise - - - - - - 472
— — in diuresis with mercurials - - - 382
— magnesium phosphates in urine (*Fig* 96, D) 80
— tartrate in lime burns of eye - - - 436
— urate in urine - - - (*Fig.* 96, B) 81
Ampoule cannula - - - - (*Fig.* 26) 29
— file for opening - - - (*Fig.* 25) 29
Amputation stump, strapping extension applied to - - - - - (*Fig* 375) 306
Amyl nitrite in persistent hiccup - - - 275
— — white asphyxia - - - - - 12
Anæmia, carbuncles and - - - - - 357
— pre-operative treatment of - - - 265
— resulting from burns - - - - - 19
Anaerobic streptococcus causing necrotizing pneumonitis - - - - - - 124
Anæsthesia in anal dressings - - - - 260
— aspiration of chest - - - - - 198
— basal - - - - - - - 97–99
— care of patient under - - - - - 605
— in cleansing of burns - - - - 21, 24
— continuous pentothal - - *Fig* 788) 609
— death during - - - - - 639, 640
— endotracheal - - - *Figs* 780–786) 602
— — complications of - - - - - 606
— in endotracheal suction - - - - 208
— gastric intubation - - - - - - 134
— general - - - *Figs* 773–786) 596–606
— impending death under - (*Figs* 19, 20) 10-14
— in incision of drumhead - - - - 422
— intravenous - - *Figs* 787, 788 606–610
— — collapse in - - - - - - 13
— local - - - - (*Figs* 377–383) 308
— for circumcision in adult (*Figs* 403, 404) 317
— — tooth extraction - - - - - 450
— low spinal - - - - - - 399
— in manipulative work - - - - 479
— for operations on diabetic - - - - 95
— in reduction of fracture - - - - 514
— for scalp wound - - - *Fig* 216) 181
— spinal - - - - - - - 399
— — collapse in - - - - - - 13
— stages of - - - - - - - 596
— in tonsillectomy - - - - - - 401
Anæsthesin in pain after dental extraction - 454
Anæsthetic agents - - - - - - - 598
— machine, Boyle's - - - (*Fig* 774) 600
— — closed circuit - - - (*Fig* 779) 602
Anæsthetics, oil-soluble, in ano-rectal operations - - - - - (*Fig.* 429) 330
Anæsthetist, care of patient by - - - - 605
— pre-operative duties of - - - - - 596
Anæsthetizing urethra - - *Figs* 409–411) 320
Anal canal, dilatation of - - (*Fig* 300) 260
— tissure, operative cure for - (*Fig.* 428) 329
— — post-operative injection of proctocaine in - - - - - - 330, 331
— — management of - - - - - 260
— — proctoscopy in - - - 324, 325
— hæmatoma - - - - (*Fig.* 420) 325
— spasm, treatment of - - - 326, 330
— skin tags - - - - - - - 325
Analeptic drugs - - - - - - - 10
Analgesics - - - - - - - - 114
Anaphylactic reactions to blood transfusion - 55
— — sera injections - - - - - - 66
Anaphylactoid crisis following arsphenamine treatment - - - - - - - 471
Anasarca, treatment of - - (*Fig.* 497) 380
Anethaine in gastric intubation - (*Fig.* 140) 134
— sialography - - - - - - 147
Angular vein, ligature of, in carbuncle of face (*Fig.* 475) 359

PAGE

Aniline dye treatment of monilial infection 266, 335
Ankle, adhesive plaster bandage for (*Fig.* 367) 304
— anterior marginal fracture of (*Fig.* 729) 573, 575
— dislocation of - - - - - - 571
— fracture of - - - (*Figs.* 727, 728) 571
— — bimalleolar with outward dislocation (*Figs.* 727, B, 730) 573
— — external malleolus - - - - 573
— — internal malleolus - - - - 573
— — temporary splinting of - (*Fig* 677) 508
— — weight-bearing in - - - - 519
— fracture-dislocation of - (*Figs* 727–731) 571
— manipulation of - - (*Figs* 620, 621) 481
— optimum position of - - (*Fig* 615) 478
— rupture of external lateral ligament of - 474
— sprain of - - - - - - - 570
— — external lateral ligament of - - 473, 571
— — — — — adhesions in - - - 476
— tuberculous - - - - - - 583
Ankylosis, optimum position for, in manipulation - - - - - (*Fig.* 615) 477
Ano-rectal operations, minor (*Figs* 416–429) 324–331
Anterior shell - - - - - 498, 500
Anthelmintic enema - - - - - 146
Anthrax, dose of antisera in - - - 67
Antidotes to swallowed poison - - - 613
— — — list of - - - - - - 616
Antifebrine in acute prostatitis - - - 464
Anti-gas-gangrene serum in paralytic ileus - 271
Antihæsin for removing adhesive plaster - 295
Antimony poisoning, antidote to - - - 616
Antiphlogistine in epididymitis - - 465
Antiseptics, urinary - - - - - 237
Antisera, dosage of - - - - - 67
Antrum, puncture and lavage of (*Figs* 533, 534) 408
Anuria - - - - - - - - 240
— due to crush syndrome - - - - 242
— — sulphonamides - - - - - 279
— — sulphonamide crystalluria - - - 241
— during blood transfusion - - 55, 56
— obstructive, intravenous infusion for 47, 241
— post-operative, in gynæcological case - 269
— treatment of - - - - - - 241
Anus, artificial, care of - - - - - 263
— wound of, dressing of - - (*Fig* 299) 259
— — management of sphincter - - - 259
Aorta, abdominal, digital compression of - 3
Aperient before radical rectal operation - - 258
Apomorphine hydrochloride as emetic - - 614
Apoplexy following arsphenamine treatment - 471
— unconsciousness due to - - - - 185
Appendicectomy, adhesive plaster dressing after - - - - - (*Fig* 352) 299
— after Ochsner-Sherren treatment - - 224
Appendicitis, Ochsner-Sherren treatment of 216, (*Fig* 261) 222
Arch supports, ordering of - - - - 589
Argyrol in blocked lacrimal passages - - 434
— gonorrhœa in female - - - - 466
Arkansas stone - - - - *Fig* 24) 29
Arm abduction splint, ordering of - - - 591
— fractures and dislocations of (*Figs* 685–708) 526–548
— functional use of, in fracture - (*Fig* 681) 519
— splints, ordering of - - - - - 591
— upper, application of plaster bandage to (*Fig.* 642) 491
Arsenic poisoning, antidote to - - - 616
Arsenotherapy, intensive, in early syphilis - 470
Arsenoxide in syphilis - - - - - 468
Arsphenamine treatment in syphilis - - 468
— — — contra-indications to - - - 470
— — — toxic reactions to - - - 471
Arteries (*see also specific arteries*)
— bleeding from, arrest of - (*Figs.* 1–5) 1–16
Arthritis, adhesions complicating - - - 477
— gonorrhœal - - - - - - 465
Arthrodesis, in tuberculous joint 581, 582, 583
Articular adhesions - - - - - 476

PAGE

Artificial anus, care of - - - - - 263
— pneumothorax for hæmoptysis - - 389
— — induction of - - (*Figs.* 499–504) 384
— — refill of - - - - (*Fig.* 505) 388
— respiration - - - (*Figs.* 13–16) 7–9
— — after tracheotomy - - - - 414
— — in carbon monoxide poisoning - 612, 620
— — for impending death under anæsthesia 11, 12
Ascaris lumbricoides in urine - - - 85
Ascorbic acid in wound healing - - - 179
Asphyxia, blue, management of - - - 10
— due to poisoning - - - - - 616
— — — summary of treatment of - - 620
— post-operative - - - - - - 119
— white, management of - - - - 10
Aspiration, bronchial - - (*Figs.* 241, 242) 207
— bronchoscopic, in lung abscess - - 125
— — pneumonitis - - - - - 124
— of chest - - - (*Figs* 230, 231) 198
— gastric (*see* Gastric Aspiration)
— of hæmatoma - - - - - - 472
— and injection of bursæ and ganglia - - 377
— intestinal - - - (*Figs* 149–153) 139
— of stomach contents - (*Figs* 146, 147) 137
— therapeutic, of empyema - - - 200
Astragalus, fracture of neck of - - - 576
— — with dislocation of body - - - 576
Atrophic rhinitis - - - - - - 410
Atropine in burns of eye - - - - 436
— corneal abrasions - - - - - 439
— — ulcers - - - - - - 440
— detached retina - - - - - 445
— fat embolism - - - - - - 126
— gall-stone colic - - - - - 216
— poisoning, antidote to - - - - 616
— post-operatively, in cataract - - - 443
— — glaucoma - - - - - - 444
— — warning against - - - 118, 119
— pre-operative, contra-indication to - - 118
— — in pyloric stenosis - - - - 214
— — use of - - - - - 97, 117
— sulphate in acute prostatitis - - - 464
Attempted suicide - - - - 633, 641
Attic perforation of drumhead - - 420, 423
Augmentation limit in blood-urea clearance test - - - - - - - - 232
Auricle, hæmatoma of - - - - - 427
Auricular fibrillation after thyroidectomy - 194
Auto-injection of blood, in carbuncles - - 358
Auvard's speculum - - - (*Fig.* 434) 333
Avascular necrosis of femoral head - - 557
Avertin in basal narcosis - - - - - 98
Avulsion of epiphysis of tibial tubercle - - 565
— fracture of great tuberosity - (*Fig.* 689) 530
— of ligamentum patellæ - - - - 565
— nail - - - - - - - - 344
— quadriceps - - - - - - - 565
Awl for hammer-toe operation - (*Fig.* 451) 345
Axillary abscess - - - - (*Fig* 472) 355
— artery, arrest of hæmorrhage from - - 2
Azochloramid, buffered saline solution of - 238
— injected into breast-abscess cavity (*Fig* 471) 354
Azochloramide-T in irrigation of empyema - 203
Azotæmia, extra-renal - - - - 227, 228

B*ACILLUS coli communis* in pus (*Fig* 197) 171
— — — urine - - - - 85, 238
— *proteus* in urine - - - 85, 237, 238
— *pyocyaneus* in urine - - - - - 238
— *tuberculosis (hominis)* in sputum (*Fig.* 197) 171
— *welchii* in pus - - - (*Fig.* 197) 171
Back, manipulation of- - (*Figs.* 624–626) 483
Backache, manipulation for - - - - 483
Bacteria, pathogenic, in urine - - - - 85
Bag truss for irreducible scrotal hernia (*Fig* 766) 593
Bailey's (Hamilton) bladder perforator (*Fig.* 282) 248
— — lead strap - - - - (*Fig* 272) 245
— — sialography syringe - - (*Fig.* 164) 149
— — tube - - - - (*Fig.* 138) 134
Balanced weight-traction in fractured femur (*Fig.* 720) 563

PAGE

Balanitis, incision of foreskin for - - - 318
Baltimore paste to prevent skin excoriation in fæcal fistula - - - - - - 272
Bandage(s) and bandaging (*Figs* 313–339) 286–294
— — adhesive plaster technique (*Figs.* 340–476) 295–307
— Esmarch's - - - - (*Figs* 11, 12) 6
— plaster (*see also under* Plaster Bandages) - 486
— for sprained ankle - - - - - 474
— varicose veins - - - - - - 372
'Bamo splint' in fracture of metatarsals - - 577
Barbitone as hypnotic - - - - - 115
Barbiturate(s), anæsthesia by - - - 607
— in delirium and convulsions - - - 619
— fat embolism - - - - - - 126
— poisoning by, danger of dehydration in - 618
Barbituric acid series as hypnotics - 115, 116
Barium salts, poisoning by, antidote to - - 616
Barker's lumbar-puncture needle - (*Fig* 510) 394
— — — for hydrocele - - *Fig* 413) 321
Barrel bandage - - - - *Fig* 330) 290
Bartholin abscess - - - - - - 341
— cyst - - - - - - - - 342
Bartholin's gland, enlarged - - - - 333
Bartholinitis, gonorrhœal - - - - 467
Basal fracture of neck of femur - - - 559
— metabolic rate, preparation of patient for - 172
— narcosis - - - - - 97–99
Base of skull, fractures of - - - - 186
Batchelor method of applying double hip spica (*Figs.* 655–657) 496
Batten's hydrophthalmoscope - (*Fig* 577) 436
Bed isolation - - - - - - 636
Bed-sore, deep, complicating excision of rectum 264
— treatment of - - - (*Figs* 476–479) 360
Beer's knife - - *Figs* 564, 565) 430, 431
Behring venule - - - - (*Fig* 188) 165
Bellevue scrotal bandage *Figs* 363, 364) 303
Bell's palsy, application of adhesive plaster in (*Fig* 345) 297
Below-knee instruments, ordering of (*Figs.* 744, 745) 586
Bence-Jones protein in urine - - - 72
Benedict's test for glucose in urine - - 73
Bennett's fracture-dislocation of thumb (*Figs* 706, 707) 546
Benzedrine inhalations, pre-operative - - 118
— sulphate in persistent hiccup - - 275
Benzocaine in gastric intubation - - - 134
— tablets in laryngoscopy - - - 415, 417
Benzoin dressing in circumcision - - 317, 318
— use of, before applying adhesive plaster - 295
Berry's bottle - - - - (*Fig* 32) 33
Bial's test for pentose in urine - - - 74
Biceps, rupture of - - - - - 475
— sprain of - - - - - - 475
Bi-coude catheter in retention due to prostatic enlargement - - - - - 247
Bier's bandage in infection of hand (*Fig* 480) 363
Bile, feeding of, in biliary fistula - - - 219
— in urine, tests for - - - - - 77
Bile-duct, common, management of tube in (*Figs* 249, 250) 218
— — obstruction of - - - (*Fig* 248) 218
— — stone impacted in - - - - 219
Biliary fistula, feeding of bile in - - - 219
— — protection of skin in - - - - 217
Bimalleolar fracture with outward dislocation (*Figs.* 727, B, 730) 573
Biopsy, bone-marrow - - - - - 382
Bipp in after-treatment of mastoid - - 427
Births, notification of - - - - - 633
Bismuth intolerance - - - - - 471
— preparations in syphilis - - - - 469
Bivalve speculum - - (*Fig* 433) 332, 333
Bivatol in syphilis - - - - - 469
Bladder cases, records of - - (*Fig.* 298) 257
— decompression of overfull (*Figs.* 278, 279) 247
— drainage - - - (*Figs* 290–294) 253
— epithelium in urine - (*Fig* 97, A, 2, 4) 83
— injury to, in fractured pelvis - - - 553
— irrigation in acute cystitis - - - 255
— — anuria - - - - - 241, 242

PAGE
Bladder irrigation to prevent clotting, - - 240
— perforator, Hamilton Bailey's - (*Fig.* 282) 248
— and prostatic cases, management of (*Figs.* 285–298) 251–257
— tidal drainage of - - - (*Fig* 284) 250
— washes - - - - (*Figs* 285–289) 251
— — for hæmorrhage after prostatectomy - 255
Blade's method of strapping thorax (*Fig* 351) 299
B.L.B. oxygen mask - - - (*Fig* 226) 197
— — — in burns - - - - - 18
Blepharitis - - - - - - - 432
— expression of Meibomian glands in - - 430
Blepharostat - - - - (*Fig* 566) 431
Blisters complicating fracture - - - 523
Blood, auto-injection of, in carbuncles - - 358
— casts in urine - - (*Fig* 97, C, 3) 83
— chemistry, normal - - - - - 174
— collection of, for pathological examination 165
— cross-matching, as preliminary to transfusion - - - (*Figs* 189–191) 166
— donor, treatment of - - - - - 60
— estimation in sulphonamide therapy - - 277
— examination of - - (*Figs* 189–196) 166
— — pre-operative - - - - - 88
— — in renal function tests - - - 227
— fresh, administration of - (*Fig* 85) 58, 60
— — collecting of - - *Figs* 82–84 58
— groups, distribution of - - - - 173
— occult, examination of stool for - - 173
— stored, administration of - - - - 54
— — condition of - - (*Figs* 74, 75) 54
— — filter for - - - - - - 57
— — reactions to - - - - - 55
— transfusion(s) - - (*Figs* 74–88) 54–61
— — after drainage of empyema - - - 205
— — — excision of rectum - - - 263
— — — thyroidectomy - - - 193, 194
— — for anæmia from burns - - 19, 61
— — into bone-marrow - - - - 58
— — — corpus cavernosum - *Fig* 80) 57
— — in collapse - - - - - 9
— — contra-indications to - - - - 54
— — drip, combined with saline infusion (*Fig* 81) 58
— — — in hæmatemesis - - - - 212
— — in gastric cases - - 210, 211, 212
— — grouping as preliminary to 54, (*Figs* 190, 191) 166
— — in hæmorrhage after prostatectomy - 256
— — — from tooth socket - - - 454
— — necrotizing pneumonitis - - - 124
— — post-operative hæmorrhage - - 269
— — preliminaries to - (*Figs* 189–191) 166
— — pre-operative - - - - - 91
— — — in jaundice - - - - - 218
— — preparation for, in rectal operation - 258
— — to prevent œdema of wound - - 179
— — reactions to - - - - - 55
— — in shock - - - - - - 505
— — sternal - - - - - 51, 58
— — technique of - - - - - 56
— — in tonsillectomy - - - - - 404
— — toxic cachexia - - - - - 19
— — into vein - - - (*Figs* 76–79) 57
— in urine - - - - - - - 75
— — test for - - - - - - 240
— withdrawal of, in aspiration of chest - 199
Blood-calcium - - - - - - 229
Blood-cholesterol - - - - - 229
Blood-clot in bladder causing retention - - 249
— urine - - - - - - - 84
Blood-corpuscles, red, in urine (*Fig* 97, B) 82
Blood-count in carbuncles - - - - 357
Blood-creatinine - - - - - - 228
Blood-culture, collection of specimen for - 165
Blood-grouping as preliminary to transfusion 54, (*Figs* 190, 191) 166
Blood-letting - - - - - - - 379
— before cataract operation - - - 441
Blood-phosphate - - - - - 229
Blood-plasma (*see* Plasma)
Blood-pressure in head injury - - 183, 187
— pre-operative taking of - - - - 88
Blood-pressure readings in shock - - - 505
Blood-saline drip into bone-marrow - - 58
Blood-sedimentation rate in tuberculous joints 581, 584
Blood-serum, collection of, for pathological examination - - - - - - 165
Blood-smear, making of - - (*Fig* 196) 169
Blood-sugar estimations, collection of specimen for - - - - - - - - 165
Blood-urea clearance test - - - - 232
— estimation - - - - - 227, 234
— — in persistent hiccup - - - 274
— — preliminary to urography - - - 149
'Bloody tap' in lumbar puncture - - - 397
Blue asphyxia, management of - - - 10
Bohler-Braun splint with skeletal traction (*Fig.* 721) 563
Bohler's compression clamp - - - - 576
— scissors - - - - - (*Fig* 669) 502
— swivel stirrup - - - (*Fig* 398) 314
Boil(s), abortive treatment of - - - 358
— complicating carbuncles - - - 358
— of ear - - - - - - - - 421
— treatment of - - - - - - - 460
Bone forceps for circumcision - *Fig* 400) 316
Bone-marrow biopsy - - - - - 382
Bonney's blue paint in monilial infection 266, 335
Boots, Denis Browne's, for club-foot (*Figs* 454, 464) 347, 350
— surgical, ordering of - *Figs* 750–754) 589
Boric acid for bladder washes - - - - 251
— — and iodine for discharging ear - - 424
— — in irrigation of eye - - 271, 438, 439
— — lotion in burns of eye - - - 436
— — — cataract - - - - - 442
— — — in corneal ulcer - - - - 440
— — — Meibomian cyst - - - - 430
— — ointment in conjunctivitis - - - 437
Boroglycerin in gonorrhœa in female - - 466
Bottle, Berry's - - - - (*Fig* 32) 33
— for pathological specimens - (*Fig.* 183) 163
— rubber-capped stock - (*Figs* 31, 32) 33
Botryomycosis hominis, cauterization of - - 459
Bougie, gum-elastic, for urethral stricture - 320
— — — — causing retention - *Fig.* 275) 246
— metal, for urethral stricture - (*Fig* 412) 320
— — — — causing retention - (*Fig* 276) 246
— suction - - - - - - (*Fig* 614) 464
Bowman's probe - - - - (*Fig* 572) 434
Bozemann's intra-uterine douche (*Fig.* 442) 337
Boyle's anæsthetic machine - - (*Fig* 774) 600
Brachial artery, arrest of hæmorrhage from (*Fig.* 4) 2
— — compression of, crippling caused by - 521
Bradford frame in faecal fistula - (*Fig* 305) 273
— — tuberculous spine - - (*Fig* 741) 583
Braun's splint - - - - - (*Fig.* 726) 569
Breast abscess - - - (*Figs* 469–471) 353
— adhesive plaster dressings for (*Figs* 348, 349) 298
— bandage for *Fig* 334) 292, (*Fig* 470) 354
— cyst of, excision of - - - - - 311
Breathing exercises after drainage of empyema 205
— — post-operative 118, 120, (*Figs* 127–136) 128–132
— — pre-operative - - - - - 118
'Brick-dust' deposit in urine - - 70, 79
Bright's disease as contra-indication to venosection - - - - - - - 47
Bromides in fracture of base of skull - - 186
— as hypnotics - - - - - - 115
Brompin in bronchography - - - - 158
Bromural as hypnotic - - - - - 115
Bronchial aspiration 120, (*Figs.* 241, 242) 207
— secretion, excessive, exercises for - - 130
— spasm, pre-operative management of - 118
Bronchiectasis following collapse of lung - 123
— pre-operative recognition of - - - 117
Bronchitis, post-operative - - - - 119
— — acute suppurative - - - - 120
— pre-operative measures in - - - 117
— septic - - - - - - - - 120
Bronchography - - (*Figs.* 177–182) 158–162

PAGE

Bronchography in infants - - - - - 162
Bronchopleural fistula contra-indicating irrigation of empyema - - - - 203
Bronchopneumonia, post-operative - - 122
Bronchoscopic aspiration in lung abscess - 125
— — pneumonitis - - - - - 124
Bronchoscopy to clear air-tubes - - 207, 209
— in collapsed lung - - - - - 122
Bronchus, endotracheal tube passed into - 606
Browne's forceps for tonsillectomy (*Figs* 524–526) 403
Bruises, treatment of - - - - - - 472
'Bubbly' patient, post-operative management of - - - - - - - 118, 121
Bubo - - - - - - - - - 355
Buller's shield - - - - (*Fig.* 579) 437
Bunyan-Stannard envelope for burns (*Figs* 21, 22) 23
Burns, assessing seriousness of - - - 15
— degrees of - - - - - - 15
— electrical - - - - - - 28
— of eye - - - - - - 27, 436
— infected - - - - - - 16
— inhalation - - - - - - 27
— irradiation - - - - - - 26
— minor - - - - - - - 26
— phosphorus - - - - - - 27
— serious - - - - - - - 16
— — closed therapy in - - 19, 20, 21, 24
— — open therapy in - - - 19, 20, 21
— — plaster-of-Paris in - - - 20, 21
— — treatment of, first-aid - - - 17
— — — general - - - - - 17
— — — late - - - - - - 26
— — — local - - - - - 19
— treatment of - - (*Figs* 21–23) 15–28
Bursæ, injection treatment of - - 377, 378
Burst abdomen, prevention of - - - - 219
Burton 'donkey' - - (*Figs* 255, 259) 220
Butobarbital sodium - - - - - - 99

CACHEXIA, toxic, in burns - - - - 19
Cajuput, oil of, for post-operative flatulence - - - - - 270, 271
Calcium in blood - - - - - - 229
— carbonate in urine - - - - - 81
— intravenous, in salpingitis - - - - 467
— oxalate in urine - - - (*Fig* 96, C) 79
— in parathyroid tetany - - - - 195
— phosphates in urine - - (*Fig* 96, H) 80
— pre-operative use of, in jaundice - - 218
— salts, intravenous, in gonorrhœal complications - - - - - - 464, 465
Calculus, impacted, in common bile-duct - 219
— — urethral, causing retention - - - 249
— salivary, removal of, from Wharton's duct 312
— urinary - - - - - - - - 70
Callander's modification of Samway's tourniquet - - - - (*Fig* 7) 4
Calliper splint in fractured femur - - - 562
— walking, ordering of - - (*Fig* 747) 587
— — in tuberculous knee - - - - 582
Callus, formation of - - - - - - 516
"Camden" pump for wound drainage (*Fig.* 205) 176
Canine teeth, extraction of - (*Figs.* 600, 601) 452
Cannula for intravenous infusions - (*Fig* 51) 41
— — — insertion of - (*Figs* 56–58) 43
— Thompson's, for tibial marrow infusions (*Figs* 71, 72) 51
— and trocar for sternal puncture (*Figs.* 67, 68) 50
— Ultzmann's prostatic - - (*Fig.* 612) 463
Capeline bandage - - (*Figs.* 323, 324) 288
Carbachol injection for post-operative retention 267
Carbaminoyl choline for post-operative retention - - - - - - - - 267
Carbarsone in *Trichomonas* infection - - 334
Carbol-fuchsin stain, strong - - - - 171
— — weak - - - - - - 172
Carbolic acid in corneal ulcer - (*Fig.* 584) 440
— — poisoning, urine in - - - - - 69
Carbolized resin in pulpitis - - - 446
Carbon dioxide inhalation in persistent hiccup (*Fig.* 306) 274
— — — post-operative - - - - 119
— — and oxygen in carbon monoxide poisoning - - - - - - - 612
— — — collapsed lung - - - - 122
— — — post-operative bronchitis - - 120
— — snow - - - - - (*Fig* 610) 458
— monoxide poisoning, asphyxia in - - 617
— — — diagnosis of - - - 612 *n*
— — — treatment of - - - - 612
Carbromal as hypnotic - - - - - 115
Carbuncles, treatment of - (*Figs* 474, 475) 357
— — on face - - - - (*Fig.* 475) 359
Carcinoma of rectum, sigmoidoscopy in - - 326
Cardiac disease, pre-operative management of 91
— massage in white asphyxia - (*Figs* 19, 20) 12
Cardiazol as analeptic - - - - - 10
Cardiovascular complications of excision of rectum - - - - - - - 263
— stability, estimation of - - - - 596
— syphilis, treatment of - - - - - 470
Carotid artery, common, arrest of bleeding from (*Fig* 2) 1
Carpus, fracture of scaphoid bone of (*Figs* 702 703) 543
Cascara evacuant, post-operative, in rectal cases 259
Case-sheets, hospital - - - - - - 632
Cast, plaster-of-Paris, in burns - - 21, 25
Castex and Ontaneda's method of cisternal puncture - - - - - - - 399
Cataract, complications of - - - - 443
— treatment of, post-operative - (*Fig* 586) 442
— — pre-operative - - - - - 441
Catarrh, pre-operative management of - - 118
Catarrhal conditions, inhalations for - - 127
Catgut container - - - (*Fig* 105) 104
Cathcart's apparatus - - - (*Fig* 202) 178
Catheter(s) and catheterization (*Figs* 267–284) 243–250
— de Pezzer - - - (*Figs* 288, 290) 253
— indwelling, in female - - (*Fig* 274) 246
— nasal, for endotracheal anæsthesia (*Fig.* 781) 603
— self-retaining - - - - (*Fig* 270) 244
— sterilization of - - - - - - 243
— tying in - - - - - - - 243
— ureteric indwelling - - (*Fig* 263) 239
— washing out bladder through - - - - 251
Catheterization in acute cystitis - - - 255
— anuria - - - - - - - 241
— cases of prolapse - - - - - - 266
— Eustachian - - - (*Figs* 557, 558) 425
— failure of, acute retention in - - - 247
— in gynæcological cases - - - 266, 267
— post-operative, in rectal cases - - 258
— pre-operative, in rectal cases - - - 258
— in retention caused by retroverted gravid uterus - - - - - - - 341
— — post-operative - - - - - 256
— suprapubic - - - (*Figs* 281–283) 248
— — catheter dragged from bladder in (*Fig* 289) 253
— — in retention with overflow - - - 249
Cauterization of cervix - - (*Fig* 439) 335
— chancroid - - - - - - - 471
— corneal ulcer - - - - - - - 440
— for ectropion - - - - - - 433
— of endocervix, in chronic gonorrhœa - - 466
— for epistaxis - - - - (*Fig* 537) 411
— of Skene's tubule - - - - - - 335
— skin lesions - - - - - - - 459
'Cayenne-pepper' deposit in urine - 70, 79
Cellulitis following injections - - - - 30
Celluloid-covered truss - - - - - 593
Cephalhæmatoma, subpericranial - - - 472
Cerebral compression, acute - - - - 186
— irritation - - - - - - - 187
Cerebrospinal fluid, examination of - - 172
— — pressure, measurement of (*Figs.* 515, 516) 398
Certificates, signing of - - - - - 634

PAGE

Certification of death - - - - - - 638
— — in Scotland - - - - - - 640
Cervical abscess, deep - - (*Fig.* 468) 352
— caries, application of plaster jacket in (*Figs.* 658, 659) 497
— lymphatic glands, non-tuberculous suppurating - - - - - - 353
— spine, fracture-dislocation of - - - 553
— — subluxation of - - - (*Fig* 712) 552
— swabs for pathological examination - - 164
Cervix, cauterization of - - (*Fig* 439) 335
— dilatation of - - - - - 336, 339
— irrigation of, in gonorrhœa - - - 466
Cetavlon in cleansing of burns - - - 21
Cetyl-trimethyl-ammonium-bromide - - 21
Chalazion - - - - - (*Figs* 565, 566) 430
Chalk powder in fæcal fistula - - - 273
Chancre, incision of foreskin for - - - 468
Chancroid, incision of foreskin for - - 318
— treatment of - - - - - - 471
Chassaignac's tubercle, in compression of common carotid artery - (*Fig* 2) 2
Chemotherapy in burns - - - 19, 20, 23
— 'collapse-pneumonitis' - - - - 123
— empyema - - - - - - 200
— gonorrhœa - - - - - - 461
— lung abscess - - - - - - 125
— pneumonitis - - - - - - 124
Chest, aspiration of - - *Figs* 230, 231) 198
— complications in gastric cases, prevention of 210
— tightness of, complicating artificial pneumothorax - - - - - - 387
Chicken-pox, control of, in hospital - - 635
Chloral hydrate as hypnotic - - - - 115
Chloride and inorganic phosphate estimation, blood for - - - - - - 165
Chloroform - - - - - - 598
— contra-indicated in diabetes - - - 95
— and ether mixture - - - - - 598
Chloroxylenol in Berry's bottle - - - 33
Cholangiography - - - - - - 219
— post-operative - - - *Figs* 175, 176) 156
Cholecystectomy in cholecystitis - - 216, 217
Cholecystitis, acute - - - - - - 216
— chronic - - - - - - - 217
Cholecystography - - - *Fig* 174) 155
— contra-indications to - - - - 216
— intensive oral - - - - - - 156
Cholecystostomy tube, management of *Fig* 248) 218
Cholesterol in blood - - - - - - 229
— urine - - - - - - - 82
Choroid, sarcoma of - - *Figs* 502, 593 448
Chromocystoscopy test - - - - - 234
Chyluria, urine in - - - - - - 82
Circumcision - - (*Figs* 400–405) 316
Cisternal puncture - - *Figs* 517–520) 399
Clavicle, fracture of - - - (*Fig* 688) 526
— — comminuted - - - - - 527
— — temporary splinting of - - - 506
Clawing of toes, rigid, in fracture of leg - - 519
Cleansing enema - - - - - - 145
Cleft palate, operation for - - - - 191
'Closed' drainage in empyema (*Figs* 234, 235) 200
— method of dressing open wounds (*Figs* 208–213) 178
Closed-circuit type of anæsthetic machine (*Fig* 779) 602
Clostridia causing necrotizing pneumonitis - 124
Clot retention - - - - - - - 249
Clove-hitch knot - - - (*Fig* 111) 106
Cloves, oil of, in pulpitis - - - - 449
Club-foot - - - - (*Figs* 454–464) 347
Clubbing of fingers - - - - - - 117
Coagulant dyes in burns - - 20, 21, 24, 25
Cocaine for anæsthetizing nose - - - 407
— in cataract operation - - - 441, 442
— endotracheal suction - - - - 208
— incision of drumhead - - - - 422
— laryngoscopy - - - - 415, 417
— poisoning, antidote to - - - - - 616
Cocainization of eye - - - 430, 431, 433

PAGE

Cod-liver oil treatment of bed-sores - - 362
Coffee and brandy enema - - - - 146
Cohen and Blatt's rubber collector (*Fig.* 266, B) 242
Collapse in anæsthesia, intravenous - - 13
— — spinal - - - - - - 13
— intravenous infusion in - - - - 47
— of lung, differentiated from pneumonia - 122
— — massive - - - (*Figs.* 125, 126) 120
— — — due to hæmoptysis - - - 389
— — — post-operative precautions against 118
— in poisoning - - - - - - 618
— treatment of - - - (*Figs* 17, 18) 9
'Collapse-pneumonitis' - - - - - 123
Collar-and-cuff sling (*Fig* 673) 506, (*Fig.* 686) 527
Colles's fracture of radius - (*Figs.* 699–701) 542
— — — temporary splinting of - (*Fig.* 675) 507
— — recovery after - - - - - 517
Collodion splint for sprained finger - - 548
Colloidal silver in gonorrhœa in female - - 466
Collosol phospho-mandelate in acidification of urine - - - - - - 236
Colostomy belts, ordering of (*Figs* 770–772) 594
— complications of - - - - - 263
— disadvantages of washout into - - - 263
— enemata - - - - - - 145
— late management of - - - - 263
— loop - - - - - - - 261
— management of - - *Figs* 302, 303) 261
— terminal - - - - - - 261
Coma, alcoholic - - - - - - 617
— due to poisoning - - - - - 617
— — — summary of treatment of - - 620
Comminuted Colles's fracture - - - 543
— fracture of head of radius - - - 539
— — tuberosity of tibia - - (*Fig* 722) 566
— — vertebral body - - *Fig.* 709, B) 549
Compensated impairment of renal function - 226
Complications after abdominal operations (*Figs* 304–306) 270–275
Compound fractures, treatment of - - - 509
Compression, cerebral, acute - - - 186
— — unconsciousness due to - - - 185
— dressing - - - (*Figs* 341–343) 296
Concussion, labyrinthine - - - - - 422
— unconsciousness due to - - - - 185
Condyle external of humerus, fracture of *Figs* 695, 696) 536
Condyles of humerus, fracture of both - - 536
Conjunctiva, affections of - (*Figs* 577–580) 436
Conjunctival concretions - - - - 430
Conjunctivitis, causes of - - - - 438
— chronic, expression of Meibomian glands in 430
— treatment of - - - (*Figs* 578–580 437
Connective-tissue shreds in urine - - - 85
Contact glass for burns of eye - - - 27
— — keratitis - - - - - - 432
Contusion crack fracture of neck of humerus (*Fig.* 690, A) 531
— fracture of great tuberosity - *Fig.* 688) 530
Convulsions due to poisoning - - - 619
— — — summary of treatment of - - 620
— ether - - - - - - - 14
— novocain - - - - - - - 14
Copper sulphate in conjunctivitis - - - 437
— — phosphorus burns - - - - - 27
Coramine as analeptic - - - - - 10
— in overdosage of pentothal - - - 610
— pulmonary œdema - - - - - 45
— toxæmia due to burns - - - - 19
— toxic coma - - - - - 618, 620
Cornea, affections of - - (*Figs* 581–585) 438
Corneal abrasions - - - - - - 438
— spud - - - - - (*Fig.* 581) 439
— ulcers - - - - (*Figs.* 584, 585) 440
— — in burns of eye - - - - - 27
— wounds - - - - - (*Fig* 583) 439
Corns, treatment of - - - - - 344
Coronary artery, arrest of hæmorrhage from (*Fig* 1) 1
Coroner, payment of fees by - - - 639
— reporting death to - - - - - 638

PAGE

Corpus cavernosum, blood transfusion into (*Fig* 80) 57
Corrosive acid poisoning, treatment of - 613, 615
Corsettage - - - - (*Figs* 357–360) 301
— in fæcal fistula - - - - - 272
— to maintain empyema dressing (*Fig* 237) 204
— minimize œdema - - - - - 179
Cortin preparations as analeptic - - - 10
Crack fracture of head of radius - - - 539
— — patella - - - - - - 565
Cramer wire in 'dry' treatment of hand infection - - - - - - - 369
Creatinine in blood - - - - - 228
— urine - - - - - - - 80
Creosote inhalations - - - - - 127
— — for post-operative bronchitis - - 120
Cross-matching as preliminary to blood transfusion - - - - (*Fig* 189) 166
Crush syndrome, anuria due to - - - 242
Crutches, ordering of - - (*Figs* 758–760) 591
Culture, collection of specimens for - - 163
Curettage of uterus - - - - - 336
— — complications of - - - - 337
Curette, Sims' blunt - - - (*Fig.* 441) 336
Curtis abdominal support - - (*Fig* 763) 592
Cusco's bivalved speculum - - (*Fig* 433) 332
Cyanide poisoning, antidote to - - - 616
Cyanosis in anæsthesia - - - - - 605
— following administration of sulphanilamide 279
— in pre-operative examination - - - 117
Cyclonal - - - - - - - 607 *n.*
Cyclopropane - - - - - - - 601
Cylindroids in urine - - - - - 85
Cyst(s) Bartholin - - - - - 342
— of breast, excision of - - - - 311
— epididymis, unilocular, injection treatment of - - - - - - 322
— sebaceous, excision of - - (*Fig* 385) 310
Cystin in urine - - - (*Fig* 96, G) 80
Cystitis, acute, treatment of - - - - 255
Cysto-diathermy, records in - (*Fig.* 298) 257
Cystography - - - - (*Fig.* 166) 152
Cystoscopy, records kept in - (*Fig* 298) 257

DAGENAN - - - - - - - 276
— sodium - - - - - - - 276
Dakin's solution injected into breast-abscess cavity - - - - (*Fig.* 461) 354
Dangerous drugs in hospitals - - - 634
Dattner's needle for lumbar puncture (*Fig* 514) 397
Deafness, tests for - - - - - - 424
— treatment of - - - (*Figs.* 556–558) 425
Death(s) from accident - - - - - 640
— certificates - - - - - - 638
— — in Scotland - - - - - 640
— during anæsthesia - - - - 639, 640
— in hospital - - - - - - 636
— as result of operation - - - 639, 640
— 'unnatural' - - - - - 639, 640
Dechloridation due to poisoning, summary of treatment of - - - - - - 620
— toxic - - - - - - - 618
Decicain in anal dressings - - - - 260
— chronic glaucoma - - - - - 443
Decompensated impairment of renal function 226
Decompression of overfull bladder (*Figs* 278, 279) 247
Dehydration, avoidance of, - - - - - 92
— due to poisoning, summary of treatment of 620
— in elderly - - - - - - - 91
— infant - - - - - - - 90
— pre-operative treatment of - - - 93
— in prolonged coma - - - - - 618
— toxic - - - - - - - 618
— treatment of, in pyloric stenosis - - 214
Delirium due to poisoning - - - - 619
— — — summary of treatment of - - 620
— tremens complicating fracture - - - 525
Deltoid, intramuscular injection into - - 35
— paralysis of, complicating dislocated shoulder - - - - - - 530
— strain of - - - - - - - 475

PAGE

Denis Browne's splints and boots (*Figs* 454, 464) 347, 350
Dental elevators - - (*Figs.* 599, C, D, 604) 453
— forceps - - - (*Fig* 599, A, B) 452
— nerve, inferior, anæsthetization of (*Fig.* 383) 310
— pain after extraction - - - - - 454
Dentalone in pain after dental extraction - 454
De Pezzer catheter - - - (*Fig* 288) 253
— — changing of - - - (*Fig* 290) 253
— — for 'permanent' suprapubic - - 257
Depressed fracture of skull - - - - 186
Depression of nervous system due to poisoning 617
Dermatitis, contact - - - - - 456
— — test for cause of - - - - - 457
— following arsphenamine treatment - - 471
— of operational field - - - - 89
— purulent, complicating fracture - - 523
Dermatological operations - - - - 458
Desensitization - - - - - 62, 65
Desoxycorticosterone acetate as analeptic - 10
Detached retina - - - - (*Fig* 589) 445
Detachment glass - - - - (*Fig* 589) 445
Dettol lotion in dressing perineal wound - 264
— for rectal dressings - - - - - 259
'Devine' disconnecting transverse colostomy 262
Dextrose, intravenous, in anuria - - - 241
Diabetes, carbuncles and - - - - 357
— contra-indicating varicose vein injection - 372
— insipidus, urine in - - - 68, 70
— mellitus, urine in - - - 68, 70, 73, 74
— and operation - - - - 95–96
Diagnostic aspiration of chest - - - 198
Diamorphine hydrochloride as hypnotic - 115
Diastase in urine, estimation of - - - 78
Diathermy in chronic gonorrhœa in female - 466
— endocervical, in leucorrhœa - - - 335
— in hallux rigidus - - - - - 346
— infection of Skene's tubule - - - 335
— intracervical, in chronic cervicitis - - 336
— for removal of lashes - - - - 428
— short-wave, in eye infections - - - 443
— — furunculosis of ear - - - - 421
— — glaucoma - - - - - 444
— — pelvic inflammation - - - - 260
Dick test - - - - - (*Fig* 91) 63
Diet after gastric operations - - - - 210
— — Ramstedt's operation - - 214, 215
— in burns - - - - - - - 18
— carbuncles - - - - - - 357
— fæcal fistula - - - - - - 273
— hæmatemesis - - - - - 212
— Ochsner-Sherren treatment of appendicitis 224
— of patient with colostomy - - - 263
— pre-operative - - - - - - 88
— — of children - - - - - 90
— and wound healing - - - - - 180
Dieulafoy's aspirator for air replacement of pleural effusion - - - - 388
— syringe in aspiration of empyema - - 200
Differential cell count - - (*Fig* 196) 169
Digit, anæsthetization of - (*Figs* 380, 381) 309
Digital compression, arrest of hæmorrhage by (*Figs.* 1–5) 1–3
Digitalis for pulmonary congestion - - 118
Digoxin in pulmonary œdema - - - 45
Dilatation of cervix - - - - 336, 339
— stomach, acute post-operative - - - 270
— urethral stricture - - - (*Fig* 412) 320
Dilator, Kollmann's four-bladed - (*Fig.* 613) 464
Diodone in excretory urography in infants - 157
— intramuscular urography - - - 150
Diphtheria antitoxin serum, desiccated - - 65
— control of, in hospital - - - - 635
— culturing swab for - - - - - 164
— dose of anti-sera for - - - - - 67
Disabled Persons (Employment) Act, 1944, medical certificate connected with - 622
Disablement Rehabilitation Officer - - 622
Discharging ear, conservative treatment of (*Fig* 555) 423
Discission needle - - - (*Fig* 582) 439
Dislocation(s) (*see also under*) Fractures and dislocations) - - - - - 478

PAGE
Dislocation(s) of acromio-clavicular joint (*Fig.* 686) 527
— ankle-joint - - - - - - - 571
— elbow-joint - - - - - - - 538
— fingers - - - - - - - 548
— hip-joint - - - - - (*Fig* 715) 556
— knee, traumatic - - - - - - 566
— lower jaw - - - - - - - 549
— myositis ossificans after - - - - 523
— radio-ulnar, with fracture of radial shaft - 541
— of radius with fracture of ulnar shaft - - 541
— of semilunar - - - (*Figs* 704, 705) 545
— — with half of scaphoid - - - 540
— shoulder-joint - - - (*Fig.* 687) 528
— thumb - - - - - - - 548
Disuse œdema, prevention of - - - 562
Diuretic, contra-indication to, in obstructive anuria - - - - - - - 241
— intravenous mercurial - - - - 381
Divinyl ether - - - - - - 601
D O C A as analeptic - - - - - 10
Dorvl injection in rectal cases - - - 258
Dott, Norman, method of dressing head (*Fig* 328) 289
Douches, acid, for vaginal discharge - - 266
— in gonorrhœa in female - - - 465, 467
Drainage of abscess - - - (*Fig.* 467) 352
— bladder - - - - (*Figs* 290–294) 253
— — tidal - - - - (*Fig* 284) 250
— common bile-duct - - (*Figs* 249, 250) 218
— empyema, 'closed' - (*Figs* 234, 235) 200
— — intercostal - - - - - 200
— — mechanically imperfect - - - 204
— — 'open' - - - (*Figs* 234, 236 203
— through abdominal wall after gastrectomy - 212
— tube(s) - - - (*Fig* 123, C, D) 112
— — in cholecystectomy - - - - 217
— — empyema - - - - - 201
— — management of - *Figs* 236, 237) 203
— — lower abdomen - - - - 222
— — perinephric space - - - - 239
— of wounds - - - - (*Fig* 123) 111
Dressing(s) of burns - - - - - 22
— in rectal cases - - - (*Fig.* 299) 259
— supervision of, at operation - - - 107
— vaccination - - - - (*Fig* 508) 392
— of wounds, newer methods in (*Figs.* 201–215) 175–179
— — no-touch technique of - - - 512
Drinker's mechanical respirator - - - 8
Drip blood transfusion after excision of rectum 263
— — — combined with drip saline infusion (*Fig* 81) 58
— method for gravitating fluid into stomach (*Fig* 148) 138
— — continuous, for penicillin - (*Fig* 308) 283
Dripper decompression apparatus (*Figs* 278, 279) 247, 249
Drop-foot appliance, ordering of (*Figs* 744, 745) 586
Drug fever due to sulphonamides - - - 280
Drumhead, traumatic rupture of - - - 421
'Drunk or dying,' problem of - 185, 618, 632
'Dry' after-treatment of seriously infected hand - - - - (*Fig* 490) 369
Dunlopillo knee-rest - - - (*Fig* 256) 220
Duodenal fistula following gastric operation - 212
— — skin excoriation in - - - - 273
Duodenum, transnasal intubation of (*Figs.* 149–153) 139
Dusting powder in gonorrhœa in female - 466
Dysentery, dose of anti-sera for - - - 67
Dyspareunia - - - - - - - 342
Dyspnœa, mechanical post-operative - - 194

EAR - - - (*Figs* 550–558) 419–427
— discharge from, in fracture of base - 186
— — conservative treatment of - (*Fig* 555) 423
— examination of - - (*Figs.* 550, 551) 419
Easton's syrup in carbuncles - - - - 357
Echinococcal cysts in urine - - - - 85
Ectropion - - - - - (*Fig* 569) 433
Eczema teat - - - - - - - 457
Edmund's sandwich dressing - (*Fig* 215) 178
Edwards's, Tudor, spectacle carrier for intranasal catheter - - - (*Fig* 229) 198
— vein seeker (*Figs.* 45, 46) 36, 37, (*Fig.* 264) 241
— — — in intravenous anæsthesia (*Fig.* 787) 608, 609
Effleurage of sprained ankle - - - - 474
Elastic band truss - - - - - 593
— hosiery, ordering of - - (*Fig.* 755) 590
Elastoplast (*see also* Adhesive plaster)
— for strapping chest - - - - - 299
Elbow, application of plaster bandage to (*Figs* 640, 641) 490
— dislocation of - - - - - - 538
— figure-of-8 bandage for - - (*Fig.* 316) 286
— fracture of, position of arm in - - - 522
— — temporary splinting of - - - 506
— inclusion of fractured epiphysis in - - 538
— optimum position of - - - (*Fig* 615) 478
— stiffness of, complicating fracture (*Fig.* 684) 524
— tennis, manipulation of - - (*Fig* 627) 484
— tuberculous - - - - - - 583
Electric heater in glaucoma - - (*Fig* 587) 444
— pumps for wound drainage (*Figs.* 203, 204) 176
Electrical burns - - - - - - 28
Electro-cautery for skin lesions - - - 459
Electrolysis for removal of lashes - - - 428
Elevators, dental - (*Figs* 599, C, D, 604)453
Embolism, fat - - - - - - 126
— — complicating fracture - - - 525
— pulmonary, post-operative - - 125, 222
— — — precautions against - - 118, 119
— — resulting from intravenous infusion - 42
Embolus, air, precautions against, in blood transfusion - - - - 55
— — — — in saline infusions - - 47, 53
Emesay suture button (*Figs.* 116, 117) 109, 111
Emetics, use of, in poisoning - - 613, 614
Emollient enema - - - - - - 145
Emphysema, subcutaneous, complicating artificial pneumothorax - - - - 387
Empyema cavity, aspiration of gas from - - 199
— — chronic, radiography of - (*Fig* 161) 147
— — irrigation of - - - - - 203
— operations, adhesive plaster dressings after 295
— post-operative - - - - - 129
— treatment of - - - (*Figs* 232–237) 203
— removal of drainage tubes in - - - 116
Endocervicitis, chronic gonococcal - - 460
Endotracheal anæsthesia by intubation (*Figs.* 780–786) 602
— suction to clear air-tubes (*Fig.* 242) 207, 208
Enemata, administration of (*Figs.* 154–156) 143
— in anuria - - - - - - 214
— before gynæcological operations - - 266
— — rectal operation - - - - 258
— contra-indications to - - - - 144
— opaque - - - - - - - 155
— preparation of - - - - - 145
Entropion - - - - (*Figs* 560–562) 428
Enucleation of eye - - - - - 447
Ephedrine in anaphylactic reactions to serum injection - - - - - - 66
— blocked lacrimal passages - - - 434
— bronchial spasm - - - - - 118
— injections during blood transfusions - - 55
Epicondyle, internal, of humerus, fracture of (*Fig.* 697) 537
Epicutan - - - - - - - 180
Epididymal cyst, unilocular, injection treatment of - - - - - - - 322
Epididymitis complicating gonorrhœa - - 465
Epilation forceps for removal of lashes (*Fig* 559) 428
— — Whitfield's - - - (*Fig* 606) 455
Epiphora, three-snip operation for (*Figs* 573–575) 435
Epiphysis of femur, displaced lower - - 564
— — — upper - - - - - - 559
— humerus, separated from epicondyle (*Fig.* 697) 537

PAGE

Epiphysis of radius, displaced lower - 543
— tibia, displaced lower - - - - 575
— tibial tubercle, avulsion of - - - 565
Epistaxis, treatment of - - - - - 410
Epithelial casts in urine - (*Fig.* 97, C, I) 83
— cells in urine - - (*Fig.* 97, A) 82
Ergometrine to arrest uterine bleeding - - 337
Erythrocyte sedimentation rate, normal - - 174
Esbach's albuminometer - - - - 72
Escharotics (*see* Coagulant Dyes)
Eserine instillation in acute glaucoma - - 444
— — in iris prolapse - - - - - 443
Esmarch's bandage - - (*Figs* 11, 12) 6
Esmodil injection in rectal cases - - - 258
Ethamoline in injection of varicocele - - 323
— — varicose vein - - - - 373, 375
Ether - - - - - - - - 598
— convulsions - - - - - - - 14
— use of, in biliary stone - - - - 219
Ethyl chloride - - - - - - 598
— — in alveolar abscess - - - - 450
Eucortone in burns - - - - - 18
Eugenol in pulpitis - - - - - 449
Eumydrin for pyloric stenosis - - - 214
Eusol dressings in chancroid - - - 471
— — hand infection - - - - - 370
— — perineal wound - - - - 264
— — piles - - - - - - 326
— — of rectum - - - - - 259
Eustachian catheterization - (*Figs.* 557, 558) 425
Eustrongylus gigas in urine - - - 85
Eversion of lids - - - (*Figs* 563, 564) 429
— — in infants - - - - - - 438
— lower lid - - - - (*Fig* 569) 433
Eve's method of resuscitation by rocking (*Fig* 16) 8
Evipan anæsthesia, complications of - - 610
— — in incision of drumhead - - - 422
— — indications and contra-indications for - 607
— — in manipulative treatment - 481, 484
— — premedication in - - - - 607
— sodium in ether convulsions - - - 14
— — novocain poisoning - - - - 14
— solution, strength of - - - - 608
— technique of administration of (*Fig.* 787) 608
Excretory cystography - - - - - 152
— urography - - - - - - 149
— — in infants - - - - - - 157
Exercises, post-operative (*Figs* 127–136) 128–132
— to prevent joint stiffness - 517, 519, 521, 533
— re-educational, after manipulation - 479, 484
— in spinal fracture - - - - - 551
Exostosis of ear - - - - - - 421
— subungual - - - - - - 344
Expectorant and antispasmodic, prescription for 127
— prescriptions for - - - - - 127
Extension, strapping, by Liverpool method (*Figs* 368, 375) 304
— — in tuberculous hip - (*Figs* 732–736) 578
Extensor apparatus of knee, rupture of - - 565
External otitis - - - - - - 420
— rotation fracture of ankle (*Fig* 727) 571
Eye(s) - - - (*Figs.* 559–595) 428–448
— bandage - - - (*Figs* 325, 326) 289
— burns of - - - - - - 27
— enucleation of - - - - - 447
— examination of, in infants - - - 438
— shield, after cataract - - (*Fig.* 586) 442
Eyelid(s) - - - - (*Figs.* 559–569) 428
— margins, inflammation of - - - 432
— wounds of - - - - (*Fig* 567) 432

FACE, adhesive plaster dressing for (*Fig* 345) 297
— fracture of bones of - - - - 549
— œdema of, following serum injection - - 66
Fæcal fistula, drainage of - - - - 177
— — post-operative - - - (*Fig* 305) 272
— incontinence, prevention of bed-sores in - 362
Fagge's myringotome - - - (*Fig.* 553) 422
Faggot method in dilatation of urethra (*Fig.* 275) 246, 321
Fainting during varicose vein injection 373, 374

PAGE

Fasciæ, adhesions in connexion with - - 477
Fascial space infections - (*Figs* 487–489) 367
Fasciitis, plantar - - - - - - 347
Fat embolism - - - - - - 126
— — complicating fracture - - - 525
— in urine - - - - - - - 82
Fatty casts in urine - - - (*Fig.* 97, D) 83
Feeding after hare-lip operation - - - 190
— through gastrostomy tube (*Figs.* 243, 244) 213
— of unconscious patient - - - - 184
Feet (*see also* Foot)
— minor operations on (*Figs* 448–464) 343–350
Fehling's test for glucose in urine - - - 73
Felamine, post-operative use of - - - 217
Femoral artery, arrest of hæmorrhage from (*Fig* 5) 2
Femur, fracture of, abduction cervical (*Figs* 716, 717) 558
— — adduction cervical (*Figs* 717, B, 718) 559
— — causing stiffness of knee - - - 564
— — lower shaft of, supracondylar (*Fig* 721) 563
— — neck of (*Fig.* 676) 508, (*Figs.* 716–718) 557
— — — basal - - - - - - - 559
— — shaft of - - - - - - 560
— — — through middle third - (*Fig* 720) 563
— — — — two-thirds - - (*Fig.* 719) 560
— — temporary splinting of - - - 508
— lower epiphysis of, displaced - - - 564
— necrosis of head of, complicating dislocated hip - - - - - - - 557
— upper epiphysis of, displaced - - - 559
Fergusson's speculum - - - (*Fig.* 438) 333
Fermentation test for glucose in urine - - 73
Ferric chloride test for aceto-acetic acid - - 74
Fever complicating fracture - - - - 525
— therapy in neurosyphilis - - - - 470
— — relapse cases of gonorrhœa - - - 462
Fibrin foam in hæmorrhage from tooth socket - 454
— in urine - - - - - - - 84
Fibro-adenoma, excision of - - - - 311
Figure-of-8 bandage - - (*Figs* 315, 316) 287
— — for fractured clavicle - (*Fig* 685) 526
Filaria sanguinis hominis in urine - - 82, 85
Filiform guides, passing of, in urethral stricture (*Fig.* 275) 246, 321
Finger(s), adhesive plaster bandage for (*Fig* 376) 307
— anæsthetization of - (*Figs.* 380, 381) 309
— application of plaster bandage to (*Fig.* 638) 489
— exercises in fracture of upper limb - - 517
— infection of terminal pulp space of (*Figs* 481, 482) 363
— injuries of - - - - - - - 547
— pricked during operation - (*Fig* 113) 107
— sprains of - - - - - - - 547
— stiffness of, after fracture (*Fig* 679) 517, 524
First-aid splinting of fractures - (*Fig.* 671) 503
— treatment of burns - - - - - 17
Fissure, anal (*see* Anal fissure)
Fissured fracture of skull - - - - 184
Fistula, anal, post-operative management of - 260
— — radiography of - - (*Fig* 160) 147
— fæcal, drainage of - - - - - 177
— — post-operative - - - (*Fig* 305) 272
Fixation forceps for eye operations (*Fig* 562) 428
Flat-foot - - - - - - - - 346
— rigid transverse, in fracture - - - 519
— spasmodic - - - - - - 346
— surgical boots for - - - (*Fig* 750) 589
Flatulence, post-operative - - - - 270
Flatus tube - - - - (*Fig.* 154) 143
Fluid(s), administration of, in burns - 17, 18
— — by gastric tube (*Figs* 145, C, 148) 133, 136, 138
— — pre-operative - - - - 89, 92
— — in toxic dehydration - - - - 618
Fluorescein in burns of eye - - - - 436
— corneal abrasions - - - - - 438
— foreign body in cornea - - - - 439
Foley's bag - - - - - - - 244
— — for controlling hæmorrhage (*Fig* 296) 256
Fontanelle, anterior, for venepuncture in infant - - - - - (*Fig* 49) 38

PAGE
Foot, fracture of, temporary splinting of (*Fig.* 677) 508
— — weight-bearing in 519
— strain 346
— — manipulation for 481
— tuberculous 583
Forceps, bone, for circumcision (*Fig* 400) 316
— duck-bill, for removing syringes from sterilizer (*Fig.* 27) 29
— epilation (*Fig* 559) 428, (*Fig* 606) 455
— ethmoidal (*Fig* 536) 409
— fixation (*Fig* 562) 428
— nasal (*Fig.* 530) 407, 411
— tonsillectomy (*Figs* 524–526) 403
— tooth extraction (*Fig.* 599) 451
— T-shaped (*Fig* 561) 428
Forearm, application of plaster bandage to (*Figs* 640, 641) 490
— crutch (*Fig.* 759) 591
— fracture of both bones of (*Fig* 698) 540
— — temporary splinting of 506
— involvement of, in tenosynovitis (*Fig* 486) 367
Foreign bodies causing collapsed lung 121, 122
— — in cornea (*Figs* 581, 582) 439
— — ear 426
— — eye (*Fig* 563 430
— — nose 409
— — urine 86
— substances excreted by kidneys 231
Foreskin, incision of, for balanitis and chancroid 318
Formol-corrosive 163
Fowler's position (*Figs* 251–259 220
— — high (*Figs.* 258, 259) 221
Fractional test-meal procedure 383
Fracture(s) of ankle (*see* Ankle, Fracture of)
— astragalus 576
— boards 507
— of bones of face 549
— Colles's (*Figs* 699–701) 542
— complications of, general 525
— compound, treatment of 509
— delayed reduction of 515
— — union of 524
— and dislocations of clavicle (*Figs* 685, 686) 526
— — lower limb (*Figs* 715–730) 556–577
— — upper limb (*Figs* 685–708) 526–548
— emergency treatment of (*Fig* 671–678) 503–513
— of femur (*see* Femur)
— general principles in treatment of (*Figs* 679–682) 514–520
— of humerus (*see* Humerus)
— immobilization of fragments in 516
— infected, Winnett-Orr treatment of 510
— of leg (*Figs* 723–726 567
— lower jaw 549
— malar bone 549
— metacarpals 546
— metatarsals 576
— nasal bones 549
— non-union of 524
— of olecranon 539
— os calcis 576
— patella 565
— pelvis (*Figs* 713, 714) 553
— periods of incapacity following 626
— of phalanges 548
— radius (*see* Radius)
— reduction of displacement in 514
— retaining functional activity in (*Figs* 679–681) 517
— of scaphoid bone of carpus (*Figs* 702, 703) 543
— skull 184
— spine (*see* Spine)
— temporary splinting of 506
— of tibia 566
— toes 577
— ulna (*see* Ulna)
Fracture-dislocation of ankle (*Figs* 727–731) 571
— Monteggia 541
— of pelvis (*Figs.* 713, 714) 554
— semilunar cartilage, manipulation for (*Figs.* 616–619) 479
PAGE
Fracture-dislocation of spine (*Fig* 709, C) 550
— — cervical 553
— thumb, Bennett's (*Figs.* 706, 707) 546
Frænal stitch, three-in-one (*Fig.* 402) 316, 317
French pattern of crutch (*Fig.* 758) 591
French's blood-collecting needle (*Fig* 83) 59
Fuch's lattice shield 442
Fuchs Rosenthal counting chamber 172
Fundus oculi, examination of (*Figs.* 591–595) 448
Furunculosis complicating carbuncles 358
— of ear 421
— treatment of 460
— — abortive 358

GAG, in tonsillectomy (*Fig.* 521) 401
Gallenkamp's pump for wound drainage (*Fig.* 206) 176
Gall-bladder cases, management of (*Figs*, 247, 248) 216
Gall-stone colic 216
Gall-stones (*Fig.* 247) 217
Galvano-cautery for epistaxis (*Fig.* 537) 411
Ganglia, injection treatment of 377, 378
Gangrene complicating fracture 521
— — spike arthrodesis 345
Gardenal as hypnotic 115
Gas gangrene, dose of anti-sera for 67
— — following compound fractures 511
— — — injections 30
— — sulphonamides in 280
— poisoning, treatment of (*see also under* Carbon Monoxide) 620
Gastrectomy, drainage through abdominal wall after 212
Gastric aspiration (*Figs* 137–147) 133, 137
— — after excision of rectum 264
— — continuous 137
— — in dilatation of stomach 270
— — paralytic ileus 271
— — perforated peptic ulcer 212
— — persistent hiccup 274
— — pre-operative 210
— — tube, feeding bile through 219
— — — unconscious patient through 184
— — in vomiting 137, 211
— — Wangensteen's apparatus for (*Fig.* 201) 175
— cases, management of (*Figs* 243–246) 210–215
— intubation, transnasal (*Figs.* 137–148) 133
— — — care of indwelling tube in 136
— — — for gravitating fluid by drip method (*Figs* 145, C, 148) 133, 136, 138
— — — in refractory non-co-operative patients 134
— — — unconscious patients 134
— lavage in poisoning (*Fig* 789) 613, 620
— — pyloric stenosis 214
— mobility test 137
— operations, feeding after 210
— — vomiting after 211
Gastrostomy belt (*Fig* 245) 213
— for feeding (*Figs.* 243–246) 213
— spigot (*Fig* 246) 213
Gastro-intestinal tract, radiography of (*Figs* 171–173) 154
Gelato-glycerin capsules in pelvic inflammation 269
Genital organs, male, minor operations on (*Figs.* 400–415) 316–323
— tract, radiography of (*Figs.* 169, 170) 153
Gentian violet in exterior otitis 421
— — jelly for burns 25, 26
— — in monilial infection 335
— — pruritus vulvæ 467
Genu valgum splints, ordering of 588
Gerrard's ureometer (*Fig* 95) 78
Giddiness 426
Gingivectomy 450
Glaucoma, post-operative treatment of chronic 443
— pre-operative treatment of acute (*Figs* 587, 588) 444
— — — chronic 443
Glioma of retina (*Fig* 591) 448

PAGE
Glomerulo-nephritis, acute diffuse, blood-urea in - - - - 227, 228, 234
Gloves, surgeons' - - (*Figs.* 101–103) 101
Gluconogalactogluconate in gall-stone colic - 216
Glucose, intravenous - - - - - - 41
— — in acute glaucoma - - - - 444
— in post-operative acidosis - - - 275
— pre-operative use of, in jaundice - - 218
— and saline, intravenous, in appendicitis - 223
— — in pyloric stenosis - - - - - 214
— in urine - - - - - 68, 73
— — in carbuncles - - - - - - 357
Gluteal region, contra-indication to injection into - - - - - - - 35
Glycerin and borax in burns of mouth - - 27
— enema - - - - - - - - 145
— instillations in gonorrhœa - - 463, 466
— and olive oil, after colostomy - - - 263
— tampons in pelvic inflammation - - 269
Glycerinated calf lymph - - - - 391
Glycerol enema in delayed treatment of appendicitis - - - - - - 224
— for 'stuck' syringe - - - - - 31
Glycosuria - - - - - - 68, 73
— in carbuncles - - - - - - 357
Glyco-gelatin pessaries in leucorrhœa - - 335
Glycuronic acid in urine - - - 73, 77
Goldman's bag - - - - (*Fig* 778) 601
Gonococcus causing pelvic inflammation - 269
— — vaginal discharge - - - - 334
— in pus - - - - - (*Fig* 197) 171
— urine - - - - - - - 85
Gonopar in gonorrhœa in female - - - 466
Gonorrhœa, complications of, in female - - 467
— — male - - - - - - 464
— relapse cases of - - - - - 462
— tests of cure of, in female - - - 467
— — — in male - - - - - 465
— treatment of, in female - - - - 465
— — male - - - (*Figs.* 611, 612) 461
Gonorrhœal warts - - - - - 342
Gout, acute, urine in - - - - - 70
Gowns, surgeon's - - - - - - 102
Gram's method of staining pus cells - - 170
Granular casts in urine - (*Fig* 97, E, 1, 2) 83
Granulocytopenia due to sulphonamides - 280
Granuloma pyogenicum, cauterization of - 459
'Gravel' in urine - - - - - - 70
Gravitation method of administering enema - 143
Gravity technique in administering sera (*Fig* 92) 64
Gray's pump for wound drainage - (*Fig.* 207) 176
Great toe, fracture of - - - - - 577
Greene's technique in excision of fibro-adenoma of breast - - - - - 311 *n.*
Greenfield's spinal manometer - (*Fig* 515) 398
Greenstick fracture - - - - - 567
— — manipulation of - - - - - 514
Groin, spica bandage for - (*Figs.* 317, 318) 287
— suppurating glands of - - - - 355
Guaiac test for blood in urine - - - 75
Gummatous lesions, treatment of - - - 470
Gums, laceration of, in tooth extraction - - 454
— massage of, in pyorrhœa - - - - 450
Guy's pill in treatment of late syphilis - - 470
Gynæcological cases, management of - 265–269
— procedures and minor operations (*Figs* 430–447) 332–342

HÆMARTHROSIS, aspiration of - - 472
— associated with sprain - - - 473
Hæmatemesis, non-post-operative - - 212
— post-operative - - - - - - 211
Hæmatoidin in urine - - - - - 82
Hæmatoma, anal - - - (*Fig.* 420) 325
— of auricle - - - - - - 427
— septum - - - - - (*Fig.* 535) 408
— subungual, evacuation of - (*Fig.* 387) 312
— treatment of - - - - - - 473
Hæmatoporphyrinuria - - - - - 76
— spectrum of - - - - (*Fig.* 94) 76
Hæmaturia - - - - - - 75, 76
— causes of - - - - - - - 76
PAGE
Hæmaturia due to sulphonamides - - 279
— management of - - - - - - 240
Hæmochromogen in urine, spectrum of (*Fig.* 94) 76
Hæmoglobin, estimation of - (*Figs.* 192, 193) 166
— — pre-operative - - - - - 210
— normal values of - - - - - 173
— percentage in shock - - - 505, 506
Hæmoglobinometer, use of - 55, (*Fig.* 192) 167
Hæmoglobinuria - - - - - 75, 76
— due to sulphonamides - - - - 280
Hæmolysis, blood transfusion and - - - 54
Hæmolytic anæmia due to sulphonamides - 280
— reactions to blood transfusions - - 55
Hæmophilia, bruising in - - - - 473
Hæmoptysis complicating artificial pneumothorax - - - - - - - 387
— treatment of - - - - - - 389
Hæmorrhage in abortion - - - 338, 339
— arrest of - - - - (*Figs* 1–12) 1–6
— complicating cataract - - - - 443
— — cauterization of cervix - - - 335
— — circumcision - - - - - 317
— — curettage of uterus - - - - 337
— — prostatectomy - - (*Figs* 295, 296) 255
— from ear following explosion - - - 422
— — thyroid operation - - - - 194
— — tooth extraction - - - - 454
— middle meningeal - - - - - 186
— plasma infusion for - - - - 61
— post-operative, in gynæcological cases - 268
— reactionary or secondary from rectum (*Fig* 301) 260
Hæmorrhoids, external - - (*Fig* 420) 326
— internal, proctoscopy in - - 324, 325, 327
— — treatment of, injection (*Figs* 421–423) 327
— — — operative - - (*Figs* 424–427) 428
— — — palliative - - - - - 326
Hæmostasis in operation - - - - 106
Hæmostat, application of - - - - 106
Hæmostyl in hyphæmia - - - - 443
Hallux rigidus - - - - - - 346
— valgus - - - - (*Figs.* 452, 453) 345
Hammer-toe - - - (*Figs* 450, 451) 344
Hand(s), anæsthetization of palm of (*Fig.* 382) 309
— application of plaster bandage to (*Figs.* 637, 638) 489
— infections of, serious - - - - 365
— — — 'dry' after-treatment of (*Fig* 490) 369
— — treatment of - (*Figs* 480–490) 363–370
— pre-operative preparation of - - - 101
— wounds of, importance of - - - 511
Hare-lip - - - - (*Figs* 222–224) 189
Harris's operation of prostatectomy, bladder-washes after - - - - - - 252
Hawley table in application of hip spica - - 494
Hay's sulphur test for bile-salts in urine - - 77
Head, adhesive plaster dressing for (*Fig.* 344) 297
— bandages for - - - (*Figs* 323–328) 288
— bleeding from, arrest of - - - - 1
— injuries, management of (*Figs* 216–221) 181–188
— mirror in examination of nose - - - 406
Headache, post-operative, in lumbar puncture 397
Hearing tests - - - - - - - 424
Heart, failing, as contra-indication to venesclysis 47
Heat, application of, in collapse - - - 9
Heath's method of arresting bleeding from tongue - - - - - - - 1
Heel, application of plaster, rubber or iron (*Figs* 649, 650) 493
Heels, tender - - - - - - - 346
Hegar's dilators, passing of - - - 336
Heparglandol B for wound healing - - 180
Heparin, post-operative use of - - - 119
Hernia operations, adhesive plaster dressing after - - - - - (*Fig.* 354) 300
— ordering abdominal belt for - - - - 592
— — truss for - - - (*Figs.* 765, 766) 593
— umbilical, in child, belt for - (*Fig.* 767) 594
Herniotomy, adhesive plaster dressing after (*Figs.* 355, 356) 300

PAGE
Herxheimer reactions in syphilis - 470, 471
Hexamine in acidification of urine - - - 236
— as urinary antiseptic - - - - 237
Hiccup, complicating intravenous anæsthesia 610
— persistent post-operative - (*Fig* 306) 274
Higginson's syringe - - - - - 143
Higgs's spike arthrodesis - (*Figs.* 450, 451) 344
Hilton's method of opening abscess - 351, 355
Hip, dislocation of - - - (*Fig* 715) 556
— — congenital, plaster bandage for - - 495
— optimum position of - - (*Fig* 615) 478
— spica, double - - (*Figs* 653–657) 495
— — long, in plaster - - - - - 495
— — operating, in tuberculous hip (*Fig* 738) 581
— — short, in plaster - (*Figs* 651, 652) 494
— — — — in tuberculous hip - - - 581
— tuberculous - - - (*Figs* 732–738) 578
Hippuran in cholangiography - - - 157
— oral urography - - - - - 150
Hippuric acid in urine - - - - - 80
Histamine test-meal - - - - - 383
Histological examination, tissues for - - 163
Hodge pessary - - - (*Figs.* 446, 447) 340
Hollow needle - - - - - - - 30
— — for intravenous infusion - (*Fig* 53) 42
— — sharpening of - - - (*Fig.* 24) 29
— — technique in injection therapy (*Figs* 24–49) 29–39
Homatropine in cataract operation - - 441
Hordeolum - - - - - - - 431
— removal of lash from - - - - 428
Horsehair sutures - - - - 108, 110
Hoskin's bed-elevator - - - (*Fig* 259) 221
Hospital administration - - - 631–637
— patients, relationship of house surgeon to - - - - - - - 629
— relations between medical and nursing staffs in - - - - - - - 630
Hot bathing of eye - - - - - 430, 431
— packs to precordium in white asphyxia - 11
House surgeon, relationship of, to chiefs - 629
— — — to nursing staff - - - - 630
— — — to patients - - - - - 629
Humerus, fracture of condyles of (*Figs* 695, 696) 536
— — great tuberosity of - (*Figs* 688, 689) 530
— — internal epicondyle of - (*Fig* 697) 537
— — neck of - - - (*Figs* 690–692) 530
— — shaft of - - - - - - 533
— — supracondylar - - (*Figs* 693, 694) 534
— — temporary splinting of - (*Fig* 673) 506
— splint, Robert Jones's, ordering of - - 591
Hyaline casts in urine - - (*Fig* 97, I, 2) 83
Hydrocele, injection treatment of - (*Fig.* 413) 321
Hydrochloric acid, pre-operative administration of - - - - - - - 210
Hydrogen peroxide dressings in hand infection 370
— — — epistaxis - - - - - 411
Hydrophthalmoscope, Batten's - (*Fig* 577) 436
Hymen, imperforate - - - - - 342
Hyoscine compound - - - - - 97
— in fracture of base - - - - - 186
— pre-operative medication - - - 97
Hyoscyamus in acute cystitis - - - 255
Hypersensitivity to serum, testing of (*Fig* 91) 63
Hypertension as contra-indication to venesection 47
Hyperthyroidism and diabetes, operation in - 95
Hyphæma complicating cataract - - - 443
Hypnotics, post-operative - - - 114–116
Hypochlorhydria, pre-operative care in - - 210
Hypochlorite solution in irrigation of empyema 203
Hypodermic injections, technique of (*Figs.* 33, 34) 33
— medication, making dose from tablet (*Fig.* 30) 32
— needles - - - - - - - - 30
— — in skin suturing - - - - 110
— — for use as infant's cannula - - - 52
Hypopyon - - - - - - - - 440
Hypostatic pneumonia complicating fracture - 525
Hysterectomy, obtaining consent for - - 265
Hysterosalpingography - - (*Fig.* 170) 154

PAGE
ICE-PACKS in thyroid crises - - - 194
Ichthammol in exterior otitis - - - 421
Ichthyol in exterior otitis - - - - 421
— furunculosis of ear - - - - - 421
— and glycerin in gonorrhœa in female - - 466
— — gonorrhœal complications - 464, 465, 467
— in glycerin for perineal wound - - - 264
Ichthopaste to prevent disuse œdema - - 520
Ileus, paralytic, post-operative (*Fig.* 304) 270, 271
Iliac crest, insertion of Steinmann's nail through (*Fig.* 397) 314
Immobilization in fracture of scaphoid - - 544
— repair of fractured bone - - - - 516
Immunization against measles - - - 635
Imperforate hymen - - - - - 342
Incapacity, assessment of - - - - 625
Incisions, operative repair of (*Figs* 114–124) 108–113
Incisor teeth, extraction of - (*Figs* 600–603) 452
Incomplete abortion - - - (*Fig* 443) 338
Incontinence of fæces, prevention of bed-sores in - - - - - - - - 362
— urine, prevention of bedsores in (*Fig* 479) 362
Index finger, draining tendon-sheath of (*Fig* 485, 1) 366
Indigo in urine - - - - - - - 82
Inductotherm for gonorrhœa - - - 462
Inevitable abortion - - - - - 338
Infantile paralysis, walking instrument for (*Fig* 748) 587
Infection of eye, post-operative - - - 443
— hand, treatment of (*Figs* 480–490) 363–370
Infectious cases, admission of, to hospital - 631
— — in hospital, control of - - - 635
Infusions - - - (*Figs* 50–73) 40–53
— in infancy - - - - - - - 52
— — marrow - - - - - - - 51
Ingram's test for aceto-acetic acid and acetone 75
In-growing toe-nail - - (*Figs* 448, 449) 343
Inhalation burns - - - - - - 27
Inhalations, prescriptions for - - - 127
Injection, continuous, of penicillin (*Fig* 309) 284
— of radio-opaque media in sinuses, etc (*Figs.* 157–161) 147
— — — into veins - - - - - 150
— of sera - - - - - - - - 63
— treatment of bursæ and ganglia - - 377
— — hollow-needle technique in (*Fig* 24–49) 29–39
— — of hydrocele - - - (*Fig.* 413) 321
— — piles - - - (*Figs* 421–423) 327
— — varicocele - - - - (*Fig.* 415) 322
— — varicose veins - - (*Figs.* 491, 492) 372
— — ulcer - - - - - - - - 374
Injector mask - - - - (*Fig* 227) 197
Insulin in pre-operative treatment of diabetic 96
— post-operative acidosis - - - - 275
— use of, intravenous infusions - - - 41
Insurance, medical reports connected with - 622
Interceptor for intravenous infusions (*Fig.* 52) 41
Intercostal drainage in empyema - - - 200
— neuritis following drainage of empyema - 205
Intestinal aspiration - - (*Figs* 149–153) 139
— — in paralytic ileus - - - - 271
— infections, sulphonamides in - - - 281
— obstruction, radiological demonstration of (*Fig.* 172) 155
Intracranial tension, increased - - - 187
— — — in fractures of base - - - 186
Intradermal injections - - (*Fig.* 35) 34
Intragastric drip infusion in infancy - - 53
— infusions, transnasal - - - - 49
Intra-epidermal vaccination - - - - 393
Intramedullary infusion, special precaution for 53
Intramuscular infusion - (*Figs.* 64, 65) 48
— injections - - - (*Figs.* 36–39) 34
— — of serum - - - - - - 64
— — sites for - - - - - - 35
— urography - - - - - - 150
Intranasal administration of oxygen (*Fig.* 229) 198
Intra-ocular pressure, measurement of (*Fig.* 575) 435
Intrathecal injection of serum - - - 64

PAGE
Intravenous anæsthesia (*Figs.* 787, 788) 607–610
— — collapse in - - - - - 13
— — in gastric intubation - - - - 134
— infusion in acute glaucoma - - - 444
— — continuous - (*Figs.* 50–63) 40–47
— — — in appendicitis - - - - 223
— — — balance sheet for - (*Fig.* 50) 40
— — — contra-indications to - - - 47
— — — in infancy - - - - - 52
— — — nursing instructions for - - 44
— — — rate of flow in - - - - 44
— — — rules for house surgeon concerning 45
— — — technique of - - - - - 41
— — in fat embolism - - - - 126
— — massive dose - - - - - 47
— — pyloric stenosis - - - - 214
— — special precaution for - (*Fig* 73) 53
— injections - - (*Figs* 40–47) 36–39
— — of serum - - - - - - 64
— — — hazards of - - - - - 66
— mercurial diuretics - - - - - 381
— saline after thyroid operation - 193, 194
— — in collapse under spinal anæsthesia - 14
— — continuous, in toxic coma - - 618, 620
— — — — dehydration - - - - 619
— — in dilatation of stomach - - - 271
— — and glucose in fæcal fistula - - - 273
— — — paralytic ileus - - - - 271
— — in thyroid crises - - - - 195
— therapy in anuria - - (*Fig* 264) 241, 242
— urotropine in acute pyelitis - - - 239
Intubation, complications of anæsthesia by - 606
— of duodenum - - (*Figs* 149–153) 139
— in endotracheal anæsthesia (*Figs* 780–786) 602
— paralytic ileus - - - - - 271
— post-operative - - - - - 119
— transnasal gastric, duodenal and intestinal (*Figs.* 137–153) 133–142
Intussusception, radiological demonstration of (*Fig* 173) 155
Iodatol in bronchography in infants - - 162
Iodides in syphilis - - - - - - 469
Iodine and boric powder in after-treatment of mastoid - - - - - 427
— — — for discharging ear - - - 424
— idiosyncrasy - - - - - - 90
— intolerance - - - - - - 158
— poisoning, antidote to - - - - 616
— preparation of operative site - - 90, 103
— test for bile in urine - - - - 77
— therapy in thyroid surgery - - - 192
Iodoxyl in excretory urography in infants - 157
Ionization in chronic gonorrhœa in female - 466
Ipecacuanha as emetic - - - - - 615
Iris prolapse complicating cataract - - 443
— scissors - - - - - (*Fig.* 574) 435
Iron and ammonium citrate in hæmatemesis - 213
— heel to plaster bandage - (*Figs.* 649, 650) 493
Irradiation burn - - - - - - - 26
Irrigation in acute gonorrhœa in female - - 466
— — — male - - - - (*Fig* 611) 462
— of bladder, automatic - - (*Fig* 287) 252
— eyes - - - - - (*Fig* 580) 438
— — in burns - - - - - - - 436
— of wounds - - - - (*Fig* 214) 178
Isaac's spectacle-frame holder for gastric tube (*Fig* 145, B) 136
Ischæmic contracture, Volkmann's (*Fig.* 683) 521
Ischiorectal abscess - - - (*Fig.* 473) 356
Isogel in fæcal fistula - - - - - 273

JACQUES type catheter for 'permanent' suprapubic - - - - - - - 257
Janet's method of washing out bladder - - 251
— syringe for gastric aspiration - - - 138
Jaques' stomach tube - - - - - 613
Jaundice, cholecystography contra-indicated in 216
— due to sulphonamides - - - - 280
— following arsphenamine treatment - - 471
— — injections - - - - - - 30
— pre-operative treatment of - - 218
— urine in 69, 77
Jaw, bandage for - - (*Figs.* 330, 331) 290
— lower, dislocations of - - - - 549
— — fractures of - - - - - 549
Jejunostomy for feeding - - - - 213
— in high fæcal fistula - - - - 273
Jenner's stain - - - - - - 169
Joint(s), adhesive plaster bandage for (*Fig* 367) 304
— functional and hysterical conditions of - 477
— optimum position of, in manipulation (*Fig.* 615) 477
— stiffness, complicating fracture (*Fig* 684) 524
Jones's abduction frame, ordering of - - 588
— double abduction frame - (*Fig.* 737) 580
— 'Robert', humerus splint, ordering of - 591
Jugular vein, external, for venoclysis (*Fig.* 55) 43
— — — for venepuncture in infant (*Fig* 48) 38

KANAVEL'S sign in tenosynovitis - - 366
Kaolin paste to prevent skin excoriation in fæcal fistula - - - - - - 272
Kelly's method of corsettage - (*Fig* 358) 301
Keloid, treatment of - - - - - - 26
Kemble's technique of urethrography - - 152
Keratitis, exposure - - - - - 432
— neuroparalytic - - - - - 432
Kerley's method of cholecystography - - 156
Ketonuria - - - - - - - - 74
— odour of urine in - - - - - 69
Ketosis, avoidance of, in operation on diabetic 96
— post-operative - - - - - 275
Kettering hypertherm for gonorrhœa - - 462
Kharsulphan in syphilis - - - - 468
Kidney(s), capacity of either, separately - - 234
— concentration and dilution power of - - 229
— excretion of foreign substances by - - 231
— function, tests for (*see also under* Renal) 226–234
— urea-excreting capacity of - - - 232
Kifa clips - - - - - - - - 110
Kirschner's wire in skeletal traction - - 315
Krause's laryngeal forceps - - (*Fig* 241) 208
Knee, adhesions of - - - - - 476
— cage, jointed, ordering of - - (*Fig* 749) 588
— dislocation of - - - - - - 566
— fracture of, temporary splinting of - - 508
— involvement of, in sprain - - - 473
— manipulative technique on (*Figs* 616–619) 479
— optimum position of - - (*Fig* 615) 478
— rupture of extensor apparatus of - - 565
— — ligaments of - - - (*Fig* 722) 566
— stiff, after fracture of femur - - - 564
— tuberculous - - - (*Figs* 739, 740) 582
'Knife-rest' phosphates in urine (*Fig* 96, D) 80
Knock-knee splints, ordering of - - - 588
Knot for attaching suture to needle (*Fig* 107) 105
— clove-hitch - - - - (*Fig* 111) 106
— reef - - - - - (*Fig* 109) 105
— surgeon's - - - - (*Fig* 110) 105
Kocher's method of reducing dislocated shoulder - - - - (*Fig* 687) 529
Kollmann's four-bladed dilator - (*Fig* 613) 464
Kummell's disease - - - - - 550
Kuss's needle for artificial pneumothorax (*Fig* 502) 386

LABAT'S syringe - - (*Fig* 38) 35
Laboratory normals, table of - - - 173
Labyrinthine concussion - - - - 422
Lacrimal apparatus - - (*Figs.* 570–576) 433
— cannula and syringe - - (*Fig.* 571) 433
— passages, testing patency of (*Figs* 570, 571) 433
— — — — in cataract - - - - 441
Lactic acid douche - - - - - 266
— — — for senile vaginitis - - - 335
Lactosuria - - - - - - - - 74
Lambkin's cream in syphilis - - - 469
Lambrinudi's operation for pes cavus - - 347
Laparotomy corsets - - - (*Fig.* 360) 301
Laryngeal mirror - - - (*Fig.* 545) 415
— spasm in anæsthesia - - - - 605
Laryngoscope in endotracheal anæsthesia (*Fig* 782) 605

PAGE
Laryngoscopy, direct - (*Figs.* 548, 549) 415, 417
— indirect - - - - (*Figs.* 545–547) 415
— Magill's - - - - (*Fig.* 548) 417
Larynx - - - (*Figs.* 540–549) 413 418
— examination of - (*Figs.* 545–549) 415
Lashes, cutting of, before cataract operation - 441
— removal of - - - - (*Fig.* 559) 428
Lead lotion compresses for piles - - - 326
— and opium in epididymitis - - - 465
— salts, poisoning by, antidote to - - - 616
Learmonth's method of corsettage (*Fig.* 237) 204, (*Fig* 359) 301
Leeches, application of - - - - 380
— — in acute glaucoma - - - - 444
Leg appliances, ordering of - (*Figs* 743–755) 586
— application of plaster bandage to (*Figs.* 644–650) 492
— bones, fracture of, temporary splinting of - - - - - - - 508
— — — with overriding - (*Figs.* 723–725) 567
— — — — oblique - - - (*Fig* 726) 569
— — — without overriding - - - 567
Leishman's stain - - - - - 169
Lennox Browne's modification of Politzer's bag - - - - - (*Fig* 556) 425
Leptazolum B P as analeptic - - - 10
Leptospira icterohemorrhagiæ in urine - - 85
Letterman foot corrective support (*Fig.* 752–754) 589
Leucin in urine - - (*Fig* 96, L) 80
Leucocyte count - (*Figs* 194, 195) 168
— — in appendicitis - - 223
— — normal - - - 173
Leucocytes in urine - - - 82
Leucopenia due to sulphonamides 280
Leucorrhœa - - - 334
— treatment of - - - 335
Leukæmia, urine in - - - 70
Lichtwitz's antrum trocar and cannula (*Fig* 533) 408
Life Assurance examination, arrangement of reports on - - - - - - 622
Ligament, rupture of - - - - - 473
Ligamentous sprain - - - - 473
Ligamentum patellæ, avulsion of - - - 565
Ligature sling - - - - - (*Fig* 106) 104
— operation for external piles (*Figs* 424–427) 328
— tube breaker, Denis Browne's - (*Fig* 105) 104
Ligature-carrying forceps, Browne's (*Fig* 526) 403
Lillington-Pearson artificial pneumothorax apparatus - - - (*Figs* 500, 506) 385
Lime burns of eye - - - - - 436
Linctus codeinæ for unproductive cough 120, 126
— simplex for unproductive cough - - 126
Lindsay-Rea needle for retro-ocular injection (*Fig* 588) 444
Lip, bleeding from, arrest of - - - 1
Lipiodol in bronchography - - - 158, 162
— cholangiography - - - - 157, 9
— injection of, into sinuses, etc - - 147
— in radiography of empyema - 204
— — genital tract - - - 153, 154
— sialography - - - - 147
— urethrography - - - 152
Lipoma, subcutaneous, excision of (*Fig.* 384) 310
Lipuria - - - - - - - - 82
Lithium salicylate quinine hydrochloride and urethane for injecting ganglia - - 378
Lithocaine in varicose vein injection - - 373
Liverpool method of applying strapping extension - - - (*Figs* 368–378) 304
Lloyd's plaster opener - - (*Figs.* 669, 670) 502
Lobeline in septic bronchitis - - - 120
Loeffler's medium - - - - - 164
Logan's bow, modified - - (*Figs* 223, 224) 190
Loop colostomy, management of - (*Fig.* 303) 261
Lovibond comparator - - 71, (*Fig* 193) 167
L.P.I. tourniquet - - - (*Fig* 10) 5
Luc's ethmoidal forceps - - (*Fig* 536) 409
Lugol's solution in thyroid surgery 192, 193, 194, 195
Lumbago, manipulation for - - 477, 483
Lumbar puncture - - (*Figs.* 510–516) 394
Lumbar puncture for collapse under intravenous anæsthesia - - - 13
— — needles - (*Figs.* 510, 514) 394, 397, 398
— — — in suprapubic puncture (*Fig.* 280) 248
— — to reduce intracranial tension - 186, 187
— — in toxic coma 618, 620
Lumbosacral corsets - 593
— strain - - - 483
Luminal in burns - 19
— fracture of base - 186
— as hypnotic - - 115
Lunate bone, dislocation of (*Figs.* 704, 705) 545
Lung abscess in necrotizing pneumonitis - 124
— — post-operative - - - - - 124
— burns of - - - - - - - 27
— cavity, "Silent" pump for drainage of - 176
— massive collapse of (*Figs* 125, 126) 120, 123
— — — precautions against - - - 118
Lymph for vaccination - - - - 391
Lymphangitis - - - - - - 365
Lysol in cleansing of syringes - - - 31

MACDONALD'S box for suprapubic drainage - - - - - - (*Fig* 291) 254
Mackenna's spray for penicillin - (*Fig.* 310) 284
Magill's laryngoscope - - (*Fig.* 548) 417
Magnesia in acid poisoning - - - - 615
— milk of, post-operative, in rectal cases 259, 263, 264
— — pre-operative, in rectal cases - - 258
Magnesium phosphates in urine - - - 82
— sulphate for carbuncles - - 358, 359
— — in cerebral irritation - - - - 187
— — dressings in hand infection - - - 370
— — enema - - - - - - 146
— — fomentations in breast abscesses - - 353
— — in furunculosis of ear - - - 421
— — paste in boils - - - - - 460
— — to reduce intracranial tension - 186, 187
Magnifying spectacles for skin examination (*Fig.* 605) 455
Maingot's T-tube for draining bile-duct (*Fig* 250) 218
Malaise following serum injection - - 66
Malar bone, fracture of - - - - 549
Malaria therapy in neurosyphilis - - - 470
Male genital organs, minor operations on (*Figs* 400–415) 316–323
Malecot catheter (*Figs.* 281, 282, 288) 248, 249
— — changing of - - - - - 254
Malleolus, fractures of - (*Figs* 727, 728) 571
— — external, without displacement - - 573
— — internal, without displacement - - 573
Mallet finger - - - - - (*Fig* 708) 548
Malleus in examination of ear - - - 419
Mandelic acid preparations in acidification of urine - - - - - - 236
— — treatment, acidity of urine in - - 71
Mandelix in acidification of urine - - - 236
Manipulation causing stiff knee - - - 564
— of fracture under anæsthesia - - - 514
— for periarticular adhesions of shoulder - 533
— traumatic adhesions - - - - 475
— treatment by - - (*Figs.* 615–627) 476–485
Manipulative reduction of displacement in fracture - - - - - - - 514
— treatment of Colles's fracture (*Figs* 699, 700) 542
— — dislocated hip - - - (*Fig* 715) 556
— — dislocation of semilunar bone - - 545
— — fractured condyle of humerus - - 536
— — — olecranon - - - - - 539
— — — radius and ulna - - - - 540
Mantoux test - - - - - - - 458
Many-tailed bandage (*Figs.* 333, 334) 291, (*Fig* 470) 354
Mapharside in syphilis - - - 468, 470
Marfanil - - - - - - - 277 *n.*
Marginal fracture of acetabulum - - 557
— — ankle with forward dislocation (*Fig* 729) 573, 575
— — head of radius - - - - - 539

PAGE

Marrow, blood transfusions into - - 51, 58
— plasma infusion into - - (*Fig.* 90) 62
— infusions, special precautions for - - 53
— — sternal - - - (*Figs.* 67–70) 49
— — tibial, for infants - (*Figs.* 71, 72) 51
Marsh's knee cage - - - (*Fig.* 749) 588
Mask, surgeon's - - - (*Figs* 99, 100) 100
Massage of eye, in glaucoma - - - 443
— in late treatment of burns - - - 26
— post-operative - - - - - 119
— pre-operative - - - - - - 118
— of prostate - - - - (*Fig.* 414) 323
Mastitis, acute suppurative - (*Figs.* 469–471) 353
Mastoid bandage - - - (*Fig.* 329) 290
— operation, after-treatment of - - - 427
Maxwell artificial pneumothorax apparatus (*Fig.* 499) 385
Mayo's operation, adhesive plaster dressing after - - - - (*Fig.* 353) 299
M & B 693 - - - - - - - 276
— after excision of rectum - - - - 263
— in otitis media - - - - - 422
— soluble - - - - - - 276, 278
M & B 760 - - - - - - 276
Measles, control of, in hospital - - - 635
Meatotomy - - - - (*Fig.* 48) 319
— in impacted urethral calculus - - - 249
Meatus, dilatation of - - - - - 319
Medical 'operations' - (*Figs.* 496–506) 379–390
— staff of hospital - - - - - 631
— — relationship of, with nursing staff - 630
Medico-legal reports - - - - - 621
— — arrangement of - - - - - 622
Medinal in burns - - - - - - 19
— as hypnotic - - - - - - 115
Meibomian cyst - - - (*Figs.* 565, 566) 430
— glands, expression of - - - 430, 433
Melæna, remote severe post-operative - - 211
Melanin in urine - - - - - - 82
Meningitis, examination of cerebrospinal fluid in - - - - - - - 172
— following spinal injection - - - 30
Meningococcal infections, sulphonamides in 280
Menstruation, operation during - - - 265
Mental symptoms due to sulphonamides - 279
Menthol inhalations - - - - - 127
Mentholated steam, inhalation of - - - 407
Mercurial diuretics - - - - - 381
— preparations in syphilis - - - 469
Mercurochrome for bladder washes - - 251
— in gonorrhœa in female - - - - 466
— infection of Skene's tubules - - - 335
— injections in bartholinitis - - - 467
— in irrigation of renal pelvis - - - 239
— necrosis following injection of piles - - 328
— ointment in chancroid - - - - 471
— in peri-urethral abscess - - - - 464
— prevention of post-operative retention - 250
Mersalyl as diuretic - - - - - 381
— in pulmonary congestion - - - 118
— — œdema - - - - - - 45
Merthiolate in irrigation of empyema - - 203
Metacarpals, fractures of - - - - 546
Metastatic complications of gonorrhœa - - 465
Metatarsal bar - - - - (*Fig* 751) 589
— supports - - - (*Figs* 752–754) 589
Metatarsals, fractures of - - - - 576
Metatarsus varus - - (*Figs.* 456–459) 348
Methæmoglobin cyanosis - - - - 279
— in urine, spectrum of - - (*Fig* 94) 76
Methedrine as analeptic - - - 10, 13
Methylene blue in methæmoglobin cyanosis - 279
— — and novocain in cystitis - - - 255
— — as urinary antiseptic - - - - 237
Methylsulphonal as hypnotic - - - - 115
Michel's clips - - - (*Figs* 115, 119) 110
Micrococcus ureæ - - - - - - 85
Micro-organisms in urine - - - - 85
Middle ear, inflation of - - - - 425
— — suppuration in, causing external otitis 421
Mid-tarsal joint, manipulation of (*Figs.* 622, 623) 482
Mill, suction apparatus - - - - 176

PAGE

Millbank clip - - - - (*Fig.* 671) 503
Miller-Abbott double-lumen tube (*Figs.* 149–153) 139
Milligan's technique in ligature operation for piles - - - - - - 328
Millin's suprapubic belt - - (*Fig.* 769) 594
Mills's fenestrated bougie - - (*Fig.* 614) 464
Milton for irrigation of burn - - - 24
Mirror laryngoscopy - - (*Figs.* 545, 546) 415
Molar teeth, extraction of - (*Fig.* 603) 452, 453
Mole, pigmented, excision of - (*Fig.* 386) 311
Monilial infection, treatment of - - - 335
— vaginal discharge - - - - 266, 334
Monteggia fracture-dislocation - - - 541
Moorfield's bandage - - - (*Fig.* 327) 289
Moots' law - - - - - - - 596
Morphine in abortion - - - - - 338
— after thyroidectomy - - - - 193
— in acute retention of urine - - - 246
— anaphylactic reactions to blood transfusions - - - - - - 55
— and atropine, pre-operative use of - - 97
— in breast abscess - - - - - 353
— burst abdomen - - - - - 274
— contra-indicated in appendicitis - - 223
— — unconsciousness - - - 184, 186
— in hæmatemesis - - - - - 213
— hæmoptysis - - - - - - 389
— hydrochloride as hypnotic - - - 115
— and hyoscine combined with sodium pentothal - - - - - - 97
— — pre-operative use of - - - - 97
— in intravenous anæsthesia - - 607, 608
— not advised in gall-stone colic - - - 216
— in pain due to poisoning - - - 619, 620
— paralytic ileus - - - - - 271
— post-operative hæmorrhage - - - 269
— persistent hiccup - - - - - 274
— pre-operative contra-indication to - - 118
— in pulmonary embolus - - - - 125
— removal of uterine pack - - - - 267
— suppository in acute prostatitis - - 464
— in treatment of burns - - - 17, 19, 21
Mouth, burns of - - - - - - 27
Mucous-casts in urine - - - - - 85
Mucous-corpuscles in urine - - - - 85
Mucous-threads in urine - - - - - 85
Mucus in urine - - - - - - 70 84
Multiple-pressure method of vaccination - 391
Mumps, control of, in hospital - - - 635
Murphy's method of continuous rectal infusion (*Fig* 66) 48
Muscles, adhesions in connexion with - - 477
— rupture of - - - - - - 474, 475
— suture of, periods of incapacity following - 626
Muscular strain - - - - - - 474
Musculospiral palsy complicating fractured humerus - - - - - - 534
Myositis ossificans complicating dislocated elbow - - - - - - 538
— — — fracture - - - - - - 523
— — of quadriceps - - - - - - 565
Myringotome, Bagge's - - (*Fig* 553) 422

NÆVI, spider, cauterization of - - - 459
— — treatment of, with CO_2-snow - - 459
N.A.B in syphilis - - - - - - 468
Nail bed, excision of - - - (*Fig* 449) 343
— removal of splinter beneath - (*Fig* 388) 312
Narcommal - - - - - - 607 *n.*
Narcosis, basal - - - - - - 97–99
Nasal bones, fracture of - - - - - 549
— catheter for endotracheal anæsthesia (*Fig* 781) 603
— — oxygen - - - - (*Fig* 229) 198
— infection due to intubation - - - 606
— inhalations in acute rhinitis - (*Fig* 531) 407
— mucus, irritation and infection of wound by 190
— obstruction, chronic - - - - 409
— — of recent origin - - - - 407
— operation, duties of assistant at - - 410
— polypi - - - - - - - - 409

PAGE

Nasal speculum - - - (*Figs.* 528, 529) 406
— swabs for pathological examination - - 164
Naso-lacrimal duct, probing of - (*Fig.* 572) 434
— — syringing of - - (*Figs.* 570, 571) 433
Neck, adhesive plaster dressing for (*Figs.* 346, 347) 297
— bandage for - - - - (*Fig.* 332) 290
— bleeding from, arrest of - - - - 1
Necrosis of femoral head, avascular - - 557
— superficial, following injection of piles - 328
Necrotizing pneumonitis - - - - 124
Needle(s), Billimoria and Dunlop's (*Fig* 65) 48
— care of, after use - - - - - 31
— cisternal - - - - (*Fig.* 519) 399
— French's blood-collecting - (*Fig.* 83) 59
hollow - - - - - - 29
— — for intravenous infusion - (*Fig* 53) 42
— intradermal - - - - (*Fig* 35) 34
— intramuscular - - - (*Fig.* 36) 34
— lumbar puncture (*Figs* 510, 514) 394, 397
— — — for hydrocele - - (*Fig.* 415) 321
— ordering of - - - - - - 30
— sterilization of - - - - - 30
— storage of, after sterilization, - - - 31
— surgeon's - - - - - - 109
— threading of - - - - (*Fig* 112) 106
Needle-catching forceps, Browne's (*Fig.* 525) 403, 405
Nelson bed in lung abscess - - - - 125
— — for postural drainage - - - 207
Nembutal in basal narcosis - - - - 98
— as pre-operative sedative in cataract - - 441
Neoarsphenamine and bismuth, in syphilis - 469
— in syphilis - - - - - - 468
Neocardyl in syphilis - - - - - 469
Neo-halarsine in syphilis - - - 468, 470
Neo-hydriol in bronchography - 158, 160, 162
— fluid in urethrography - - - - 152
— in radiography of empyema - - - 204
Neokharsivan in syphilis - - - - 468
Neorsphenamine as urinary antiseptic - - 238
Neotropin as urinary antiseptic - - - 237
Nephritis, chronic, blood-urea in - 227, 228
— urine in - - - - - 68, 69, 83
Nephrons, functioning - - - - 226
Nephrostomy, management of - - - 239
Neptal as diuretic - - - - - - 381
Nerve lesions, complicating fracture - - 522
— suture, periods of incapacity following 626, 628
Nervous excitation due to poisoning - - 619
— depression due to poisoning - - - 617
Nettleship's dilator - - - (*Fig* 570) 433
Neuralgia, dental - - - - - 449
Neuroparalytic keratitis - - - - 432
Neurosyphilis, treatment of - - - - 470
Neutral-red in test for reaction of urine - 235
Newborn babies, identification of - - - 633
Nicholson's method of cardiac massage (*Fig* 20) 13 *n.*
Nicotinic acid in conjunction with sulphonamide - - - - - - 280
— — gastric fistula - - - - - 210
— — vomiting due to sulphapyridine - - 279
Night shoes, ordering of - - - - - 588
Nikethamide in œdema following serum injection - - - - - - 66
Nikethamidum B.P. as analeptic - - - 10
Nitric acid test for bile in urine - - - 77
'Nitritoid' crisis following arsphenamine treatment - - - - - - 471
Nitrogen-retention, tests for - - - 227
Nitro-glycerin in gall-stone colic - - - 216
Nitrohydrochloric acid fort, in acidification of urine - - - - - 236, 238
Nitrous oxide anæsthesia - - - - 599
— — in incision of drumhead - - - 422
— — manipulative treatment - - 479, 481
— — and oxygen anæsthesia - - - 599
— — — and ether anæsthesia (*Figs* 774–777) 599
Nitschke's scrotal bandage - (*Fig.* 337) 293, 300
Northfield's apparatus for measuring cerebro-spinal fluid pressure - (*Fig* 516) 398

PAGE

Nose and accessory sinuses (*Figs.* 528–539) 406–412
— bleeding during endotracheal operation - 606
— — treatment of - - - - - - 410
— discharge from, in fracture of base - - 186
— foreign body in - - - - - - 409
'Nosebag' mask - - - - (*Fig* 99) 100
Novocain for anæsthetizing urethra - - 320
— in circumcision of adult - - - - 317
— convulsions, cause of - - - - 309
— in detached retina - - - - - 445
— diagnosis of ruptured ligament - - 473
— for local anæsthesia - - - - - 308
— injection in aspiration of chest - - - 198
— — of sprain - - - - - - - 474
— in manipulative treatment - - 479, 481
— poisoning - - - - - - - 14
— in probing naso-lacrimal duct - - - 434
— reduction of fracture - - - - 514
— retro-ocular injection of - - - - 444
— in retention due to prostatic enlargement - 247
— ruptured internal ligament of knee - - 566
— tooth extraction - - - - - 450
Novaldin in gall-stone colic - - - - 216
Novalgin in gall-stone colic - - - - 216
Novostab in syphilis - - - - - 468
Nupercaine, injection of, in anal spasm 326, 330
Nursing in burns - - - - - - 18
— staff, medical care of - - - - 637
— — relationship of house surgeon to - - 630
Nux vomica and ammonium carbonate mixture 127
Nylon sutures - - - - - - 108, 110

OBESITY, pre-operative management of - 91
Obstetric cases, enema contra-indicated in 145
'Obstetrician's hand' in tetany - - - - 195
Obstructive anuria - - - - - - 240
Occult blood, examination of stool for - - 173
Occupational therapy in burns - - - - 26
Ochsner-Sherren treatment of appendicitis 216, (*Fig.* 261) 222
— — in pelvic inflammation - - - 269
Ocular tension in acute glaucoma, reduction of - - - - - - - - - 444
Odontalgia - - - - - - - - 449
Œdema complicating fracture, - - - - 521
— — varicose ulcer - - - - 376, 377
— disuse, prevention of - - - - - 520
— fluid, removal of - - - - 380, 381
— following serum injection - - - - 66
— of knee, causing stiffness - - - - 564
— optic disc - - - - (*Fig.* 594) 448
— pulmonary, resulting from venoclysis - 45
— of sprained ankle - - - - - 571
— wound, prevention of - - - - - 179
Œstrogen treatment of senile vaginitis - - 335
Officer's apparatus for drip blood transfusion (*Fig.* 81) 58, 263
Oidium albicans infection causing vaginal discharge - - - - - - - 334
Olecranon, fracture of - - - - - 539
— — with forward dislocation - - - 540
Oleum iodisatum in bronchography in infants 162
Oliguria - - - - - - - - 240
— due to sulphonamides - - - - 279
— intravenous infusion in - - - - 47
— post-operative, in gynæcological case - 269
Olive oil enema - - - - - - 145
— — and gruel enema - - - - 145
— — — — in rectal cases - - - 259
— — injunctions in burns - - - - 26
Omnopon as hypnotic - - - - - 114
— in intravenous anæsthesia - - 607, 608
— pre-operative medication - - 97, 98
Opacol in cholecystography - - - - 155
Opaque enema, preparation for - - - 155
— meals, preparation for - - - - 154
'Open' drainage of empyema (*Figs* 234, 236) 203
Operation(s), assisting at (*Figs.* 99–113) 100–107
— consent for - - - - - 87 *n.* 632
— death resulting from - - - 639, 640
— gynæcological, consent for hysterectomy in 265

PAGE
Operation(s), minor, general principles in (*Figs.* 377–394) 308–315
— periods of incapacity following - - 626
— preparation for - - (*Fig.* 98) 87–94
Operative incisions, repair of (*Figs* 114–124) 108–113
Ophthalmia, sympathetic - - - - 439
Ophthalmoscopy - - (*Figs.* 591–595) 448
— in detached retina - - - - - 445
Opium as a hypnotic - - - - 115, 116
— poisoning, antidote to - - - - 616
— — unconsciousness due to - - - 185
Optic atrophy - - - - (*Fig* 595) 448
— disc, examination of, in neurosyphilis - 470
— — œdema of - - - (*Fig* 594) 448
Oral cholecystography, intensive - - - 156
— hygiene, pre-operative - - 87, 88, 118
— intubation, anæsthesia by - - - 605
— urography - - - - - - 150
Orthoform in pain after dental extraction - 454
— spray in burns of mouth - - - - 27
Os calcis, fractures of - - - - - 576
— — insertion of Steinmann's nail through - 314
— — spur from, causing tenderness - - 346
Osmotic dressings - - - - - 178
Osteomyelitis following tibial marrow infusion 52
Otitis, external - - - - - - 420
— media, acute - - (*Figs* 553, 554) 422
— — chronic suppurative - - (*Fig* 555) 423
— — in infants - - - - - 423
Otosclerosis, deafness due to - - - 424
Otoscope, electric - - (*Figs* 550, 551) 419
Oxalic acid poisoning, antidote to - - - 616
Oxaluria - - - - - - - 80
Ox-bile enema - - - - - - 146
— — in paralytic ileus - - - - 271
Oxford unit in dosage of penicillin - - - 284
Oxycyanide of mercury in gonorrhœa - 463, 464
Oxygen administration in burns - - 17, 18
— and carbon dioxide after tracheotomy 414, 415
— — — in asphyxia due to poisoning - 617, 620
— — — collapse - - - - - 9
— — — ether convulsions - - - - 14
— — — novocain poisoning - - - 14
— — — white asphyxia - - - - 12
— masks - - - - (*Figs* 226–228) 107
— pressure, pumps operated by - - - 176
— tents - - - - - (*Fig* 225) 196
— — for post-operative pneumonia - - 122
— — septic bronchitis - - - - 120
— therapy - - - - - - - 196
— — in asphyxia due to poisoning - - 617
— — collapse - - - - - - 9
— — danger of fire in - - - - - 198
— — in fat embolism - - - - - 126
— — pulmonary œdema - - - - 45
— — thyroid crises - - - - - 194
— use of, in operation - - - - - 600
Oxyhæmoglobin in urine, spectrum of (*Fig.* 94) 76
Oxyuris vermicularis in urine - - - 85

PACKING of nose - - - - - 411
— prostatic cavity - - - - 256
— uterus - - - - - - - 267
— vagina to control hæmorrhage - - 268, 269
— — pre-operative - - - - 266, 267
Page, Max, nail holder - - (*Fig.* 399) 314
Palm of hand, anæsthetization of - (*Fig.* 382) 309
Palmar bursa (*see* Ulnar Bursa)
— space, middle - - - (*Fig.* 487) 368
— — — treatment of infections of (*Fig.* 489) 369
Pancreatic cases, management of - - - 219
— — post-operative treatment of - - 219
Pancreatitis, diastase index in - - - 78
Pantopon as hypnotic - - - - - 114
Papilloedema - - - - (*Fig.* 594) 448
Papillomata of vulva - - - - - 342
Paquelin cautery for skin lesions - - - 459
Paracentesis abdominis - - - - 381
— of corneal ulcer - - - - - 441
— tympani - - - - - - 422
PAGE
Paracentesis tympani in infants - - - 423
Paraffin, liquid, in cystitis - - - - 255
— post-operative, in rectal cases - 259, 263, 264
— pre-operative, in rectal cases - - - 258
Paraldehyde in basal narcosis - - - 98
— cerebral irritation - - - - - 187
— as hypnotic - - - - - 115, 116
— in unconsciousness - - - 184, 186
Paralysis causing retention - - - - 250
— of deltoid complicating dislocated shoulder 530
— ulnar, following fracture of condyle - 536
— — — — epicondyle - - - - 537
Paralytic ileus, intestinal aspiration in - - 139
— — post-operative - - (*Fig* 304) 270, 271
Paraphimosis - - - (*Figs* 406, 407) 318
Paraplegia complicating spinal fracture - - 553
Parasites, animal, in urine - - - - 85
Parathyroid tetany - - - - - 195
Paratonsillar vein - - (*Figs* 522, 523) 401
Parolene in burns of eye - - - 27, 436
— conjunctivitis - - - - - - 437
Paronychia - - - - (*Fig* 483) 364
Parotid gland, radiography of - (*Fig* 162) 147
Patch test - - - - - - - 457
Patella, excision of fractured - - - - 565
— fracture of, with displacement - - - 565
— — without displacement - - - 565
Pathogenic bacteria in urine - - - 85
Pathological investigations, collection of specimens for - - (*Figs* 183–189) 163
Pathology, house surgeon and (*Figs* 183–200) 163–174
Patients, admission of, to hospital - - - 631
— discharge of - - - - - - 634
— information about - - - - - 634
— transfer of, to other hospitals - - - 635
Patten worn with crutches - - (*Fig* 760) 591
Paul-Mikulicz operation, after-treatment of - 262
Pectoralis major, intramuscular injection into 36
Pediculosis capitis - - - - - 457
'Pellagroid' syndrome - - - - - 279
Pelvic abscess - - - - - - 269
— — development of - - - 224, 225
— examination under anæsthesia in gynæcological cases - - - - - 266
— inflammation, acute, treatment of - - 269
— suspension, to prevent bed-sores (*Figs* 476, 477) 360
Pelvis, fractures and dislocations of 507, (*Figs* 713, 714) 553
Penicillin, administration of - - - - 283
— in burns - - - - - - - 23
— carbuncles - - - - - - - 357
— conjunctivitis - - - - - - 437
— cream - - - - (*Fig.* 311) 283, 284
— dosage of - - - - - - - 283
— in gonorrhœal complications - - - 465
— pastilles - - - - - - - 283
— in pneumonitis - - - - - - 124
— relapse cases of gonorrhœa - - - 462
— staphylococcal septicæmia - - - 281
— syphilis - - - - - - - 470
— therapy - - - (*Figs* 307–312) 282–285
— toxic effects of - - - - - - 285
— use of drainage tube in wounds treated by 112
— in wound excision - - - - - 509
Penile jacket - - - - (*Fig* 269) 244
Pentosuria - - - - - - - - 74
Pentothal anæsthesia, continuous - (*Fig* 788) 609
— — in glaucoma - - - - - 444
— — indications and contra-indications for 607
— — premedication in - - - - 607
— in ether convulsions - - - - 14
— intravenous, in manipulative treatment 479, 481, 484
— overdosage of - - - - - - 610
— preparation of solution of - - - 608
— in skeletal traction - - - - - 315
— sodium in basal narcosis - - - - 97
— — intravenous, in burns - - - 22
— technique of administration of (*Fig.* 787) 608
Peptic ulcer, perforated - - - - 212
Perabrodil in excretory urography - - 150

PAGE

Perchloride lotion compresses for piles - - 326
Perforated peptic ulcer - - - - - 212
Perforation of drumhead - - - - - 423
Peri-apical abscess - - - (*Fig* 597) 449
Peri-articular adhesions - - - - 476
— — causing shoulder stiffness - - - 533
Perinephric space, drainage tubes in - - 239
Periodontitis - - - - - - 449
— chronic suppurative - - - - - 450
Peripheral neuritis due to sulphonamides - 280
Peritonsillar abscess - - - (*Fig* 527) 404
Peritonitis, continuous rectal infusion for - 49
— drainage in - - - - - - - 222
Peri-urethral abscess - - - - - 464
Perivenitis complicating varicose vein injection 374
Pernocton in delirium and convulsions - 619, 620
Peroxide of hydrogen, for rectal dressings - 259
— — for 'stuck syringe' - - - - - 31
— — in tooth extraction - - - - 454
Pes cavus - - - - - - - - 347
Pessaries, indication and management (*Figs* 444–447) 340
Pethidine in gall-stone colic - - - - 216
Phalanges, fracture of - - - - - 548
Phalanx, excision of base of, for hallux valgus (*Fig* 453) 345
Pharynx, anæsthetizing, in laryngoscopy 415, 417
Phenobarbitone as hypnotic - - - - 115
Phenol in almond oil injection for internal piles - - - - - - - 327
— poisoning, antidote to - - - - 616
— for sterilization of syringes and needles - 30
Phenol-sulphone-phthalein excretion by kidneys - - - - - - - 231
Phenyl-hydrazine test for glucose in urine - 73
Phimosis, incision of foreskin in - - - 318
Phlebitis complicating varicose vein injection 374
— contra-indicating varicose vein injection - 372
Phosphates, inorganic, in blood - - - 229
— in urine - - - - - 70, 80, 82
Phosphoric acid wash for alkaline cystitis - 251
Phosphorus burns - - - (*Fig* 23) 27
— poisoning, antidote to - - - - - 616
Phrenic nerve, anæsthetizing, in persistent hiccup - - - - - - 275
Physiotherapy in late treatment of burns - 26
Pickerill's method of supporting musculature in Bell's palsy - - - *Fig.* 345) 297
Pictagol in *Trichomonas* infection - - 334, 335
— vaginitis - - - - - - - 266
Picric acid in gonococcal endocervicitis - - 466
Picrotoxin as analeptic - - - - 10, 13
— in overdosage of pentothal - - - 616
Picton clip - - - - - - - 503
Pigmented mole, excision of - - *Fig.* 386) 311
Pilcher's bag for controlling hæmorrhage (*Fig* 295) 256
Piles (*see* Hæmorrhoids)
Pilocarpine, post-operative, in chronic glaucoma - - - - - - - 443
Pipe-cleaner method of tying in catheter (*Fig* 271) 244
Pirquet test - - - - - - - 488
Pitocin to arrest uterine bleeding - - - 337
Pitressin injection in cholecystography - - 155
post-operative flatulence - - - - 270
— prevention of paralytic ileus - - - 272
Pituitary extract in inevitable abortion 338
— — post-operative headache - - 398
Pituitrin to arrest uterine bleeding 337
Placenta, retained - - - - - 339
Plantar fasciitis - - - - - - 347
— warts, treatment of - - - - - 459
Plantaris tendon, rupture of - - - - 475
Plasma, collection of, for pathological examination - - - - - - - 165
— dried - - - - - (*Fig* 89) 61
— infusion - - (*Figs* 89, 90) 61
— — in burns - - - 17, 21, 61
— — sternal - - - - 51, 62
— overdosage of - - - - - - 17
— proteins - - - - - - - 229
— in stored blood - - - - - - 54

PAGE

Plasma transfusion after drainage of empyema 205
— — in collapse - - - - 9, 61, 62
— — shock - - - - - 505, 506
Plaster bandage, application of (*Figs.* 635, 636) 487
— — — in special regions - (*Figs* 637–668) 489
— — in Colles's fracture - - (*Fig* 701) 542
— — finishing - - - - - - - 502
— — in fracture of radius and ulna (*Fig.* 698) 540
— — making - - - (*Figs* 628–634) 486
— — removal of - - (*Figs.* 669, 670) 502
— bed - - - - - (*Figs.* 665–668) 498
— cast, causing impaired circulation - - 521
— — for fracture, change of - - - 515
— — prevention of adhesions due to - - 477
— — in treatment of burns - - - 21
— — wound excision - - - - 510
— heel - - - - - - - - 493
— jacket - - - - - (*Figs.* 658, 659) 497
— — for spinal fracture - (*Figs* 710, 711) 551
— for ruptured ligament - - - - 474
— slab, application of - - (*Figs.* 635, 636) 488
— — making of - - (*Figs.* 633, 634) 487
— sores, causes of - - - - - - 523
— spica, operating, in tuberculous hip (*Fig* 738) 581
— — walking, in tuberculous hip - - - 581
— splint in treatment of burns - - 21, 22
— technique - - (*Figs* 628–670) 486–502
— in treatment of burns - - 20, 21, 22, 25
— and vaseline pack in Winnett-Orr treatment of fracture - - - - - 511
— wedging of, in fracture of leg - (*Fig* 725) 568
Plastic repair of burns - - - - - 26
Playfair's probe - - - - (*Fig* 436) 333
Pleura, gauging thickness of - - - - 199
— involvement of, in necrotizing pneumonitis 124
Pleural effusion, air replacement of (*Fig* 506) 388
— shock complicating artificial pneumothorax 387
Pleurisy in pulmonary embolism - - - 125
Pleurograms in empyema - - - - 204
Plugging the rectum in post-operative hæmorrhage - - - - (*Fig* 301) 260
P M syringe for local anæsthesia - *Fig* 377) 308
Pneumatic tourniquet - - - - - 5
Pneumococcal infections, sulphonamides in - 280
— lobar pneumonia, post-operative - - 122
Pneumococci in pus - - - (*Fig* 198 171
Pneumonia differentiated from collapse of lung 122
— hypostatic, complicating fracture - - 525
— post-operative - - - - - 122
— — precautions against - - - - 118
Pneumonitis, diffuse suppurative - - - 123
— necrotizing - - - - - - 124
Pneumoperitoneum, radiological demonstration of - - - - (*Fig* 171) 155
Pneumothorax, artificial, for collapsed lung - 122
— — induction of - - (*Figs* 499–504) 384
— — refill of - - - - *Fig* 505) 388
— spontaneous, treatment of - - - 390
— valvular, treatment of - - - - 390
Poisoning, acute, lethal effects of - - - 616
— — treatment of - *Fig* 789) 611–620
— — — summary of - - - - 620
Poisons, counteraction of dangerous effects of 616
— entering body by unusual routes - - 616
— inhaled, removal or neutralization of - - 612
— injected - - - - - - - - 616
— swallowed, removal or neutralization of - 613
Poliomyelitis, anterior, mechanical respirator for - - - - - - - - 8
Politzerization in deafness - - (*Fig.* 556) 425
Polypus complicating pregnancy - - - 338
— of ear, removal of - - - - - 423
— nasal - - - - - - - - 409
Polyuria - - - - - - - - 68
Popliteal abscess - - - - - - 355
'Port-wine stains', treatment of, with CO_2 snow - - - - - - - 459
Position of assistant in operation - - - 104
— patient in operation - - - - 103
Post-epileptic unconsciousness - - - 185
Post-mortem examinations - - - - 637
— — in Scotland - - - 640

PAGE
Post-operative breathing and other exercises (*Figs.* 127–136) 128–132
— care in pyloric stenosis - - - - 215
— cholangiography - - (*Figs.* 175, 176) 156
— complications, pulmonary (*Figs* 125, 126) 117–127
— — — prophylaxis against - - 118, 125
— crises after thyroidectomy - - - 194
— dehydration avoidance of - - - 92
— exercises in gynæcological cases - - 268
— hæmatemesis - - - - - - 211
— hæmorrhage in gynæcological cases - - 268
— headache in lumbar puncture - - - 397
— hypnotics and sedatives - - 114–116
— retention - - - - - - 250
— treatment of cataract - - - - 442
— — gastric cases - - - - 210
— — gynæcological cases - - - - 267
— — rectal cases - - (*Figs.* 299, 300) 258
— — thyroid cases - - - - - 193
Post-renal anuria - - - - - - 240
Postural drainage of bronchial tube (*Figs* 238–240) 206
— — in bronchography - - - - 159
— — Coleman's, of unconscious patient (*Fig* 221) 184
— — in intravenous infusion - (*Fig* 60) 45
— — of lung abscess - - - - - 125
— — in necrotizing pneumonitis - - 124
— — pre-operative - - - - - 118
— — prone - - - - (*Fig* 260) 222
— treatment of collapse - (*Figs* 17, 18) 9
— — in fæcal fistula - - (*Fig.* 305) 273
Postural-percussion drainage in bronchography 159
— — collapsed lung - - - (*Fig* 126) 122
— — lung abscess - - - - - 124
Posture in dilatation of stomach - - - 271
— of unconscious patient - - - - 183
Potain's aspirator for air replacement of pleural effusion - - - - (*Fig* 506), 388
— — in aspiration of empyema - - 200
Potassium acetate in post-operative retention - 250
— citrate in gonorrhœa - - - - 461
— — vomiting due to sulphapyridine - - 279
— iodide mixture - - - - - 127
— — pre-operative use of - - - - 118
— — and stramonium mixture - - - 127
— — in syphilis - - - - 469, 470
— permanganate for bladder washes - - 251
— — irrigation in gonorrhœa - - - 463
Powder blower for discharging ear (*Fig* 555) 423
Pregnancy, varicose vein injection during - 372
Pregnanediol excretion in urine, measurement of - - - - - - - - 338
Premedication in intravenous anæsthesia - 607
Premolar teeth, extraction of - - - 452
Pre-operative care of children - (*Fig* 98) 90
— — of diabetic - - - - - - 95
— — of elderly - - - - - - 91
— medication and basal narcosis - 97–9
— preparation - - (*Fig* 98) 87–94, 117
— — of 'bad-risk' patient - - 91, 117
— — gastric cases - - - - - 210
— — 'good-risk' patient - - - - 88
— — jaundiced patients - - - - 218
— — thyroid cases - - - 192, 193
— treatment of cataract - - - - 441
— — gynæcological cases - - - - 265
— — pyloric stenosis - - - - - 214
— — rectal cases - - - - - - 258
Pre-renal anuria - - - - - - 240
Pressure expansion exercises, post-operative - 128
— gangrene, operational danger of - - 103
— sores complicating fracture - - - 522
— — in tuberculous joint - - - 581, 582
Prevesical space, drainage of, in suprapubic catheterization - - - - - 248
Priapism following circumcision - - - 317
Pribram's method for biliary stone - - 219
Pricked finger during operation - (*Fig* 113) 107
Priestly-Smith tape for examination of squint (*Fig.* 590) 445
Pritchard's nasal forceps - - (*Fig.* 530) 407
Probe, Playfair's - - - (*Fig.* 436) 333
Procaine in intramuscular injection of M & B 693 - - - - - - - - 278
— lumbar puncture - - - - - - 395
Procidentia, pre-operative treatment of vagina in - - - - - - - - 267
Proctocaine in detached retina - - - 445
— injection of, for anal spasm - - 326, 330
— method of withdrawal of, from bottle - 33
— retro-ocular injection of - - - 444
Proctoclysis - - - - - - - 49
Proctoscope, tubular - - - (*Fig.* 416) 324
Proctoscopy - - - (*Figs* 416–418) 324
Proflavine for scalp wounds - - - - 182
Progesterone in threatened abortion - - 338
Prolapse, catheterization in cases of - - 266
— pessaries for - - - (*Figs.* 444, 445) 340
Prolapsed piles - - - - - - 326
Prone postural drainage - - (*Fig.* 260) 222
Prostate, massage of - - - (*Fig* 414) 323
— pre-operative examination of - - 91
Prostatectomy contra-indicating enema - - 145
— hæmorrhage after - - (*Figs.* 295, 296) 255
— by Harris's method, bladder washes after - 252
Prostatic abscess, retention complicating - 249
— cannula, Ultzmann's - - (*Fig* 612) 463
— cavity, packing of - - - - - 256
— enlargement, retention due to - (*Fig* 277) 246
— involvement in gonorrhœa - - - 463
— massage, examination of fluid expressed by (*Figs* 199, 200) 172
— obstruction, blood-urea in - 227, 228, 234
— threads in urine - - - - - 83
Prostatitis, acute, retention complicating - 249
— — complicating gonorrhœa - - - 464
— pathological examination for - (*Fig* 200) 173
Prostato-vesicular massage in gonorrhœa - 463
Prostigmine methyl-sulphate in post-operative retention - - - - - - - 250
— in prevention of paralytic ileus - - - 272
Protargol suppositories in gonorrhœal rectal infection - - - - - - - 467
Protein : carbohydrate diet for wound healing 180
Proteins in diet in burns - - - - 18
— urine - - - - - - - - 71
Proteose in urine - - - - - - - 72
Pruritus ani, injection of oil-soluble anæsthetic in - - - - - - - - 331
— vulvæ, gonorrhœal - - - - 467
Pseudomonas pyocyanea in urine - - - 238
Psoas abscess in tuberculous spine (*Fig* 742) 584
Ptosis operations - - - - - - 448
Puerperal retroversion, pessary for - - 340
Pulmonary complications of excision of rectum 264
— — post-operative - (*Figs* 125, 126) 117–127
— congestion as contra-indication to venoclysis - - - - - - - 47
— — pre-operative - - - - 117, 118
— diseases, pre-operative measures in - - 117
— embolism, post-operative - - 125, 222
— — prevention of, after gynæcological operation - - - - - - 268
— — resulting from intravenous infusion - 42
— œdema resulting from venoclysis - - 45
— suppuration, post-operative - - - 123
Pulpitis - - - - - - - - 449
Pulse-rate in anæsthesia - - - - 606
— delayed treatment of appendicitis - 223, 224
— of unconscious patient - - - - 183
Purpura in fat embolism - - - - 126
— hæmorrhagica following arsphenamine treatment - - - - - - 471
Purulent dermatitis complicating fracture - 523
Purves-Stewart's cisternal needle - (*Fig* 519) 399
Pus casts in urine - - (*Fig* 97, C, 2) 83
— cells in urine - (*Fig* 97, B, 1, 2) 82
— examination of - (*Figs* 197, 198) 169
— smears, staining of (*Figs.* 197, 198) 170
— in urine, tests for - - - - - 77
— vaginal, obtaining specimens of (*Figs* 436–438) 334
— withdrawal of, in aspiration of chest (*Figs* 230, 231) 199

PAGE
Pyelectan in excretory urography - - - 150
Pyelitis, acute, treatment of - - - - 238
Pyelography, excretory, contra-indication to - 241
— retrograde - - - - (*Fig* 165) 150
Pyloric stenosis, avoidance of dehydration in - 92
— — salt loss in - - - - - - 93
— — treatment of - - - - - 214
Pyorrhœa alveolaris - - - - - 450

QUADRICEPS, avulsion of - - - 565
— — 'drill' - - - - - - 519
— — in dislocated knee - - - - 566
— — fractured femur - - - - 562
— sprain of - - - - - - 475
— wasting of - - - - - 476, 519
Queckenstedt's test for cerebrospinal fluid pressure - - - - - - - 398
Quinine hydrochloride and urethane for injecting into bursæ - - - - - - 378
— — — — hydrocele - - - - 322
— — — — and lithium salicylate for injecting ganglia - - - - - - 378
— — — for varicose veins - - - - 372
Quinsy - - - - - - (*Fig* 527) 404

RADIAL bursa, drainage of - *Fig* 485) 367
— — — infection of - - *Fig* 484) 365
— — — — signs of - - - - - 366
— epiphysis, lower, displaced - - 543
— styloid, fracture of - - - - 543
Radiography in anuria - - - - - 241
— before removal of tube from bile-duct - 219
— in collapse of lung - - - - - 121
— contrast, in empyema - - - 204, 205
— as diagnostic aid in acute abdomen (*Figs* 171–173) 155
— in dislocated elbow - - - - - 538
— — semilunar bone - - - - 545
— — shoulder - - - - - 529
— following injection of opaque media (*Figs* 157–162) 147
— in fractured ankle - - 573, 574, 575
— — arm - - - 533, 535, 536, 541
— — leg - - - - - 568, 569
— — scaphoid - - - - - - 544
— — spine - - - - - - 550
— infection of terminal pulp space - - 364
— lung abscess - - - - - - 124
— need for, before manipulation - - 476, 483
— in post-operative pneumonia - - 122, 123
— pulmonary embolism - - - - 125
— setting fracture - - - - 514, 515
— sinus infection - - - - - 408
— of skull in unconscious patient - 183, 186
— in spontaneous pneumothorax - - - 390
— sprained ankle - - - - 570, 571
— tuberculous joints - - - 581, 548
Radiology, house surgeon and (*Figs* 157–182) 147, 162
Radio-opaque media, injection of, into sinuses, etc - - - (*Figs* 157–161) 147
— — injection of, into veins - - - 150
Radiotherapy in late treatment of burns - - 26
Radio-ulnar dislocation, inferior, with fracture of radius - - - - - - - 541
Radius, Colles's fracture of - (*Figs* 699–701) 542
— dislocation of head of, with fracture of ulna - - - - - - - 541
— fractures of head of - - - - 539
— — temporary splinting of - (*Fig* 675) 507
— — with inferior radio-ulnar dislocation - 541
— and ulna, fracture of shafts of - (*Fig* 698) 540
— — — upper third of - - - - 541
Ramstedt's operation, management of infants undergoing - - - - 214
Range of specific gravity test - 229, 230, 234
— urea concentration test - - - - 229
Reactionary hæmorrhage from rectum - - 260
Record syringe for gastric aspiration (*Fig.* 147) 138
— — intestinal aspiration - - (*Fig* 150) 140
— — local anæsthesia - - - - 308
— — prevention of breakage of, in sterilization - - - - - - - 32
PAGE
Records, preservation of - - - - 624
Rectal cases, management of (*Figs.* 299–303) 258–264
— hæmorrhage, post-operative - (*Fig.* 301) 260
— infection in gonorrhœa in female - - 467
— infusions - - - - - (*Fig* 66) 48
— magnesium sulphate - - - - 187
— saline, continuous, in toxic coma - 618, 620
— tube for post-operative flatulence - - 270
Rectum, excision of, management of - - 263
— injury to, in fractured pelvis - - - 554
— plugging of, in post-operative hæmorrhage (*Fig* 301) 260
Rectus femoris, partial rupture of - - - 475
Recurrent bandage - - (*Figs* 321, 322) 288
Red blood-cells, normal count - - - 173
— lotion in chancroid - - - - 471
— — for perineal wound - - - - 264
— — rectal dressings - - - - - 259
Reef knot - - - - - (*Fig* 109) 105
Rehabilitation in late treatment of burns - 26
Renal activity, kindling - - - - 241
— anuria - - - - - - - 240
— capacity, total, tests for - - - - 227
— cases, management of (*Figs* 262–266) 235–242
— colic due to sulphonamides - - - 279
— complications of sulphonamide therapy - 279
— disease contra-indicating varicose vein injection - - - - - - 372
— epithelium in urine - (*Fig* 97, A, 1) 83
— function, compensated impairment of - 226
— — tests - - - - - - 226–234
— insufficiency - - - - - - - 226
— pelvis, cells from, in urine (*Fig* 97, A, 3) 83
— — irrigation of - - - - - 239
Resorcin ointment for lid margins - - - 430
Respiration, artificial - - (*Figs* 13–16) 7–9
— — in impending death under anæsthesia 11, 12
Respirator, mechanical - - - - - 8
Respiratory centre, toxic depression of, causing asphyxia - - - - - 617
— disease, pre-operative management of - 91
— infections, isolation of - - - - 636
— paralysis during anæsthesia - - - 597
— system, pre-operative examination of 88, 117
Resuscitation - - - - - - 7–14
— by rocking, Eve's method - *Fig.* 16) 8
Retention of urine, acute, suprapubic catheterization in - - - - - - 248
— — — — puncture in - - *Fig* 280) 248
— — — treatment of - (*Figs* 275–277) 246
— — after gynæcological operation - - 267
— — complicating acute prostatitis - - 249
— — — prostatic abscess - - - 249
— — — spinal fracture - - - 553
— — due to acute urethritis - - - 249
— — — blood-clot - - - - 249
— — — impacted calculus - - - 249
— — — paralysis - - - - - 250
— — — retroverted gravid uterus - - 341
— — post-operative - - - - 250, 258
— — with overflow - - - - - 249
Retina, detached - - - *Fig* 589) 445
Retinoblastoma - - - - (*Fig.* 591) 448
Retractors, application of - - - - 107
Retrograde pyelography - - - (*Fig.* 165) 150
Retro-ocular injection - - - (*Fig* 588) 444
Retropharyngeal abscess - - - - 405
Retroversion of uterus, pessaries for (*Figs.* 446, 447) 340
Retroverted gravid uterus - - - - 341
Reversed Colles's fracture - - - - 543
— spiral bandage - - - (*Fig* 314) 286
Rhesus factor in blood transfusion - - 56
Rheumatic arthritis, adhesions complicating 477, 478
Rheumatism, gonorrhœal - - - - 465
Rhinitis, acute - - - (*Figs* 531, 534) 407
— allergic - - - - - - - 410
— atrophic - - - - - - - 410
— prevention of, in nasal therapy - - - 136
Rhinoscopy, anterior - - - - - 406
— posterior - - - - - - - 407

PAGE
Rib resection for empyema - (*Figs* 233–237) 201
Rigors following serum injection - - - 66
Riley's rocking stretcher - - (*Fig* 16) 8
Ring finger, draining tendon-sheath of - - 367
— pessary - - - - (*Figs.* 444, 445) 340
Ringworm - - - - (*Figs.* 608, 609) 456
Rinne's test - - - - - - - 424
Riviere's needle for artificial pneumothorax (*Fig* 501) 386
Robert's bottle to produce lung expansion - 206
Rocking stretcher - - - (*Fig.* 16) 8
Rodent ulcer, treatment of, with CO_2-snow - 459
Roller bandage - - - (*Figs* 314–332) 286
Rose and Sellors's improvised oxygen mask (*Fig* 228) 198
Rose's operation for hare-lip - - - - 189
'Rotation' dressings in after-treatment of seriously infected hand - - - 370
Rothera's test for aceto-acetic acid and acetone 74
Rubber, corrugated, for wound drainage (*Fig* 123, 1, *b*, *c*) 111
— heel to plaster bandage - - - - 493
— tissue for wound drainage (*Fig* 123, *a*) 111
— tubing in wound drainage (*Fig* 123, *c*, *d*) 112
Rupture of crucial ligament of knee (*Fig* 722) 566
— drumhead, traumatic - - - - 421
— extensor apparatus of knee - - - 565
— external ligament of ankle - - - 571
— — — knee - - - - (*Fig* 722) 566
Ryles' tube - - - - (*Fig* 137) 133
— — for passing Miller-Abbot tube (*Fig* 151) 140

SACRO-ILIAC corset - - (*Fig* 764) 593
— strain - - - - - - 483
Sahli's hæmoglobinometer - - (*Fig* 192) 167
StClair Thomson's caged curette - (*Fig* 538) 411
St. Mark's Hospital apparatus for bladder irrigation - - (*Fig* 287) 252, 264
— — — in catheterization - - 246, 249
— — dilator - - - - (*Fig* 300) 260
— — pattern of colostomy belt - - - 595
Salicyl-sulphonic acid test for albumin - - 72
Saline bath in treatment of burns - - - 23
— for dehydration, pre-operative - - - 93
— douches in pelvic inflammation - - 269
— and glucose infusion after excision of rectum - - - - - - - 263
— half-normal, in toxic dehydration - - 619
— infusions (*see also* Intravenous Infusions) (*Figs* 50–73) 40–53
— — in collapse - - - - - 9, 14
— — combined with drip blood transfusion (*Fig* 81) 58
— — continuous intravenous (*Figs* 50–63) 40–47
— — intramuscular - - (*Figs* 64, 65) 48
— — post-operative, in thyroid surgery 193, 194
— — rectal - - - - (*Fig* 66) 48
— — subcutaneous - - - - - - 48
— — in thyroid crises - - - - - 195
— irrigation of burn - - - - - 24
— — eye - - - - - - - 436
— normal, dressings in hand infection - - 370
— solution, preparation of - - - - 41
Salivary calculus, removal of, from Wharton's duct - - - - - - 312
Salpingitis, gonorrhœal - - - - - 467
Salyrgan as diuretic - - - - - 381
Samway's tourniquet - - (*Figs* 6–9) 4
Saphenous vein, internal, for venectomy (*Fig* 54) 43
— — — — in infants - - - - - 52
— — ligature of - - - (*Fig* 493) 374
— — tests for valves of - - - - 371
Sarcoma of choroid - - (*Figs* 592, 593) 448
Saugmann's refill needle - - (*Fig* 503) 386
Scabies - - - - - (*Fig* 607) 456
Scalp wounds - - - (*Figs* 216–218) 181
— — with loss of substance - (*Fig.* 219) 182
Scalpel as bladder perforator - (*Fig.* 283) 249
Scaphoid bone of carpus, fracture of (*Figs* 702, 703) 543
— — — — with dislocation of semilunar - 546
Scarification method of vaccination - - 392
Scarlet fever, control of, in hospital - - 635
— — dose of anti-sera for - - - - 67
— red ointment for rectal dressings - - 259
Schafer's method of artificial respiration (*Fig* 15) 8
Schimmelbusch's mask - - (*Fig* 773) 598
Schistosoma hæmatobium in urine - - - 85
Schlatter's disease - - - - - 565
Sciatic plaster - - - (*Figs* 660–664) 498
Sclerosing solutions for varicose veins - - 372
Scoliosis, spinal support for - (*Fig.* 756) 590
Scopolamine-morphine, subcutaneous, in gastric intubation - - - - 136
Scotland, certification of death in - - 640
'Scotland Yard' test for blood in urine - 240
Scrotal bandage, Bellevue - (*Figs* 363, 364) 303
— — Nitschke's - - (*Fig* 337) 293, 300
— hernia, irreducible, bag truss for (*Fig* 766) 593
— sling - - - - - (*Fig* 365) 303
Sebaceous cyst, excision of - (*Fig* 385) 310
Sedative enema - - - - - 143, 146
Sedatives in burns - - - - - - 19
— post-operative - - - - - 114–116
— for unproductive cough - - - - 126
Sedimentation rate, estimation of, by Westergren's method - - - - 165, 169
— — normal, by Westergren's method - 174
Sellors, Holmes, back-rest - - (*Fig* 254) 221
— — postures for bronchography (*Fig* 182) 162
Semilunar bone, dislocation of (*Figs* 704, 705) 545
— — — with half of scaphoid - - - 546
— cartilage, fracture-dislocation of - - 479
Seminal vesiculography - - (*Fig* 169) 153
Semile vaginitis - - - - - - 335
Sepsis in diabetics, operation for - 95, 96
Septal deviation - - - - - - 409
— displacement, traumatic - - - 409
Septic abortion - - - - - - 339
— bronchitis - - - - - - 120
Septicæmia, staphylococcal, treatment of 281
Septum, nasal, hæmatoma or abscess of (*Fig* 535) 408
Sera, administration of (*Figs* 91–93) 63–67
'Serum disease - - - - - - 66
— dried - - - - - (*Fig* 93) 65
— five-times concentrated - - - - 188
— — — in anuria - - - - - 241
— hypersensitivity to - - - - 63, 65
— infusion - - - - - - 61
— injections - - - - - - 63
— — hazards of - - - - - 66
— 'pains' - - - - - - - 66
— rash - - - - - - - 66
Shadocol in cholecystography - - - 155
Shock complicating artificial pneumothorax - 387
— cradle - - - - - - - 9
— due to burns - - - - 16, 17, 28
— during operation - - - - - 597
— forestalling operation, in infant (*Fig* 98) 90
— in poisoning - - - - - - 619
— treatment of - - - - - - 9
— — in fracture - - - - - 504
— — by plasma infusion - (*Fig* 90) 61, 62
Shoulder, dislocation of - - (*Fig* 687) 528
— — with avulsion of supraspinatus - - 529
— — fracture of tuberosity - - - 529
— — paralysis of deltoid - - - - 530
— fracture of, temporary splinting of - - 506
— optimum position of - - (*Fig* 615) 478
— spica bandage for - - (*Fig* 319) 287, 292
— — plaster - - - - (*Fig* 643) 491
— — for tuberculous shoulder - - - 583
— stiffness of, in fractured clavicle - - 326
— — — upper limb - - (*Fig* 689) 517
— — from peri-articular adhesions - - 533
— tuberculous - - - - - - - 583
Shrapnell's membrane, examination of - - 420
Sialography - - - (*Figs* 163–164) 147
Sidden's operating plaster spica - (*Fig.* 738) 581
Sigmoidoscope, use of, in paralytic ileus - - 271
— 'Yeomans' - - - - - (*Fig* 419) 325

PAGE

Sigmoidoscopy - - - - - - - 325
'Silent' pump for wound drainage (*Fig.* 203) 176
Silkworm gut sutures - - - - 105, 109
— — for wound drainage - - - - 111
Silver arsphenamine in neurosyphilis - - 470
— iodide in cystography - - - - 152
— nitrate applied to conjunctiva (*Fig.* 563) 430
— — for bladder washes - - - 251, 252
— — in conjunctivitis - - - - 437
— — ectropion - - - - - - 433
— — gonorrhœa in female - - - 466, 467
— — poisoning, antidote to - - - - 616
— proteinate in conjunctivitis - - - 437
Silvester's method of artificial respiration (*Fig* 14) 7, 11, 12
Sims' blunt curette - - - (*Fig* 441) 336
— duck-bill speculum (*Figs* 430–432) 332, 333
Simpson's shelf pessary - - - - 340
Sinus infection in acute rhinitis - - - 407
Sinuses, injection of radio-opaque media into (*Figs.* 157–161) 147
Sister Doris bed support - - (*Fig* 253) 220
Sitz bath in gonorrhœa - - - - - 461
Skeletal traction - - - (*Figs* 395–399) 314
— — in applying plaster bandage (*Fig* 648) 493
— — fractured femur - (*Figs* 720, 721) 563
— — — leg bones (*Figs* 723, 724, 726) 568, 569
— — — os calcis - - - - - - 576
— — supracondylar, causing stiff knee - 564
Skene's duct, expression of pus from - - 333
— tubules, infection of - - - - 345
Skin blistering complicating fracture - - 523
— and bone lesions of syphilis treatment of - 470
— dressings, non-adherent covering for - 460
— examination of - - (*Figs* 605–609) 455
— excoriation in faecal fistula - - - 272
— and muscle operation for entropion (*Figs* 562–562) 428
— operations on - - - (*Fig* 619) 458
— preparation for gynæcological operation - 266
— — for operation - - 89, *Fig* 104 103
— tests for tuberculosis - - - - - 458
— treatment of, after pancreatic operation - 219
Skin-grafting in burns - - - - - - 23
— — electrical - - - - - - 28
— keloid - - - - - - - - 26
— by Thiersch's method - (*Figs* 380–394 312
— of wounds - - - - (*Fig* 678) 510
'Skin-mastoid' distance - - - - - 400
Skull, fractures of - - - - - - 184
Sleep, depressed activity of cortex in - - 114
— pre-operative - - - - - - 89
Sling, collar-and-cuff - - - (*Fig* 673) 506
— for forearm - - - - (*Fig* 313) 286
S-methylisothiourea in collapse under spinal anæsthesia - - - - - - 13
Snake venom in hæmorrhage from tooth socket 454
Snellen's sutures for ectropion - (*Fig* 569) 433
Soap and water enema - - - - - 145
Sodium acid phosphate in acidification of urine 236
— bicarbonate in burns of eye - - - 436
— — injections to alkalinize urine - - 56
— — in post-operative acidosis - - - 275
— — syringing ear - - - - - 420
— chloride, administration of, in dehydration 93
— — in burns of eye - - - - - 436
— — intravenous, in acute glaucoma - - 434
— — in varicose vein injection - - 373, 375
— citrate in alkalinization of urine 237, 238, 255
— — as anti-coagulant in blood transfusion (*Figs* 82, 84) 59
— — in anuria - - - - - - 242
— — and bicarbonate to alkalinize urine - 56
— — to prevent venous thrombosis - - 268
— evipan (*see* Evipan)
— hypochlorite, electrolytic, in perineal dressings - - - - - - 268
— — for irrigation of burn - - - 24
— iodide in cystography - - - - 152
— — retrograde pyelography - - - 150
— — syphilis - - - - - - 469
— lactate and bicarbonate to alkalinize urine 55, 237, 239

PAGE

Sodium luminal, intramuscular, in gastric intubation - - - - - - 136
— — in unconsciousness - - - - 184
— morrhuate inadvisable in varicose vein injection - - - - - 373
— — in injection of varicocele - - - 323
— penicillin in necrotizing pneumonitis - 124
— pentothal (*see* Pentothal)
— salicylate in varicose vein injection - 373, 375
— soneryl in basal narcosis - - - - 99
— sulphate, intravenous - - - 47, 241
— — — in retention with overflow - - 249
— — isotonic solution of, in anuria - - 241
— — packs for perineal pain - - - 268
— — in proflavine for osmotic dressings - 178
— urate in urine - - - - - - - 79
Southey's trocars and cannulæ (*Fig* 497) 380, 381
Sparklet 'resuscitator' in persistent hiccup (*Fig.* 306) 275
Spasmodic flat-foot - - - - - - 346
Spectroscopic test for blood in urine (*Fig* 94) 75
Speculum, nasal - - - (*Figs.* 528, 529) 406
— for paracentesis of cornea - (*Fig* 585) 441
— vaginal examination by - (*Figs* 430–434) 332
Speech training after repair of cleft palate - 191
Spencer Wells' forceps - - (*Fig.* 124) 113
Spermatozoa in urine - - - - - - 83
Spica bandage - - - (*Figs* 317–320) 287
— hip, in plaster - (*Figs* 651, 652) 494, 495
— — — for tuberculous hip - - - 581
— shoulder in plaster - - (*Fig* 643) 491
Spinal anæsthesia - - - - - - 399
— — collapse in - - - - - - 13
— — in paralytic ileus - - - - - 271
— anæsthetic, headache after - - - - 397
— collar - - - - - (*Fig* 757) 590
— cord lesion causing retention - - - 250
— graft in tuberculous spine - - - 585
— manometer, Greenfield's - (*Fig* 515) 398
— puncture (*see* Lumbar Puncture)
— supports, ordering of - (*Figs* 756, 757) 590
Spine, fracture of - - (*Figs* 709–712) 549
— — cervical, emergency treatment of - - 507
— — — transport in - - - - - 503
— — with paraplegia - - - - - 553
— — suspected, transport in - (*Fig* 672) 503
— — temporary splinting of - - - 507
— manipulation of - - *Figs.* 624–626) 483
— tuberculous - - - (*Figs* 741, 742) 583
Spirochæta icterohæmorrhagiæ in urine - - 85
Splenic puncture - - - - - - 382
Splinter beneath nail, removal of - (*Fig.* 388) 312
Splinting, temporary - - (*Figs* 673–677) 506
Splint sand in burns - - - - - 21, 22
— Denis Browne's, for club-foot (*Figs* 454, 461–464) 347, 349
— first-aid - - - - *Fig* 671) 503
— for hallux valgus - - - (*Fig* 452) 345
— ordering of - - - - - 587, 591
— plaster (*see* Plaster)
Spontaneous pneumothorax, treatment of - 390
Sprains of ankle - - - - - - 570
— finger-joints - - - - - - 547
— internal ligament of knee - - - 566
— ligamentous - - - - - - 473
— muscular or tendinous - - - - 474
— prevention of adhesions in - - - 477
— treatment of - - - - - - 473
Spreader for attachment to extension straps (*Figs* 373, 374) 306
Spring truss - - - - - - - 593
Spur from os calcis, causing tenderness - 346
Sputum, collection of, in infants - - 174
Squint - - - - - (*Fig.* 590) 445
Squire's cream in syphilis - - - - 469
Stabilarsan in syphilis - - - - - 468
Stabismol in syphilis - - - - - 469
Stannard silk for skin dressings - - - 460
Stannoxyl in Meibomian cyst - - - 430
Staphylococcal infections, sulphonamides in - 280
Staphylococcus aureus causing necrotizing pneumonitis - - - - - - 124
— *pyogenes albus* in urine - - - 85, 238

PAGE

Staphylococcus pyogenes aureus in pus (*Fig* 197) 270
— — — urine - - - - - 85, 238
Starch and opium enema - - - 143, 146
Stay-put knee-rest - - - (*Fig* 257) 220
'Stealing' the thyroid - - - - 193
Steam tent after tracheotomy - (*Fig* 544) 414
Stedman's tube for bladder drainage (*Fig* 293) 254
Steinmann's nail, insertion of (*Figs.* 396, 397) 314, 315
— — in pelvic suspension - (*Fig* 477) 360
'Stellar' phosphates in urine (*Fig.* 96, H) 80
Stensen's duct, radiography of (*Figs.* 162, 163) 147
Stercobilin - - - - - - - 69
Stercobilinogen - - - - - - 69
Sterilization of catheters - - - - 243
— syringes and needles - - - - 30
Sterivac, transfusion with - (*Figs* 86–88) 60
Sternal biopsy - - - - - - 382
— marrow infusions - - (*Figs.* 67–70) 49
— puncture - - - (*Figs* 67–70) 49
— — needle and stylet - - (*Fig* 498) 383
Sternomastoid sign of massive collapse of lung 121, 123
Stiffness after fracture - 517, (*Fig* 684) 524, 564
— due to peri-articular adhesions - - 533
Stilboestrol, in complete procidentia - - 267
— senile vaginitis - - - - - 335
Stille's shears - - - - (*Fig.* 669) 502
Stilling's knife - - - - (*Fig* 573) 435
Stitch abscess - - - - - - 274
Stock bottle, technique of rubber-capped (*Figs* 31, 32) 33
Stocking, elastic, ordering of - (*Fig* 755) 590
'Stole' bandage after thyroid operation (*Fig* 347) 297
Stomach, dilatation of, acute post-operative - 270
— tube for gastric lavage - - - - 613
Stone (*see* Calculus)
Stovaine in low spinal anaesthesia - - - 399
Stovarsol vaginal compound tablets - - 334
— — — in vaginitis - - - - - 265
Strain - - - - - - - 473
Stramonium and potassium iodide for bronchial spasm - - - - - 118
— — — mixture - - - - - 127
Strapping the breast - - - (*Fig* 349) 298
— buttocks together - - - (*Fig* 366) 304
— extension, Liverpool method of applying (*Figs* 368, 375) 304
— — in tuberculous hip - (*Figs* 732–736) 578
— the thorax - - - (*Figs* 350, 351) 299
Streptococcus, dose of anti-sera for - - 67
Streptococcus faecalis in urine - - 85, 238
— *haemolyticus* causing pelvic inflammation - 269
— *pyogenes* in urine - - - - - 85
— of scarlet fever in pus - - (*Fig* 197) 270
Stretcher, rocking - - - (*Fig* 16) 8
Strychnine in septic bronchitis - - - 120
— in toxic coma - - - - 618, 620
Stump, recurrent bandage for (*Figs* 321, 322) 288
Stye - - - - - - - 431
— removal of lash from - - - - 428
Styh in gonorrhœa in female - - - 466
Styloid of radius, fracture of - - - - 543
Stypven in haemorrhage from tooth socket - 454
Subclavian artery, arrest of haemorrhage from (*Fig* 3) 2
Subcutaneous infusion in infancy - - - 52
— injections - - - - (*Fig* 37) 35
— lipoma, excision of - - (*Fig* 384) 310
— saline infusion - - - - - 48
— urography - - - - - 150
Subluxation(s) - - - - - - 478
— of cervical spine - - - (*Fig* 712) 552
Subperiosteal abscess - - - (*Fig* 598) 450
Subpœna, service of - - - - - 623
Subungual exostosis - - - - - 344
— hæmatoma, evacuation of - (*Fig* 387) 312
Succinyl sulphathiazole - - - 276, 281
Sucrose, intravenous, in acute glaucoma - 444
Suction apparatus in duodenal fistula - - 273
— drainage of bladder - - (*Figs* 293, 294) 254
— — to produce lung expansion - - - 206
Suction drainage of wounds (*Figs.* 201–207) 175
Sugars in urine - - - - - - 72
Suicide - - - - - - - 641
— attempted - - - - - 633, 641
Sulfarsenol in syphilis - - - - - 468
Sulphacetamide - - - - - 276, 280
— in burns - - - - - - 23
— Meibomian cyst - - - - - 430
— sodium M & B - - - - - 276
Sulphadiazine - - - - 276, 277, 280
— in 'collapse-pneumonitis' - - - 123
— gonorrhœa - - - - - - 462
— pneumonitis - - - - - - 124
Sulphaguanidine - - - - - 276, 281
Sulphamezathine - - - - - - 276
Sulphanilamide - - 276, 277, 278, 280, 281
— for bladder washes - - - - - 251
— cream in burns - - - - 22, 23
— cyanosis due to - - - - - 279
— in fractures of base - - - - - 186
— hæmolytic anæmia due to - - - 280
— in infection of hand - - - - 363
— ointment in prevention of rhinitis - - 136
— — — urethritis - - - - - 244
— in perforation of uterus - - - 338
— powder in dressing circumcision - - 317
— preparations for parenteral administration 276, 278
— for scalp wounds - - - - - 182
— therapy in pelvic inflammation - - - 269
— — quinsy - - - - - - 404
Sulphapyridine - - - - 276, 277, 280
— in 'collapse-pneumonitis' - - - 123
— otitis media - - - - - - 422
— pneumonitis - - - - - - 124
— renal complications due to - - - 279
— vomiting due to - - - - - 279
Sulpharsphenamine in syphilis - - - 468
Sulphasuxidine - - - - - - 276
Sulphathiazole - - - - 276, 277, 280
— in burns - - - - - - - 23
— carbuncles - - - - - 357, 359
— 'collapse-pneumonitis' - - - - 123
— gonorrhœa - - - - - - 462
— pneumonitis - - - - - - 124
— rashes caused by - - - - - 279
— renal complications due to - - - 279
— as urinary antiseptic - - - 237, 238
Sulphonal as hypnotic - - - - - 115
Sulphonamide(s) in abortion - - - 338, 339
— appendicitis - - - - - - 223
— contra-indicated in acute cystitis - - 255
— in corneal ulcers - - - - 440 *n*
— crystalluria, anuria due to - - - 241
— dosage of - - - - - - 277
— in empyema - - - - - - 200
— need of alkaline urine in use of - - 235, 237
— powder in after-treatment of abscess - - 382
— — bubo - - - - - - 355
— — local application of - - - - 279
— preparations in chronic pyelitis - - 239
— rashes - - - - - - - 279
— therapy - - - - - - 276–281
— — in chancroid - - - - - 471
— — conjunctivitis - - - - - 437
— — eye infections - - - - - 443
— — gonorrhœa - - - - - 462
— — gonorrhœal complications - - 464, 465
— — hand infections - - - 363, 370
— — otitis media - - - - - 422
— — relation of individual infections to - 280
— — toxic reactions to - - - - 279
— in urine - - - - - - - 80
Sulphone group of hypnotics - - - - 151
Sulphostab in syphilis - - - - - 468
Suppression of urine - - - - - 240
Suppurating glands of groin - - - - 355
Suppuration, pulmonary post-operative - - 123
Suppurative pneumonitis, diffuse - - - 123
— tenosynovitis - - - (*Figs* 484–486) 365
Supracondylar fracture of femur (*Fig* 721) 563
— — humerus - - - (*Figs* 693, 694) 534
— skeletal traction, causing stiff knee - - 564

PAGE

Suprapubic belt (*Fig.* 297) 257
— 'boxes' (*Fig.* 291) 254
— catheterization (*Figs* 281–283) 248
— — catheter dragged from bladder in (*Fig* 289) 253
— — in retention with overflow 249
— — — from paralysis 250
— — urinary incontinence 362
— drainage apparatus, ordering of (*Figs.* 768, 769) 594
— — 'permanent' 257
— puncture in acute retention (*Fig* 280) 248
— wound, washing out bladder through 251
Supraspinatus, avulsion of, complicating dislocated shoulder 529
— tendon, rupture of 475, 529
Surgeon's knot (*Fig* 110) 105
Surgical appliances and splints, ordering of (*Figs.* 743–772) 586–595
— boots, ordering of (*Figs.* 750–754) 589
— thoracic cases, management of (*Figs.* 225–242) 196–209
Sutton's method, in intravenous infusions (*Fig* 53) 43
Suture(s) (*Fig.* 108) 104, 108
— buried 108
— continuous 108, (*Figs* 121, 122) 111
— deep tension (*Figs* 114–116) 108, 109
— of drainage tube 112
— eyelid (*Fig* 567) 432
— interrupted (*Figs* 117, 118) 108, 109
— — deep (*Fig* 114) 109
— knot for attaching, to needle (*Fig* 107) 105
— removal of (*Fig.* 124) 113
— — in hare-lip operation 191
— of scalp wound (*Fig.* 218) 182
— secondary 113
— — of wound 510
— subcuticular (*Fig* 122) 111
— superficial 108, 109
— threading needle to (*Fig* 112) 106
— three-in-one frænal (*Fig.* 402) 316, 317
Swabbing of wound in operation 107
Swab(s), conjunctival, in cataract 441
— culturing of (*Figs* 185–187) 164
— stick (*Fig.* 184) 164
Symblepharon, breaking down of 436
Syme's knife for opening abscesses 351
Syphilis, tests of cure of 471
— treatment of, early 468
— — late 470
Syringe(s) adaptor (*Fig* 28) 29
— for administering sera *Fig.* 93) 63, 64
— all-glass 30, 32
— for aspiration of empyema (*Fig* 232) 200
— care of, after use 31
— for injection of piles (*Fig.* 421) 327
— intravenous injections (*Fig* 40) 36
— Labat's (*Fig* 38) 35
— prevention of breakage of 32
— Record (*see* Record Syringe)
— sterilization of 30
— storage of, after sterilization 31
— 'stuck' 31
— varicose vein (*Fig.* 491) 372
Syringing the ear (*Fig.* 552) 420

TAIT, Lawson, bed (*Fig.* 252) 220
— — — in cataract 442
Talipes equinovarus, congenital (*Figs* 454–464) 347
— — night shoes for 588
Talus, fractures of 576
Tannic acid in burns 19, 24
— — — toxæmia and 19
— — post-operative treatment of anal fissure 330
— — and silver nitrate treatment of bed-sores 361
Tarsal cyst (*Figs* 565, 566) 430
Tarsorrhaphy (*Fig.* 568) 432
Taylor's vein seeker (*Fig.* 47) 38
T-bandage (*Figs.* 335, 336) 292
Teeth (*see also* Dental) (*Figs* 596–604) 449–454

PAGE

Teeth damage to, in intubation 606
— extraction of (*Figs.* 599–604) 450
— — wrong 454
— fracture of 454
— scaling of 450
Temperature, taking of, in unconscious patient (*Fig.* 220) 183
Tender heels 346
Tendo Achillis, rupture of 475
Tendon, adhesions in connexion with 477
— rupture of 474, 475
— strain of 474
— suture, periods of incapacity following 626
Tendon-sheaths of hand (*Fig.* 484) 365
— — incisions for draining (*Fig.* 485) 366
Tennis elbow, manipulation of (*Fig.* 627) 484
Tenosynovitis, gonorrhœal 465
— suppurative (*Figs.* 484–486) 365
'Tension bridge' in hare-lip operations (*Figs* 223, 224) 190
Terminal colostomy, management of (*Fig.* 302) 261
— pulp compartment of finger, infection of (*Figs.* 481, 482) 363
Tetanus, dose of anti-sera for 67
Tetany, parathyroid 195
T-forceps for entropion operation (*Fig.* 561) 428
T-fracture of condyles of humerus 536
Thenar space (*Fig.* 487) 367
— — treatment of infections of (*Fig.* 488) 368
Thiazamide 276, 279
Thiersch's method of skin-grafting (*Figs.* 389–394) 312
Thigh and leg, application of plaster bandage to 494
Thiouracil in thyrotoxicosis 192
Thoma chamber (*Fig* 195) 169, 172
Thomas knee splint, ordering of (*Fig.* 756) 587
— (Melbourne) bed 220
— splint, attaching extension straps to (*Fig* 372) 305
— — as emergency splint 503
— — in fracture of femur, leg, and knee 508, (*Fig* 719) 560
— — intravenous infusion 44
— — tuberculous knee (*Fig* 740) 582
— — with Pearson's attachment (*Fig* 720) 563
Thompson and Wright's lamp-wick drainage of bladder (*Fig* 292) 254
Thomson-Walker tray (*Fig.* 286) 252
Thoracic cases survival, management of (*Figs* 225–242) 196–209
— complications in gastric cases 210
— operations, post-operative exercises in (*Figs* 131–136) 130
Thorax, adhesive plaster dressings for (*Figs* 350, 351) 299
— bandage for 292
Thorek's operation 217
Thread-worms, enema for 146
Threatened abortion 338
Three-snip operation for epiphora (*Figs.* 573–575) 435
Throat, burns of 27
— swabs for pathological examination 164
Thrombin in hæmorrhage from tooth socket 454
Thrombo-phlebitis of cavernous sinus in carbuncle 359
Thrombosis complicating fracture 522
— following injection of piles 328
— post-operative, precautions against 118, 119
— — treatment of 119
Thrombotic external pile (*Fig* 420) 325
Thrush causing vaginal discharge 334
— pus in (*Fig.* 198) 172
Thudichum's nasal speculum (*Fig* 528) 406
Thumb, Bennett's fracture-dislocation of (*Figs* 706, 707) 546
— dislocation of 548
— draining tendon-sheath of (*Fig.* 485, 4) 367
— infection of terminal pulp space of (*Figs* 481, 482) 363
— spica bandage for (*Fig.* 320) 288
— suppurative tenosynovitis of 365
— tendons, rupture of, complicating Colles's fracture 543

PAGE
Thymol in blocked lacrimal passages - - 434
Thyroid cases, management of - - - 192
— — post-operative complications of - - 194
— crises - - - - - - - - 195
— — post-operative - - - - - 194
— operation, adhesive plaster dressings after (*Fig* 347) 297
— — bandage after - - - (*Fig.* 332) 290
— tablets, pre-operative use of - - - 118
Thyroidectomy, preparation of patient for 192, 193
Thyrotoxicosis - - - - - - 192, 193
— pre-operative management of - - - 91
Tibia, avulsion of epiphysis of tubercle of - 565
— and fibula, fractures of (*see* Leg Bones, Fractures of)
— fracture of spine of - - - - - - 566
— — tuberosity of - - - (*Fig* 722) 566
— insertion of Steinmann's nail through (*Fig* 396) 314
— lower epiphysis of, displaced - - - 575
Tibial blood transfusions for infants - - 58
— marrow infusions for infants (*Figs* 71, 72) 51
Tidal drainage of bladder - - (*Fig.* 284) 250
Tinea of scalp - - - (*Figs* 608, 609) 456
Tissues for histological examination, collection of - - - - - - - - 163
Toe(s), anæsthetization of - - - - 309
— clawing of, in fracture - - - - 519
— exercises in fracture of leg - - - 519
— fractures of - - - - - - - 577
— manipulation of - - - - - - 482
Toe-nail, avulsion of - - - - - - 344
— ingrowing - - - (*Figs.* 448, 449) 343
Tollen's test for glycuronates - - - 77
Tongue, bleeding from, arrest of - - - 1
— traction on, to clear airway - - - 612
Tonometry - - - - - (*Fig* 575) 435
Tonsil-holding forceps, Browne's (*Fig.* 524) 403
Tonsillectomy - - - (*Figs* 512–526) 401
Tonsillitis, quinsy complicating - - - 404
Tonsils, anatomy of - - (*Figs* 522, 523) 401
— operations on - (*Figs* 521–527) 401–405
— removal of - - - (*Figs* 521–526) 401
Tooth (*see* Teeth)
Tourniquet(s), arrest of hæmorrhage by (*Figs* 6–10) 3–5
— in intravenous infusions - - - 43, 44
— L.P.L. - - - - - (*Fig.* 10) 5
— pneumatic - - - - - - 5
— Samway's - - - - (*Figs* 6–9) 4
— test for varicose veins - - - - 371
— vein - - - - - (*Fig* 42) 37
Toxæmia resulting from burns - - - 19
Toxic cachexia in burns - - - 19
Tracheal collapse after thyroidectomy - - 194
Tracheitis after thyroidectomy - - - 194
— post-operative - - - - 119, 120
Tracheo-bronchial 'toilet' - - - 207
Tracheotomy after thyroid operation - - 194
— in burns of throat - - - - - 27
— urgent - - - - (*Figs* 540–544) 413
Traction (*see also* Skeletal Traction)
— fixed, in fractured femur - (*Fig* 719) 560
— in fracture-dislocation of thumb (*Fig* 707) 547
— tuberculous joint - - - - 578, 582
Transillumination of hydrocele - - - 321
— infected sinus - - - (*Fig* 532) 407
Transnasal intragastric infusions - - - 49
— intubation, care of indwelling tube in - 136
— — gastric, duodenal and intestinal (*Figs* 137–153) 133–142
— — for high-calorie continuous drip feed - 139
Transport of fracture case - - (*Fig* 672) 503
Transpulmin in pulmonary complications of excision of rectum - - - - 264
Trauma of eye - - - - - - 436
Traumatic septal displacement - - - 409
Treacle enema - - - - - - 146
Trendelenburg's test for varicose veins - - 371
Triangular bandage - - - (*Fig* 313) 286
Tri-brom-ethyl alcohol - - - - - 98
Trichiasis - - - - - - - 428
Trichlorethylene - - - - - 601
PAGE
Trichomonas vaginalis, examining swab for - 164
— — infection causing vaginal discharge - 334
— — — treatment of - - - - - 334
— — in urine - - - - - - 85
— — from vaginal discharge - (*Fig* 198) 171
— — vaginitis due to - - - - - 265
Trilene - - - - - - - 601
Trimalleolar fracture with outward and backward dislocation - (*Fig* 727, C) 574
Trional as hypnotic - - - - - 115
Triple dye for burns - - - - - 25
— — monilial discharge - - - - 266
— phosphates in urine - - - - - 80
Trismus complicating tooth extraction - - 454
Trocar and cannula, antrum - (*Fig* 533) 408
— — for aspirating psoas abscess - (*Fig* 742) 584
— — sternal puncture - - (*Fig* 67) 50
— — (Thompson's) for tibial marrow infusions - - - (*Fig* 71) 51
Trousseau's sign - - - - - - 195
Trusses, ordering of - - (*Figs* 765, 766) 593
Tryparsamide in neurosyphilis - - - 470
T-tube for drainage of common bile-duct (*Figs* 249, 250) 218
Tube casts in urine - - (*Fig* 97, C–I 83
Tubercle bacillus, identification of (*Fig* 197) 171
— — in urine - - - - - - - 85
Tuberosity of humerus, fracture of (*Figs* 688, 689) 530
— — — complicating dislocated shoulder - 529
Tuberculosis, pulmonary, in pre-operative examination - - - - - 117
— skin tests for - - - - - 458
Tuberculous joint, results of manipulation of 476
— — treatment of - (*Figs* 732–742) 578–584
Tuning fork, use of - - - - - 424
Turpentine enema - - - - - 145
— — in paralytic ileus - - - - 271
— — post-operative flatulence - - - 270
— oil of, in hæmorrhage from tooth socket - 454
Twilight sleep in gastric intubation - - 136
Two-glass test for gonorrhœa - - - 461
Tympanic membrane, in examination of ear (*Fig* 551) 419
Typhoid bacillus in urine - - - - 85
Tyrosin in urine - - (*Fig* 96, I 80

ULCER(S) complicating varicose vein infection - - - - - - - 371
— corneal - - - (*Figs* 584, 585) 440
— varicose, treatment of - (*Figs* 494, 498) 376
Ulna, fracture of, with dislocation of head of radius - - - - - - 541
— non-union of shaft of - - - - 541
— and radius, fracture of shafts of (*Fig* 698) 540
— — — upper third of - - - - 541
Ulnar bursa, drainage of - - (*Fig* 485) 367
— — infection of - - (*Fig* 484) 365
— — — signs of - - - - - 366
— paralysis following fracture of condyle - 536
— — — — epicondyle - - - - 538
Ultra-violet light for boils - - - - 466
— — carbuncles - - - - - 357
Ultzmann's prostatic cannula - (*Fig* 612) 464
Umbilical belt for adult - - - - 594
— — child - - - (*Fig* 767) 594
Unconscious patient, care of (*Figs* 220, 221) 183
— — examination of - - - 181, 185
Undine for irrigation of eye - - (*Fig* 586) 438
Unna's paste to prevent disuse œdema (*Fig* 682) 520
— — for varicose ulcer - - - - 377
'Unnatural' death - - - - - 639
— — in Scotland - - - - - 640
Upper limb, fractures and dislocations of (*Figs* 685–708) 526–548
Uræmia contra-indicating excretory urography 149
— surgical, intravenous infusion for - - 47
— unconsciousness due to - - - - 185
Urates in urine - - - - - 70, 79
Urea in blood, tests for - - - - 227
— circulating, reduction of - - 241

PAGE
Urea concentration test - - - - 229
— group of hypnotics - - - - 115
— splitting of, by *B proteus* - - - 238
— in urine, estimation of percentage of - - 78
Ureter, operative damage to - - - - 269
Ureteric catheter, indwelling, management of (*Fig.* 263) 239
— — for use as infant's cannula - - - 52
— cells in urine - - - - - - 83
Urethra, anæsthetizing the - (*Figs.* 409–411) 320
— anterior, instrumentation of - - - 464
— expressing pus from - - (*Fig.* 437) 333
— injury to, in fractured pelvis - - - 553
Urethral calculus, impacted, causing retention 249
— catheter, washing out bladder through - 251
— cells in urine - - (*Fig* 97, A, 6) 83
— irrigation in gonorrhœa in female - - 466
— — — male - - - - - - 462
— stricture causing retention (*Figs* 275, 276) 246
— — dilation of - - - (*Fig.* 412) 320
— syringe - - - - - (*Fig.* 267) 243
Urethritis, acute, retention of urine with - 249
prevention of, in catheterization (*Fig* 269) 244
Urethrography - - - (*Figs.* 167, 168) 152
Uric acid in blood - - - - - - 228
— — urine - - - 70, (*Fig* 96, A) 79
Urinary antiseptics - - - - - 237
— — in relation to bacteriology - - - 238
— — retention of urine - - - - 246
— incontinence, prevention of bed-sores in (*Fig* 479) 362
— — in unconscious patient - - - 184
— infections, gynæcological operations and 266, 267
— — sulphonamides in - - - - 280
— output in burns, recording of - - - 18
Urine, abnormal constituents of - - - 71
— acetone bodies in - - - - 74, 88
— acid, deposits in - - - - - 79
— acidification of - - - - - 236
— acute retention of, treatment of (*Figs* 275–277 246
— alkaline, deposits in - - - 79, 80
— alkalinization of - - - - - 237
— — in cystitis - - - - - 255
— animal parasites in - - - - 85
— bile in - - - - - - - 77
— blood in - - - - - - - 75
— — test for - - - - - - 240
— blood-corpuscles, red, in (*Fig* 97, B, 3) 82
collecting specimens of, in infants (*Figs.* 265, 266) 242
— colour and transparency of - - - 69
— consistence of - - - - - 69
— containing sulphonamides, culturing of - 280
— deposits in - - - - - - 70
— — organized - - - (*Fig* 96) 79, 82
— — unorganized - - - (*Fig* 96) 79
— diastase in - - - - - - 78
— epithelial cells in - - - - - 82
— examination of - (*Figs* 94–97) 68–86, 227
— — bacteriological - - - - - 238
— — in carbuncles - - - - - 357
— — chemical - - - - - - 70
— — microscopical - - - - - 79
— — physical - - - - - 68
— — pre-operative - - - - - 78
— fat in - - - - - - - 82
— foreign bodies in - - - - - 86
— glycuronic acid in - - - - 73, 77
— leucocytes in - - - - - - 82
— management of, after excision of rectum - 264
— micro-organisms in - - - - 85
— odour of - - - - - - 69
— pregnanediol excretion in - - - 338
— proteins in - - - - - - 71
— pus in - - - - - - 77, 82
— — cells in - - (*Fig.* 97, B, 1, 2) 82
— reaction of - - - - - - 70
— — control of - - - - - 235
— — verification of - - - (*Fig.* 262) 235
— retention of (*see* Retention of Urine)
— specific gravity of - - - - - 69
PAGE
Urine, sugars in - - - - - 72, 88
— sulphonamide concentration in - - 277
— suppression of - - - - 69, 240
— testing of, preliminary to blood transfusion 54
— tube casts in - - (*Fig.* 97, C–F) 83
— volume of - - - - - - 68
Urinometer - - - - - - 69
— in range of specific gravity test - - 230
Urobilin - - - - - - - 69
Urobilinogen - - - - - - 69
Urography, excretory - - - - - 149
— — in infants - - - - - 157
— intramuscular - - - - - 150
— oral - - - - - - - 150
— subcutaneous - - - - - 150
Urolithiasis medicamentosa - - - - 279
Uropac in excretory urography - - - 150
— retrograde pyelography - - - - 150
— sialography - - - - - - 147
Uroselectan B in excretory urography - - 150
— retrograde pyelography - - - - 150
— vesiculography - - - - - 153
Urotropine, intravenous, in acute pyelitis - 239
— — fractures of base - - - - 186
— as urinary antiseptic - - - - 237
Urticaria following serum injection - - 66
Uterine douche tube, Bozemann's - (*Fig* 442) 337
— fundus, perforation of - - - - 337
— pack - - - - - - - 267
— retroversion, pessaries for (*Figs* 446, 447) 340
— sound, use of - - - (*Fig* 440) 336
Utero-vaginal fistula, post-operative - - 269
Uterus, curettage of - - - - - 336
— digital evacuation of - - (*Fig* 443) 339
— estimating length of - - (*Fig* 440) 336

VACCINATION - (*Figs* 507–509) 381–383
— intra-epidermal - - - - 393
Vaccine, polyvalent detoxicated, in gonorrhœa 464
— therapy in relapse cases of gonorrhœa - 462
Vagina, plugging of, to arrest bleeding - - 337
— pre-operative cleansing and packing of - 266
Vaginal depressor - (*Figs* 432, 435) 332, 333
— discharges, examination of, pre-operative - 265
— — purulent, obtaining specimens of (*Figs* 436, 438) 333
— — treatment of - - - - - 334
— epithelium in urine - (*Fig* 97, A, 5) 83
— examination by specula - (*Figs* 430–434) 332
— pack to control hæmorrhage - - 268, 269
— — pre-operative - - - - 266, 267
Vaginismus - - - - - - 342
Vaginitis due to *Trichomonas vaginalis* - - 265
— senile - - - - - - - 335
Van Herff's serrefines - - (*Fig* 120) 110
Varicocele, injection treatment of - (*Fig* 415) 322
Varicose ulcers, treatment of (*Figs* 494, 495) 376
— veins, treatment of- - (*Figs.* 491–493) 371
— — — by injection - - (*Figs* 491, 492) 372
— — — ligature and injection - - - 374
— — — palliative - - - - - 372
Vaseline gauze for drainage of lower abdomen 222
Vastus externus, intramuscular injection into (*Fig.* 39) 35
— internus, wasting of - - - 476, 519
Vein seeker, Edwards's - (*Figs* 45, 46) 36, 37
— — — in intravenous anæsthesia (*Fig* 787) 608, 609
— — Taylor's - - - - (*Fig.* 47) 38
— tourniquet, self-releasing - (*Fig.* 42) 37
Venaflask for intravenous infusions (*Figs* 61, 62) 46
Venereal disease, discussion of, with patient - 629
Venesection - - - - (*Fig.* 496) 379
— in fat embolism - - - - - 126
— post-operative pneumonia - - - 122
Venepuncture in infant - (*Figs.* 48, 49) 38
— technique of - - - - - - 36
Venoclysis (*see* Intravenous Infusions)
Veronal as hypnotic - - - - - 115
Vertebra, comminuted fracture of (*Fig.* 709, B) 549

PAGE
Vertebra, wedge compression of (*Fig.* 709, A) 549
Vertigo - - - - - - - - 426
Vesicular massage, examination of fluid expressed by - - - - - 172
Vesiculitis, acute, complicating gonorrhœa - 464
— pathological examination for - - - 172
Vesiculography, seminal - - (*Fig.* 169) 153
Vincent's angina, pus in - - (*Fig.* 198) 172
Vinegar douche - - - - - 266, 267
— — for senile vaginitis - - - - 335
Vinesthene - - - - - - - 601
Visceral syphilis, treatment of - - - 470
Visceroptosis, abdominal support for (*Fig* 763) 592
Viscopaste bandage - - (*Figs.* 338, 339) 293
— — in after-treatment of abscess - - 352
— — carbuncles - - - - 358, 359
— — circumcision - - - (*Fig* 405) 317
— — to extend spica to hip - - - - 520
— — in infections of hand - - - 364, 369
— — varicose ulcer - - - - - 377
— — — veins - - - - - - 372
Visitors to hospital - - - - - 632
Vitamin B deficiency and wound healing - 180
— — in pre-operative treatment of thyrotoxicosis - - - - - - 193
— C to counteract reactions to arsphenamine 471
— — deficiency and wound healing - - 179
— in diet in burns - - - - - 18
— E in habitual abortion - - - - 338
— K, pre-operative use of, in jaundice - - 218
— — in wound healing - - - - 179
— therapy following cataract operation - - 443
— — in gastric cases - - - - - 210
Volkmann's ischæmic contracture - (*Fig* 683) 521
Vomit chart after gastric operations - - 211
— — in appendicitis - - - - - 223
Vomiting after excision of rectum - - - 264
— — gastric operations - - - - 211
— avoidance of dehydration in cases of - - 92
— in delayed treatment of appendicitis - 224, 225
— following administration of sulphapyridine 279
— gastric aspiration in - - - 137, 211
— post-operative, in child - - - - 275
Vulva, care of, post-operative - - - 267
— papillomata of - - - - - 342
Vulvar adhesions - - - - - 342

WALKING calliper, ordering of (*Fig* 747) 587
— — instrument to thigh - - - 587
— — — with pelvic band (*Fig* 748) 587
Wangensteen's apparatus - - *Fig* 201) 175
War casualties - - - - - - 639
Wart(s), excision of - - - - - 310
— paint for papillomata of vulva - - - 342
— plantar, treatment of - - - - 459
— treatment of, with cautery - - - 459
— — — CO_2-snow - - - - 459
Wassermann reaction in syphilis - - 468, 469
Watch-spring pessary - - - (*Fig* 444) 340
Water pump for wound drainage (*Figs.* 205–207) 176
'Watershed' dressing - (*Figs* 361, 362) 302
Watson-Jones's tibial traction apparatus (*Figs* 723, 724) 568
Waugh's gag in tonsillectomy - (*Fig* 521) 401
Wax baths in late treatment of burns - - - 26
Waxy casts in urine - - (*Fig* 97, F, 1) 83
Wedge resection operation for ingrowing toenail - - - - - - (*Fig* 448) 343
Weil's disease, urine in - - - - - 85
Wheat-germ oil in habitual abortion - - 338
Whitehurch Howell's nail - (*Fig.* 395) 314, 315
White asphyxia, management of - - - - 10
— blood-cells, normal count - - - - 173
White-cell pipette - - - (*Fig* 194) 168
Whitfield's epilation forceps - - (*Fig* 606) 455
Whooping-cough, control of, in hospital - 635
'Wick drainage' of bladder - - (*Fig* 292) 254
'Window' attachment for syringe (*Fig.* 29) 30, 37
Winnett-Orr treatment of infected fractures - 510
Wintrobe's mixture - - - - - 382, 383
Witness box, doctor's evidence in - - - 623
Wood's light, fluorescence of infected hairs under - - - - - - - 457
Workmen's Compensation Act, medical reports connected with - - - - 621
Wound(s), after-treatment of - - - - 511
— closure - - - - - - (*Fig* 678) 510
— of cornea, perforating - (*Fig.* 583) 439
— drainage of - - - (*Fig.* 123) 111
— — deep - - - - - - 112
— excision - - - - - - 509
— of eyelid - - - (*Fig* 567) 432
— healing, accelerators of - - - - 180
— — factors in - - - - - 179
— infected, management of - - - - 178
— irrigation of - - - - (*Fig* 214) 178
— newer methods in dressing (*Figs.* 201–215) 175–179
— open, closed method of dressing (*Figs* 208–213) 178
— open-air treatment of - - - - 179
— secondary cross-infection of - - - 512
— superficial, drainage of - - - - 111
— treatment of - - - - (*Fig* 678) 509
Wrist, application of plaster bandage to (*Figs* 637, 639) 489, 490
— fracture of, temporary splinting of (*Fig* 675) 506
— manipulation of - - - - - - 482
— optimum position of - - (*Fig* 615) 478
— tuberculous - - - - - - 583

X-RAY examination (*see also* Radiography)
— — in duodenal intubation - - 142
— — sprains - - - - - - 473
— screening, danger of - - - - 516
X-rays in abortive treatment of carbuncles - 358
— treatment of keloid - - - - - 26

YELLOW oxide ointment in Meibomian cyst 430
Yeomans' sigmoidoscope - (*Fig* 419) 325
Y-fracture of condyles of humerus - - 536

ZIEHL-NEELSEN'S method of staining pus cells - - - - - - - - 170
Zinc and castor-oil cream in anal dressings - 260
— chloride for chronic cervicitis - - - 336
— permanganate irrigation in gonorrhœa 463, 464
— sulphate as emetic - - - - - 615
— sulphocarbolate irrigation in gonorrhœa - 464
Zoff for removing adhesive plaster - - 295

JOHN WRIGHT AND SONS LTD., PRINTERS AND PUBLISHERS, BRISTOL, ENGLAND

लाल बहादुर शास्त्री राष्ट्रीय प्रशासन अकादमी, पुस्तकालय
L.B.S. National Academy of Administration, Library
मसूरी
MUSSOORIE
यह पुस्तक निम्नाँकित तारीख तक वापिस करनी है।
This book is to be returned on the date last stamped

दिनांक Date	उधारकर्त्ता की संख्या Borrower's No.	दनांक Date	उ की संख्या Borrower' No.

617
Pye
15th ed.
अवाप्ति सं. 110727
ACC. No. 11908
Class No.
पुस्तक सं.
Book No.
लेखक
Author
शीर्षक
Title Pye's surgical handi-craft.
निर्गम दिनाँक | उधारकर्ता की सं.
Date of Issue
617
Pye
15th ed.
LIBRARY
LAL BAHADUR SHASTRI
National Academy of Administration
MUSSOORIE
Accession No. 110727
1. Books are issued for 15 days only but may have to be recalled earlier if urgently required.
2. An over-due charge of 25 Paise per day per volume will be charged.
3. Books may be renewed on request, at the discretion of the Librarian.
4. Periodicals, Rare and Reference books may not be issued and may be consulted only in the Library.
5. Books lost, defaced or injured in any way shall have to be replaced or its double