SYSTEM OF

PHYSIOLOGIC THERAPEUTICS

VOLUME VII

System of Physiologic Therapeutics

Eleven Octavo Volumes

American, English, German, and French Authors

A Practical Exposition of the Methods, Other than Drug-giving, Useful for the Prevention of Disease and in the Treatment of the Sick. Edited by SOLOMON SOLIS COHEN, A.M., M.D.

Electrotherapy. Thoroughly Illustrated. 2 Volumes

By GEORGE W. JACOBY, M.D., New York, with special articles by EDWARD JACKSON, A.M., M.D., Denver, Col.—By WILLIAM SCHEPPEGRELL, M.D., New Orleans.—By J. CHALMERS DA COSTA, M.D., Philadelphia.—By FRANKLIN H. MARTIN, M.D., Chicago.—By A. H. OHMANN-DUMESNIL, M.D., St. Louis.

Climatology and Health Resorts, Including Mineral Springs. 2 Volumes. With Colored Maps

By F. PARKES WEBER, M.A., M.D., F.R.C.P., London; and GUY HINSDALE, A.M., M.D., Philadelphia. With a special article on the Climate of Hawaii, by DR. TITUS MUNSON COAN, of New York. The maps have been prepared by DR. W. F. R. PHILLIPS, of the United States Weather Bureau, Washington, D. C.

Prophylaxis—Personal Hygiene—Civic Hygiene—Nursing and Care of the Sick. Thoroughly Illustrated

By JOSEPH MCFARLAND, M.D., Philadelphia; HENRY LEFFMANN, M.D., Philadelphia; ALBERT ABRAMS, A.M., M.D. (University of Heidelberg), San Francisco; and W. WAYNE BABCOCK, M.D., of Philadelphia.

Dietotherapy—Food in Health and Disease

By NATHAN S. DAVIS, JR., A.M., M.D., Chicago. With Tables of Dietaries, Relative Value of Foods, etc.

Mechanotherapy and Physical Exercise—Massage—Muscular Exercise—Orthopedic Apparatus—Corrective Manipulations—Physical Methods in Ophthalmic Therapeutics. 229 Illustrations

By JOHN KEARSLEY MITCHELL, M.D., Philadelphia; and LUTHER GULICK, M.D., Brooklyn, N. Y. Special articles on Orthopedic Apparatus, by DR. JAMES K. YOUNG, of Philadelphia, Corrective Manipulations in Orthopedic Surgery (Including the Lorenz Method), by H. AUGUSTUS WILSON, A.M., M.D., and Physical Methods in Ophthalmic Therapeutics, by DR. W. L. PYLE, Philadelphia.

Rest—Therapeutics of Mental Diseases—Suggestion

By FRANCIS X. DERCUM, M.D., Professor of Nervous and Mental Diseases in the Jefferson Medical College of Philadelphia; Neurologist to the Philadelphia Hospital, etc., Philadelphia.

Hydrotherapy — Thermotherapy — Phototherapy — Heliotherapy — Crounotherapy — Balneology. Thoroughly Illustrated

By DR. WILHELM WINTERNITZ, Vienna, assisted by DRS. STRASSER and BUXBAUM, and DR. E. HEINRICH KISCH, Prague. Translated by A. A. ESHNER, M.D., Philadelphia. Includes notes by GUY HINSDALE, M.D., of Philadelphia; a Chapter on Classification of Mineral Waters, by DR. A. C. PEALE, of the National Museum, Washington, D. C.; an Article on Phototherapy, by J. H. KELLOGG, M.D., Battle Creek, Mich.; an Article on Saline Irrigations and Infusions, by HARVEY CUSHING, M.D., of Johns Hopkins Hospital, Baltimore; and an Appendix by the EDITOR.

Pneumotherapy—Aerotherapy—Inhalation Methods and Therapy. Thoroughly Illustrated

By DR. P. TISSIER, Paris, Chief of Clinic of the Faculty of Medicine of the University of Paris.

Serotherapy—Organotherapy—Blood-letting, etc.—Radium—Principles of Therapeutics—Digest and Therapeutic Index to all Volumes

By JOSEPH MCFARLAND, M.D., Philadelphia.—O. T. OSBORNE, M.D., New Haven, Conn.—FREDERICK A. PACKARD, M.D., Philadelphia.—SAMUEL G. TRACY, M.D., New York.—THE EDITOR, and AUGUSTUS A. ESHNER, M.D., Philadelphia.

A SYSTEM

OF

PHYSIOLOGIC THERAPEUTICS

A PRACTICAL EXPOSITION OF THE METHODS, OTHER THAN DRUG-GIVING, USEFUL FOR THE PREVENTION OF DISEASE AND IN THE TREATMENT OF THE SICK

EDITED BY

SOLOMON SOLIS COHEN, A.M., M.D.

SENIOR ASSISTANT PROFESSOR OF CLINICAL MEDICINE IN JEFFERSON MEDICAL COLLEGE; PHYSICIAN TO THE JEFFERSON MEDICAL COLLEGE HOSPITAL, AND TO THE PHILADELPHIA, JEWISH, AND RUSH HOSPITALS, ETC.

VOLUME VII

MECHANOTHERAPY AND PHYSICAL EDUCATION

INCLUDING

MASSAGE AND EXERCISE

BY

JOHN K. MITCHELL, M.D.,

FELLOW OF THE COLLEGE OF PHYSICIANS OF PHILADELPHIA; PHYSICIAN TO THE PHILADELPHIA ORTHOPEDIC HOSPITAL AND INFIRMARY FOR NERVOUS DISEASES; ASSISTANT NEUROLOGIST TO THE PRESBYTERIAN HOSPITAL OF PHILADELPHIA, ETC.

AND

PHYSICAL EDUCATION BY MUSCULAR EXERCISE

BY

LUTHER HALSEY GULICK, M.D.,

DIRECTOR OF PHYSICAL TRAINING IN THE PUBLIC SCHOOLS OF GREATER NEW YORK; PRESIDENT OF AMERICAN PHYSICAL EDUCATION ASSOCIATION; CHAIRMAN OF PHYSICAL TRAINING COMMITTEE, LOUISIANA PURCHASE EXPOSITION; CHAIRMAN OF NATIONAL BASKET-BALL COMMITTEE, ETC.

With Special Chapters on **Orthopedic Apparatus**, by JAMES K. YOUNG, M.D., Professor of Orthopedic Surgery in the Philadelphia Polyclinic; Assistant Orthopedic Surgeon to the Hospital of the University of Pennsylvania, etc.: On **Corrective Manipulations in Orthopedic Surgery** (including the 'Lorenz Method'), by H. AUGUSTUS WILSON, M.D., Clinical Professor of Orthopedic Surgery in Jefferson Medical College; Orthopedic Surgeon to the Philadelphia Hospital, etc.: And on **Physical Methods in Ophthalmic Therapeutics**, by WALTER L. PYLE, M.D., Assistant Surgeon to Wills Eye Hospital, Philadelphia.

With 229 Illustrations

PHILADELPHIA

P. BLAKISTON'S SON & CO.

1012 WALNUT STREET

1904

REGISTERED AT STATIONERS' HALL, LONDON, ENGLAND

WM. F. FELL COMPANY
ELECTROTYPERS, PRINTERS
PHILADELPHIA, PA.

PREFACE

The general title of this volume, 'Mechanotherapy and Physical Education,' suggests but imperfectly the scope and the character of its contents. What these are can be learned only from a study of its pages, but the subsidiary titles—'Massage and Exercise,' 'Orthopedic Apparatus,' 'Corrective Manipulations in Orthopedic Surgery' and 'Physical Methods Employed in Ophthalmic Therapeutics'—indicate the variety of the topics discussed. The main theme, of course, is that treated by Dr. Mitchell, but the other subjects need full consideration in a System of Physiologic Therapeutics and their relations with the use of exercises and manipulations of the tissues are sufficiently evident to justify the association. As an example of this intimate connection, the subject of Spinal Curvature may be cited. The origin of this affection frequently may be traced to faulty position at the school-desk, this in turn sometimes depending, in part at least, upon ocular defects. Educational gymnastics and correct glassing may prevent the occurrence of curvature, while massage, remedial exercise, orthopedic apparatus and corrective manipulations all play a part in the treatment of its various forms and degrees.

Another example may be drawn from headache, which if it is sometimes to be treated by massage, may be prevented in other cases by the exercise that restores digestive tone or improves faulty metabolism, while in still other instances it disappears when eye-strain is corrected. For the relief of eye-strain and the manifold symptoms to which it may give rise, not only refractive correction is needed, but often suitable exercises must be prescribed for the ocular muscles.

The medical profession and its patients owe to a physician of Philadelphia—Weir Mitchell—the recognition of the part played by eye-strain in causing or aggravating many nervous and other disorders. They are further indebted to William Thomson, William F. Norris, and other ophthalmologists of Philadelphia for the development of Mitchell's discoveries; in especial to George M. Gould for clear perception of the important place of ocular disturbances in medical diagnosis and the reiterated teaching needed to make this knowledge an integral part of the general professional consciousness. It seems appropriate therefore that a treatise like the present, emanating from Philadelphia, should give this subject its deserved prominence, probably for the first time in general therapeutic literature.

Extremes, however, are to be avoided in this, as in all other questions of therapeutic diagnosis. The editor trusts, therefore, that the judicious conservatism with which the subject has been treated by Dr. Pyle will be recognized and that the whole chapter on 'Physical Methods in Ophthalmic Therapeutics' will be found a safe and useful guide. Every physician needs to be able to judge whether or not the symptoms presented by his patients may be the result of ocular anomalies and should have an intelligent appreciation of the methods employed by specialists in studying and remedying such defects.

The attention recently drawn to the bloodless method of reducing congenital dislocation of the hip, devised by Professor Lorenz of Vienna, will give to the article descriptive of this procedure a timely interest. Dr. Wilson's contribution, however, while it describes and illustrates Lorenz's operation comprehensively and in great detail, is not confined to this subject but also embraces many other methods for the skilful application of manual force to the correction of deformities of the osseous structures.

The title 'Corrective Manipulations' has been adopted for the collective description of these procedures in order to avoid the apparent tautology of the perhaps more expressive title 'Manual Manipulations.' The methods described are only those in which the correction is made by manual movements—manipulations in the most restricted sense of the term. While most of these corrective methods have been described in treatises and monographs in connection with other methods for the relief of the affections to which they are applied, it is believed that this is the first time that they have been treated together and as a whole. It is hoped that this will serve to draw greater attention to 'Corrective Manipulations' and lead to a wider adoption of the practice.

The article upon 'Exercise as a Method of Physical Education' has been given a separate place instead of being incorporated with the work of Dr. Mitchell, in order to emphasize the importance of the theoretic views advanced by Dr. Gulick, especially as to the correlation between the development of the race and that of the individual and the necessity for guiding the physical training of individuals on evolutionary and historical lines. The maxim that 'function makes structure' and its corollary that function is the guide for the exercise of parts, cannot be too strongly emphasized. Important also is the realization of the physical effects of city life, so that we may take under conscious direction those muscular activities necessary to the preservation of health that in a better environment might safely be entrusted to unconscious nature.

Dr. Gulick's chapters are not theoretic only. His long experience in physical education and especially his work in developing that gymnastic system to which the name of the Young Men's Christian Association has been applied, have afforded a sufficiently broad foundation for his practical advice. This is to be studied also in relation with the chapters on 'Remedial Exercise' contained in Dr. Mitchell's work. While unavoidably overlapping to some extent in a few special considerations, the two authors do not simply repeat, but mutually supplement and complement each other, having by correspondence and otherwise arrived at an agreement not only as to division of work but also as to substance of teaching.

Exercise as a therapeutic method has suffered so much discredit from the wild theories and the fantastic and exaggerated overstatement of its value by excited enthusiasts that any one who would write usefully on it must constantly endeavor to make his work not only precise and scientific, but modest and rational in its claims and practical in its methods. Attention must likewise be directed, and strongly directed, to the great harm that may result from following the advice of those who undertake to order, whether for educational or for remedial ends, the physical activities of persons whom they have never seen and whose therapeutic needs and pathologic liabilities they would be unable to recognize even upon personal examination. Dangerous, even indirectly fatal, heart-strain has been thus caused.

It is proper to say that there is almost no form of application of exercise or manipulation to the treatment of disease or to the maintenance of health herein considered in which the authors have not had practical experience to guide them. In the chapters on 'Massage,' for instance, Dr. Mitchell has drawn upon his experience as lecturer on Massage in the Orthopedic Hospital and Infirmary for Nervous Diseases, where the supervision of the teaching of this art to the nurses of the institution and to the large number of pupils instructed there annually has been for some years under his direction. In order to insure the desired simplicity and exactness of statement, the descriptions of movements were submitted by him to the test of use in instruction and the wording of the directions critically examined by Miss Hannah Heald and Mr. A. S. Pennington, the present and former instructors in massage practice at the Infirmary. The frequent abuse of massage, a form of treatment quite capable of doing harm, by lay practitioners who give it without medical prescription or authority, its exploitation as an exclusive means of treatment under some fanciful name and the slight attention that some physicians are in the habit of giving to the details of the manipulations they may order, all combine to make it particularly desirable that the medical profession should have within reach a clear and explicit statement of what can and cannot be done by massage and of how its ends are accomplished.

It is desired especially to acknowledge the aid of Dr. A. A. Eshner, assistant physician to the Philadelphia Orthopedic Hospital and Infirmary for Nervous Diseases, in preparing a part of the chapter on 'Exercises of Precision.'

To Dr. Albert McConaghy thanks are due for help with the chapter on 'Free Work,' and to the same gentleman and to Dr. Mandeville Thum for many of the illustrations.

To the friend who prepared the index and to Dr. R. Max Goepp for editorial assistance, acknowledgment is also to be made.

CONTENTS

PART I—MASSAGE AND EXERCISE

SECTION I—PRINCIPLES, METHODS, AND THERAPEUTICS OF MASSAGE

SECTION II—EXERCISE AS A REMEDIAL MEASURE

PART II—PHYSICAL EDUCATION BY MUSCULAR EXERCISE

LIST OF ILLUSTRATIONS

MASSAGE AND EXERCISE

ORTHOPEDIC APPARATUS

CORRECTIVE MANIPULATIONS IN ORTHOPEDIC SURGERY.

PHYSICAL METHODS IN OPHTHALMIC THERAPEUTICS

PART I

MASSAGE AND EXERCISE

BY

JOHN K. MITCHELL, M.D.,

FELLOW OF THE COLLEGE OF PHYSICIANS OF PHILADELPHIA; MEMBER OF THE ASSOCIATION OF AMERICAN PHYSICIANS, AMERICAN NEUROLOGICAL ASSOCIATION, AMERICAN MEDICAL ASSOCIATION; PHYSICIAN TO THE PHILADELPHIA ORTHOPÆDIC HOSPITAL AND INFIRMARY FOR NERVOUS DISEASES; ASSISTANT NEUROLOGIST TO THE PRESBYTERIAN HOSPITAL OF PHILADELPHIA; ETC.

A SYSTEM OF PHYSIOLOGIC THERAPEUTICS

MECHANOTHERAPY AND PHYSICAL EDUCATION

PART I
MASSAGE AND EXERCISE

Section I
PRINCIPLES, METHODS, AND THERAPEUTICS OF MASSAGE

CHAPTER I

TECHNIC AND EFFECTS OF MASSAGE

Definition. Personal Requirements of the Operator. Technic. Classification of Methods: Effleurage; Friction; Pétrissage; Tapotement. General Massage; Modifications of General Massage. General Effects of Massage: Physiologic Effects; Effects upon Pathologic Processes. Indications for General Massage; Counterindications to General Massage. Indications for Local Massage; Counterindications to Local Massage. Mechanical Massage.

Massage is a form of passive exercise by systematic manipulation of the body for definite therapeutic ends. Properly used, it affects the muscular, circulatory, digestive, and nervous systems in various ways, according to the method and extent of the application.

The **results** are obtained by mechanical means; the hand-grasps stimulate the muscle-fibers to slight contraction, press the venous and lymphatic currents onward,—thus lessening the heart's work,—increase the peristaltic activity of the intestines, and promote secretion throughout the body.

All these are the ordinary effects of active exercise, but active exercise is not always possible or desirable. One person may have a disabling local injury; for another, general exercise may be too fatiguing or may make too great a demand upon the nerve-centers. Yet a certain amount of exercise is necessary for health, and inactivity brings with it a long train of evils. To avoid or remedy these bad effects, we substitute massage for active exercise, with confidence that we shall thus secure a large proportion of the good effects of muscular exertion. In this form of passive exercise there is no expenditure of nervous energy to direct and control muscles; there is no attempt to force feeble or ill-nourished organs to continued effort by mere will-power.

Again, since inactive muscles rapidly waste, massage may usefully be employed to keep in health muscles temporarily cut off by wound or disease from the central controlling power, as happens in certain forms of paralysis, or after nerve section, or from disuse following a sprain, dislocation, or fracture.

No resort to theories of personal electricity, magnetism, or peculiar healing powers is needed to explain these results. The whole apparatus required is a warm, dry hand, skilfully directed.

Personal Requirements of the Operator

The manual part of the art is not very difficult to learn, given some knowledge of physiology and of the relations of the several parts of the body. Increased dexterity and delicacy of touch come only with practice, experience, and observation. Great strength is not required so much as a firm, steady grasp. In this country massage is seldom performed by physicians, and it is therefore necessary to impress on the manipulator that he has duties and obligations to the physician whose hands, so to speak, he is for the time, as well as to the patient. In all cases direct orders should be asked from the attending physician and the most precise loyalty be observed in carrying out instructions in letter and spirit. Anything observed by the operator which might be of use in the care of the patient should be reported to the physician at once, and his advice taken in any difficulty or doubt. During the time of manipulation the operator should not talk to the patient—nor as a rule permit the patient to talk to him. Patients prefer an operator whose manner is quiet and courteous. The utmost cleanliness and nicety in person and dress should be observed, and although, of course, the masseur washes his hands after finishing his work, he should always wash them again, and in the presence of the patient, before he begins with a new subject.

An operator with very small hands is apt to pinch, and has to make more movements in covering a given area than one with larger hands; but very large coarse hands usually lack that fineness of touch which is desirable. The early attempts of the learner should be watched closely, as bad habits of manipulation are easily acquired and not easily discarded. The most usual faults are making the movements too fast, pinching or working superficially, instead of kneading deeply, or putting too much muscular effort in play, thus bruising the tissues. It cannot too often be repeated that a practised operator can rub thoroughly and very deeply without discomfort or inconvenience to his subject, and that almost no manipulation need be painful.

Another first principle to be impressed upon the student is, that so soon as the habit of right use of the hands in the several movements has been acquired, he must try to think during his work of the character of the tissues upon which he is operating, and how he wishes to affect them, rather than of the mechanical method he is employing.

Some men rub better than women; but except where strength is needed, as in the forced movements and very hard massage required for old articular disease with adhesions, it is obviously better to make use of a manipulator of the patient's sex.

Technic

As the value of massage and its good effects are wholly dependent upon the exact performance of the movements used, it will be necessary to describe them with some minuteness; but no amount of written description can replace direct instruction. If the physician who prescribes massage be even moderately familiar with the technical detail, he is less at the mercy of ignorant or unskilled operators, and better enabled to prescribe the different methods or amounts of massage suited to different cases.

Massage has been a good deal discredited through uneducated 'rubbers,' who attempt to treat all cases alike, quite often damaging their patients, and still more often hurting and frightening them.

The medical man who merely orders 'massage' and leaves the matter of **how much, when,** and of **what sort** it shall be, to the manipulator, is as much to be blamed for carelessness as if he prescribed digitalis, and left the dose and the time of administration to be settled by a nurse.

How massage is to be used in any case is a matter for prescription by the physician, who should order the **duration of application,** give some idea of **how much force** is to be used, and **how frequently** the sitting is to be repeated.

If a **merely local condition** is to be treated,—as a sprain, a luxation, or a deposit of inflammatory exudate,—**short** and **frequent** applications should be used. **General massage** of the whole body, as a means of combating the ill effects of enforced inactivity, in convalescence, as a promoter of nutrition, or as introductory to more energetic exercise, should be given **at least once daily,** and in bed-fast patients—for example, during the 'rest treatment'—may sometimes be used twice a day with advantage.

The **force** to be exerted is dictated by the state and needs of the individual patient; but it must be remembered that nervous and irritable persons are often afraid of massage and sometimes are at first annoyed by it. In very thin individuals, still more in the very fat, soreness and even ecchymoses may develop at the beginning of the treatment. An addition to the force used and to the length of the administration will soon be possible, if every care is exercised at the start not to frighten or hurt the patient. The character of the manipulations, too, may have to be altered for a time; but it will generally be found that after four or five sittings, both force and frequency may rapidly be increased. **Slow effleurage** and **light pétrissage** as introductory movements, and the avoidance of all exciting or over-stimulating manipulations, such as tapotement, will get over these early difficulties.

Except under special circumstances and with distinct orders from the physician **no lubricant** should be used, as the employment of an oil lessens the superficial frictional effect of the massage, is untidy, and if long continued stimulates an undesirable growth of hair. If a masseur says that he cannot rub without oil, or that in its absence the hair will be pulled disagreeably, he confesses incompetence. Still less should he be permitted to remove hair from body or limbs by shaving, as the annoyance is extreme when the hair thus strengthened begins to grow again. In very hairy persons a little talcum powder or an oleate in very small quantities may sometimes be called for, and in emaciated or elderly people with a very harsh, dry, or scaly skin some oil may be needed for a time. If a small area has to be rubbed frequently and for long periods, as in **arthritic disorders,** the use of an emollient will save the skin from irritation. In such instances the most desirable unguent is wool-fat with the addition of enough oil of sweet almonds to make a mixture of the consistency of thick cream. Petrolatum preparations are objectionable, as they are irritating to sensitive skins. Cocoa-butter is preferred by some operators and has the advantage that very little is required.

It is hardly necessary to say that massage should be performed **upon the naked skin,** as clothing interferes with accuracy and delicacy of touch. All manipulations should be made upon tissues in a state of the **most complete relaxation.** Some counsels as to how to secure this condition are given in the directions for treatment of special regions.

What **length of time** each application shall last must depend on the condition of the patient and on the effect sought.

In disorders **wholly local,** frequent short applications are best; for example, from five to fifteen minutes, twice, thrice, or four times daily. In extensive old arthritic disease with adhesions, on the other hand, the patient is sometimes unable to endure the pain of effectual manipulation more than once in two or three days. When **continuing effects** are wanted, as in promoting absorption of exudates, or stimulating circulation in weak or palsied parts, long treatment is ordered; but how long must depend on the extent of territory involved, and on the masseur's observations of the result of manipulation. A single limb may be rubbed from eight to fifteen minutes; if only a part of a limb is treated, the time must be reduced. **General massage** in convalescence, in rest treatment, in anemia and similar conditions, should last from fifty to sixty minutes; or in large and fat people, even seventy-five minutes.

CLASSIFICATION OF METHODS

The movements are of four classes, and the French names of these are generally employed: (1) **Effleurage**; (2) **pétrissage**; (3) **friction**; (4) **tapotement.** These may all be used in varying directions and strongly or lightly to attain special ends.

Further subdivisions are made by some authorities, to the extent of classifying sixty or seventy movements; but, practically, all may be included under the heads mentioned. To describe separately all the possible varying intermediate or combined movements, not differing in essence or in physiologic effect from the type, and make minute and hair-splitting definitions of them, would only serve to complicate with words what is, after all, a very simple matter.*

* This is clearly evidenced when one watches in succession three or four competent masseurs. Even if they have all learned from the same teacher or, at least, on the same system, when once they have mastered the technic, each soon begins to form a 'style' of his own, different from the next man's and as individual as his handwriting. Each rubs in his special way and with his special modification, but all reach the same result.

Effleurage.—Effleurage is slow stroking with the flat hand, the heel of the hand, the edge of the hand, a thumb, thumb and fingers, or finger-tips. Effleurage should always be **centripetal**; that is, in the direction of the venous flow. The degree of **pressure** applied will necessarily vary with the region rubbed, the portion of the hand used, and the result desired. Rapid effleurage is stimulating to the skin and surface nerves and vessels, and is annoying to many patients.

The movement should generally be slow, smooth, and sweeping, the returning hand traveling a little faster and with much less pressure than in the upward stroke, but still keeping its contact with the skin. Effleurage is used as an **introductory movement** to begin the manipulations of every part, either with one hand, with both together, or alternating. Its chief **physiologic effect** is the hurrying of venous and lymphatic currents. Where such effects are especially sought, it is employed for a longer time and with more pressure than if applied in the course of general massage as a beginning movement, when it simply serves as a slight stimulation to the surface, and to accustom the patient to the hand-contact.

Friction.—Friction is **rubbing in small circles** with the thumb or tips of one or more fingers. Moderate, steady pressure should be maintained during the movement. This manipulation might well be classed as a subdivision of the next form, pétrissage, the uses and effects of the two being similar.* In regions where the larger grasp of pétrissage is not possible, as in the face, the eyes, the interosseous spaces, and crevices about joints, friction takes its place. When long-continued manipulation of a small area is required, as when exudates and infiltrations are to be removed, it is the preferable movement for use. Dry, harsh, hard states of the skin are benefited by friction and finger-tip pétrissage.

Pétrissage.—Pétrissage is performed by **grasping with the whole hand** the tissues to be operated upon, **lifting** a little the mass thus seized, and **kneading** it with an alternate tightening and loosening of the hold. The palm of the hand and the parts of the finger and thumb nearest the palm should be used, not the finger-tips, in order to avoid pinching. The fingers must be kept pretty close together, not sepa-

---

* Confusion is often produced by the name, and learners think of the effect to be produced as 'friction' in the English sense, a result which, when it is desired, is attained by rapid effleurage. The French word *friction* would be better represented in English by 'rubbing,' but this term being commonly used to cover the whole process of massage, it seems unwise to attempt a change.

rated. The movement may be made with one hand, with both hands together, with the hands operating on opposite sides of the same limb, or with one hand supporting the tissues while the other kneads and presses them. (See Fig. 3.)

The pressure should be close enough to make the skin move with the hand over the underlying tissues. If the hands slip over the surface, the hair will be dragged upon painfully.

This is the most important movement of massage, and much the most difficult to acquire; both hands should be equally practised in it. Several modifications of this manipulation suited to different situations are in use, to which, for convenience in instruction or prescription, separate names are sometimes given:

Rolling is a procedure suitable for use where long muscular masses can be seized between the two hands. For example, in pétrissage of the upper arm, one hand, held flat with straight fingers, moves back and forth on the outer aspect of the arm; the other hand performing like movements on the inner aspect, but in the opposite direction.

Fist-kneading—in which the knuckles of the closed or partly-closed fist compress the tissues—is used over the abdominal cavity, especially in manipulation of very fat persons. (See Figs. 15 and 16.)

Wringing—in which the two hands grasp the tissues and with firm hold twist them in opposite directions, as one wrings out a wet cloth—is applied, like rolling, where long muscle masses can be readily seized.

Digital-kneading—in which the finger-tips only are used, one at a time or all held close together in pyramidal shape—is applied to limited areas, not accessible to larger grasp; as in working interosseous spaces, or treating certain portions of the intestines.

Fulling * is a term applied by certain masseurs to a special form of pétrissage useful where several groups of large muscles are disposed in successive layers, as in the thigh; by this movement the outer muscles are made to press upon and knead the deeper layers, since the latter cannot be reached and handled separately.

Beginning with a large but steady hold, the hands upon the upper

---

* Fulling takes its name from an obsolete process incident to the manufacture of fine woolen cloths. The cloth was pressed, rubbed, and rolled at the same time with the application of a good deal of force and weight, in order to mat together the fine fibers of the wool. The name is used by some authors for superficial kneading or pinching, a movement to which this description of the fuller's operation would not well apply. Whence it came into massage-practice I do not know, but the name has been used for ten or twelve years at the Infirmary for Nervous Diseases in Philadelphia, and the description given is taken from the performance of a former instructor there, Mr. A. S. Pennington.

thigh, the right hand starts first with a rotary upward motion, the left making the same movement later, so that both do not work at the same time; then, reversing the motion, the masseur works downward, making sure that the push of each grasp is in an upward direction. The next section below is then worked. About three hand-holds in this fashion will cover the thigh, or four if the operator have small hands; but it is not a procedure very suitable for small hands.

Push-roll is a somewhat similar manipulation and, like fulling, useful for large muscle masses. With the hands in the same position as for fulling, the close-held tissues are shoved upward in a mass; the operator presses his weight upon them and turns the whole mass to the right, then slacks pressure enough to allow the tissues to return to their normal position. Then the hands slip downward to the place of beginning and the operation is repeated, turning this time to the left, until the whole area to be treated has been handled. The procedure is sometimes called 'rotary kneading.' (See Fig. 5.)

The **general effects of pétrissage** are most important; a slight direct stimulation of the muscles, a hurrying of the lymphatic and venous circulation, and thus an indirect effect upon the arterial stream, an immense increase in the quantity of blood flowing through the tissues manipulated, and more remotely an actual increase in the number of blood-cells.

The flushing of the muscle with blood carries off fatigue products, and thorough pétrissage is the best possible means of relieving **muscle-tire** and **cramp from overuse.**

If the tightening hand-pressure is sharp and quick, the muscles will contract quite decidedly, as they do in response to a blow; but this is not an effect to be desired.

Tapotement.—The several forms of tapotement may all be included by defining this movement as a series of rapid blows, delivered with the finger-tips—**percussion;** the flat of the hand—**slapping;** the edge of the hand—**hacking;** or with the hand held in a cup shape, and a very rapid vibratory movement produced by the contraction of the forearm muscles, either while the fingers, held firmly together but without rigidity, are kept touching the part, or with the whole hand laid open upon the part—**vibration.** (See Figs. 19 and 20.) This last movement is the only manipulation of massage that can be done as well by mechanical means as by the human hand. But with a machine, although much more rapid and more long-continued vibration can be produced than is possible with the hand, the skilled touch to measure the force is wanting. (See pages 132 to 136.)

Finger-tip percussion is done with a motion of the wrist only, and is used chiefly along nerve-trunks for mechanical stimulation. **Slapping** excites the surface nerves and dilates the vessels. **Hacking** is applied to muscles with the ulnar edge of the hand at right angles to the long axis of the muscles. **Cup-hand slapping** stimulates both the skin and, in a minor degree, the deeper structures, and, even when forcibly applied, is less annoying than slapping.

Vibration has the same uses as percussion and a special value of its own in the stimulation of deep-lying muscles, as, for example, those of the intestines.

It is also occasionally used in **neuralgias** and is even applied as a general treatment by a shaking chair devised for the purpose.

Percussion with the knuckles, the finger-tips being half closed, is sometimes used; as is striking with the ulnar edge of the closed fist.

GENERAL MASSAGE

The combination into a procedure for the manipulation of the whole body of the several movements described in the foregoing paragraphs must be detailed somewhat minutely; but, as in any manual art, what is impossible to describe accurately without going to undue length may be both easily and exactly learned by observation. Kleen says very happily, in speaking of over-elaboration of technic and the attempts at exhaustive description of it: "To one who clearly understands the indications, anatomic, physiologic, and pathologic, in any given case, the different manipulations to be used will come, so to speak, 'of themselves,' always supposing the operator to know what effect is sought."

It is usual to begin with a lower extremity, but this is not important, though it *is* important to follow a **regular order.** That most generally desirable is: legs; arms; back; chest; abdomen. This order involves the least amount of moving of the patient. The bed should not be too springy. The subject should lie upon his back, between blankets, and conveniently near to the side of the bed; each part must be exposed only so much as is needed for manipulation and be closely covered at once after finishing.

The procedure with the lower extremity is described in detail as an example. The handling of the other parts will not be so minutely set forth.

Foot.—The operator, standing at the patient's right or at the foot of the bed, begins by taking the **left foot** in his left hand (Fig. 1), the right hand on the dorsal surface, and strokes with both hands to the ankle, kneads the plantar arch with fingers or with full left hand, and, with firm grasp on the sides of the foot, grinds the metatarsal bones together; then pulls, twists, and kneads the toes (Fig. 2), kneads with the thumb in the interosseous spaces, with thumb and forefinger around the malleoli and up along the tendo Achillis; moves the ankle in all directions; and ends by rapid stroking of the whole surface.

The illustrations show the right foot in course of treatment. The relative position of the hands is therefore the reverse of that described in the text.

FIG. 1.—MASSAGE OF (RIGHT) FOOT, FIRST MOVEMENT.

A stocking is put on the foot if the patient has a tendency to chill, or the member may be covered with a blanket.

Leg.—The patient turns upon his right side, the masseur seats himself on the edge of the bed and takes the foot into his lap (Fig. 3), beginning with a few steady strokes to the knee; **pétrissage** of the calf muscles then follows, and the same masses are squeezed against the bone with the wringing movement. The anterior tibial muscle is kneaded against the bone with thumbs or finger-tips; or, where the muscle is well developed, it is picked up and treated with **pétrissage**

and friction; and finally the calf mass is once more treated by being rolled between the hands held flat-wise on opposite sides of the limb and moved alternately back and forth. In persons with large and firm muscles the **fulling movement** may be used for the calf groups, in addition to the procedure described.

Next, the two hands surround the leg and are pushed upward with firm pressure from ankle to knee two or three times, light rapid **effleurage** concluding the manipulation of the lower leg.

FIG. 2.—MASSAGE OF FOOT.

Knee.—After covering the finished part the operator, standing up again, takes the knee in both hands. The knee is stroked; the hands separate to come together again without losing contact, thus stretching the skin; the thumbs are used with circular friction around the patella and on the sides of the joint (Fig. 4); the fingers knead the popliteal space. Supporting the knee with one hand, the other flexes and extends the leg several times, and **effleurage** again ends the handling. Some good operators prefer to make these manipulations with the lower leg held in the lap.

Thigh.—For convenience merely, the masseur arbitrarily divides the thigh into three sections. The large muscular masses usually require the use of both hands at once; the two either working together, or one supporting the tissues while the other seizes and manipulates them.

The operator begins with **effleurage** of the whole of the thigh and hip. Next, **pétrissage** is given about the head of the femur; then with a firm grasp of both hands upon the tissues of the uppermost section

Fig. 3.—Pétrissage of the Calf Muscles.

of the thigh, an upward push is given to the mass (Fig. 5); the masseur, pressing heavily at the same time, even throwing his weight upon his hands if necessary, turns the whole mass of the tissues to the right, then slacks pressure enough to allow the muscles to resume the natural situation, and repeats the operation downward, section by section. It is important that each **grasp** be *below* the previous one, but that the **motions** be made *upward*.

At the knee, this **push-roll** movement is begun over again, the turn being made in the opposite direction to that first given. **Deep pétris-**

sage, section by section, follows; and if it be desired to work the thigh muscles with special thoroughness, **fulling** (see page 23) is used instead of simple kneading. **Effleurage** ends the manipulation. In muscular subjects or persons with much fatty deposit, the push-roll and fulling may require to be repeated several times to reach the deep tissues and properly work them.

The same series of procedures is gone through with on the middle,

FIG. 4.—FRICTION OF THE KNEE.

and finally on the lower section, ending all with effleurage of the whole thigh.

Hip.—The left hip is treated while the patient lies on the right side. The operator presses the left hand against the sacrum to support the patient and performs **effleurage** around the head of the hip-joint with the right hand; then he **kneads** the muscles about the trochanter with the heel of the hand, and effleurage, as usual, completes the manipulations.

The **right foot** is then taken up and the leg and thigh are handled in the same manner as the left extremity.

Arm.—The left arm is the next member treated. The **hand** in ordinary cases will need but little manipulation. The stretching and pulling about of the hand is peculiarly disagreeable to many patients. Hands showing any peculiar weakness may demand special attention and careful working of the deficient muscles, **finger-tip kneading** for the interossei, **friction** of the thenar and hypothenar masses, and so on. **Forearm treatment** begins with **effleurage** of the whole limb, then, with the patient's hand pronated, **kneading, spreading,** and **squeezing**

FIG. 5.—PÉTRISSAGE. PUSH-ROLL MOVEMENT ON THE THIGH.

together of the hand bones is practised, and each finger is separately **pulled, turned,** and **kneaded.** After this the operator should stretch and knead the **annular ligament,** and use thumb and finger-tip friction to the **wrist.** The wrist is then moved in all directions. The patient's left hand being held in the operator's right, **effleurage** is applied to the forearm with **pétrissage** of the ulnar half. The whole forearm is then supinated and **kneaded,** the masseur working with both hands at once, and the application is terminated with effleurage. Holding the elbow in his hand, the operator next **kneads** inside and behind the joint, paying special attention to thumb friction around the inner and posterior parts. After effleurage in the upper arm, **kneading** and **fulling** are used, special care being given to the treatment of the deltoid muscle.

Shoulder.—The manipulation of the shoulder-joint, of the supraclavicular and suprascapular regions, is performed after rubbing the upper arm. The patient lies on his side and the operator with one hand supports the shoulder-joint in front, while the other **kneads** the scapular muscles with flat hand (Fig. 6). Around the whole border

FIG. 6.—FLAT-HAND KNEADING OF THE SCAPULA.

of the scapula, **digital kneading** and **alternate pressure** should be used; and **rubbing** with the ulnar edge of the hand, and, finally, **pétrissage** of the scapular region and the top of the shoulder should end the manipulation of this region.

If the **joint** needs particular care, the best method is to control movement by allowing the arm to lie loosely on the operator's forearm while, with one hand in the axilla and one on the top of the shoulder, the fingers and thumbs are used upon both anterior and posterior surfaces of the shoulder at once. (See Fig. 7.) In mild grades of arthritis,

FIG. 7.—MASSAGE OF SHOULDER.

FIG. 8.—POSITION FOR MASSAGE OF THE BACK.

such as result from lack of use of the arm for a time, this is an excellent way of treating the articulation.

A gradual raising of the operator's supporting elbow as he works, exposes the accessible parts of the joint surface little by little to the effects of the manipulation.

Back.—Massage of the **right arm** is next in order, and when this is completed, the patient is turned upon his face for the treatment of the **back.** The arms are extended above the head, and the head rests

FIG. 9.—THUMB-SEPARATING ON THE BACK.

upon the crossed forearms, face down (Fig. 8). The arms need not be extended after massage of the interscapular region is finished, the position being taken only to separate the scapulæ as widely as possible, and the posture of the head need not be maintained after the manipulation of the back of the neck has been concluded. In order to secure relaxation of the back muscles, a firm pillow is placed under the upper abdomen. The proper position of the body and the placing of the pillow are shown in Fig. 8.

The patient must be close to the side of the bed in order to enable direct downward pressure to be used (Fig. 9).

The following manipulations are then practised:

Stroking and **kneading** the back of the neck with the right hand, the left supporting the top of the head; **friction** to the occipital region, **kneading** of the posterior cervical area as far forward as the line of the sternocleidomastoid muscles, **stroking** and **kneading** these and the adjacent parts of the shoulders with both hands; **effleurage,** first down

FIG. 10.—STRADDLING THE SPINE (EFFLEURAGE).

the whole back, one hand following the other with strokes somewhat faster and more vigorous than in other parts, then with one hand crossing the track of the other and reversing in a diamond-shaped movement, stroking the back and posterolateral parts of the ribs and belly; **kneading** with both hands. The erector spinæ muscles are treated with **thumb or finger-tip kneading, friction** in both small and large circles, and with the hands pressing upon the ribs the thumbs are separated, thus stretching and pulling the muscles and skin ('thumb-separating,' Fig. 9).

The **right hip** is next treated, with the patient still in the prone position, the left hip having been cared for after manipulation of the left leg. The operator then **kneads both hips and buttocks** and returns to the back. Beginning from the occiput, the hands work together down the back with the first and second fingers on opposite sides of the spine (**'straddling the spine,'** Fig. 10), then **cross-hand palmar rubbing** is done from mid-ribs to spine, first down one side, then the other; then with a hand on each side **'wiping'** with both is carried toward

FIG. 11.—BEGINNING ABDOMINAL MASSAGE; LIFTING MOVEMENT.

the spine. **Rapid effleurage** of the whole back comes next, and finally very fast **stroking** over the spine, one hand following the other until the skin is well reddened. **Tapotement** of the spine, **vibration** of the sacrum, **hacking** or **pounding** over the sacrum, are sometimes given if specially ordered, but are not necessary parts of the general process. In very rare cases massage of the sacral region or of the buttocks causes sexual excitement in men; in such cases all manipulation of the thighs, buttocks, and lower spine must be omitted.

Chest.—The patient turns upon the back and the manipulation is started by **stroking** from the back of the neck, drawing both hands down and forward over the sides of the neck. The muscles forming the anterior axillary folds and the ribs are **kneaded, thumb and finger-tip friction** is made along the sternum, and followed by **palmar rubbing** and **digital kneading** of the sides of the chest, working in the line of the ribs and compressing the flat and closely attached muscles against the bones. In women the **breasts** should not be manipulated unless under special orders. (See chapter III.) **Tapotement** over the heart or

FIG. 12.—PÉTRISSAGE OF THE ABDOMEN.

general tapotement of the chest is sometimes ordered, and if administered should always be given with the chest fully inflated. (See also under "Heart Massage," page 57.)

Abdomen.—The bladder and bowels should be emptied before massage of the abdomen is begun. If there is any reason to believe that the bowels are packed, great care must be exercised in the rubbing; and until the manipulation has had time to affect the sluggish intestines favorably, it is best to make certain by the use of enemas that the feces are thoroughly removed daily.

To insure relaxation, the head and shoulders are elevated, the knees flexed, and the patient is directed to breathe deeply and regularly. In nervous and hysterical women the abdominal muscles are at first very tense; but this tension is mostly involuntary and may be overcome by persistence; it usually relaxes of itself after the patient grows accustomed to the handling. (See also special treatment of the abdomen.) As an introductory movement, the operator puts both hands under the patient until the fingers meet in the lumbar region,

Fig. 13.—Kneading the Abdomen with the Heel of the Right Hand, Left Hand Used as Support.

and draws the hands forward, compressing and lifting at the same time till they meet in the middle line of the abdomen. (See Fig. 11, in which, however, the operator is standing too low to make the movement to the best advantage.) **Deep pétrissage** is begun in the right iliac space with both hands, and the whole abdomen is thus thoroughly kneaded several times, working across from the left side to the right (Fig. 12). The left iliac space is treated in the same way, and the large intestine is followed throughout the whole accessible course of the ascending, transverse, and descending colon with digital kneading, several times repeated. A similar movement, making wider pressure with the heel of the left hand while the right supports the abdomen, may be added (Fig. 13).

For still further stimulation, **fist-kneading** and deep pétrissage in the same course is used after patients have become tolerant of the abdominal manipulation (Figs. 16 and 17). Figure 17 well illustrates the **ex-**

FIG. 14.—DEEP SINGLE-HANDED PÉTRISSAGE OF ABDOMEN.

treme deep kneading of the skilled operator, performed without the smallest discomfort to the patient.

These movements may be as well done with one hand as with two, if the hand be a large one and the abdomen not very flabby or fat (Fig. 14). When the subject is thin and is able to relax thoroughly, a small portion of the anterior wall of the stomach may be reached by deep pressure in the manner shown in Fig. 17. When any degree of gastric dilation or displacement is present, still more of the wall will be accessible. (See under "Massage of the Stomach," page 69.)

The process should be ended by the operator making light but firm pressure upon the abdominal walls with the whole hand closely applied and imparting rapid **vibratory movement** to them and to the abdominal contents (Fig. 18). **Tapotement,** usually with the **cupped hand,** over the liver and gall-bladder or over the umbilicus is sometimes added. The last procedure is supposed, without much evidence, to affect the ganglia favorably.

It is of the highest importance that the patient should be warmly covered and remain quietly in bed for at least an hour after the completion of general massage.

FIG. 15.—"CART-WHEEL" MOVEMENT ON ABDOMEN.

Modifications of General Massage.—The only modifications likely to be necessary are in the force and duration of treatment; and, in occasional cases, in the order of application. Patients with tender spots or local pains may need to have directions given for less or more work to be done, or time to be spent, on the particular regions involved; or if constipation be severe, more time may be used on the abdomen.

The convenience of the **order of procedure** here described lies chiefly in the fact that the subject is required to move only once (except to turn on the right side), and that the most soothing part of the application, namely, the abdominal manipulation, comes last, thus leaving the patient clothed, quiet, and lying upon the back. But if it is found that the patient is not properly quieted and soothed at the end of the massage—is made restless or chilly, for example—the order may be changed, so as to rub the back last; or the whole process may be reversed. For example, instead of legs, arms, back, abdomen, let it be abdomen, back,

FIG. 16.—FIST-KNEADING OF THE ABDOMEN.

arms, legs; or arms, legs, abdomen, back. There is nothing so vitally important about the recommended arrangement that it may not be endlessly changed if circumstances require. If cold feet are complained of, let the operator try returning to them after the completion of the remainder of the manipulations, to treat them with sharp rapid friction and effleurage, leaving them carefully rolled in a blanket when finished.

A hot-water bottle warms but sweats, and does more harm than good.

GENERAL EFFECTS OF MASSAGE

If careful palpation be made of the **muscles** of a feeble and flabby patient, they will be found directly after massage to have distinctly **increased in firmness.** At first lasting but a few minutes, with every repetition of treatment this improvement endures longer, and finally becomes permanent.

The **secretion of the skin** is stimulated, the surface vessels begin

FIG. 17.—DEEP MASSAGE OF ABDOMEN AND ANTERIOR STOMACH-WALL.

to show, where before they were invisible, the **color** of the whole surface improves; and in a week a harsh, rigid, dry skin begins to be elastic, softer, and smoother.

Besides these obvious effects, the patient will perceive, after a few days, agreeable changes in his general feelings. The most decided will probably be the disappearance of the sensation of **constant fatigue,** so regularly a symptom in the **neurasthenic** and **hysterical** subject. Like the other changes, this will be temporary at first, the discomfort returning two or three hours after treatment; but the periods of ease will steadily lengthen until the tiredness wholly leaves. As the result of the improved blood-supply, the numerous **tender spots** about the body by degrees cease to be felt, **appetite** increases, both gastric and intestinal **digestion** improve, there is a general sense of **comfort** and well-being, and **sleep** grows sounder and more prolonged.

Physiologic Effects

Consideration of the physiologic effects of massage must be limited

Fig. 18.—Vibration of the Abdomen.

to the barest statement of the ascertained results of clinical and experimental observation. It is to be remembered that very opposite effects may be produced by different methods of application. For example, the pulse may be slowed or hastened, the blood-pressure increased or reduced, vessels caused to dilate or to contract. These different results are not contradictory; they are due, first, to the **movement used**; second, to the **way** in which that movement is used; and third, to **the area of the body** acted upon. Something has already been said, for example, of the varying effects of rapid and slow effleurage, the former being exciting, the latter soothing. **Pétrissage** is the most important of the individual movements, and has the most far-reaching consequences. But the effect of **mixed massage**—that is, the application of the several movements in succession—is still wider.

In attempting to state the effects of massage, the special effects of each manipulation will not be repeated, as that has been done in defining them, the intention being rather to describe briefly the **results of mixed massage,** local and general.

FIG. 19.—VIBRATION ABOUT THE HEAD OF THE RECTUM.

A temporary **increase of temperature** of from two-fifths of a degree to one degree Fahrenheit (0.2° to 0.6° C.) or a little more is ordinarily produced.

When the temperature of a part is much below normal, as in the paralyzed limbs in infantile palsy, the rise is often very great—six to ten degrees (3° to 6° C.)—a change probably due in part to the long contact of the operator's hand. More of the increase is no doubt owing to another very constant effect of massage, namely, the **stimulation of the circulation,** a marked addition to the quantity of blood flowing through the masséd part having been demonstrated.

At the same time the **pulse is slowed** and its force is increased. So constant is this effect that a record of the pulse before and after treatment is a sufficient index to the character of the manipulation. If massage has been of the **deep, slow** sort, the pulse will be **slowed and strengthened**; on the other hand, **superficial rubbing,** especially effleurage and tapotement, makes the pulse **weaker and more rapid.** It is because of this difference in effect of different methods of massage that many patients say they "can't stand massage." Some 'profes-

FIG. 20.—VIBRATION ON LUMBAR REGION.

sional rubbers' do a great deal of flourishing, rapid, light slapping, and effleurage—manipulations that are especially irritating to nervous or excitable people, much less difficult and laborious of execution than pétrissage, and in the majority of cases of little physiologic effect.*

* Deep slow kneading is the most effective and necessary form, and the number of patients in whom for any reason this cannot be applied does not exceed a fraction of one per cent. A practical counsel to the physician is, if a patient finds massage disagreeable, or you yourself think the effect is not what it should be, order the method altered or change sequence of movements; if it still does not meet proper expectations, change the operator.

The increased flow of blood sometimes produces unpleasant effects at first, **headaches,** or **fulness, flushing** of the face or other **signs of slight plethora.**

The deep as well as the superficial circulation is changed by massage, and in an amazingly short time an enormous **addition to the actual number of red blood-cells** in the vessels is brought about, sometimes amounting to forty or fifty per centum. This takes place in healthy people as well as in those suffering from anemia of all forms and grades. The addition is greatest about an hour after treatment, slowly decreasing from that time. The increase, however, is postponed further if the manipulations be daily repeated.

The **hemoglobin value** of the blood-corpuscles is somewhat increased; but the increase is less constant and proportionately less great than the numerical increase of the cellular elements. This corpuscular addition is due not merely to the added motion of the blood-current, bringing blood-cells into circulation, but also, secondarily, to the **stimulation of metabolic processes,** by the new movement and greater activity of the cells.

The **lymphatic stream** is likewise hastened, thus helping the nutrition in all the tissues and promoting absorption and secretion.

Another effect of the change in circulation is shown in a **larger secretion of urine** containing an added proportion of solids. This diuretic effect is most marked when abdominal massage is used—a means which, in addition, affects the secretions and muscular activities of the **digestive tract,** thus again directly aiding nutrition. The increased blood-supply to the **skeletal muscles,** like the direct stimulation of them by the hand-grasp, helps their nutrition. The **nerves** are excited in all their functions, motor, sensory, and secretory, as is shown by the improved **vasomotor control.**

Effects upon Pathologic Processes

The influence of massage upon pathologic processes is no less decided than upon physiologic ones. The **resorption of exudates** in serous cavities, in tendon and nerve sheaths, or in joint capsules, of extravasations into the cellular tissues, and of local edema* is thus brought about. Old exudates in the abdomen, whether general, as from peritonitis, or local-

* Edema from kidney, heart, or liver disease may, of course, be similarly removed, but will return as quickly as before; besides, the introduction in a short time of so much fluid into the vessels of the body might very well result in a still more dangerous dropsy in internal organs, the lungs or pleural sacs, for example.

ized, as from periovarian and perimetritic, even perityphlitic inflammations, may be largely removed by long-continued massage.

The mechanical stimulation of the accessible nerves by tapotement and effleurage is useful to aid in the **restoration of their functional powers** to sensory, motor, and vasomotor **nerves,** and even to those dubious scapegoats, the trophic nerves. Further discussion of the pathologic conditions in which massage is suitable will be found in the chapters on Special Therapeutics.

INDICATIONS AND COUNTERINDICATIONS

Indications for General Massage

The foregoing statement of the effects of massage, though very brief, suffices to suggest its wide possibilities of usefulness. It will strengthen muscles too weak to be used voluntarily, and keep in condition muscles over which voluntary control is deficient or absent. It may be made use of to stimulate the skin, to promote digestion, and to increase intestinal action. No better means can be found for improving a feeble circulation and relieving a laboring or overburdened heart. In such conditions its effect has the advantage over drugs of being used upon the blood in the vessels, and not applied to the already struggling heart like a whip to a tired horse. Its influence, too, upon the blood-making functions is an important one, and this makes it valuable in the treatment of anemia. A remoter result of its action upon the blood-vessels is an increased diuresis, and thus it may be employed especially to promote urinary secretion when there is a deficiency. Sluggish metabolic processes, as in the gouty, and sometimes in the diabetic and the obese, may be stimulated by it, and during periods of enforced muscular inactivity, as in the rest-cure, or in convalescence from acute diseases or in cases of general or local paralysis, this becomes especially useful. In short, the nutrition of all the tissues of the body is affected by massage. Pathologic deposits when in situations accessible to the manipulations are removable by massage, and even those that cannot be directly reached may be affected indirectly through the circulatory alterations brought about.

Counterindications to General Massage

A few words may be said about the conditions which prevent or limit the application of the treatment.

First, as a rise of temperature is one of the results, the presence of **fever** in a case should forbid massage. It has, indeed, been used to reduce temperature, an end which may be attained by reversing the usual centripetal direction of the hand-grasps and thus slowing instead of hastening the blood-current; but the benefit of the procedure is more than doubtful, the possible evil results serious, and the operation disagreeable to the patient and very trying to the masseur. In certain feverish cases in which the treatment is indicated for general nutritive failure,—for example, in **phthisis,**—a moderate application may be cautiously made during the afebrile interval.

The other counterindications are few in number and naturally follow from what is known of the physiologic effects, or from obvious necessities of the method. Any **breaks in the skin,** as from burns, imperfectly closed wounds, or cutaneous inflammations, make massage impossible upon the affected area; though it may sometimes be used in the neighborhood to get derivative effects. In **pus formations,** in **malignant growths,** and in **cystic tumors,** a measure which may disperse infective products through the tissues is evidently unsuitable.

It is usual to stop the application during **menstruation,** though unless the flow is excessive, it will suffice to omit massage of the abdominal and lumbar regions for a time, treatment of the limbs and upper back being kept up. Although pregnancy is considered by some authorities to forbid massage, in women who have not shown any tendency to miscarriage massage, if otherwise indicated, may be continued during pregnancy, at any rate up to the fourth or fifth month, if the masseuse be careful and intelligent; but later than this, the abdominal region should be omitted in treatment, and the patient should not be put in the prone position for back rubbing. Muscle kneading and general rubbing may continue up to the date of parturition. The occasional need and usefulness of massage directly after childbirth, like the special forms of manipulation for various uterine conditions, are matters to be treated separately. If no complication should have occurred during parturition, massage may be very carefully applied to the abdomen within a week or ten days, but it is usually best to wait longer before thorough application, and to use only gentle superficial rubbing at first.

Indications for Local Massage

Where the pathologic tissue changes are limited in extent, massage may be used in the affected areas only; or if general manipulation is indicated and used, the parts that need special treatment may receive extra attention. Local changes in the circulation, such as occur in some forms of headache; circumscribed inflammations, such as occur with dislocations and sprains; injuries which impair the nutrition of a part, as in a paralysis of a single member; fractures of bones; cicatricial formations; arthritic adhesions; gouty or rheumatic deposits; may all be suitably treated by local massage.

Counterindications to Local Massage

Acute **inflammatory conditions,** local or general, periosteal, peritoneal, and so on, are with a few exceptions unsuited for treatment by massage.

Patients with **gastric** and **duodenal** ulcers should not be rubbed, owing to the possibility of dangerous bleeding; or, at any rate, the epigastric and hypogastric regions should be omitted from the treatment.

The increased blood-pressure resulting from general or from abdominal massage of itself serves as a counterindication, not only in **atheroma, aneurysm,** and **severe varicose veins,** but wherever and whenever there is any marked tendency to hemorrhage or any sign of serious weakness of the blood-vessel walls.

MECHANICAL MASSAGE

The muscle-beaters of Klemm, Sahli's iron balls for rolling on the abdomen, and such other more or less inadequate substitutes for massage or adjuncts to it, only need to be mentioned. Like these, the several forms of roller apparatus due to the ingenuity of the proprietors and exploiters of the '*laboratoires de beauté*' of the French, are intended for self-massage; and, moreover, promise, if one believes the advertisements, to eradicate wrinkles, improve the complexion, remove undesirable fatty deposits, better the figure, and repair the ravages of time. To other European inventors are owing a number of instruments for the combined application of massage and heat, of massage with electricity, and of heat, massage, and electricity at once. The value of such devices to any one except their inventors, is very doubtful. At all events I have never been able to find an occasion suitable for the use of these instruments; most of which, indeed, deserve no more serious consideration than the electric belts and life-saving apparatus of the advertising quack. The **electric percussor** of Granville is, however, a useful instrument, and one which deserves more extended vogue. It applies regulated and extremely rapid vibration locally. The instruments recently perfected by several American and foreign physicians for **pneumatic massage** of the ear-drum and nasal chambers are of established, though limited, usefulness.

The **Zander system** of massage by machinery is described in the section on general exercise, as the machines are intended for both massage and movements, and the latter is their more important and more valuable use.

CHAPTER II

THERAPEUTICS OF GENERAL MASSAGE

Rest Treatment; Hysteria and Neurasthenia: Drug Habituations. Diseases of Spinal Origin: Atrophic Palsies; Locomotor Ataxia; Infantile Paralysis; Spastic Paralysis. Chorea, Insomnia, Mental Disorders, Anemia, Convalescence, Organic and Functional Heart Disease; Constipation; Diarrhea; Obesity; Myxedema; Graves's Disease; Gout, and Diabetes.

The therapeutics of massage can be studied most conveniently under the two heads of **general massage** and **special** or **local** massage; and to each of these, a chapter will be given.

It is in nervous diseases that the value of massage has been longest known in this country, and in these its application is very wide. Functional and organic diseases are alike susceptible of amelioration, if not of cure; but it is important in all cases that the character and details of the manipulations should be definitely prescribed and that their application be supervised by the physician. Otherwise much harm may be done.

Without attempting an exact classification of the disorders in the treatment of which massage is applicable, we may here consider together a number of affections in which the influence of the manipulations upon general nutrition is chiefly sought.

HYSTERIA AND NEURASTHENIA

General massage finds one of its widest fields of usefulness in the treatment of hysteria and neurasthenia. It forms an indispensable part of the '**rest treatment**' of Weir Mitchell for these diseases. (See also volume VIII.) Patients requiring treatment of this kind are always feeble, and nearly always **anemic** or **chlorotic**; hence the influence of massage upon the muscular tissue and upon the circulation, as well as its stimulating effect on the blood-making functions and on the heart, are here especially valuable.

Special changes in method may be needed at first on account of sensory disturbances, such as spinal or inguinal tenderness. If these are present, it is better at first to avoid touching the tender areas at all, so as not to risk an explosion of emotion. In a week the masseuse may begin cautiously to approach the painful spots, and in two or three days more should be able to rub them as thoroughly as the rest of the body.

Length and Frequency of Applications.—In beginning massage with feeble nervous invalids, the **early treatment** should last not more than **half an hour,** and if fatigue is felt afterward, even this may be lessened. But this curtailment need not last more than a very few days, after which a **full hour** should be given, fifteen to twenty minutes of the time being spent on the abdomen.

Massage must be used **at least once daily,** and for not less than an hour to be of service in rest treatment, unless the patient is unusually small and thin, in which case less time will suffice. It is often advantageous, after the patient is on full diet, to make the manipulations **twice a day,** or at least to repeat the abdominal massage.

The **abdominal procedures** are of the utmost importance, as on their proper administration the patient's ability to take and digest large quantities of food, as well as the regularity of action of the bowels, will chiefly depend. Some difficulty is usually experienced in getting women to rub the abdomen with sufficient depth and thoroughness, as they are fearful of injuring patients. Unless there is some inflammatory disease of recent origin in the peritoneal cavity, no alarm need be felt on this subject; due respect being paid, of course, to the rules against massage at menstrual periods and when certain diseases are present.

The **final test** of good massage is its usefulness. If, therefore, after a reasonable time—ten days of full massage is enough—a rest-patient is not decidedly improved in appetite, in gastric and intestinal digestion and in sleep, has not daily stools or is not gaining weight, something is wrong. If no error in diet is found, the method or quantity of massage needs to be examined. Some masseurs think fifty minutes is the same thing as an hour. If a change of method does not soon better matters, a change of masseurs should be tried. Finally, except in cases of atony of the bowel, or of long-standing habitual constipation, no laxative medicine should be needed if abdominal massage is thoroughly performed. The gain in weight ought not to exceed four or five pounds in a week, as a maximum. If flesh is put on with abnormal rapidity, either there is some defect in the feeding, or the massage is insufficient to produce proper tissue waste.

DRUG HABITUATIONS

In drug habits, notably in addiction to **morphin,** massage is an immense help toward overcoming some of the evils wrought by the drug, and in minimizing some of the difficulties of its withdrawal. The pains, the restlessness and insomnia, caused by its stoppage, are all lessened by general manipulation. The obstinate constipation may be at least improved by massage in the manner described for the overcoming of constipation (see page 59). When the morphin has been stopped, the opposite condition of diarrhea from relaxation of the intestines is not infrequent, and the same treatment does good in exactly the same way, namely, by improving the tone and muscular ability of the intestines. In treatment of addictions to drugs which lower the circulation, such as **chloral** and **cocain,** massage helps during the withdrawal of the drug, by strengthening the peripheral circulation. Still more sure is this in **alcoholism,** where the enfeebled heart may be relieved of a great portion of its work. (See also volume VIII.)

DISEASES OF SPINAL ORIGIN

In the **system paralyses** due to nutritive changes or degenerative alteration of the **spinal cord,** the results of massage vary according to the cause of the disorder, its extent and, even more, the stage at which treatment is begun. The **atrophic palsies** may be arrested in favorable cases. **Pseudo-hypertrophic paralysis** sometimes is delayed in its course, and several cases, indeed, have come within my observation in which it seemed to have been permanently arrested by massage; although no restoration of the degenerated muscular fibers can be expected. In paralysis due to **myelitis,** whether acute or chronic, if the inflammatory process has stopped before too much damage has been done, much may be effected in restoring the wasted muscles. In the paralysis of **acute poliomyelitis** massage and electricity offer the only means from which any help can be expected. Treatment should be begun as soon as the disease is recognized and continued for at least a year, even if no improvement is apparent. If any increase in bulk or strength is shown by the muscles, the manipulations should be kept up until no further gain can be perceived or until the patient is able to use the limb actively. When once the muscular fibers have disappeared and have been replaced by fatty or connective tissue, they can, of course, never be renewed; but even very late, after the disease has existed for years, the few remaining muscular fibers may be improved in their strength and nutrition. The **circulation** in these paralyzed limbs is usually very bad, and their extreme coldness is a common cause of complaint; even when there is little hope of improving the muscular tissue, the circulation may be bettered and the blood-vessels improved in tone, so as to do away with this annoyance. The surface temperature is sometimes only 90° to 92° F. before massage and has often been observed to rise six or eight degrees after treatment. The **contractures** resulting from this and other forms of paralysis, when not too great, can be overcome by treating them first by massage, then by remedial gymnastics, and finally by forced movements; when all possible improvement has been secured in these ways, the surgeon must be called upon to cut the contracted tendons, after which the masseur should undertake the case again to bring back power to the atrophied and contracted muscles.

LOCOMOTOR ATAXIA

In the modern therapeutics of locomotor ataxia, the first rule of treatment in advanced cases is 'no exercise afoot.' To prevent the bad effects of this inaction is but one of the uses of massage. Pains are benefited by it: the nervous irritability, sleeplessness, obstinate constipation, formication or other disturbances of sensation—all common symptoms in ataxia—are helped or cured by massage. Complete rest in bed for from four to eight weeks, with no transaction of business, no correspondence and few visitors, is often the best way to begin with an ataxia case. General massage is at once begun, and special methods are used for special symptoms. If **local pains** are troublesome, the part most affected should receive more than its ordinary share of rubbing; deep hard pressure or flat-hand vibration over tender points relieves the pains. Anesthetic or dysesthetic areas are treated by superficial kneading or pinching, rather rapid effleurage, and slapping. If **constipation** is troublesome, the abdominal manipulation is prolonged. A marked effect, sometimes even an immediate desire to go to stool, can be produced by vibration at the head of the rectum. (See Fig. 19.) Digital kneading of the large intestine should be repeated several times daily. The further treatment of such patients after a period of rest in bed, involves careful training in **muscular co-ordination** (see chapter x), and the thorough regulation of the whole course of life. **Hydrotherapy** in the stimulating forms of cold brief douching to the spine and to relaxed muscles is of service after improvement has begun. As ataxic patients should never be allowed to use the legs to the point of fatigue, it is difficult for them to get enough exercise and fresh air for health. Massage in persons able to afford it may be continued for months or years as a substitute.

The digestion of tabetics is not, as a rule, disturbed, except in those subject to gastric or intestinal crises. With the former there is apt to be vomiting and consequent disorder of the stomach; with the latter there is constipation or alternating constipation and diarrhea. Except when one of these symptoms is present the patients can usually be well fed—a vital necessity in a disease with such marked degenerative changes. As, however, many of them can take little or no active exercise, it is important in order to make sure that they can digest their food thoroughly and thus maintain their nutrition at its highest point, that special care should be given to massage of the abdomen. Too much stress cannot be laid upon this matter.

INFANTILE SPASTIC PARALYSIS

The wretched victims of infantile cerebral palsy—**birth palsy**—do not usually show a degree of muscular weakness sufficient of itself to make massage necessary; but a course of careful manipulation is a valuable preliminary to that prolonged training in the use of the muscles which is the only hope of relief to such patients. Most of them are able to move about so little that they lack development; in all, the spastic condition can be partially overcome by manipulation, followed by painstaking training in co-ordination. (See page 215.) In severe cases, every voluntary muscle is affected; patients must be taught to walk, to use the hands, to sit, to rise, to speak, and even to masticate. The muscular control is better directly after massage than in the intervals between the applications. The muscular rigidity is overcome by deep massage preceded or followed by **forced movements in extension.** It is sometimes, but not always, found that to reverse the usual direction of massage and rub from the center toward the extremities relaxes spasm best. In some cases it is necessary to use forced extension, both voluntary and involuntary, for weeks before beginning massage. Each case will require a few days of experimental treatment to discover the most useful plan. Weeks of massage and movements thus combined will be required before much improvement will appear in the patient's power to relax the spasm by his own will. When the first improvement is attained, the very simplest co-ordinate voluntary movements which will call into action the improving groups of muscles should be used to begin with. A small success will prove a great stimulus to the patient's efforts. When he has acquired the power to force his respiratory movements, he is taught to attempt speech only with the chest full of air, and to try to utter monosyllabic sounds clearly. Let him **see** the action desired done by some one, so as to have the aid of example as well as description. These patients are often of perfect intelligence though hampered by difficulties in expressing themselves and by the impossibility of being taught in ordinary schools. Indeed an unusual teacher, devoted, painstaking, ingenious, and untiring, gives the only prospect of help for them. With such a teacher and with time, very good results may be looked for.

CHOREA

Massage was systematically applied in the treatment of chorea so long ago as 1854; but although some practitioners have constantly and successfully used it in this disease, it has never been prescribed by the mass of medical men, who prefer arsenic and eight weeks' waiting. In mild cases, arsenic, tonics, and fresh air will suffice to cure; in the severer cases rest in bed and massage will act more quickly and satisfactorily. The manipulation must be of the soothing kind. with no rapid, sudden, or exciting movements. As the co-ordination improves and the involuntary twitchings lessen, cautiously increased gymnastics should be added.

INSOMNIA

Insomnia, as was said in speaking of rest treatment, is often successfully overcome by general massage. When sleeplessness is a prominent symptom, massage may be repeated for thirty to forty minutes at bedtime in addition to its regular daily use, or be given at bedtime only. Every other means must be taken to aid and invite sleep, and the room and the patient must be made ready for the night before treatment is begun, so that the drowsiness that should accompany the final stages of massage may pass insensibly into sleep without being broken by the closing or opening of windows, making up of fires, or other matters of sick-room routine. Should general massage not prove somnifacient, certain **special procedures** may be tried in addition to or apart from the general treatment. Ignorant though we are of the physiology of sleep, it is quite certain that one physiologic condition precedent to sleep is a mild degree of cerebral anemia. Treatment should be directed to lessening the blood in the head, which is accomplished by gentle downward stroking on the sides of the neck for from three to six minutes, and by friction and flat-hand stroking from the occiput downward. The best plan is for the operator to stand behind the seated subject, place the ulnar edges of the horizontally held hands upon the neck just below the mastoid processes, and press downward with firm gentle pressure over the jugular vein. As the hands move they are turned gradually over, so that first the ulnar edges, then the palms, come in contact, and the stroke is carried out almost to the point of the shoulder. The pressure must be made far enough back on the neck to avoid pressure upon the larynx or the hyoid bone. This plan will be found valuable when the cause of wakefulness lies in the too great activity of the brain, and may readily be performed by an amateur. It is sometimes a disadvantage to have the subject seated, as it may tend to keep him wakeful. The treatment can then be performed, though somewhat less efficiently, while he lies upon his back.

In what is called '**spinal irritation**'—an indefinite name with which one labels a pretty well understood series of symptoms—insomnia is frequent and troublesome. Massage of the neck, with addition of firm and somewhat rapid effleurage upon the back, especially the upper spine, is helpful. In persons who find difficulty in getting to sleep on account of **physical restlessness,** slow effleurage upon the legs and arms has a soothing effect. Sometimes in these cases even so limited a treatment as to knead the deltoid regions deeply and slowly produces a quite peculiarly restful and sedative result.

MENTAL DISORDERS

In certain forms of insanity there may be need of general massage to combat malnutrition, especially in those cases in which the patient is averse to activity, or, if taken out-of-doors perforce, only dawdles about. In moderate grades of stuporous **melancholia,** a disease which in its curable forms is of comparatively brief duration, lasting six to eighteen months, massage will help to keep the sufferer in fair condition, to prevent the constipation due to the neglect of the natural desires and functions from becoming habitual, and to promote sleep. In these cases it is well to add to the prescription of general massage some of the more stimulating movements, such as percussion and slapping of the back and abdomen. All the massage should be used as vigorously as possible. But, except from its general influence upon the digestion and circulation massage is of no very great importance in melancholia, better effects being had from stimulating hydrotherapeutic applications, and, if the patient can be roused or pushed into doing them, from active and resisted Swedish movements.

ANEMIA

The influence of massage upon the heart and respiration, upon the movement of the blood-current, and upon the blood-making function, indicates it as a valuable contributory means in the treatment of anemia, whatever the cause or degree. It is sometimes said that "the patient is too weak for such strong measures"; which is as reasonable as to say that he is too weak to be fed and must starve till he grows stronger. Even **pernicious anemia,** a disease, so far as we know, almost certain to be ultimately fatal, shows temporary improvement under massage. When the patient is extremely weak, it is well to consider this fact in operating, to move him as little as possible, to watch the pulse the first days, to increase the amount of massage slowly, and to make a blood examination after a few days' treatment. The massage, like that for rest treatment, should be **general,** with especial time and care given to the abdomen.

The following brief table states the facts in three cases of different forms of anemia treated by massage alone; that is, without iron or other drugs, or any special diet. Case I was a severe anemia of ordinary type. Case II, though the count was higher, had some symptoms of pernicious anemia. Case III was toxic in its origin, being due to chronic lead-poisoning.

	Before Massage		After Massage	
	Red Blood-cells	Percentage of Hemoglobin	Red Blood-cells	Percentage of Hemoglobin
Case I, ...	1,500,000	18	1,650,000	30
Do., after one week's daily treatment, . .	3,800,000	35	5,400,000	35
Case II, ...	2,600,000	56	4,666,666	56
Do., three days later, .	2,600,000	56	3,200,000	56
Case III, ...	4,000,000	30	4,500,000	30
Do., three days later, .	4,000,000	30	6,500,000	30

CONVALESCENCE FROM ACUTE DISEASE

In convalescence from acute disease the daily use of massage exerts an immense tonic influence. Especially following **typhoid** or other long-continued fevers is the good effect seen, in the increased appetite, the stimulation of peristaltic action, and the general sense of well-being experienced by the invalid. In **rest-patients** and in those recovering from long illness, after massage has brought about certain alterations in muscular and nutritive states, Swedish movements are added as a preparation for the active use of the body. At first these are simply slow extreme extensions and flexions of the limbs made by the attendant, then made partly by the patient,—assisted movements,—and, finally, active movements gently resisted by the masseur. According to the needs of the case, these movements are continued or multiplied after the patient is able to get up. For detailed descriptions of the movements used, see page 88.

DISEASE OF THE HEART

In many forms of **organic heart disease** general massage acts as an adjunct to other treatment by relieving the weak or straining heart. The immediate effect is due to the improvement in the peripheral circulation from the hand-grasp's mechanical emptying of the veins. After treatment has lasted long enough, there is an improved vasomotor nerve control and probably a direct strengthening of the muscular coats of the arteries. For the best effect, treatment ought to be repeated twice or oftener in the day, observing the pulse before and after. Some of the symptoms are greatly bettered at once; palpitation disappears, breathlessness is less marked from slight exertion, the edema and cyanosis are removed. In severe cases, massage should at first be applied to the muscles only, and not until after several applications should the abdomen be operated upon, and then with care. If the patient does not feel relieved of his oppression and like symptoms after massage, further treatment should **begin with abdominal massage,** the back and limbs being manipulated afterward. *A decided increase of the breath-rate is a hint that the patient is being too severely exercised.* In bad cases it is often undesirable to place the subject in the prone position for back treatment. It can be given, though less efficiently, while he lies upon his side; or it may at first be omitted altogether. Massage is only introductory to more radical and more valuable treatment by gymnastics, breathing exercises, baths, and similar measures. (See chapter VIII.) When much edema is present, massage, although it will lessen the dropsical condition, is not indicated, since, as has already been said, the fluid may merely be transferred by it from comparatively harmless external situations to much more dangerous internal ones, or the effort to carry it off may overburden kidneys whose ability to deal with it is already lessened by congestion.

'Heart massage,' so called, as suggested by Oertel, is a measure of more than doubtful value. Briefly stated, it is performed by pressure upon the walls of the chest during forced expiration, the hands moving downward from the axilla to the rib margin with increasing force. The influence upon the heart is very indirect and very small; whatever good does result, being due to the forced breathing rather than to the massage. **Pressure upon the pneumogastric nerve** by various forms of percussion has been used to stimulate the reflex action of that nerve and thus slow the heart. The possibility of reaching this nerve without exercising undue violence is at least doubtful. Granted that the pneumogastric nerve or the cardiac plexus can be stimulated by percussion, the amount of stimulation cannot readily be determined, and a little too much might be fatal. If this treatment be considered desirable, it should not be intrusted to a masseur, but carried out with (I should think, anxious) care by the physician himself. It is performed either by tapping or cup-hand slapping the thorax or by vibration movements with the flat hand on the chest-wall. Equally good results are had from less dangerous processes. Certain of the Zander machines are used to slow the pulse by percussion effects upon the spine.

Functional Disorders of the Heart and Circulation

In functional disorders of the circulation, as manifested by **impaired vasomotor control, local chills** or **flushings, palpitation,** or **irregular action of the heart,** general massage is one of the most rapidly successful means of treatment, especially if combined with suitable hydrotherapy. Treatment by Schott's methods may follow or be combined with massage. The same remarks apply to the conditions described by S. Solis Cohen under the name of **vasomotor ataxia.** Palpitation, irregularity, and the like, due to gastric or intestinal causes, require treatment by the removal of these causes. The **flushings** so troublesome at the **menopause** are much lessened by massage used regularly and deeply, owing to the better balance of the circulation and stimulation of the surface vessels and nerves. In the same way, massage gives useful aid in **tachycardia,** especially in the persistent form of this disease which is sometimes seen following influenzal attacks. Baths and resistance movements according to Schott's method should follow in due course or be applied at the same time as massage, according to the degree of enfeeblement. (See chapter VIII.)

In certain **other disorders of the circulatory system** massage is useful enough to be mentioned as an adjunct to treatment. For instance, **varicose veins** of moderate severity, especially when deep-seated, are improved by deep but gentle massage of the limb, but the manipulation needs to be applied during several months to make good results certain.

Massage has been applied to the treatment of **phlebitis,** but the procedure is of questionable value, except in the mildest cases, owing to the danger of distributing fragments of blood-clot. After the acute stage of the inflammation is past and the deposit has become organized—a process taking from three to four months—massage is permissible and useful.

CONSTIPATION

Of constipation as an incidental symptom in several diseases, enough has been said in previous paragraphs. Abdominal massage as part of the general manipulation will usually suffice to overcome it. Where the constipation is itself the chief symptom, and has become habitual, certain special forms of manipulation, without regard to the origin or cause of the condition, are to be used. Daily treatment is necessary, each séance lasting fifteen to twenty minutes, the manipulator spending all the time on the abdomen alone, except a minute or two for vibration in the lumbosacral region. Constipation consequent upon peritonitis, local or general, is especially susceptible of improvement by long-continued massage, which brings about absorption of the adhesions that bind down the intestines and interfere with peristalsis. Especially after appendicitis, whether recovery has been spontaneous or by surgical operation, constipation, due in this case to a weakness of the cecum and adjacent portion of the transverse colon, is a very constant and troublesome symptom. Among other contributing causes of chronic constipation are: weakness of the abdominal walls; inefficient peristaltic action; deficiency of intestinal, pancreatic, or biliary secretions; irregular habits of defecation; and accumulation of feces in the intestine, causing dilatation and consequent enfeeblement of the intestinal muscular walls. Inability of the rectum to contract with power enough to expel feces is another occasional cause of fecal retention.

In the treatment of these several states the masseur must discriminate. When the abdominal walls are very relaxed and weak, as, for example, after frequent pregnancies at short intervals, their muscles will need manipulation, and active exercises to strengthen them should also be prescribed. (For these latter, see chapter IV.) To general abdominal massage, as described in chapter I, the operator should add, in persons of constipated habit, one or more of the several manipulations of the abdomen there detailed—fist-kneading, cart-wheel movement (knuckle-kneading), and deep digital-kneading along the colon in the direction of movement of the intestinal contents. (See Figs. 12 to 17.) The hand-grasp of the abdominal walls should be as deep as possible and pick up as much of the walls as can be retained, while the thumbs are used to perform friction along the large intestine. General pétrissage of the abdomen with one or both hands, sharp tapotement (slapping or clapping), and, finally, vibration of the whole abdomen complete the sitting.

The effect of these several manipulations is to stimulate the muscles of the abdominal wall, and, in time, to strengthen them. The peristaltic movements of the intestine are stimulated and increased both directly and reflexly, and so are the secretions of the intestinal glands. The circulation, venous and lymphatic, is hastened, thus adding to the amount of intestinal liquid, and, lastly, the accumulations of feces are broken up and their passage along the intestine mechanically hurried.

When the conditions point to a lack of biliary secretion, special manipulations, chiefly vibration and tapotement, in the neighborhood of the liver and gall-duct, should be performed.

For atony of the rectum or impaired action of the ileocecal valve vibration movements must be applied; for the former condition the fingers held pyramidally together are pressed deeply down in the left iliac fossa, so as to approach as near the head of the rectum as is possible, and strong rapid vibratory movements are then imparted to the hand by contracting the forearm muscles. (See Fig. 19.) To stimulate the relaxation of the ileocecal valve and allow the propulsion of intestinal contents from the small into the large intestine, a similar movement should be administered at the point of junction of these two portions of the intestine. Vibration applied directly to the anal orifice is said to have a stimulating effect on rectal contraction. Vibration given at the ileocecal junction and also about the head of the rectum, if well done, will frequently produce an evacuation of the bowel within a few minutes.

The chief difficulties encountered in applying abdominal massage are fat abdominal walls and irritable or strongly contracting abdominal muscles. The former obstacle to massage can be overcome by deeper and stronger manipulation, using large hand-grasps, and for tapotement by stretching the skin and muscles tightly with one hand while the other performs the vibration. The latter obstacle can be influenced by persistence. After a very few days of repetition of massage it will be found that the tendency to involuntary contraction will lessen as the patient grows accustomed to the operation. When it is not thus lessened, changes of position may be tried. Instead of the usual supine position, with the shoulders a little raised and the knees bent, let the subject lie upon the right side, with the knees bent and the thighs drawn up to right angles with the trunk. Not only do the abdominal muscles lose their point of application of force to a certain extent in this posture, but the small intestines lapse toward the right and leave the rest of the abdominal organs more accessible to the touch.

When persistent irritability of the abdominal rectus muscles continues in spite of these devices, it is worth while to try to rub the belly with the patient seated and leaning forward. A narrow chair with a high back should be chosen. The subject is seated astraddle of the chair, the arms are crossed on the top of the chair-back, and the head leaned forward upon them. The position makes contraction of the recti difficult, and although, owing to the narrowing of the accessible abdominal area brought about by the lowered rib margins, massage of the abdomen cannot be so thoroughly done, vibration and general up-and-down shaking of the abdominal contents may be readily accomplished by an operator kneeling behind the patient.

Two to three months of massage will cure a great majority of cases of habitual constipation. Even a shorter course may serve, if suitable exercises be combined with massage and the patient will consent to reasonable modifications in diet and will forego drugs.

In all instances where massage is to be used for the resorption of adhesions it must be remembered that the best effects will be had from the application of the treatment after the inflammatory process has entirely subsided, but before the new tissue has taken on a completely fibrous or cicatricial character. If manipulation be not applied until a later period than this, a much longer duration of treatment will be needed to gain the same results.

The Zander machines for kneading the abdomen have exactly the same defect as curative measures for constipation that laxative medicines have. They are momentarily efficacious; that is, they produce an evacuation from the bowels soon after their use, but they have no real curative influence and produce no good effect upon weakened bowel muscles.

Chronic diarrhea is sometimes successfully healed by massage, the results depending largely on the cause of the diarrhea. When frequent or liquid stools are a local manifestation of a general nervous irritability, treatment of the general condition will do more good than topical treatment. When the cause is found in relaxed bowel muscles, intestinal adhesions causing paresis, excessive liquid secretions, and altered peristalsis, the improved muscular and secretory conditions brought about by massage will soon show in a lessened number of passages. A curious and little-described but probably not very uncommon cause of diarrhea, is seen in cases of diarrhea from irritation by retained masses of hardened feces; in short, the diarrhea is caused by constipation. In these instances the stools are generally not liquid, but consist of small stony hard lumps. The condition is not unlike incontinence of urine from retention. It is usually necessary to empty the bowel mechanically, using frequently repeated enemata of glycerin and oil or of lime-water, and after the dried masses have been thus removed to continue careful daily massage for several months. In these as in other cases of atony of the bowel, the use of electricity, both in the rectum and on the abdominal surface, is a helpful adjunct. (See volume II.)

OBESITY

This is a form of disease peculiarly suited for treatment by massage in conjunction with measures of diet, hydrotherapy, and regulated activity. Massage is especially useful when the unwieldiness is so great as to impede or make impossible active exercise, or in the infrequent but very difficult cases in which, together with excessive fat, there is **anemia.** A very small allowance of close-skimmed milk, massage twice a day, and, as soon as possible, active gymnastic movements, sum up the treatment by which such patients may be most readily and rapidly reduced in flesh. The small quantity of milk upon which patients will maintain their weight unchanged is sometimes remarkable. A girl in my charge during 1899 kept her weight for two weeks on a pint and a half of skimmed milk daily, without other food and with daily massage; it was not until a sweat-bath upon alternate days was ordered that she began to be sensibly reduced. A loss of about half a pound a day is sufficiently rapid reduction if the loss be continuous. The treatment must be cautiously carried out, with constant observation of the pulse, and occasional relaxation of the strictness of the diet upon any sign of weakness. A combination of **hydrotherapy** with **massage and active moderate exercise** is perhaps the ideal general method. A cold sponge, followed by a steam bath, this in turn succeeded by a cold plunge or shower, is **Winternitz's plan.** After the cold plunge the patient is sent for a brisk daily walk of definite duration. Later in the day massage is thoroughly applied. The whole procedure may be repeated twice or oftener in the day. The alternate use of hot and cold water is intended to reduce the temperature of the body before the muscles are used in order to counteract the weakening and anemia which are often incidental to the attempt to reduce weight by exercise alone, these disagreeable effects being attributed to an increase in the temperature of the body due to exertion—a somewhat doubtful theory. (See volume IX.)

In **robust patients** more severe means may be used, such as the administration of mild purgatives and thyroid extract. The increased tissue change, and especially the more rapid oxidation and the greater activity of the skin produced by massage, and its stimulating influence upon the circulation make very rapid reduction possible without danger, if reasonable care be taken. Very hard massage is required and superficial kneading of the whole surface should be used, as well as slapping. When excessive fat accumulation interferes with the cardiac action, other measures, as discussed in the chapter on Schott's and Oertel's methods, are needed.

The treatment is an exhausting and laborious one for the masseur, as an hour and a quarter or an hour and a half will often be needed to do justice to a very stout patient. The special gymnastics for obesity and the methods of dealing with local accumulation of fat are considered in detail elsewhere. Full consideration of the use of drugs does not enter into the plan of this work, but a word of warning may be uttered as to the **careless use of thyroid extract,** a drug with large possibilities for evil. Massage to a certain extent overcomes the bad effect of thyroid upon the heart, and a small continued dose of arsenic in the form of Fowler's solution has a remarkable and apparently a special influence upon the heart in these cases, in great part counterbalancing the depression produced by the thyroid. No treatment and no drug will guarantee against a relapse in patients who overeat or who lead idle lives. A continuance of active exercise, a diet moderate in amount and carefully regulated in character, make the only hope of these persons—and even these will not be sure methods in people with hereditary tendencies to undue fat formation and deficient oxidation.

GOUT AND DIABETES

Those who only suffer from occasional acute attacks of **gout** are able to take active exercise and should have it prescribed, but when gout in its more chronic forms affects the old or the feeble, general massage may be necessary to replace the exercise for which the patients are not fit. Massage is useful too in removing gouty deposits in the joints and fasciæ, especially when used at the same time with superheated air and various hydriatric measures.

Several other disorders of metabolism may be mentioned as amenable to more or less improvement by suitable massage. **Diabetes,** for example, may have some of its symptoms, such as the characteristic **dry skin,** distinctly ameliorated by massage. Diabetes in the gouty or the obese is improved by the general treatment—including massage or exercise—for the underlying condition.

MYXEDEMA, GRAVES'S DISEASE, AND OTHER TROPHIC AFFECTIONS

In the obscure trophic affections and in allied states massage is often extremely valuable. The thickened skin and subcutaneous tissues of **myxedema** are greatly softened and rapidly become more elastic under the handling, and when thyroid medication is used at the same time the rapidity of change is quite astonishing, indeed much more rapid than with the drug alone. Special attention needs to be given to superficial kneading, hand separating, and pinching to stretch the skin. The favorable effect of manipulation is due to the more rapid absorption or removal of the mucoid deposits and also to the increase in the red corpuscles. In **Graves's disease** massage is useful chiefly for its effect on the circulation, and its value may be measured by counting the pulse before massage is begun and half an hour after it is completed. The rate should be slower by this time than immediately after treatment. In **akromegaly,** the improvement of general nutrition and relief from pain brought about by suitable massage in certain cases, exerts no evident influence upon the pathologic process as a whole. In **rickets** careful massage with especial attention to the rubbing of the chest and abdomen is a most valuable procedure. An oil should be used to aid in the manipulation, and, when the other indications point to it, cod-liver oil may thus be applied. The unpleasant smell is against it, but with thorough and long-continued gentle rubbing a great deal of it can be introduced into the body and most of its good effects with very little of its bad ones, be gained in this way.

CHAPTER III

THERAPEUTICS OF LOCAL MASSAGE

Fractures, Dislocations, and Sprains. Fracture of the Skull. Apoplexy. Torticollis. Paralyses, Traumatic, Facial, Toxic. Neuritis, Neuralgia, Sciatica. Migraine and Other Forms of Headache. Paralysis Agitans. Uterine and Mammary Massage. Cosmetic Massage: Facial Blemishes; Cicatrices; Falling of the Hair. Osteopathy.

FRACTURES, DISLOCATIONS, AND SPRAINS

Massage in **fractures** was advocated by Lucas-Championnière and other progressive surgeons in 1886, but this useful form of treatment has taken but small hold in this country, partly on account of its cost, partly from ignorance of its value and of the method of application. The reasons in favor of massage and movement in fractures may be briefly stated.

Massage lessens the effusion in the soft parts; until the effusion is removed union cannot take place, and if the absorption of the effusion is much delayed, it becomes organized tissue which may interfere most seriously with the play of neighboring joints, tendons, and muscles, and possibly exert injurious pressure upon nerves. Massage increases the circulation in the vicinity, thus promoting healing and bone formation. Massage maintains the nutrition of the muscles thrown out of use by the enforced rest of the limb. Massage prevents the adhesion of inactive tendons to their sheaths. Massage, in conjunction with movement of the joints, minimizes the danger of arthritic troubles.

In consequence of these several effects, the period of healing and union is much shortened, and instead of the patient suffering the usual after-stiffness and disability, lasting for weeks, or, in breaks near joints, for months and often for life, he is able to make good use of the part so soon as the callus is strong enough to permit the limb to be used actively. The period of disability is thus so much shortened that the lessened stay of patients in hospital would in free cases more than offset the cost of the treatment. As the manipulation of each fracture would seldom require more than twenty minutes' time, a masseur would be able to rub with ease twenty cases of fracture or dislocation in a day, and if one hospital could not afford to employ him or had not cases enough to keep him busy, his time might be divided between two institutions.

Exactly the same reasons which have been suggested for the use of massage in fractures apply with equal force to its application in **dislocations,** in **sprains,** and in **contusions** near joints.

The time elapsed after the injury before manipulation is begun, and the situation and character of the fracture or luxation, are the factors to be considered in determining the method of application. Massage should be applied within forty-eight hours of the accident in simple fractures with no tendency to displacement,—for example, a Colles's fracture,—and should be given daily thereafter. So soon as tolerably firm union has taken place, passive movement of the neighboring joints should be made part of the daily routine. If there is no displacement and no tendency to it, this joint movement need not be delayed until some union has taken place, but may be used from the start. In fractures with much mobility, such as those of the femur and humerus, the tendency to displacement is so great that the part must be immobilized for a time, either until the tendency to displacement is overcome or until some union has occurred. In doubtful cases it is a matter for the surgeon to settle on each occasion whether massage shall be given early or late, but in the absence of some counterindication the decision can be based on his judgment about the excessive mobility or displacement. The **counterindications** to massage and to movement of fractures and dislocations are some of them temporary and some of them general. Displacement of tendons, for example, would act as a temporary prohibition of movement. Hemophilia, aneurysm, and malignant disease of the bone or of tissues near the injury, would altogether forbid the use of massage; the presence of a gouty tendency and of tuberculosis would suggest that the treatment be given with care and watchfulness of its effects. An open wound would, of course, hinder massage, and might by its situation make handling either impossible or undesirable, but mere skin-breaks need not prevent it, if the manipulator and the surface upon which he is to operate are both disinfected.

Methods.—As in the massage of **sprains,** so in that of **fractures,** it is well to begin by the use of hot water, which will soften the skin, relax the tissues, stimulate the local circulation, and diminish the pain. Compresses may be kept on for ten minutes before rubbing, or the part may be immersed in hot water. After a few days, when the pain and swelling have lessened, this preliminary treatment will not be required. Massage should be begun by stroking centripetally above the site of injury; that is, between it and the body. If the tenderness permit it, stroking may be performed lightly, directly over the fracture. Continued steady effleurage thus given, using as much force as can be applied without hurting, will lessen the pain, and the operator may then begin like effleurage below and up to the point of fracture. Ten minutes in all will be long enough for each of the first two or three sittings. If feasible, the application should be made twice daily, and in sprains it may be used oftener with advantage. When the tenderness is somewhat diminished, gentle friction should be the next movement used, and the manipulations should be increased in force and duration until the procedure occupies fifteen to twenty minutes. The force used should never be anything like as great as it would be in rubbing a sound part, at least until quite firm union has been obtained. Movement of the neighboring joints should not be made until tolerably good union has taken place, except in instances of such fractures as, once replaced in proper position, remain fairly stable.

In any fracture rubbed before union has occurred great care must be used not to shake or move the limb. One hand can steady the part by grasping or fixing the bones at the seat of the break, while the other performs the manipulations. In managing limbs too large to be thus controlled, as the thigh, the help of an assistant may sometimes be required. The result of the early treatments will serve as a guide and indicate whether deeper massage and more movement can be used or whether the force applied should be lessened. If the manipulation is well borne and does not cause any displacement or pain, then the part may be more thoroughly and frequently treated. If, on the other hand, union does not progress, then the part must be strictly immobilized for a time. The aim in massage of fractures should be *to move the neighboring parts but to keep the broken bone still.* If the tendency to displacement be very great, eight or ten days at least should be allowed to elapse from the date of injury before manipulation is permitted, in order that some degree of fixation of the fragments by callus may occur. After callus is once sufficiently formed to maintain the broken bone in place, the oftener massage is given and the joints are moved, the better.

A conservative judgment would probably suggest that ten days be allowed for the beginning of union in all cases before massage is ordered. The most striking results of early manipulation and mobilization have been obtained in fractures of the patella, after wiring the fragments, the operation doing away with any need of waiting for callus to form.

In **dislocations** there is not the same necessity for delay as in fractures, so that manipulations, very gently used if there be much contusion or swelling, may be applied from the first day. The methods of treatment are much the same as for fractures. Massage is at first used in the neighborhood of the injury to act derivatively, and so soon as the tenderness will permit, done directly over the joint. Hot water compresses or, if the situation allow of it, the use of superheated hot air, will help to lessen swelling and tenderness. In cases in which the pain is very great, the use of nitrous oxid as an anesthetic while the adhesions are being broken up has been suggested. Brilliant results have been had in the treatment of dislocation of the **semilunar cartilages** by massage, and Douglas Graham considers that massage, besides helping the successful replacement of the cartilages, may be of immense use in remedying that inherent weakness of the joint and the muscles which renders the accident so likely to recur. **Resisted movements** and **exercises,** directed especially to the muscles and fasciæ about the knee-joint and on the front of the thigh, also are indicated when a tendency to dislocation of the meniscus is present.

The treatment of **sprains** is precisely like that of dislocations. The earlier they can be got at after the occurrence of the accident, the better the result will be, in lessening pain and shortening the time of treatment. It is excellent practice to plunge the injured part into hot water and keep up the heat by adding more hot water as the first begins to cool. The hotter the water is, short of actual scalding, and the sooner the joint can be put in it, the more good will be done. Manipulation should be begun while the part is in the water, in which it ought to be kept immersed for half an hour. Light pressure, if the pain will permit it, should be made directly over the seat of injury; if this gives too much distress, effleurage should be performed up to the nearest point which can be rubbed without hurting unbearably, and continued upward from above the bruised and tender part, thus removing the extravasated material from the injured neighborhood and increasing the activity of the blood circulation.

After taking the limb out of the water a slight pressure bandage should be applied, and the part elevated to keep the swelling from increasing. A thin flannel bandage with layers of cotton batting (not absorbent cotton, which is too inelastic) between the turns of the bandage, is a good device, learned from the trotting-stables. Of course, if the swelling increases so that the bandaging gives pain, the edges of the turns of the bandage can be cut a little to relieve it. Manual treatment should be repeated in a couple of hours, without any use of hot water, and should be given, if possible, two or three times a day for the first three to five days. After that it need not be oftener than once a day until the swelling and tenderness have disappeared, and the torn and bruised tissues are restored to useful activity. In ordinary sprains of ankle or elbow this should not be longer than a week, unless the injury be a very severe one or tendons have actually been ruptured. Sprains of the knee will require somewhat longer treatment. The patient may use the part as soon as it can be employed without pain, and should need no immobilizing splint or plaster—a turn or two of flannel bandage giving enough support.

Fracture of the Skull

Derivative massage by stroking from the mastoid processes downward on the neck and shoulders, in the manner elsewhere described for promoting sleep (see page 54), has been used with good effect by Gerst for the relief of the congestion following **fracture of the skull** or **concussion**; and even in cases in which dizziness, flushing, headache, mental confusion and other signs of cerebral hyperemia point to **threatening apoplexy,** it is a valuable way of lessening the immediate danger until other measures have time to act. Deep kneading of the trapezius muscles should be added to the neck rubbing, extending the manipulations from the occipital protuberance to the level of the scapulæ. Deep breathing during the massage, as suggested by Eccles, hastens the speed of the blood-movement and thus increases the effect of the manipulations. So marked is this effect that a 'bruit' may sometimes be heard in the jugulars if listened for during the application of neck massage.

MASSAGE OF THE STOMACH

The indications for massage of the stomach are sufficiently suggested when it is said that the most important effect of massage of this organ is to increase the hydrochloric acid content of the gastric juice. Any condition in which the acid-content is absent or subnormal in quantity may properly be treated by massage, assurance being first had that the diminution of acid is not a symptom of malignant disease. In both dilatation and displacement of the stomach, conditions which would seem to call for manipulative treatment, the acid-content is often excessive. Sometimes even when one of these abnormalities is present, examination of the stomach-contents shows diminished acidity. In such cases massage could be used.

In order to reach the small portion of the anterior stomach-wall that is accessible to touch, deep manipulations must be used and the patient must be thoroughly relaxed, as even a small degree of tension of the abdominal muscles would defeat the efforts of the masseur. If any difficulty is experienced in getting the desired relaxation with the patient in the usual supine posture with the head slightly elevated and the knees drawn up, the patient should lie upon his right side while the masseur stands behind him.

Deep kneading and shaking, with sometimes the addition of vibration or slapping, are the movements to be used in conditions associated with lessened acidity. The application, if used for the stomach alone, need not last more than ten minutes. When digestion is poor, owing to the lack of acid, the treatment may be given about half an hour after taking food, and may be repeated after every meal.

For dilatation and motor incapacity, when it is desired to aid the evacuation of the stomach-contents, the rubber, after the usual preliminary effleurage and after kneading in the ordinary manner, should stroke firmly from the left lower ribs, downward and to the right. This is intended to push the contents of the stomach toward or through the pylorus. The latter end can only be attained in case the valve is relaxed.

It is often desirable to repeat the manipulations of the stomach several times a day in cases of insufficient motor power, selecting a time when gastric digestion of the last previous meal may be supposed to have been completed, in order to evacuate the digested food into the bowel for its further assimilation.

TORTICOLLIS

Ordinary cases of **torticollis,** from cold or rheumatism, are commonly cured by massage in a day or two. Careful palpation along the margins of the neck muscles, especially the borders of the sternocleidomastoid and the trapezius, will occasionally reveal small nodules or limited areas of thickening, seated, probably, in the sheaths of the muscles. These will need to be rubbed and kneaded thoroughly, the method being adapted to the particular situation where the thickening is found.

The more serious disorder of **spasmodic torticollis** is cerebral in its origin and cannot be treated by local means with the same certainty of success. Severe cases of it will often require surgical intervention for relief, but before resorting to this means, most thorough deep massage, and movements both passive and resisted, should have full trial. One difficulty in applying massage is the impossibility of getting the muscles relaxed; another is, that in many patients the muscles, or some of them, are extremely tender. The former obstacle to manipulation may sometimes be overcome by position: certain patients have little or no contraction when lying supine. Others are best treated in a prone position.

Dry cold applied by an ice-bag, dry heat by a hot-water bag, will, sometimes one, sometimes the other, serve to control the spasm temporarily, and may, if tenderness be present, lessen it also. Stretching the affected muscles by steady forcible passive movement is, if not too painful, sometimes successful in overcoming the spasm, and is useful both as a means of treatment in itself and in order to permit more efficacious massage.

Massage may either precede or follow treatment by movements, according to the effects. If movements are more readily and easily performed after massage, then it should be applied first; but, as has just been said, forced movements sometimes relax the rigid muscles better than manipulation. Rarely, massage cannot be used at all, as it adds to the spasm or gives too much pain.

Movements are, on the whole, more successful in overcoming the spasmodic action than massage, but if both can be used, the effect is better than from either alone.

The **massage** should be very slow, deep kneading and gentle but firm stroking, both following the long axes of the muscles. If nodules, such as occur in rheumatic torticollis, are present, they should be treated by finger-tip kneading and pinching followed by stroking. The **movements** to be used have two objects: one the effect of forced stretching in the direction opposed to the contraction, the other the strengthening of the muscles of the unaffected side of the neck, so as to enable them to act more powerfully against the diseased group. To bring this about, the exercises must be slightly modified according to the set of muscles chiefly involved. The ordinary movements of **rotation, forward bending,** and **extension** of the head are the needed procedures. These are opposed by the attendant, who stands in front of or behind the seated patient and places his hands on the sides of the head or clasps them over the frontal region, according to the action to be resisted, whether rotation or forward bending.

In attempting extension of the neck, which perhaps would be better described as simple elongation of the neck, the patient's effort is, while keeping the chin level or a little drawn in, to elevate the head, as if he were trying to make himself taller. **Lateral bending** of the head without rotation may be needed in certain cases. The face must be kept directed forward, while the effort is made to bring the cheek down to the shoulder; and the attendant opposes either the depression or the return of the head, according to the effect sought for.

Persistence with these movements, repeating each one from five to fifteen times twice a day or even oftener, sometimes gives remarkably good results. In one case lately seen the spinal accessory nerve had been divided, after consideration and consultation by a very eminent surgeon and an equally eminent neurologist. Improvement did not follow—but a few months later the patient was cured by resisted movements administered by a peripatetic 'magnetic healer,' and has remained well for several years.

After operation, even when the operation has produced good results, some continuance of the treatment by massage and movements will often be necessary to make the cure complete and gain for the patient perfect control of the muscles which are to take the place of those whose nerve-supply has been destroyed or whose bodies have been cut in the operation. In the very severe cases in which the only possible way of obtaining relief is by destroying the nerve-supply of the wrongly acting muscles, thus wholly paralyzing the neck, massage can have no good effect and movements are obviously impossible. A supporting collar to keep the head from falling must then be applied.

PARALYSES

In various forms of **paralysis** the best results may be looked for from a continued use of massage. When a **local injury** has compressed or destroyed a nerve, it is important to maintain the nutrition of the muscles controlled by it until the nerve can be restored to functional activity by the necessary treatment, surgical or other; and even when a very extensive injury has taken place, astonishing results in the way of recovery may be looked for from persistent massage. In one case both the ulnar and the radial nerves in the forearm had been severed and a crushing wound of the forearm had cut transversely through either the bodies or the tendons of some fourteen muscles. Four months after the injury the patient was sent to the Orthopædic Hospital in Philadelphia for massage-treatment. The surgeon had sutured both the nerves and brought together as many of the tendons and muscles as he could. The hand was almost immovably fixed in a claw shape. Sensation was wanting below the wrist, and extensive scar-tissue reaching down to the wrist and into the palm in front and crossing the back of the wrist and forearm on the opposite side of the limb, bound everything tightly together. Any attempt to move the fingers was excessively painful, but with the intelligent co-operation of the patient and his courageous endurance of the pain, in a few months a totally useless hand was restored to almost perfect functional power, the man being able to return to his work as a weaver.

Even **very old palsies** are susceptible to thoroughgoing treatment. I was recently fortunate enough to see a case of **facial palsy,** from injury to the nerve in the canal more than twenty years before, make very great improvement. The result was, of course, not all due to massage; electric stimulation of the muscles was daily carried out as well, and the relaxed tissues held in a position somewhat better than their usual one, during a part of every day, by strips of adhesive plaster.

Toxic paralyses, alcoholic, saturnine, mercurial and other forms, may all be successfully handled by massage, combined of course with the appropriate measures of hydrotherapy, electricity, and medicinal care. No special methods of manipulation are required. In extensive disease, general massage may be useful as an aid to elimination, but, ordinarily, local treatment of the palsied part will suffice.

NEURITIS AND NEURALGIA

In **neuritis,** as soon as the acute stage is passed so that some pressure may be exerted on the nerve without the production of unbearable pain, massage should be begun. Neuritis in the more accessible situations about the head, arm, and leg is most suitable for treatment. Upward stroking with moderate pressure over the track of the nerve is the form usually applied. It sometimes may be found that stroking in the reverse direction is more serviceable. This is a good deal a matter of individual trial. The amount of pressure should be as great as can reasonably be borne, and the blood should also be carried away from the irritated part by rubbing the adjacent and unaffected areas as thoroughly as possible.

In **sciatica,** in **crural neuritis,** and in **inflammation of the arm nerves,** pressure may be maintained upon the nerve between the periods of treatment by bandaging. Similar treatment in **neuralgia** is often valuable and is useful in the intervals of freedom, as well as during attacks. French and Swedish operators make much use of tapotement and vibration in neuralgias, somewhat to the neglect of the procedure above described, which is at least equally valuable. In the lesser, superficial neuralgias, tapotement is of more use than in deeper-seated disease; this application needs special skill and practice on the part of the operator, or it may be very painful.

Professional Neuroses.—In **writer's cramp, telegrapher's palsy, hammer palsy, piano-arm,** and the several allied neuroses, massage has been used for many years. Its best service in such cases is when there is **true cramp** and it does less good in the instances in which the trouble is simply **pain on use** of the part. Although this pain is of the same character as that due to persistent slight neuralgia or low grades of neuritis, it does not yield in the same way that these diseases do to treatment by mechanical manipulation.

HEADACHE AND MIGRAINE

In all forms of **headache** accompanied with a sense of fulness, or with flushing of the face, as in migraine, temporary comfort may be afforded by stroking of the sides of the neck and kneading of the back to the scapular level, as recommended for fracture of the skull (page 69). **Migraine,** however, is best treated in the intervals by dietetic measures and by thorough abdominal massage to improve gastric and intestinal activities and stimulate the secretions of the liver. General massage of the head using friction movements chiefly (practically 'shampooing') is useful in most forms of headache. **Vibration** has been recommended for migraine during attacks and in the interval, but many patients cannot bear the manipulation while the seizure lasts.

PARALYSIS AGITANS

Shaking palsy is dealt with by first getting the utmost possible relaxation of the muscles affected, by dint of **passive over-extension** of the limbs, by **thorough rubbing,** and by teaching the patient to **slacken the tension.** The effort to control the tremor is naturally made by contracting the muscles—with the effect of increasing the shaking. The sufferer's will should be exerted to 'take off' the tension. It will also be observed that steady *extreme* contraction of the muscles will overcome the tremor for a time, and both this and voluntary relaxation should be used in the treatment, as methods of training. Some patients have less tremor after massage; when this is the case, a time immediately after massage should be chosen for training in movement. Others are freer from spasm after the passive extension movements suggested above, and with them this is the proper moment for exercise. Further details and suggestions will be found in the chapter on **precision exercises.** The dull aching stiffness of the affected parts and of the back is relieved by massage in part. Some of it is due to the continued muscular spasm and disappears when the patient has acquired the habit of 'letting go.' In long-established cases this probably cannot be acquired, owing to the organic changes which have taken place, but even in them the ache and dull discomfort will be helped by massage. Charcot thought very highly of treatment by **vibration** in this disease and used for it the shaking chair, as well as local vibrations, manual or mechanical. The feeling of constraint, due to the muscular rigidity, is relieved by this application, and its use is thought to bring about favorable alterations in the peripheral nerve-endings, by both reflex and direct stimulation. The Zander apparatus includes like machines.

UTERINE MASSAGE

Massage of the uterus and its appendages, strongly advocated by its originator, Thure-Brandt, and recommended by various authorities, such as Profanter, Prochovnik, and Schauta, has not had much success in this country. In my experience, which has not been very large, it has not been of value even in the sort of cases in which its inventor and his followers have particularly recommended it, namely, metritis, endometritis, prolapse, displacements, dysmenorrhea, and menorrhagia, periuterine inflammatory exudates, salpingitis, and oöphoritis.

Manipulative treatment of some of these disorders in the method prescribed approaches so closely to a surgical undertaking that it should not be entrusted to any one except a physician, and the whole proceeding is of so technical a character that it seems best to refer the reader desiring information about it to the several books on the subject, such as Profanter's "Die Massage in der Gynäkologie" (1887), Prochovnik's "Massage in der Frauenkrankheiten" (1890), Norström's "Le Massage de l'utérus" (1889), the same author's "Massage dans les affections du voisinage de l'utérus" (1892) and his "Handbook of Massage" (1896).

MASSAGE OF THE BREASTS

Massage of the breasts, gently but thoroughly performed twice daily, is an excellent plan for **inducing a flow of milk** or for **increasing deficient secretion.** Treatment for a week is usually enough to get good results. If the flow is not promoted by the end of that time, there is little likelihood that longer continuance will bring it. The **method** followed should be light friction around the breast, working toward it and stroking with the finger-tips in the same direction, succeeded by gentle kneading with one or both hands pressing upon the whole breast at once from the circumference toward the nipple. The pressure in all these operations should be firm, but gentle, steady, and continuous without jerkiness, and never hard enough to cause pain. The minutest cleanliness, both of the breasts and of the operator's hands, must be made sure of; if the manipulation is frequently repeated, a bland aseptic ointment like woolfat will be necessary to prevent the skin from becoming tender.

PROSTATIC ENLARGEMENT

Massage of the prostate gland when that organ is beginning to undergo senile changes, or even when the alterations have progressed to a considerable point, is useful in lessening the hardness and reducing the size of the gland. The manipulation is one for the surgeon's performance rather than for the masseur's. It is given by inserting one finger in the rectum while the thumb makes pressure in opposition upon the perineum, and the gland is thus kneaded with the finger-tips. The operation should not last more than two or three minutes. It may be repeated daily or on alternate days.

COSMETIC MASSAGE

The cosmetic uses of massage are much exploited by the manufacturers of face-creams and patent complexion improvers, proprietors of beauty-parlors and the like, whose interest lies in making as much as possible of what is really a simple matter. For the same reason they put their clients through a variety of mysterious and complicated processes, and apply, moreover, what are supposed to be secret preparations of marvelous efficacy.

Cosmetic massage has legitimate uses which, if not so great as charlatans may claim, are yet sufficiently important to warrant a brief exposition.

Various **blemishes and defects of the face and complexion** can be successfully handled by massage, and the results are often permanent, as well as gratifying. Pimples, engorged veins, wrinkles, pendulous cheeks, double chin, scars from burns or disease, are some of the blemishes that are amenable to manipulative treatment. A woman whose skin is marred by pimples, by a dull greasy appearance, or by enlarged veins on the nose or cheeks, cannot, however, be endowed with a brilliant fresh color unless the conditions of life and health which cause these defects are also set right by treatment that will correct faulty habits as to food, air, exercise, and clothing, and will regulate the bowels and the other functions; for some or all of the matters indicated are usually among the remoter causes of the condition of which the skin-appearances are only one manifestation.

These points having been properly seen to, **local treatment** may be considered. When the skin is harsh, dry, or scaly, or when it has the look of being thin, parchment-like, and too tightly drawn over the bones, an ointment should be used in the massage. On the other hand, oily, thickened, dull looking skins should be treated with drying and stimulating lotions, of which grease or oil should form no part.

In the treatment of **wrinkles,** some knowledge of their cause is necessary to success. Cases in which the obnoxious lines are due to age alone are not very promising, but furrows appearing prematurely are often the effect of habitual distortions, such as frowning or wrinkling up the eyebrows or eyes, or other tricks of expression. These will have to be corrected by the patient to prevent the increase of the disfigurement, while the masseur's efforts are directed to the removal of the effects of past bad habits. Folds and wrinkles are sometimes seen in those who have lost flesh very rapidly, without the skin's having contracted correspondingly. In others none of these causes can be assigned, and the facial markings must be considered as symptoms of unknown origin. Rapid loss of flesh is the commonest cause of hanging, pendulous cheeks.

Where **cicatrices** have resulted from burns or other injuries, deformity may be to a great extent prevented by early massage. While the scar tissue is still soft it can be stretched and thinned, and its tendency to contract much lessened, and adhesion to the underlying tissue broken up and hindered from taking place. Finger-tip kneading, friction, and stretching are the movements used for superficial scars. Where the scars are adherent to deeper tissues, deep-kneading, thumb-separating, and pressure with kneading should be used. Even when the scar is old and deformity has been caused by its contraction, persistent massage in this manner will be rewarded by great improvement.

In the treatment of **smallpox pitting** the method is the same, but a bland ointment of a readily absorbable kind can be used to advantage, as part of the manipulation.

Next to be considered is the method of handling a too **dry skin.** The water and the soap—if soap be used—with which the face is washed are of some importance. A soap containing either much glycerin or rosin, or over-alkalized, should be avoided and the simplest plain soap only be used. Soft water or rain-water is less drying than hard water. If an ordinary soap makes a good, abundant lather, it is usually a sufficient indication that the water is a soft one. Many women who are very careful of their complexions use cold cream after washing without soap, wiping the ointment off with a soft towel; others will not even use water, depending entirely on the ointment. In the present condition of the atmosphere in many cities, some application of an ointment, wiping it off with thoroughness, is undoubtedly valuable in freeing the skin from the clogging with dust and soot which is almost inevitable.

The **massage** should consist of finger-tip friction, kneading, pressing, and pinching. The first few minutes' manipulation should be made without any ointment, then the treatment be repeated after the blood-vessels and glands are flushed and stimulated, using the prescribed ointment. Care should be taken that the space under the jaws and the front and sides of the neck are included. After as much ointment as has been ordered, or as much as is readily taken up by the skin, has been used, the face and neck should be lightly wiped with an old soft towel or handkerchief to remove any superfluity of greasy matter. **Ointments** suggested for such use are: a good, freshly made, cold cream, to be had anywhere; cold cream made with purified wool-fat, which is a little more costly and is perhaps rather more thoroughly taken up by the skin; wool-fat made into a sort of thick cream by rubbing it up with oil of sweet almonds, the amount of the oil varying with the season of the year and the temperature. In the use of any salve in this way the quantity applied should always be the least that will serve, and no superfluous grease should be left upon the skin. Plain cocoa-oil and cocoa-butter are other agreeable unguents. Petrolatum and the preparations of it are irritating to some skins and are less well absorbed than the oils mentioned. Often-repeated applications of oily substances with friction may increase the growth of hair, an undesirable result in most cases. To avoid this, treatment should not be continued longer than is necessary to get the desired effect upon the skin and the surface muscles.

In rubbing to remove **lines and wrinkles** the movement should be made as much as possible at right angles to the markings, and should consist in friction and finger-tip kneading. Distended veins should be emptied by the pressure of a finger, following the course of the vessel in the direction of the blood-flow. When the venous enlargement has lasted long, more radical measures may be necessary if the vessels from over-distention have lost their resilience. Some of the methods of cosmetic surgery may then be employed, such as slitting the larger veins or obliterating them by the use of an electric needle.

Pimples, comedones, and dull skins should be treated by applications of hot water or by steaming two or three times a week to free the clogged pores. The occasional use of a good soap increases the effect, applying a thick lather and leaving it on for two or three minutes. When the skin is particularly greasy, the tincture of green soap is useful. After this thorough cleansing, moderately energetic friction should be applied, and at the end of the treatment an alcoholic solution of sulphur, made either with alcohol or cologne-water (one dram of sulphur to the ounce of the liquid), is dabbed on and allowed to dry upon the skin. A few drops of ammonia in the water used for washing is very drying to greasy skins, but must be used with care. A wash of dilute toilet-vinegar is stimulating and toning to relaxed skins. If the pimples of the acne are inflamed or irritated, spots showing inflammation must be avoided in rubbing until the irritation has passed.

Falling of the hair not due to disease of the follicles, but caused by want of circulation and consequent impairment of nutrition, is easily cured by frictional rubbing of the scalp. The scalp in cases of premature baldness often seems tight-drawn over the skull and less movable than usual, and these conditions appear to predispose to the loss of the hair. The manipulation should be thoroughly done without any oil at first; after the scalp vessels are well stimulated and the scalp shows a clear pink color, an oil or unguent should be used. Petrolatum preparations, not satisfactory substances for use on the face, do very well for applications to the head, or any bland oil may be applied with renewed rubbing. Whatever oily material is used should be in moderate amount and be applied upon the skin, not to the hair merely, and well rubbed in. The treatment should be repeated daily for three weeks, two or three weeks allowed to pass without massage, and then a repetition of the course be given.

Under this heading of the cosmetic uses of massage it may be well to call attention to the effect of manipulation in hastening the disappearance of extravasated blood from **contusions,** as in a 'black-eye.'

OSTEOPATHY

Since the admirers of the very latest curative system that has gained vogue proclaim loudly that it is not massage, there is an evident necessity for one writing on massage to say something about that method which rejoices in the sufficiently barbarous name of osteopathy. Its prophets announce that it is destined altogether to supersede ordinary medical practice. Ordinary medical practice, according to the prophets of the new dispensation, consists only in the administration of drugs; and with these, osteopathic practice asserts that it does not concern itself. In short, we have to deal with a new ''pathy,' that is to say, with an exclusive system, founded on one idea; an idea, to be sure, rather more rational than that now-abandoned theory on which another exclusive system was built—namely, the origin of all chronic diseases in the itch. This 'osteopathic' idea is—or was—that nearly all diseases are the result of displacements of bones, which, thus displaced, press upon various nerves and organs, and so give rise to manifold and varied symptoms. The 'osteopath' treats the resulting conditions, theoretically, by replacing the bones; practically, by a rather rude massage. It hurts his feelings to call the proceeding massage, and it is indeed rather hard—on massage; but that is what it is—a fact which is not altered by the claim of its having been invented in Missouri. The books of the school are numerous, and generally hyperbolic or ill-written; the work of its founder being particularly vague, windy, and pompous. In their manuals of practice may be found directions for the treatment of smallpox, scarlet fever, apoplexy, whooping-cough and headache, by manipulation of certain regions in which they find 'lesions.' Everything is due to a 'lesion,' and a lesion apparently means only a bone out of place. Some of the 'lesions' which they commonly find are interesting. For example, 'Dr.' Hazard's book on the subject describes dislocation of a vertebra as a very frequent cause of disease and one easily remedied by proper manipulations; the atlas vertebra is particularly subject to 'lesion,' but is fortunately readily restored. Another fruitful source of trouble is 'displacement of a rib!' This causes heart disease, dyspepsia, constipation, and other difficulties.

Except for its wide spread, the matter is hardly worth wasting time on. The 'new school,' as it likes to call itself, knows nothing that is not already a part of legitimate medical literature, barring its absurd invention of 'lesions.' It magnifies and verbosely misapplies its little knowledge—and much unfounded assumption—concerning the vasomotor or sympathetic nervous system. The 'osteopaths' put aside as useless lumber all physiology, all pathology, all etiology, all physical diagnosis except what they pretend to learn by touch—a wide enough claim, since they assert that they can touch a number of unreachable organs. Bacteriology, chemistry, and the normal and abnormal functions of the organs of digestion and assimilation are impartially ignored by them.

The fact is that if all educated physicians really knew and appreciated the proper place and value of massage and other forms of mechanical therapeutics, and made right use of the knowledge, the osteopaths would never have had a chance; for, let them say what they will, if study of their books makes any one thing certain about the system, it is that they have found out and exploited the usefulness of massage and manipulations. The force of the accusation against them lies in their claiming impossible things and doing harmful ones.*

* In a recent article (American Medicine, Oct. 17, 1903) Dr. R. C. Newton, who states that the practice is of old Italian origin, sums up the osteopathic matter in the following excellent terms: "Whatever permanent good the osteopaths do, they do by mental suggestion, followed by massage and manipulation, and in some cases by hydrotherapy and the use of heat and cold. They probably accomplish more than ordinary masseurs because they are fiercer and bolder in the application of their methods. The lesson they teach is that the human frame cannot only endure, but can be benefited by maneuvers which are usually regarded as so severe as to be dangerous. To teach people the necessity of bodily exercise, if they wish to enjoy good health, has been and still is a difficult and discouraging task. But the people are learning their lesson for all that; and the osteopaths are contributing (albeit unwittingly) their share to the fund of human knowledge."

Section II

EXERCISE AS A REMEDIAL MEASURE

CHAPTER IV

METHODS AND EFFECTS OF EXERCISE

General Exercise, Remedial and Developmental. Therapeutic Gymnastics; Hygienic Gymnastics; Calisthenic Exercises. Introductory Exercises for Convalescents or Very Weak Patients; Passive Movements. General Breathing Exercises. Chest-bandaging. General Suppling Exercises. Leg Exercises; Trunk Exercises; Relaxing Movements.

GENERAL EXERCISE, REMEDIAL AND DEVELOPMENTAL

The assertion that exercise is an absolute necessity to the best health cannot be made too strongly, and is the more true, the wider the application of the word 'exercise.' Use is the very condition of the life of muscle and brain, and neglect to use, results either in atrophy at best, or in decay, if circumstances be worse.

It is as nearly exactly true as any sweeping assertion can be, that every one needs general muscular exercise. Exceptional individuals of exceptional constitutions may survive and work and even be well without taking any exercise; and, on the other hand, exceptional persons may injure themselves by active exercise of comparatively mild type; while any one is liable to be harmed by injudicious exercise. But to maintain that bodily exercise is useful for all, and necessary for most men and women, is very far from asserting that violent exertions are needed by every one, or that athletic sports should be part of everybody's daily life.

The people of whom one hears it reported that they 'do very well without exercise,' or that they find that 'exercise does not agree with them,' are ignorant of how much better and more capable of making good use of their minds and bodies they would be with suitable exercise, or they have not gone about it in the right way, or they are setting traps for their future. Men vary in the demands which their bodies make upon them; some need little work, others a great deal, to keep them well. We come into the world with very different conditions of health and strength. Some have hereditary predispositions to disease, or organs only just equal to the daily requirements of existence. By properly adapted physical exercises weak parts may be strengthened and the bodily conditions improved, so that the chances of disease, premature decay, or early death may be greatly lessened. An opposite course of physical apathy or of misdirected effort may increase hereditary tendencies to disorder, and diminish the likelihood of valuable health or long existence.

It will not do to talk of exercise and the moderate and reasonable indulgence in outdoor sports as if their effects upon mere muscular development were the only results to be expected from them. The active use of the body improves every function; nothing will more quickly lessen nervousness; no other remedy is as good for that morbidness of temperament, common in intellectual workers of sedentary habits, which develops so often into melancholia.

It is a commonplace that has been repeated until it has lost the force which it should have, to say that a healthy mind depends upon a healthy body. It is quite as true to reverse the phrase, and say that a healthy body depends upon a healthy mind. But the phrase so often misquoted really states the indisputable fact that the best is to have a healthy mind in a healthy body. How this ideal state of things can be brought about without undue expenditure of time it is the aim of these chapters to teach.

Different Forms of Bodily Exercise.—Much technical discussion and dispute has been needlessly expended upon attempts to distinguish between the **preventive, medical,** and **educational** forms of bodily exercise. The fact is that although the methods of application must vary in different cases, it is practically neither necessary nor possible to make such a differentiation, if we lay aside the violent and laborious games and sports as out of the range of ordinary therapeutic usefulness. The punching-bag which the prize-fighter utilizes in his training may, with proper modifications in the method of use, be a valuable means of exercise for the fat elderly hypochondriac. The bicycle, although overdone by foolish people who strain their hearts and cramp their chests by long runs and bad position, is none the less an admirable machine for a middle-aged woman's use, and may undo the ill effects of many sedentary years of idleness and corsets. With discrimination all forms of exercise may be therapeutic; and the present intention is to point out the methods of application proved most valuable by experience, with the fewest possible words of explanation of the reasons, physiologic or others, for their usefulness.*

Therapeutic gymnastics, originally only used in the treatment of disorders evidently due to lack of exercise, have of late years been suddenly 'discovered' by innumerable 'professors' and, partly by the efforts and advertisements of these persons, partly by more legitimate means, have had their field extended until enthusiastic devotees proclaim 'physical culture' as a universal panacea for all forms of disease and disorder from bunions to baldness, while advertising instructors promise 'cures' of locomotor ataxia or progressive atrophy.

The truth, as usual, lies in the middle ground: incurable diseases are not to be cured by exercise any more than by incantations or by medicines; but the remedial effects of muscular effort properly directed are immensely valuable and of very wide applicability. The chief obstacle to their still wider use has been the manner in which patients of all classes cling to medieval superstitions in favor of drugs, and their unwillingness to follow up a daily, definite, systematic routine.

When all has been claimed and adjusted, curative gymnastics have still their most important sphere in the treatment of disorders arising from lack of exercise, such as muscular enfeeblement, gastric and intestinal atonies, insufficient cardiac and respiratory action, and venous congestion. To such disorders they are applicable in all periods of life, but, with the exception of the postural deformities and troubles caused by imperfect muscular development in childhood and youth, they have their most valuable field of use in the diseases of middle life. In more advanced age, too, they furnish a method by which one may accurately prescribe measured quantities of exertion.

Hygienic Gymnastics.—For children deprived of proper opportunity for active games, for the ill developed or malformed, remedial or hygienic gymnastics will be required and will give most admirable results. In schools where large numbers of children, many of them physically defective, have to be dealt with, a few minutes' daily systematic exercise will be a great help as an introduction to, and preparation for, training in other matters. Such needs will be best met by slight modifications of the several movements of the 'setting up' drill as used for military recruits. But however valuable ordered gymnastics may be, they can no more take the place of games and sports in the education of youth than the concoctions of the

---

*Elsewhere in this volume (Part II) these reasons are considered, and certain general aspects of exercise as a means of physical education discussed, by one who has done much to rationalize our American practice in such matters.

laboratory can permanently replace ordinary food. Elements of immense and not altogether appreciated importance in games are the habits of subordination of self, of rapid decision and closely following action, restraint of temper, prompt obedience, and, in many sports, the manner of life that a participant must lead to be fit for them. These advantages belong to almost all active sports in which concerted effort—'team play,' as the phrase runs—is required, from tennis, cricket, or baseball to polo; and few of them are gained by gymnastic exercises. Of course, games, and especially the athletic sports of the track, may be overdone, and a boy or young man may devote himself too exclusively to one kind of exertion and thus fail to attain the general development that would come from a proper variety of effort.

A recent French writer has reminded us of Rabelais's account of the education of the king's son, in which the list of bodily exercises included is interesting from the varied character of the efforts included. After describing the studies ordered, he proceeds to details of the physical exertions, which include rackets, tennis, riding, wrestling, running, leaping, climbing walls, trees, and mountains, swimming, fencing, single-stick, casting of lance and javelin, shooting, rope-climbing, the horizontal bar, weight-lifting and hurling. If we analyze this list it will be found to include exercises of activity, of strength, of skill in eye, hand, and balance; continued exertion for muscle development; and violent exercise for condition, so that no part of the body is neglected.

Prescription of Exercise.—The prescription of exercise for any individual must be founded on the bodily indications and on a study of the personal history and peculiarities in order that, while meeting and overcoming the deficiency, too much may not be demanded of muscles or nerves untrained for the work required.

Fatigue is a phenomenon of double origin: the local effects of exercise on muscle, and the general nervous results on the nerve-centers in the brain and spinal cord. It is of the utmost importance in prescribing exercise to remember that forms of exertion which need strict attention in their performance—that is, the distinct **willing** of each action—are nervously fatiguing to a degree corresponding with the effort of will required. The same is true of exercises done **by order** and requiring the performer to watch and imitate an instructor. To show how quickly fatigue comes when an action, easily, even automatically, performed under ordinary conditions, is done with willed attention, let a man try his most accustomed exercise in this fashion. A walk of a few hundred yards will be fatiguing if the contraction of each group of muscles is made a separate cerebral act. The practical bearing of this in the selection of forms of exercise is obvious. Persons already nervously weak or too readily tired must first have either massage or passive exercise by assisted movements; or, if it is not necessary to be so cautious as this, they may be ordered those which can be almost mechanically performed without strain of attention. It is for this reason that it is unwise to drill school children in difficult and long-continued **calisthenic** exercises. Their minds are sufficiently worked already, and unless the drills are in very light and very simple movements, the strain required in learning and doing them defeats its own object. A romping game would do much more good and would send the children back to work hot and flushed with their play, but with fresh minds and untired nerves. Moreover, the game has, or can have, the advantage of the open air.

The **rule** which arises from these facts works well both ways. For indolent minded invalids or persons sedentary in body and idle in brain, but not nervously overdone, it is well to prescribe exercises that exact attention and some orderly effort of mind and will in the execution. Let them perform the more complicated and difficult movements; or, if their condition will allow it, order riding, fencing, or sparring, so that they shall be forced to exert their nervous systems at the same time as their bodies. On the other hand, neurasthenic persons to whom all attention is an effort, and may be harmful, must have only the simplest direct single movements and breathing exercises, all used moderately at first, before they go on to more difficult actions; thus gradually accustoming both the nervous centers and the muscles to the new demands upon them.

Some **general rules** need stating here, and then special exercises will be taken up *seriatim:*

1. **Weak patients** must not be pushed to the point of serious fatigue. If a few minutes' or, at most, an hour's repose after exertion does not restore them, the quantity of work must be lessened. When once sufficient strength has been gained to permit more exertion, the work *should* be pushed to the point of decided fatigue, or little good will be done. Even then the rule remains, however, that the measure of proper exercise has been exceeded when fatigue persists after reasonable rest. At first in those totally unused to muscular effort, stiffness and soreness of the muscles will, of course, be complained of; but this should be overcome by going on with the exercise, or massage of the sore muscles will quickly relieve it.

2. In **beginners,** exertion must stop short of producing breathlessness or palpitation, until the muscles are well suppled and the capacity of the heart and lungs improved.

3. To get good results, exercises must be done **daily** and as nearly as possible at the same hour. Shortly before a meal is the most suitable time, if a sufficient interval for rest, say fifteen to thirty minutes, can be had after the work. It may be advisable to order the repetition of exercise twice a day, or the whole amount may be divided into three or four portions for very feeble or very nervous persons. The last time should be not less than one hour before bedtime. Two or three minutes together may be found enough at first for convalescents from acute disease or persons recovering from nervous disorders. When what is sought is merely enough exercise for health and general condition, fifteen to twenty minutes' work daily is sufficient, if properly used and if the suggestions of rule 7 have been complied with. Of course, when the individual is once in good condition more may be done for pleasure, but then a different class of exercises will probably be found more agreeable.

4. In **remedial movements** to correct physical defects the chief value of the exercises will be lost if they are done rapidly. The movements can scarcely be too slow. In exercise for condition this is not true. It is then often necessary to prescribe rapid work. A pause of the space of four or five inspirations should follow the completion of each movement. Each should be done steadily, with distinct tension of all the muscles used, with regular full breathing and no jerkiness. Beginners are apt to hold the breath while performing the movements, a fault which may be prevented by making them count aloud slowly during the exercises.

The exceptions to these rules are noted where they occur.

5. **Apparatus.**—In the beginning no apparatus is required. Children may sometimes do better if light dumb-bells or wands are used, merely from the suggestion made by the presence of the weights. If muscle-making is the end desired, weights or bells may be used, but, as a rule, the bells should not, even for adults, exceed about four to six pounds in total weight, or, to make an individual rule, from one-thirtieth to one-twentieth of the personal weight.

Exceptions to this are made in the exercises for spinal curvature.

6. Exercises should be done, if possible, **out-of-doors** or with the windows open. **Clothing** that in no way restricts the freedom of movement should be worn; but, as every gymnast or athlete knows, close-fitting garments, if yielding and elastic, are more suited for exertion than loose and baggy clothes. Corsets, of course, should be discarded by women, and slippers, preferably of the gymnasium pattern with rubber soles and without heels, will add to the steadiness of the station and to the ease with which the standing and leg-stretching movements are done.

7. **Preliminary Physical Examination.**—Before beginning exercise

at all, proper physical examination must be made, not only of the heart and lung conditions, but by measurements of the chest, contracted and expanded, the taking of height and weight, and a study of the patient from the point of muscular development. Such inspection is best made with the subject stripped. In this way the specially deficient regions or muscular groups are determined. After the first week or two of preliminary suppling work and of breathing exercises, attention should be given to bringing up the weak parts to the individual's average level by special exercises. When this has been attained, exercises of general character should commence, but not before.

INTRODUCTORY EXERCISES FOR CONVALESCENT OR VERY WEAK PATIENTS

The exercises first to be detailed are suitable for convalescents and feeble persons at the beginning of treatment. For simplicity and directness, they will be given in the form of orders, rather than of descriptions; thus in the second person. Necessary comments and explanations will be interpolated.

Comment on Exercises 1 to 8.—Movements of upper and lower extremities should be alternated; an interval of rest sufficient to permit the taking of four or five long breaths should follow each exercise. The instructor should see that only the part of the body to be exerted performs the movements, other muscles remaining lax. Constant attention must be given to enforce natural breathing.

1. Extension and flexion of leg, lying

Resting quietly on the back on a firm mattress or couch or on a blanket on the floor, the arms lying by the side, flex one leg at a time slowly to its extreme limit and extend as slowly, without allowing the heel to touch the bed.

2. Extension and flexion of arm, lying

(*a*) With the body in the same position as in 1, extend one arm at right angles laterally, then bring it forward directly in front of the body, the hand open, the fingers straight; return to original position. (*b*) Extend the arm straight forward at right angles to the trunk, bring the elbow to the side; return to original position. (*c*) Raise the straight arm above the head. (*d*) Raise the straight arm above the head, flex the elbow, bring the elbow to the side; return to original position.

After four or five days the patient may be required to perform the movements with both arms at once.

3. **Rotation of thighs, lying**

Bend the thigh to a right angle with the body, allowing the lower leg muscles to remain relaxed; carry the knee inward as far as possible past the middle line of the body, raising the leg only so far as to allow the foot to move clear of the bed. From this inward rotation position, raise the knee toward the chest, carry the foot inward and the knee out to the limit of comfortable motion; then return the knee to the middle line of the body and extend the leg into the straight resting position. The movement may be modified, if necessary, by performing outward rotation alone or inward rotation alone.

4. **Forced breathing, lying**

Lie flat, without a pillow; fill the chest by using the abdominal muscles, 'pushing' with them; expire by reversing the proceeding—'drawing' the abdomen as strongly as possible. The air should be retained six or eight seconds between inhaling and exhaling, and two or three ordinary expirations should be taken before the forced breathing is repeated.

These four sets of movements are useful in preparing bed-fast patients for getting up. When patients have been long in bed it is usually necessary to precede active movements by similar ones performed *for* them; an attendant bringing the limb slowly and steadily into the required position,—**passive movements.** The next step is for the attendant to *aid* the patient's effort, so that the latter makes very little exertion,—**assisted movements.** The assistance is daily lessened until the patient receives **no help.** Next, the single- or double-arm movements and the breathing exercises are done sitting in a chair. The chair should be straight-backed, springless, and firm. Thigh rotation, active or resisted, may also be done sitting. (See page 91 for description of resisted movements.) In persons not extremely weak the arm movements described may be performed standing.

When patients are bed-fast, passive movements may sometimes be advantageously kept up through long periods, either in connection with massage or independently of it. In order to exercise the lower limbs well and move all the joints thoroughly, a rather more elaborate series of exercises will be needed than the simple flexion, extension, and rotation described under Exercises 1 and 3. The following movements cover these necessities and are inserted here without numbers, in order not to break the sequence of the active exercises.

Attention to the proper position of the limb and to the exact manner in which the hands support and direct its movements will make the work easier and more efficient. These are well shown in the illustrations.

Passive Movements

Adduction and Abduction of the Leg (Fig. 21).—The operator standing beside the bed, picks up the ankle, with his thumb on the external malleolus and the fingers underneath, laying the other hand firmly on the knee. He steps back, moving the leg outward to the limit of com-

FIG. 21.—PASSIVE ABDUCTION AND ADDUCTION OF THE LEG.

fortable abduction and returns it slowly, carrying it across the middle line as far as he can without allowing the knee to bend.

Elevation and Depression of the Leg (Fig. 22).—With the hands in the same positions as in the previous movement the leg is carried straight upward to the limit of elevation, and returned.

Flexion and Extension of the Leg (Fig. 23).—One hand seizes the foot under the heel, with the thumb on the inside, the ball of the foot resting against the forearm; the other hand is laid upon the knee. The leg is bent by pushing the foot toward the buttock, the hand on the knee serving to support and maintain the leg in a straight line.

Knee Traction (Fig. 24).—With one hand under the foot as in Fig. 23 the foot is lifted, the knee bent and the lower leg pushed hard and steadily upward until the knee and thigh are bent as far as possible.

FIG. 22.—PASSIVE ELEVATION AND DEPRESSION OF THE LEG.

The other hand is pressed on the leg below the knee-cap to assist in the extremest flexion.

Rotation of the Thigh (Fig. 25).—With the same position of the hands as in the beginning of the two preceding exercises, the foot is lifted and carried outward while the knee is pressed inward, the foot being moved upward enough to allow the free bending of the knee. The movement is continued to the limit of possible inward motion, and the action then reversed, the foot carried inward and across the middle line of the body and the knee pressed outward to the limit of comfortable motion.

In all of these exercises the support and movement is given entirely by the operator, and is continued till the limb is returned to its original resting position. With a very little alteration in the positions of the hands these **passive** exercises may be changed into **assisted** or into **resisted** movements; in the former the effort of the patient being aided by the

FIG. 23.—PASSIVE FLEXION AND EXTENSION OF THE LEG.

operator, and in the latter the patient resisting the operator's attempts to move the limb or, better, with the resistance supplied by the operator.

The passive and resisted movements of the arms are too simple to need further detailed description, and may be left with the reminder that all should be done very slowly and evenly and carried to the extreme limit of motion in the prescribed direction.

Importance of Correct Station.—We proceed now to the consideration of exercises that call for the erect posture. A correct standing position is necessary to their proper carrying out; and the teacher must constantly watch that the pupil maintains this proper carriage, which is in itself of educational and hygienic importance. If the manner of standing be slovenly, the back and belly muscles will miss their proper share of work, fatigue will come more readily, breathing will be less full, and much of the desired effect of the exercises will be lost. No one walks well who does not stand well, and an easy upright carriage, a light, smooth-stepping walk,

FIG. 24.—KNEE TRACTION.

are the first and final expressions of grace and strength. We begin, therefore, with **instructions as to standing.**

The commonest fault is **round shoulders**; next in frequency is **protrusion of the abdomen.** In the endeavor to correct the former, many persons throw the upper part of the body back until it passes the perpendicular. This only accentuates and increases the relaxation and forward thrust of the abdominal walls. Women especially, whose abdominal muscles are usually very feeble from being tight-held in corsets, manage thus to balance the abdomen and its contents on the pelvic bones without using the muscles of the front of the trunk at all. Those who stand in this way are usually quite satisfied that they are splendidly erect, but the position entails excessive use of the back muscles and is usually paid for with aches and lameness in the back, especially in the lumbar regions.

The military pose of 'attention' is insisted upon by many gymnastic instructors, but it is not the ideal one for the starting-point of remedial

FIG. 25.—PASSIVE ROTATION OF THE THIGH.

work, lacking freedom and ease. In 'straight standing' the feet should be almost parallel, the heels from one to six inches apart, as may be easiest, the toes turning outward but little,—no more than is natural and comfortable for the individual,—and the arms should hang easily by the side (Fig. 26). The weight should be more on the toes and the ball of the foot than on the heel. Let the ease and balance of this position be tested by rising on the toes as high as possible, maintaining the position for a moment, and coming gently down till the heels touch the

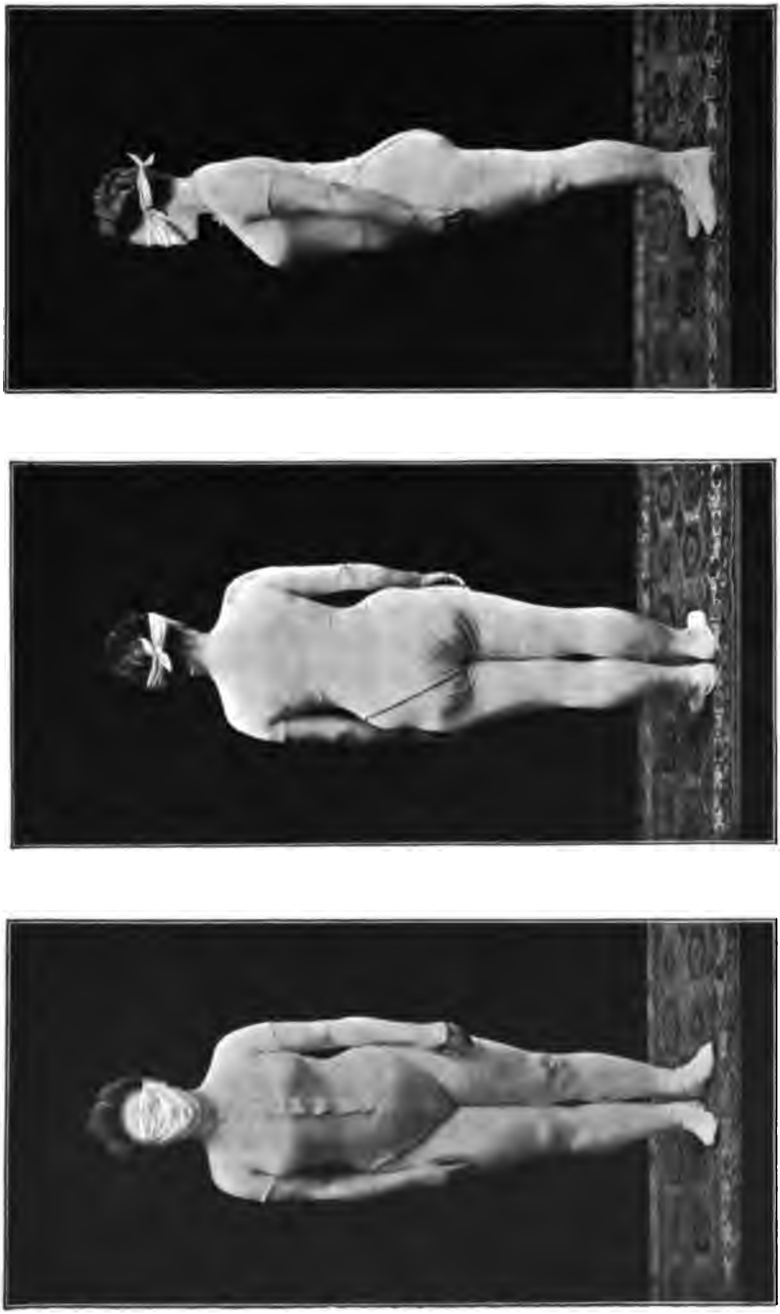


FIG. 26.—STRAIGHT STANDING POSITION.

floor. If balance is lost in trying to do this, so that the person 'breaks ground,'—that is, must take a step forward or back to recover equilibrium,—the center of gravity is misplaced. Let the position be assumed again, breathing deeply from the abdomen a few times, remembering to throw the body-weight on the toes, and then try 'toe-raising' once more. The body is thus naturally brought into the right line, the tendency to tip the pelvis corrects itself, and after a few attempts the proper position will be found and kept. A useful trick to bring the person who stands badly—especially in the protruding-abdomen position—to a sense of his bad poise, is to make him walk backward. The alteration of carriage and balance that will be made at once will be found very convincing. A well-balanced, erect, yet easy poise is the starting-point and foundation of the most important remedial and developing movements.

When it is particularly desired to improve **co-ordination,** it may sometimes be useful to insist from the first upon the military position, heels together, toes turned out, and palms against the thighs or little fingers against the thighs with the palms to the front. The very fact that the position requires some effort to maintain it, is what renders it now and then desirable. The head must be held high. Blaikie's excellent suggestion is to remember 'to keep the back of the neck pressed against the collar.' Forcing the breathing from the abdominal muscles as described helps to rectify the carriage of the trunk and encourages much deeper inspirations. The first movement for practice in the straight-standing position is:

5. **Setting-up Movement.**—Raise the arms laterally, palms upward, until level with the shoulders. Bring them to the front till the palms touch; reverse the movement, extending the arms backward as far as possible, at the same time rising upon the toes. The arms will have to be inclined downward in this movement to the rear, and the effort should be to make the hands touch behind the back at about the level of the waist. The latter part of the movement should be rapid and swinging. This exercise is taken from the drill-instructions of the army and forms one of the most valuable in the admirable series prescribed for soldiers in that manual.

GENERAL BREATHING EXERCISES

Indications for Respiratory Exercises

Deficient chest capacity and poor expansion or movement are obviously matters calling for special attention to methods of respiration, but exercises for improvement of respiratory capacity have very wide usefulness beyond the treatment of such defects. All conditions in which the oxygenation of the blood is insufficient can be helped by persistent work at respiratory exercises until a good habit of full breathing is established and become automatic. In obesity, in anemia and chlorosis, in neurasthenic conditions and in simple fatigue both physical and mental, such exercises will prove valuable. They are of the utmost use both in the prevention and cure of a long list of pulmonary disorders, from ordinary 'cold' to tuberculous disease. In the former case to devote a few minutes several times daily to forced breathing of fresh air will often induce recovery without other means. In the latter, no other treatment is so successful as that which prescribes long hours in the open with full breathing.

Although some professors of 'physical culture' have especially proclaimed the importance of 'good breathing' and some enlightened physicians have appreciated the need of inculcating it, nevertheless its immense value in a variety of conditions in which anemia, impaired circulation, and deficient oxygenation of the blood are symptoms is not yet held in proper estimation. (See also vol. x.)

Natural **full breathing** is a combination of thoracic and abdominal breathing. In women the thoracic type predominates, in men the abdominal. The difference is sometimes asserted to be the result of the universal use of corsets, but in fact the greater prevalence of the thoracic type of respiration is necessary to permit the possible enormous distention of the abdomen in pregnancy, and thoracic respiration is as much a normal peculiarity of the female sex as broad pelvic bones are. The tendency to predominance of thoracic breathing may perhaps be increased by the constriction of the waist and abdomen by bandaging garments, but this type of respiration is seen in savage women who have never worn corsets or skirts, and belongs to the sex. Before respiratory exercises are prescribed the patient should be **examined** to determine whether development of abdominal or thoracic breathing is the more needed. The method of work will depend on which of these is deficient. It is better to attend to one thing at a time, to work separately at the group of muscles that lacks strength or the organ that calls for improvement, thus concentrating attention. Even if the deficiency is general, the exercises should nevertheless be kept distinct.

Various devices may be used to keep the attention on the special part which it is desirable to strengthen. If abdominal breathing is good, but thoracic deficient, we may put a belt about the waist, keeping it as low down as may be, draw it reasonably tight and let the patient attempt to confine his efforts to the movement of the chest and the muscles above the belt. If the thoracic movements are well performed and those of the abdomen wanting, the strap may be put around the chest below the armpits. The patient should then endeavor to inspire and expire as fully as possible without using the upper chest. Control of the diaphragm and abdominal walls is thus gained and improved. A rubber bandage may be substituted for a strap, and is perhaps better, as it does not so stringently confine the motion of the muscles. If on examination the lower portion of the chest expands well, while the upper areas of the lungs are not thoroughly filled, the constricting band may be placed around the lower ribs; or, under opposite conditions, the plan may be reversed, thus securing inflation where it is most needed. (See also volume x.)

Methods

In the treatment of ordinary examples of general muscular deficiency, of convalescents, and in the beginning of the training of weak or anemic children, the simple arm and leg movements described should be used at first, then the instruction in standing and poise should be added, each day's work combining all of these. Five to ten lessons will suffice for any except the feeblest neurasthenic persons to gain muscular control, and learn how to attend to instruction. Then the special breathing work should be started, before proceeding to more complicated movements. This order is the best because many persons will be found to hold the breath involuntarily while doing their exercises, and this trick can be overcome by teaching correct breathing and by insisting that the breath be not held except when to hold it is ordered as part of the treatment. Full or even forced respiration is, too, a very important part of general exercise, especially when there is a deficiency in the circulation or in the oxygenation of the blood, and must be practised until it grows habitual and mechanical.

There is really **only one exercise** for increasing the capacity of the lungs, and that is to **breathe deeply** and **slowly** until the extreme limit of possible expansion is reached. All other exercises to the same end involve this. We may vary the methods by which we encourage patients to expand the lungs. We may combine movements with the inspiration, partly to give variety, partly to put the chest in the best mechanical position for the reception of air; but deep, slow breathing is the essential thing in all of the numerous methods. In the beginning this may cause dizziness—especially when the breath is held between inspiration and expiration—in those unaccustomed to full chest expansion. In such cases only a few repetitions of the exercise should be made consecutively at first, and if necessary long intervals of rest may intervene even between successive efforts at deep respiration. The number of repetitions without intermission is to be gradually but steadily increased as the patient becomes more used to the exercise.

Holding the Breath.—If when the chest is full the patient will hold the breath while he counts ten, he calls to his aid a new element. The longer the air is thus retained, the warmer it becomes; and by the law of expansion the warmer a gas is, the more space it occupies. When the air is thus retained, its own expansion drives it into the furthest alveoli and thoroughly dilates them. This then gives another reason for slow inspiration and expiration. **Muscular work** is an aid when it is of the right kind, as it causes deep breathing; but unless the effort is properly directed, muscular exercise may have the effect of cramping the chest, and many very powerful men, especially professional gymnasts, have enormous muscular power and large external chest measurements with very poor lung development.

6. Upper Chest Breathing.—Standing, hands on hips, thumbs to the rear, elbows pressed back:—Inspire slowly, using the muscles of the upper chest, as much as possible. Hold the breath from five to six seconds and expire, endeavoring to empty the chest. The whole movement should occupy twelve to fifteen seconds. When it is desired to overfill the lungs, after breathing as fully as possible, two or three short gasps of additional inspiration should be made. To make expiration more complete, one leans a little forward and blows out.

7. Overhead Stretch.—Straight-standing position:—Raise the arms sidewise, elbows straight, until the backs of the hands meet above the head. Stretch the arms upward as much as possible in doing this. Inhale deeply as the arms go up, hold the breath while extending them above the head and exhale slowly as the arms descend to the sides. The whole movement should take about ten seconds.

8. Forward and Overhead Stretch.—Straight-standing position:—Extend the arms forward parallel and raise them above the head, stretching as before, and inhaling and exhaling as in the previous exercise. The duration should also be the same.

These two exercises may be done sitting, but not with such good effect. They may be done more rapidly, and without holding the breath, as simple suppling movements.

Repeat each of these ten times, twice daily, for one week, in the purest attainable atmosphere. In the second week do each twenty times. For ordinary purposes it is not necessary to increase the number beyond this. With a few seconds of rest allowed between each movement and the breathing rate kept as ordered, twenty repetitions would occupy altogether about four minutes.

For thoracic breathing

9. **Overhead Stretch and Knee Bending.**—Straight-standing position:—Extend the arms sidewise and upward above the head, inhaling deeply. Lock the thumbs together and with the arms thus at full stretch upward, lower the body, bending the knees as far as possible, rise again to erect station and exhale while lowering arms. Time, ten to twelve seconds. The knees have to be separated to allow the body to drop, and the heels are raised from the floor to permit extreme flexion of the knees.

10. **Overhead Stretch, Trunk Bending.**—Straight-standing position:—Extend the arms forward and up, palms forward till the thumbs can be locked above the head: Inhale while doing this—bend forward from the waist without bending the knees, and sweep arms slowly downward till the fingers touch the floor, still holding the breath. Rise, swinging the arms up to the overhead position and lower them slowly to the side, exhaling the while. The back should be kept flat and the shoulders not dropped in the downward reach. Exercises 9 and 10 are not suitable for invalids in the beginning of treatment, or until they have made some advance in the use of the muscles.

For diaphragmatic and abdominal breathing

11. **Abdominal Breathing.**—Standing erect, place the hands on the hips, thumbs behind, and attempt to fill the chest by the use of the abdominal muscles, 'pushing' as in 4 (forced breathing). Neglect, or endeavor not to use, the chest muscles. To bandage or strap the upper chest will aid in concentrating effort on the control of the diaphragm and belly muscles. To practise before a mirror will also be a help at first.

It may be added that abdominal breathing is best practised at first in a recumbent position, at any rate until good control of the belly muscles is gained. It is well, after some experience in single (that is, either thoracic or abdominal) breathing exercises, to advise some practice in combining the two forms. This may be done by making first an effort at deep but not forced abdominal inhalation, then adding a forced thoracic inhalation, lifting the chest and bringing all the accessory muscles into play. Some authors think this latter action is aided by clasping the hands behind the neck or on top of the head, thus giving freer play to the accessory muscles of respiration. The order of breathing in such exercises should sometimes be reversed, beginning with thoracic inspiration and ending with forced abdominal inspiration.

All these exercises encourage full breathing, but do not enforce it. Full respiration remains a voluntary effort. Exercises of speed or strength are required to cause involuntary full respiration. Those which involve the use of large masses of muscle will produce this effect sooner and more thoroughly than movements bringing into action smaller groups of muscles. The typical exercise for 'improving the wind' is steady **moderate speed running.** Other very useful but less generally available ones are **swimming** and **rowing,** and a fourth, for which opportunity can always be found, is **uphill walking.** Not only the active performance of muscular work is needed to increase respiration, but the work must be long continued to produce lasting and valuable results. The longer duration of effort adds to the muscular exertion an effect upon the general circulation. The blood flows more quickly and increases in temperature, while the quantity that passes through the lungs is greater and its oxygenation requires more rapid breathing. In walking, unless there is organic disorder or serious enfeeblement of the heart, the demand upon it is never sufficiently great to impair its working; the carbonic acid production of the laboring muscles is never so large as not to be properly removed from the blood by the lungs; and yet the introduction of air is more than three times as great in rapid walking as when the body is at rest.

In sum, after certain preliminary preparation by methodical voluntary forced breathing, the best respiratory exercises are those which call for the use of large muscular masses for some time, and either bring into play the whole body, as in swimming or rowing, or require enough exertion of some of the great muscle groups to increase respiration.

From all this we draw the conclusion that *the use of the legs will develop the capacity of the chest better than the use of the arms.*

The **aged,** the **phthisical,** those with **arterial degeneration,** with **emphysema** or any organic change impairing the strength of the lungs or the heart, should use slow and steady movements. It may be necessary to keep them entirely to prescribed gymnastic activities and not allow the livelier and more interesting work of outdoor sport; at any rate, until a certain degree of improvement has been obtained.

For the **young,** for the **fat,** for sound but **flabby idle people,** exercises requiring both endurance and speed may be ordered, and, in addition, forced breathing for five minutes twice a day. A walk should, if possible, have some object, or it becomes that most depressing form of exercise known as a 'constitutional.' If a patient is ordered to go to a certain point and there drink a glass of water and return, even that is better than an aimless stroll. The distance, the rate of speed, whether any of the walking is to be uphill, and if so how much, the hour of the day at which it is best done, are all matters for consideration and prescription. The form might run like this (reference being had to Fairmount Park in Philadelphia): "At 7 A. M. take a glass of milk and a roll, and start at 7.15 to the dairy in the East Park along the level, and up the hill by the foot-path to Strawberry Mansion. Rest fifteen minutes at Strawberry and return by the cars; or breakfast there if you prefer. The speed should be about seventeen to seventeen and a half minutes to the mile, which may be judged by the park milestones. Remember to breathe full, through the nose, and to hold the body erect."

Comparative Values of Exercise.—For comparison, it may be taken, in those able to run, that a quarter of an hour's slow steady running will be equivalent to a full hour's fast walking. In the city, where the spectacle of an adult trotting through the streets might excite remark, running must be done either at night or indoors, where the air is never very good. Fortunately many open-air tracks are within reach and may be used, and in the evening one may jog two or three times round the outside limit of one of the city parks without interference from the police.

If the ordinary exercises are properly carried out, they all become breathing exercises, and except at first or for special conditions, special respiratory work will not be required. But certain special conditions, such as beginning **tuberculous disease, collapse of the lung, old pleuritic adhesions, convalescence after pneumonia** or **pleurisy,** and moderate degrees of **asthma** due to **chronic bronchitis,** even when some emphysema is present, will call for treatment by means of **forced breathing.** (See also volume x.)

In cases of suspected **phthisis,** treatment should not wait for diagnosis to be certainly established by the presence of bacilli in the sputum or by the occurrence of cavities in the lung. The appearance of the usual superficial anemia, the characteristic chest, impaired lung expansion, the general physiognomy, and the other well-known heralds of the disease, should be taken as indications for the prompt starting of 'fresh-air treatment' with forced breathing. To send the patient to live outdoors meets the necessities of the case incompletely unless he has definite instructions for improving the breathing in order to flush the diseased alveoli with frequent currents of air, distending and cleansing them at once. The character of exercises required will depend on the state of the lung—but full, held breathing can always be given safely, and repeated many times a day. No effort should be made to **hold the breath more than four or five seconds** after inhaling. Sharp walking exercise is good, and if no tendency to hemorrhage or fever after exertion appears, the patient may, after a few weeks, be set to moderately hard physical work. **Horse exercise** seems peculiarly suited to phthisical cases, and, for those who like it, may be combined with the open-air cure by sending the patient on a long horseback journey. This will keep him outdoors seven or eight hours daily, and induce mild constant use of the muscular system at the same time.* In North Carolina, Virginia, and West Virginia in the East, and in many parts of the West he may travel in this fashion and be able to keep at a good elevation, 1500 to 2000 feet and more, for many weeks together. **Bicycle journeys** are not desirable for patients with diseases of the lungs, the usual position on a wheel cramping the chest and discouraging expansion, although if the rider will **keep the back straight,** he may breathe deeply even when leaning well forward. He must not forget that to drop the shoulders forward and put the head down makes good respiration impossible. It is not necessary to sit absolutely upright in a position which makes the legs do all the propulsion with no aid from the weight of the body: it *is* necessary to keep the shoulders thrown back and the spine straight, so that even if abdominal respiration is a little lessened by the posture, the upper chest may have good play. Short trips on the bicycle, so soon as good respiratory movement begins to be habitual, and with care of the position assumed, are good; but for long journeys, especially into rough and mountainous countries, over bad or doubtful roads, far from repair shops, a horse is a more trustworthy conveyance.

Chest-bandaging.—In the treatment of **collapse of the lung, of pleuritic adhesions,** old or new, the chest bandage, as already suggested, gives valuable aid. It should be applied firmly to that portion of the chest which is in best condition, so as to limit its movements and concentrate both muscular effort and air-pressure on those parts of the lungs needing dilatation. We may thus get distinctly localized lung effects. In **tuberculosis of the apices** a rubber band or belt encircling the lower ribs may be worn for half the day without removal, but should not be kept on all the time lest it limit too much the entrance of air into the bandaged areas. Other materials, as cotton webbing or silk webbing, may sometimes be utilized. Strapping with adhesive plaster is less effective and more disagreeable, and needs care and experience to apply it well, but may be substituted. The corset of women may here be made useful instead of harmful.

* For an historic instance of the benefit of this measure, see the case recorded by Benjamin Franklin, and cited in the article on the Therapeutics of Tuberculosis contributed by the Editor of this series to Hare's "System of Practical Therapeutics," first edition, vol. 1, p. 779; Phila., 1891.

In **catarrhal asthma** it is necessary to force the movement of the upper chest and confine the diaphragmatic excursion, as breathing is usually deficient in the costal element in this disease.

In this and some other chronic bronchial affections associated with hypersecretion—for example, bronchiectasis—a combination of forced breathing exercises with peculiar position is useful. Let the patient lie face down on a couch with the head and chest lower than the pelvis and practise the breathing exercises in this posture. Many patients who have the usual feeling that they can breathe freely only when semi-erect will object to the attempt, but one or two trials will generally suffice to convince them of its value. The secretion is more easily gotten rid of in this position and the ease that it gives is often remarkable.

In **emphysema** inspiration is accomplished almost entirely by diaphragmatic effort and the greatest difficulty is with expiration. An elastic bandage continually worn around the whole chest assists the expiratory effort, and the expiratory force may be increased by exercises especially directed to it, as by blowing out the air and holding the breath after the utmost expiratory effort has been made. Forced inspiration, theoretically counterindicated in this disorder, is practically useful from its effect upon the heart and upon the pulmonary circulation. The observation of a case of emphysema occurring in a muscular man will convince any one who needs it of the small part played in breathing by the chest muscles compared with the important share belonging to the elasticity of the lungs themselves and the power of the diaphragm. With a strong man concentrating his whole effort on the attempt to use the accessory muscles of breathing, the emphysematous chest will scarcely move at all, and were it not for the use of the abdominal and diaphragmatic muscles, the unfortunate patient would die of asphyxiation, so that continued training of the belly muscles must be kept up on the lines already suggested, to help these patients.

General Suppling Exercises

After this digression upon respiratory gymnastics we return to the consideration of general suppling and setting-up exercises. Nos. 1, 2, 3 and 5 having been done standing, for ten days, and 'straight standing' practised, we proceed with general work, still keeping up each day these preliminary movements; if special chest development is required, one or more of the breathing exercises may be added, but it must again be said that proper methods of breathing, like the standing position, should receive constant attention and be a part of all the work.

12. **Arm Thrust.**—Raise the forearms to the front until horizontal,

the hands closed, backs down, the elbows close to the side. Strike out hard to the front with both arms at once, turning the hands backs up. Return to first position, drawing the shoulders and elbows well back. Light dumb-bells may be used if desired or required.

13. **Side Stretch Pronation.**—Raise the arms laterally to the shoulder level, palms upward. Pronate the arms forcibly, supinate forcibly, and continue the movement **rapidly** with the arms at full stretch. The hands should be open and the fingers fully extended. The exercise may be made more severe by doing the motion slowly and with extreme tension, or by using heavy dumb-bells with slow movement. The movement, done with force, involves almost all the muscles of the arm.

14. **Backward Circling.**—Raise the arms laterally, palms upward, as in 13. From the shoulder level let the extended arms make a small circle about a foot in diameter up and back. The arms should not be in front of the line of the body at any time. Repeat twenty to twenty-five times in a half-minute, allowing an interval of a single full respiration once or twice. Dumb-bells may be used to make this exercise more severe.

15. **Bent Elbow Swing.**—Raise the arms laterally as in 13. Touch the tops of the shoulder with the finger-tips, keeping the upper arm horizontal. Bring the elbows swinging to the front and then force them back as far as possible in the same manner. The movement should be rapid. These three exercises (12 to 15) free the shoulder-joints and affect the muscles of both chest and shoulders, and also tend to 'open' the chest and promote erect carriage.

16. **Shoulder Thrust.**—Straight standing:—Raise the extended arms sidewise, palms up, till they are at full stretch above the head (Fig. 27, *A*). Bring the arms forward and down to shoulder level, turning the palms to the front and thrusting all the while from the shoulders hard and steadily as if pushing at some heavy object (Fig. 27, *B* and *C*). The head should be held back hard. This is a most valuable means for **correcting round shoulders** and **stoop,** as it flattens the back and strengthens all the scapular and shoulder muscles. It is also used as a local exercise in cases of accumulation of fat over the back of the shoulders and below the nape of the neck, for which the movements should be made very slowly and with extreme tension.

LEG EXERCISES

In a general scheme of exercise, leg movements should be alternated with arm and body work to a certain extent. The ordinary individual is commonly less deficient in the legs than in the trunk and upper

FIG. 27.—SHOULDER THRUST. EXERCISE NO. 16.

extremities, since even the idlest and most sedentary must make use of the lower limbs somewhat. Therefore, except special deficiencies be present the legs will not need more than two or three movements, besides those general ones which involve them at the same time with other parts. Straight standing itself is an exercise for legs unaccustomed to it.

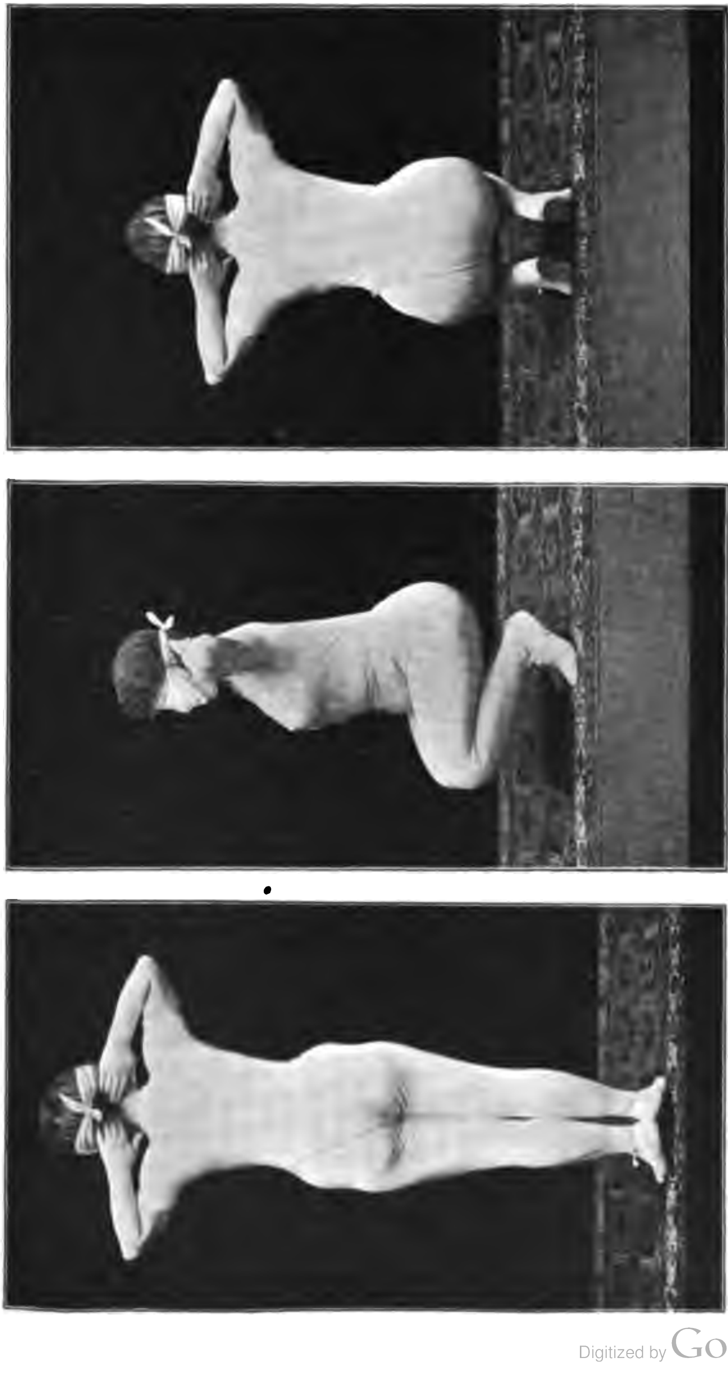
17. **Leg Flexion and Extension.**—Place the hands on the hips, thumbs behind, elbows pressed back. Raise one knee as high as possible, allowing the lower leg to hang. When the limit of flexion is reached, slowly extend the lower leg and foot, bringing the whole limb gradually down to the ground. This movement should at first be slow, to secure the fullest flexion. As pupils improve in balance and suppleness, it may be made faster until it becomes a quick, hard kick. The legs should be used alternately. The exercise may be divided into two separate movements: one, simple flexion of the leg to the greatest possible extent; the other, flexion with extension.

The effect upon the abdominal and pelvic muscles is very great, and the exercise is useful in the reduction of abdominal fat, in constipation, and in intestinal indigestion.

18. **Leg Extension Sidewise and Back.**—The position is the same as in 17. (*a*) Raise the fully extended leg straight sidewise as far as possible without changing the erect carriage of the body. (*b*) Carry it steadily backward to possible limit and bring it forward into line again, thus making a quarter circle, backward. As in 17, the two parts of the exercise may be performed separately. A certain tension should be kept up on all the muscles of the limb throughout the movement. The outside and posterior muscles of the hip and thigh share this effort with those of the lower abdomen. The effects are much like those of 17.

19. **Deep Knee Bend.**—With the hands on the hips as in 17, lower the body as far as possible, bending the knees and separating them, heels raised from the ground; the trunk held erect. Rise, straightening the knees and bringing them together, and do not let the heels touch the ground till the legs are straight. The movement should be slow and occupy about six to eight seconds. A variation of this exercise is performed with the heels kept on the ground—**light knee bend.** It calls on a slightly different set of muscles, is more difficult, and the extent of movement is less. Its most valuable effect is on the groups in the front of the lower leg.

Another useful variation is Checkley's, which makes the movement much more rapid. "Draw the arms back until the hands are about eighteen inches behind the vertical line of the body, relax the leg muscles and drop quickly" into the squatting position, keeping the weight on the balls of the feet. As the body drops, the arms are swung forward; and



C B A

FIG. 28.—DEEP KNEE BEND. EXERCISE NO. 19.

as it rises, they continue their swing till they are extended in front of the chest. The arm movement helps the balance. The exercise is rapidly repeated, six to twelve times. It is of special value in cultivating carriage and poise, and is hard muscular exertion for the legs as well, if frequently repeated, and if done slowly.

A distinct variation on this exercise consists in altering the arm position by placing the tips of the extended fingers of both hands at the nape of the neck and forcing the elbows back, then doing the knee-bending. Balance is more difficult thus, but this makes the exercise more valuable for certain persons (Fig. 28).

20. Toe-rising.—Place the hands on the hips as in **16.** Rise slowly on the balls of the feet, heels together, knees straight. Lower the body steadily till the heels touch the ground. All the muscles of the leg are used, but the chief stress is upon those below the knee. The exercise should be repeated ten to twenty times, and may be done much oftener, even fifty to a hundred times, when needed. The body must be kept upright and the chin high.

21. Still-walking and Running.—With the hands on the hips and one foot placed about fifteen inches in advance of the other, rise slightly on the balls of the feet, and with a slight spring reverse the positions of the feet. Or, with the feet side by side, rise on the ball of the right, keeping the left off the ground, and change quickly or slowly as may be desired, from one to the other. In other words, walk or trot, according to the speed with which the action is done, without advancing. The heels should not be brought to the ground at all during the whole time of continuing the movement, which may be repeated 50, 100 or more times as the muscles strengthen.

The muscular exercise of the legs is of the first importance; but there is a useful secondary effect of 'shaking up' the whole body, and if long continued a stimulation of the circulation and respiration. A movement combining respiratory and suppling motions may be added to the general list at this point.

22. Arm Stretch.—A modification and combination of **6, 7,** and **8** into one. (*a*) With arms hanging by the sides, close the fists and push down as hard as possible, inhaling as the effort is made and maintaining the stretch during slow expiration. (*b*) Then inhale and raise the arms laterally, extend them at the shoulder level, palms down, fingers extended; stretch sidewise, holding the breath during the effort and lowering the arms slowly while exhaling. (*c*) Raise the arms forward, fingers extended, inhaling the while, stretch above the head, palms to the front, breathing out as the arms descend slowly to the original position.

The three parts of the exercise may be done separately, with intervals between; but if the patient is of ordinary strength, he should be able to do the three in succession, taking about thirty seconds to the whole movement. With a rest of one or two breathing spaces on its completion, it may be repeated three to five times. If the stretching is faithfully per-

FIG. 29.—TRUNK BEND, FORWARD. EXERCISE NO. 23.

formed, using as it should all the extensor muscles of fingers, arms, and shoulders, it is an excellent suppling exercise and a good preliminary to the trunk movements which follow.

TRUNK EXERCISES

23. **Trunk-bend, Forward and Back.**—With the finger-tips touching the nape of the neck and the elbows pressed back, bend forward from the hips without bending the knee. In the forward movement keep the

back straight. Raise the body and bend backward. The movements should be slow and go in each direction as far as possible without bending the knees (Fig. 29).

24. Trunk-bend, Sidewise.—With the hands on the hips bend to the right. Keep the body in one vertical plane without turning it or raising

FIG. 30.—STOOP AND TWIST. EXERCISE NO. 26.

either heel from the ground. Repeat to the left. The movement, like 23, should be slow.

25. Trunk-circle.—Same position as in previous exercise. Bend the trunk to the right as in 24. Turn the body backward and bend back as in 23. Turn the body to the left and bend in that direction as in 24, bring the body straight and bend forward as in 23. Almost all the muscles of the back and abdomen are utilized in these movements.

26. Stoop and Twist.—Stoop forward, bend the right knee, touch the floor with the right hand an inch or two in front of the right foot, at the same time stretching the left arm back and up. The left knee must not be bent. Reverse without raising the trunk, by straightening the right leg and bringing the left hand to the floor in front of the left foot, at the same time bending the left knee and carrying the right hand up and back (Fig. 30). With practice it should be possible to put the palm of the hand flat on the floor. (See Fig. 40.) The exercise is a useful general trunk and shoulder suppling one, of service especially in obesity.

27. Arm Circling.—Swing the arms alternately in complete circles from the shoulders, reversing the direction after a few turns. This is a rapid free movement, useful as a final exercise after a series of less wide and more cramping or slow motions.

Many persons unaccustomed to the control of the muscles find difficulty in relaxing those muscles which are not in use in any given exercise, or at first are very uneven and jerky in their execution of the movements. For these, relaxing exercises may be of service as a preliminary.

28. Relaxing.—From a standing position, drop the body slowly forward, allowing the arms to swing loose, and the head to fall forward, at the same time bending one knee. Rise slowly to the upright position. The eyes should be closed during the motion. Repeat slowly several times, relaxing the right and left knees alternately.

CHAPTER V

FREE WORK FOR HOME EXERCISE

Muscle-making. Relative Usefulness of Slow and Rapid Exercises. Forms of Exercise for Different Ages. Lists of Movements and Exercises.

The reader will have observed that almost all the exercises suggested in the foregoing pages are recommended to be done slowly. In this way persons below the average physical level gain the best results in increasing muscular power and in acquiring precise control of movement. In the suggestions on the use of each exercise will also sometimes be noted the phrase, "this exercise may later be done rapidly."

Those who wish to maintain good general health or to keep in condition and who have no opportunity for active sports should prefer rapid to slow work, provided, as has been already insisted upon, that there is no special deficiency of development. No man need say that he is unable to take enough exercise to keep in health and fair muscular order, since ten minutes daily will fulfil these requirements if the time be well used. Effective and sufficiently frequent bathing, enough food and enough sleep being taken for granted, any one may keep well and active, and even fit for severe exertion, by devoting ten full minutes a day to sharp muscular work, and once in a fortnight getting a good sweating either by more prolonged activity or, if time or opportunity do not permit this, by a sweat-bath or a Turkish bath.

Muscle-making.—To build up big muscles is not very difficult, but the ordinary individual has very little need of them, whereas there is no one to whom it is not valuable to be instantly ready and fit for rapid action or for a moderate continuance of severe exertion if the necessity should arise. The innumerable correspondence schools of physical culture have for their chief aim, and most of them for their only one, the production of large masses of muscle; some add to this, instruction in respiratory exercises. The former object is easily gained: select the muscle or group of muscles to be improved and contract them steadily and slowly with all possible tension, using at the same time the naturally opposing groups so as to make the effort greater. Such an exercise, for instance, as will use the flexors of the forearm in this way may be so applied as to increase the circumference of the member a half inch or more in ten days and give the muscles a splendid firm consistence to the touch. Whether this is done by 'free work' with self-resistance, by dumb-bell exercises, or chest-weight movements, the result is the same. When patient effort has attained this end, what has been gained? Has the man with the big muscles improved his health in a permanent fashion? Has he bettered his general efficiency?

He may have improved his health, because any exercise is better than none. He has added to his power to carry a trunk or to lift a weight—matters of no very great moment in the ordinary life of the ordinary man. But the aims of exercise, apart from the pleasure of effort, should be to acquire increased endurance, and the power of rapid, accurate, and economical use of all the forces of the body. For the feeble, the convalescent, perhaps for the old and for those with imperfect control of simple muscular acts, **slow movements** should be ordered until the muscles are strengthened, and steadiness and smoothness of motion learned; for training and condition, which words mean neither more nor less than the fittest possible state of a man's functions, for muscles that shall be instantly and rapidly obedient to the will in either simple or complicated movements—in short, for useful agility and endurance—**rapid movements** should be chosen. Within limits, too, the more rapid they are, the better; just as in the proper use and application of slow movements, the slower they are—within limits—the more valuable. But it is also true of both forms of exercise that in order to extract the best results from them it is necessary that the movements, whether slow or fast, be done in the right way. Wrong habits of use of muscles are no more desirable than other wrong habits and may wholly counteract the expected good effects of the work.

The effect of exercise upon the general nervous system is of course in part due to altered nutrition, but rapid free work has the additional invaluable effect of bettering the co-ordinate relation of brain and muscle, knitting them, as it were, more closely together and increasing their mutual responsiveness. Another great point is that the improved relation between the brain and the muscles results in rendering the movements easier, automatic in fact, so that less energy and less attention, and consequently less nervous expenditure, are required for their performance. The ordinary individual has at his disposal for the processes of life a fairly definite daily nervous income, if one may use such an analogy, and the more of it that can be saved from expenditure in doing ordinary work, the more there is left for use in higher and more important ways. Concentrated attention is fatiguing—or, to pursue the image, expensive—and a saving can be effected by making automatic as many as possible of our exertions, mental and physical; a result which is attained by practising them until they are done without conscious attention.

Among the exercises described in previous chapters many will be found suitable for brisk, as well as for slow work; but in order to lessen the trouble of picking them out and of referring to various places for them, the same movements are described here again. It must be recollected that it is impossible to devise a set of universally applicable exercises, nor will it suffice to divide them into those 'suitable for children under twelve,' 'suitable for children from twelve to fifteen,' 'suitable for men,' and so on. Individual considerations will alter the list each time. Tall, slight people do not need precisely the same sort of work that short, stout ones do; one man will need more leg work, another must put more time into arm movements, and so on. Also it should be said that even when a list of exercises individually appropriate has been made, it will require revision and change, not only because of the changes brought about by the work itself, but in order to give variety and keep up the freshness of interest. All methodical exercise is tedious or soon becomes so, though the active free-work is less irksome than gymnasium practice or apparatus work.

The aim of general exercise is health and condition, not chiefly or merely muscular development. To gain this, exercises must be so arranged for any given person as to secure an equal development and an equal capability of use in all the muscles. Formal and methodical exercise may be necessary for a time to improve deficiencies. When this has once been done, games and sports, if sufficiently varied to employ all the muscles, are better than prescribed movements, because they are more interesting. In the development of children it is particularly desirable that the work should be made attractive, and this drill and calisthenic work can never be, after their first novelty is worn off. Except, then, when special groups of muscles require strengthening or individual deformities or bad postural habits need correction, **children's exercises** should be in the form of **games.** These should be such as call for varied activity and moderate endurance, and for older children, such as need special skill, quick decision, and ready action. Up to the age of **puberty** there need be no marked line drawn between the exercises of girls and boys, but after the first signs of sexual development appear, certain moderate restrictions are needed for girls. Jumping, using the skipping-rope, and hard cycling are examples of the sorts of exertion that should not be permitted to girls at or after this time of life. **Boys** between fifteen and eighteen years may reasonably be allowed exercises demanding longer continuance of effort and greater trials of endurance than should younger lads. Violent effort in feats of strength, like lifting weights, putting the shot, and long boat-races, should not be performed by those under eighteen years. From eighteen to thirty years the whole field of athletic activity is open. **After thirty** years of age few men keep enough in condition for exercises of speed, and, indeed, unless a man has kept up his activities more than is usual, work demanding continued speed may very possibly be dangerous to the integrity of heart and blood-vessels after thirty-five. By that time of life most men will be willing to content themselves with the less active forms of exertion: riding, moderate cycling, skating, walking and climbing, golf.

A few words and most important ones must be said on the immense value of exercise in **later middle years** and in **old age.** With the increasing ease and convenience of life some incidental opportunities for exertion have been removed. Where once people would have walked, they now ride, and elevators in flats and private houses have taken from many the chance of performing several times a day that journey up-stairs which might well, in the old especially, supply much-needed exercise for the heart. I am well convinced that old people frequently fall prematurely into senile decay for want of a reasonable sufficiency of active exertion, and that stiffening of joints, relaxing of the muscles, weakness of the heart, and hardening of the arteries, while perhaps ultimately inevitable physiologic alterations, may be longer postponed by a continued interest and participation in such outdoor sports and activities as are possible without overexertion; for example, walking, fishing, riding, and golf. One disorder which is common in men past sixty, namely, prostatic enlargement with all its accompanying discomfort, has certainly been most favorably affected in several instances in my experience by a return to a habit of riding, after many years' interval without being in the saddle. Probably this effect was brought about by a kind of massage of the prostate gland from the alternating pressure as the rider rose and fell to the horse's motion. Exercise is a still more vitally important matter in elderly folk with a tendency to take on fat, for as the old cannot be sweated by baths or drugs without danger, nor be severely restricted in their diet, muscular exertion becomes our only means of combating the doubled danger of fatty changes added to the usual senile degeneration of tissue.

The first arrangement of exercises which follows has been devised by Dr. Albert McConaghy, of Philadelphia, with the special view of bringing into action practically every muscle of the body. Few persons will need to go through with the whole fifteen; a judicious selection from them will meet the requirements of almost every case, and both slow and rapid movements are included in it. Two briefer lists follow, such as may be used by a busy man who can give but a few minutes to his training. All of these have had the advantage of being tested by use and may be said to be thoroughly practical. If there be no instructor to oversee them, the user should practise at first before a mirror to make sure his attitude and movement are right. The less clothing worn the better, as the exposure of the body to fresh air is wholesome in itself, and there should be plenty of air, from wide-open windows if possible, in

Fig. 31.—Exercise 29.

Fig. 32.—Exercise 30.

order that during the accelerated breathing caused by the activity, and more especially during the special breathing exercises, the lungs shall be supplied with the freshest and purest available air.

In those exercises in which dumb-bells are suggested, light bells of from four to six pounds' weight to the pair are sufficient.

All the exercises **begin from the straight standing position** unless otherwise stated, and the student should be careful to return to this attitude at the end of each movement.

29.—With the dumb-bells on the shoulders, extend the right hand laterally from the shoulder, turning the head in the same direction; bring the right hand back to the shoulder, turning the head at the same time

FIG. 33.—EXERCISE 31.

FIG. 34.—EXERCISE 32.

FIG. 35.—EXERCISE 33.

to the middle line again; extend the left hand, following with the head, and repeat (Fig. 31).

Do not roll the head, simply turn it, and do not allow the elbows to sink below the level of the shoulders. All the muscles should be tensely used and the whole movement be slow and steady.

Repeat four times in each direction.

30.—With the elbows at the sides grasp the bells with the knuckles underneath; extend and flex the arms, alternately touching the thigh and chest with the bells. Do not allow the elbows to move from their position (Fig. 32).

This should be slow for three or four movements, and then rapid.

Repeat ten to twenty times.

Position A.

Position B.

FIG. 36.—EXERCISE 34.

31.—Fix two points on the wall opposite the shoulders; face one point, make all the muscles of the neck rigid, and turn the head slowly to face the other point, and repeat, four times each way (Fig. 33).

32.—Fix two points, one on the ceiling above the head and one on the floor at the feet; throw back the head, using the neck muscles with all possible tension till the eyes look at the ceiling point, then bring the head slowly forward with like tension till the floor point is faced, and repeat four to six times (Fig. 34).

33.—From a position in which the open hands are hanging against the buttocks, raise the arms laterally, palms up, till the hands are above and behind the head line. Inhale slowly as the arms go up. Lower the arms steadily, exhaling so that the end of expiration is reached as the arms come to the sides (Fig. 35).

Repeat four to six times.

34.—With the hands on the hips, thumbs behind, turn the trunk from the waist to the left and right; as the body turns, the hands firmly rub the abdomen (Fig. 36).

Repeat two to four times.

The head is never moved, being kept in line with the body. The

FIG. 37.—EXERCISE 35.

abdominal squeezing by the hands has usefulness in cases of sluggish intestinal action and may be omitted.

35.—Bend the body to one side and touch the leg as near the knee as possible, at the same time bringing the other hand into the axilla of its own side. Reverse and repeat, four to six times.

In bending over to the side, keep the body in the same plane as when erect (Fig. 37). The movement may be either slow or fast, as required.

Dumb-bells may be used.

36.—Exhale; reach as nearly to the floor as possible (A) without bending the knees; come to position (B) and while the hands are slowly brought to position (C), take in a full breath, rising on the toes at the same time.

Position A.

Position B.

Position C.

FIG. 38.—EXERCISE 36.

Hold the breath while the hands are brought to position (D), exhale and bend the arms while taking an additional breath till the thumbs touch

Position D. *Position E.*

Fig. 38.—Exercise 36.

Position A. *Position B.*

Fig. 39.—Exercise 37.

the shoulders; then extend arms widewise and exhale slowly as they are brought down (E) (Fig. 38).

Repeat four to six times.

The breathing should be strictly normal, not jerky in character, but smooth and even.

37.—Hands on the hips with thumbs back; bend the body forward to a position at right angles to legs (*a*), and while the muscles of the abdomen are thus relaxed, knead the abdomen with the fingers. Swing the body steadily back to the possible limit, and as it is bent backward (*b*), brace it by resting hands on hips (Fig. 39).

Repeat four to six times, slowly.

FIG. 40.—EXERCISE 38.

38.—With the body bent at right angles to legs and kept in this position throughout the exercise, bend the right knee and touch the floor in line with the right foot with the right hand, extending the left arm backward and upward. Straighten the right knee and carry the right hand up and back, bringing the left hand down to touch the floor in front of the left foot, in the same way (Fig. 40). (Stoop and twist, No. 26.)

In changing from the right leg to the left leg, do not elevate the body.

Repeat four to six times with moderate speed.

39.—Elevate the shoulders as high as possible without drawing the head in (A); lower them as far as possible (B), turn the shoulders forward (C) and throw the arms backward (D) (Fig. 41).

Fast movement, repeated ten to twelve times.

40.—Drop the body with the heels raised, the knees bent and separated; straighten and close the knees and rise. At the beginning of the downward movement, throw the arms slightly backward; on the upward movement bring them forward until extended in front of the chest. Do rapidly, and repeat ten to twenty times. (Deep knee bend, No. 19, see Fig. 28.)

41.—Lie at full length on the floor, with the hands under the hips, and bring each leg alternately and slowly to a position at right angles to the body (Fig. 42).

Repeat four to six times.

42.—Lie at full length on the floor, with the hands under the hips, and bring both legs at once to right angles with the body and repeat. The exercise should be done slowly for the most effective result (Fig. 43).

43.—Lying full length on the floor, the hands clasped behind the neck,

Position A.

Position B.

Position C.

Position D.

FIG. 41.—EXERCISE 39.

the elbows on the floor, bring the elbows in, bend the body forward till the face touches the knees; return to original position and repeat (Fig. 44).

Try to do this movement without taking the feet from the floor. At first some weight on the feet, or hooking the toes under a bureau or heavy chair will be needed. The movement should be slow.

Fifteen Minutes Exercise

The following list will need, including brief periods of rest between series of movements, about fifteen minutes. The order of arrangement is such as to call alternately upon the muscles of the extremities and those of the body. No apparatus is required, though a minute with a punching-bag might be substituted for No. 54 and increase the liveliness of the exercise.

44.—**Side-stretch and rotation.** Extend the arms laterally at shoulder level, hands clinched, knuckles up. Rotate the arms to the supinated position, opening the hands and extending the fingers briskly; reverse, shutting the fists as the hands are pronated. Repeat as fast and hard as possible, twenty-five times in twenty seconds.

Fig. 42.—Exercise 41.

45.—**Deep knee bend.** With the feet a few inches apart, drop the body, separating the knees and raising the heels. The trunk must be held erect. The hands may be placed on the hips or at the back of the neck or the arms swung back with the drop and brought forward and up on the rise. (Same as No. 19 or No. 40, see Fig. 28.) Repeat twenty-five times in forty seconds.

46.—**Overhead stretch.** Elevate the arms laterally, palms forward, breathing deeply, till the thumbs touch above the head. Keep this position and hold the breath for four seconds. Lower the arms slowly, breathing out; hold the breath out for four seconds. The total time of each complete movement should be twelve seconds. Repeat six times; making the total time of the exercise one and one-half minutes.

47.—Leg-lifting, backward. Raise each foot backward to extreme limit, slowly and with tension, keeping the thigh in the same line as the body. Put them down with the same tension. Repeat four times slowly, then eight times as fast as possible with each foot; slow movements five seconds each, rapid movements one second each; total, one minute and twenty seconds.

48.—Backward circling. Raise the arms laterally, palms upward. At shoulder level describe a small circle about a foot in diameter upward and backward with the extended hands and arms. The arms should at no point be in front of the line of the body. Repeat twenty to twenty-five times in thirty seconds. (Same as No. 14.)

49.—Lateral bend. Bend the body sidewise at the waist, keeping in one plane. Repeat once or twice slowly, then do it more rapidly. With the rapid movement raise the shoulder on the uppermost side and draw the hand up to the armpit. Repeat eight times in ten seconds in each direction; total, twenty seconds.

FIG. 43.—EXERCISE 42.

50.—Setting-up movement. Raise the arms sidewise, palms forward, to shoulder level; bring them steadily forward till parallel in front of the body, keeping all muscles tense; then swing the arms backward and downward, at the same time rising on the toes. The backward swing and lowering of the arms should bring the hands about to the hip level. The beginning of the movement is steady and only moderately rapid, the concluding swing and toe-rising as fast as possible. The total time for each completed movement is five seconds. Repeat twenty-four times, making, in all, two minutes. (Same as No. 5.)

51.—Abdominal breathing. With the hands resting on the hips, thumbs behind, breathe from the abdomen, concentrating the attention on the use of the abdominal muscles; repeat twelve times in one minute. (Same as No. 11.)

52.—Forward kick. Stand on one foot and raise the thigh of the other leg as high as possible; then extend the lower leg rapidly and hard, returning to original standing position after each movement. Repeat ten times with each leg, in forty seconds.

53.—Shoulder thrust. Raise the extended arms sidewise, palms up, till the thumbs touch above the head. Turn the palms to the front and bring the arms steadily forward to shoulder level, thrusting hard all the while from the shoulders. Repeat eight times in one minute. (Same as No. 16, see Fig. 27.)

54.—Stride and strike. Strike out from the shoulder, taking a simultaneous stride forward with the leg of the same side. Be careful of the balance. Recover position and repeat with opposite arm and leg. Do this ten times each side; making the total time occupied eighty seconds.

55.—Trunk swing. Swing the body from the waist as far around as possible without moving the feet, letting the arms go so that they swing

FIG. 44.—EXERCISE 43.

loosely with the turn of the trunk. Repeat with moderate speed eight to ten times in thirty seconds.

56.—Arm-circle. Swing the arms in circles alternately from the shoulders, reversing the direction of the movement, after a few turns. Use each arm ten seconds in each direction; forty seconds in all. (Same as No. 27.)

57.—Still run. Raise the feet rather high and fast in front for a half-minute, then raise them high backward for a half-minute; gradually slow down for twenty seconds. (Same as No. 21.)

The total time required for the exercises just set forth, allowing for five or six seconds of rest to breathe quietly after each movement, is a trifle less than fifteen minutes. If the performer bears cold bathing well, this is the proper time for a quick sponge off and a stiff rubbing down with a hard towel.

A shorter list of only **ten** movements follows. Most of the movements are included in the previous selection, but the order is changed so as to give the same variety in the use of different groups of muscles afforded by the longer series. The total time required for this series is about ten minutes, and it should be succeeded by cold sponging and a hard toweling like the other exercises.

If performed at night, it is better to omit the still-running and make a corresponding increase in some of the less taxing movements to fill up the ten minutes.

Ten Minutes Exercise

No. 5, **setting-up movement,** two minutes; followed by five seconds' rest.

No. 14, **backward circling** arms, forty seconds. Rest as before.

No. 52, **forward kick,** twenty seconds.

No. 44, **side stretch and rotation** of arms; twenty seconds.

No. 16, **shoulder thrust,** one minute.

The next is a movement not previously described.

58.—Hewing movement. Throw the hands straight above the head with the utmost possible stretch, filling the chest as the arms go up; bring the arms rapidly forward and down in a sweeping motion, the body bending at the same time. The legs should be separated sufficiently for the hands to go between them. Repeat at the rate of once a second for half a minute.

No. 46—**overhead stretch**—comes next, one minute; then No. 19—**deep knee bend**—fifty seconds; and these are followed by No. 25, **trunk circle.** With the hands on the hips and the elbows pressed back, bend the body to the right in one vertical plane. When the limit of motion has been reached, push the left shoulder forward and bend the trunk backward; continue to bend to the left, bringing the right shoulder forward as the trunk reaches its limit of motion to the left, and end by bending forward with the back straight. Almost all the muscles of back and belly should be brought into action in this exercise. Repeat for half a minute.

Conclude with No. 21 (**still-running**) for one and a half to two and a half minutes.

Allowing for a space of two or three quiet breaths after each exercise, the program here outlined will occupy about ten minutes.

CHAPTER VI

SYSTEMS OF PHYSICAL CULTURE

Systems of Physical Culture: The Swedish System: Complexity and Multiplication of Movements; Order of Work; Physiologic Absurdities; Value of the System; Other Methods Founded on it. Advertising Correspondence Schools: Their Dangers. Zander Medico-Mechanical System of Movement by Apparatus. Massage by Machinery.

In the preceding pages no attempt has been made to describe all possible exercises or even exercises suitable for all forms of disease or deficiency, or to emulate the minute division, subdivision, and meticulous description of an infinite number of slightly differing movements. The effort has been rather to suggest a sufficient variety of exercises to serve most medical ends, to describe them in the simplest manner, and to indicate the general principles on which they are founded and upon which other exercises may be built as required. Something, however, may be said of certain 'systems' of exercise—or, to use the term most frequently heard, of 'physical culture'—concerning which, physicians are frequently questioned. (See also Part II.)

The **Swedish** or **Ling** system of medical gymnastics has never taken any strong hold on the profession in this country, but its importance in helping to give us a rational basis for physical culture must always be recognized by every student of the subject, however little its limitless elaborations may appeal to him. General medicine owes much to Ling's propaganda in the spread of information about medical gymnastics, though not so much as Swedish authors would have us believe. It is probable that had Ling's system been cumbered with a less appalling terminology and less burdened with fantastic theories, it would to-day occupy a higher position. Valuable as Ling's work was, the school founded by him has degenerated into a kind of barren formalism; the system has become a sort of religion in which faith replaces knowledge and one is asked to begin its study by swallowing whole a quantity of the most innutritious formulæ on which science could be fed. Moreover, almost all of Ling's theories are untenable and his physiologic statements absurd, even according to the physiology of his day. Fortunately, however, the practice of the Swedish gymnasts always has been, and is now, better than their theories; and in their specialty of corrective work they most certainly obtain results. The point most insisted upon by this school is the **sequence** of movements, or the 'day's order'; an arrangement intended to bring into play in turn all the muscles of the body—first in single or simple movements, then in combinations of several groups of muscles, next in highly co-ordinated and complex actions, and finally in forms of exertion requiring general activity of the whole body. To be more precise, the Swedish drill begins with **order movements**: the name does not accurately describe the character of the movements, but rather their purpose, which is general suppling, and what a trainer would describe as 'warming-up' work. With these are associated **leg movements,** which are separated from the movements of the upper extremities that precede them on some very queer physiologic grounds. The next procedures are flexions of the trunk backward for chest dilatation and mobilization, called **span-bending.** Third come what the English teachers of the system name **heave movements,** exercises chiefly for developing the upper chest by lifting motions, many performed in a hanging posture. These three sets are progressive, the last needing much more effort than the first. The fourth class are the **balance movements,** exercises in co-ordination and equilibrium in various positions. The fifth, sixth, and seventh classes are **trunk movements,** respectively backward, forward, and lateral, more precisely spinal flexions, involving also the use of abdominal muscles. Eighth come the most severe exercises of the 'day's order,' demanding exact co-ordinated action of many groups of muscles, **games, jumping, running,** and **vaulting,** which "should never exceed the point where severe breathlessness begins." Last comes the tapering off with slow leg movements and breathing exercises.

The practice of following sharp or violent activity with moderate movement rather than stopping all at once is a good one, and almost universal with trainers, whether of athletes or race-horses; experience telling them that there is less distress felt after exertion if the cessation be gradual. The Swedish physiologic reason is wrong, or at least insufficient, when it says this is done to "render the heart's action normal and restore free respiration." The heart's action will become normal of itself unless the heart has suffered real injury, and the respiration quickly return to its usual state without being 'restored' by moderate exercise. There are probably two quite commonplace and obvious reasons for the gradual stopping of activity; the one to allow gradual lessening of sweating and permit the evaporation of moisture to take place slowly to avoid chilling, the other to keep up for a short time a slightly accelerated action of the heart in order to maintain the circulation in good condition, thus probably helping to carry off the products of exertion from the muscles.

A good teacher, not a mere routinist, will of course vary the exercises in his order from day to day, thus keeping up the interest of the pupils and lessening or removing the tedium of gymnasium class-work, usually only less painfully monotonous than pulling weights about on an ingenious variety of machines.

The most important point, as is said above, of the Swedish system is the progressive arrangement thus briefly described—a point that belongs peculiarly to this system and which has this virtue, that the pupil is not asked to do difficult exercises until he can do easy ones. For school drill, for class work where individualizing is impossible or needless, a good teacher acquainted with the Swedish methods but not too thoroughly subdued by them can make excellent use of this plan. The objections to it are, first and least important, the physiologic reasons given for the movements and their order; second, the untenable claims some of its advocates have made for the system and its founder, from which one would think he had invented muscular contractions, and, last and most serious, the tremendous complexity of the whole business.

The Swedish gymnast distinguishes in each movement a starting-position—that is, the posture in which the part of the body to be moved is at the beginning of the movement; next, the excursion made by the part of the body. This must be minutely described. For example, there are four fundamental positions—standing, sitting, lying, and hanging. Almost all possible movements can be started from each of these positions, and every one of all these possible movements is considered as a separate exercise according to its starting position. This makes a sufficient beginning complication. Next there are a number of subsidiary or secondary starting-positions, differing in the arrangement of the lower or upper extremities, or of the trunk. From each of these, again, we have a whole array of possible movements. For example, a movement which is made from the ordinary straight standing attitude is described as an altogether separate exercise when it is made from the stride-standing attitude, commonly called straddling. Thus the possible exercises become a matter to be calculated by geometric progression. Next, all or nearly all movements can be made either passively or actively, and a good many are a combination of active and passive; and taking this into our calculation, we begin to see that the number of possible separate exercises in the Swedish system, each with a name and a full description, approaches infinity.

The system has furnished the foundation for a great many more plans of exercise of various degrees of importance than any single book could include descriptions of within its compass. Some of them, like the Delsarte system, or rather the outgrowth from it which has adopted its name, are merely esthetic in their intention. Others are considered elsewhere in this volume. (See Part II.) The recent craze for physical culture in this country has stimulated the growth of a number of 'practical systems,' each of which, according to its author, usually a retired prize-fighter or ex-athlete, is the only way to physical perfection. Most of these are good, and all are very much alike, each inventor modifying a little here or there, or adding a new and peculiar twist to a well-known movement. Some of them are bad, mostly in encouraging overexertion in untrained persons. In one or two, the kind and quantity of effort suggested is such as to constitute a serious danger if undertaken without preparation by an individual of inactive habits. Not a few cases of disturbance of the heart have occurred in consequence of the blind acceptance of the orders of an unknown instructor who never saw his pupil. These have mostly followed very active rapid movements performed with all possible speed, exactly according to the instructions received by the pupil. Another much-advertised system has also supplied some examples of slight strain of the heart from the practice of self-resisted movements by individuals with feeble cardiac muscles. Old people, and men of middle age, sedentary habits, and a tendency to obesity, are especially liable to be injured by following the manifolded advice of these knights of the typewriter. Physicians should not regard this matter either with indifference or with complacency; and, moreover, should not permit their patients to withhold from them knowledge of the exact movements carried out—as patients are sometimes prone to do, through some fancied obligation of confidence to a 'confidence man' posing as a 'professor' of physical culture, and reckless of the harm done to his confiding dupes or pupils. It is much better for the physician himself to prescribe 'home work' suited to the individual patient for the special time.

Sargent's System.—While the apparatus for the cultivation of special groups of muscles, which we owe to the study and experience of Dr. Sargent of Harvard, do not form and do not pretend to form a complete system of physical culture, yet as the only genuine original contribution of America to formal gymnastics they claim consideration here. Rightly used under proper direction these machines are of immense value. Their field is found in gymnasiums, where they can be applied to the building-up of defective muscles or of weak parts of the body. Under Dr. Sargent's careful methods of examination, the defects of each individual are noted and suitable exercises on certain apparatus prescribed, with exact orders as to speed, weight, and time of use. In this way the parts which specially need cultivation are improved until the peculiar deficiencies of each individual are supplied and his general development becomes physiologically balanced. When this ideal average level, differing for every person, has been attained, he is in fit condition to undertake any kind of further work for general strength or to go into any game or sport to which his need or fancy may point.

The apparatus is in considerable variety and may be very variously adjusted for any part, so as to offer exercises suitable for one finger or for the great muscle groups of the back or the belly.

Zander's Method.—Another system that depends upon apparatus, though of a very different sort from those of Sargent and used in a very different way, is that which its inventor, Gustav Zander, has described rather inexactly as intended for "medico-mechanic treatment." This has not had much vogue in this country, but has attained a place of sufficient importance abroad to call for some description. The two classes of Zander machines are respectively intended for the administration of the several manipulations of massage and for the production of passive, active-passive, and resisted movements. Their operation depends upon various applications of the lever-principle. A manometer is so attached as to show or register the force used, the speed of each machine is governed by the number of teeth in its several cogwheels, adjustable to obtain differing rates and extents of movement, and a special clutch-wheel or a governing handle is so fitted to each as to make it possible to throw the whole machine out of gear and stop it in an instant. The motive power is entirely separate and may be steam or electricity. The apparatus is only sold in sets, the first cost is very great, the expense of running and maintenance large, and the machines are of considerable complexity. Herz, Krukenberg, Funke, Nebel, Charcot and others in Europe, Kellogg, Phelan, and a few others in this country, have produced a vast number of mechanical devices, more or less complicated, for the same purposes as the Zander machines. Those of Herz and Krukenberg are the only ones which have met with any general success; and while their principles of operation differ somewhat from Zander's, and some of them are improvements or simplifications of the latter's apparatus, the effects sought are the same as in his system, a brief description of which will therefore suffice for all.

Effects and Uses.—The aim of all these machines is to take the place of an attendant. The partizans of the method assert that machinery can

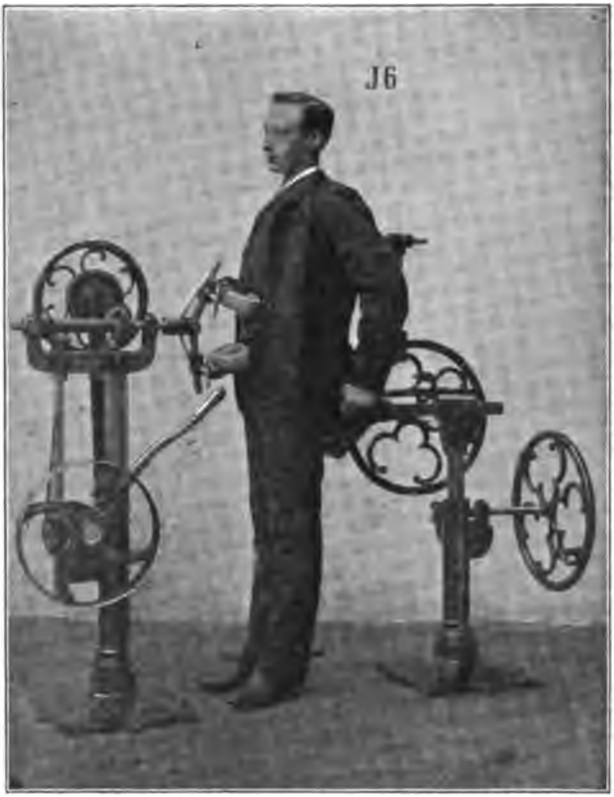


FIG. 45.—ZANDER MACHINE FOR ABDOMINAL MASSAGE.

perform with success the part of an attendant in the production of passive, resisted, and duplicate movements, in the application of vibrations, and in a large proportion of the ordinary massage manipulations; that properly adjusted it is more exact than an attendant, makes no mistakes, and, most important of all, affords a precise measurement of the amount of work done. The only deficiency they will admit is the impossibility of a machine's regulating its resistance according to the strength and capacity for exertion of the patient during the actual period of the movement.

Those who concede the possible usefulness of such apparatus in a certain limited field object to these claims that (1) all massage manipulations

FIG. 46.—ZANDER MACHINE FOR CHEST MOVEMENT.

and most resisted movements should for the best effects be momentarily varied in force and speed, and (2) that machines lack the possibility of individualizing in treatment. The advocates reply that general massage is apt to be a good deal of a routine application anyhow, and might as well be fairly done by a machine as fairly done by an ordinary masseur. Even the most enthusiastic advocates do not suggest that machines should be used for massage when there is any distinct organic disease calling for manipulation. For example, it would be obviously unjustifiable to apply mechanical massage to the abdomen of a patient suffering from inflammatory deposits consequent upon peritonitis, where the most careful, trained touch, directed by a person thoroughly acquainted with the anatomy and pathologic condition of the parts, is needed, with the use of constantly varying pressure and frequent changes of method in different parts of the diseased region.

Certain **effects,** it may be conceded at once, can be better produced by mechanical means than by any manual treatment, however good. The several forms of **vibration** can be applied with greater speed and for longer periods by machinery, and some of them cannot be produced by hand at all; for instance, the general 'trepidation' of the **shaking chair** invented by Charcot and the **shaking couch** of the Zander system. The **electric percussor** or **percuteur** of Dr. Mortimer Granville is capable of striking from one to two thousand blows in a minute, and thus producing an incomparably greater effect than is possible with manual vibration. Undoubtedly, too, certain passive and resisted movements can be given with greater smoothness and accuracy by apparatus, always with the exception noted, that the machine resistance, though it can be very minutely adjusted at the start, cannot be altered during the progress of the movement, nor stopped short of its complete excursion, as might be done by an attendant. Finally, the enormous cost of the outfit and of its running is against its use.

The conservative **conclusion** is that patients with simple **obesity,** especially those with localized fatty deposits, some of those with moderate degrees of **neurasthenia,** and those with ordinary chronic disturbances of the **digestive** and the **circulatory** systems, particularly when accompanied by **psychic depression,** may be given the necessary manipulation by machinery nearly as well as by hand, with the additional advantage that the mental effect produced by the huge and complicated machines may be a valuable adjunct. Moreover, if long-continued treatment is necessary, the cost to the patient of massage by machine will be less than that of treatment by hand for a like period.

In cases where long treatment of old **arthritic adhesions** is required the use first of vibrations to promote the circulation, and next of steady, slowly increased, passive movements by apparatus, can sometimes show excellent results. Patients after one trial have no fear that the machine may go beyond the fixed limit in making the movement, and feel in consequence an assurance that they do not have in the hands of a masseur. An exactly measured increase in the excursion is possible, and thus by slow and small advances the adhesions are gradually freed, with less pain than would be felt in their breaking-up by manual force. The final step in their manipulation is by resisted movement; or a combination of resisted movement in one direction with assisted movement in the reverse direction may be used as an intermediate step before resisted movements alone are given.

As an example of the complexity of the treatment by apparatus, Friedländer's prescription for lumbago employs the Zander machines as follows: the letters are the designations of separate pieces of apparatus: "C_1, by which the trunk is bent forward, sitting; C_2, by which the trunk is extended, sitting; C_4, in which the patient, sitting bent forward with extended legs, has the upper trunk extended; next C_6 and C_7, for sidewise trunk-movements and trunk-twisting; finally several machines for active leg-movements, followed by B_2, which performs effleurage of the hip, and B_4, which applies simultaneous effleurage to the hip- and knee-joints." Other authors suggest adding to this list of nine or ten machines, another for applying vibrations to the lumbar region.

CHAPTER VII

EXERCISES FOR OBESITY AND GOUT

General Management of Obesity: Skim-milk Treatment: Hard Exercise Necessary: Thyroid Extract: Various Forms of Exercise: Muscle-soreness and Its Causes: Dangers of Overexertion: Special Exercises. Gout.

Winternitz's method of treating obesity by the use of baths, exercise, and massage has been outlined (page 62) and Oertel's system is sufficiently described in discussing the treatment of heart disease (chapter VIII), so that neither of these need be here repeated. In general, it may be said that there are two requirements which are part of every reasonable scheme for the treatment of obesity: namely, **dietetic restriction,** a matter that does not concern us here, and **exercise** in some form. What special forms the exercise shall take must depend on the indications afforded by the condition, age, and habits of the individual. Sedentary flabby persons, unused to physical exertion, could not stand the amount or kind of work necessary to get results in more robust and active people.

The two hardest problems likely to be presented for solution are the fat patient with anemia, and the fat patient in perfect general condition with an hereditary tendency to undue accumulation of adipose tissue. The former, the anemic, is often best treated at first by diet alone, and, as has been suggested by Weir Mitchell, the reduction can be achieved by **rest in bed** on a very small quantum of **close-skimmed milk,** with **hard deep massage,** followed, when sufficient weight has been lost, by full feeding on non-fat-making foods and, as soon as the patient can be brought into proper muscular condition for it, by **hard exercise.** The latter sort, the naturally fat with inherited tendencies to adipose deposits, will tax all the resources and patience of the practitioner. While special movements can be so used as to effect the reduction of fat-deposits in special localities, nothing except **general exercise,** and that both **long-continued and hard,** will bring down systemic obesity. The work must be fast enough to produce free sweating, to hasten respiration and heart-action, and by these means to increase tissue oxidation. The treatment of the over-fat at first should be directed to general reduction in order that the weight may be lessened enough to permit greater activity. With robust patients, two or three **sweatings** a week in the **hot-air cabinet,** or the **electric light bath** of Kellogg, a diet free from fat-forming foods, moderate restriction of fluid, especially with meals, steady, long-continued **walking exercise,** a good deal of it up-hill, and keeping the bowels well open, will be the requirements for two or three weeks.

If **thyroid** or any of the thyroid preparations are used, daily examination of the heart should be made directly after exercise and, remembering that these drugs have a depressing action on the cardiac muscle, the patient should be cautioned against running for cars, going quickly upstairs, or other sudden exertion, lest dilatation of the heart should result.

When some reduction of weight has thus been effected, heavier clothes during the walk may be used, to promote sweating. If the heart is sound and the muscular condition fair, **medicine-ball, squash-ball, hand-ball,** or **lawn tennis** may take the place of walking at the end of the fourth week, the length of play allowed depending on the strength and endurance of the individual. The exercise should be followed by a cool shower-bath. If a local accumulation of fat is difficult to remove, for instance, in the abdominal walls, a flannel belt or other extra clothing may be so applied during the exercise as to induce **local sweating** and help to get rid of it. Special exercises for the reduction of these localized deposits will readily suggest themselves. Some are mentioned later.

When the loss of weight and the general condition allow it, **running** work may be added, a half-mile or a mile at a time performed at a steady gait, then an interval of a few minutes' walk, and running again, continuing thus until three miles or thereabouts have been covered. In the beginning the run should not exceed two to three minutes in length, performed at a very slow jog. The speed and time may be increased as the condition improves. Running can scarcely be taken into practical consideration, however, as obese patients for the most part are in the middle period of life, when it is not desirable to make use of any form of exertion which will increase arterial tension. **Golf,** moderate **cycling,** and **riding** are less open to this objection. For those who have not reached the time of arterial change, **rowing, paddling, swimming, fencing, sparring,** and the various **games of ball** already mentioned offer a wide choice of agreeable exercises for keeping up condition and preventing the accumulation of fat. In persons less strong it may be necessary to continue walking exercise for many weeks before the muscular strength becomes sufficient for more severe work. To the steady daily walking some prescription of special movements and breathing exercises may well be added after a week or two.

In case of marked feebleness of the heart or the muscles, two or three weeks of such exercises should be ordered before any attempt at long walks is made. When 'condition' in the trainer's sense has once been established, the general course may be the same as for the stronger patient.

In those unfit for any active outdoor work, yet not feeble, anemic, or neurasthenic enough to be put to bed for reduction by milk diet and massage, **gymnastic work at home** can be made to serve the purpose of somewhat lessening fat, and preparing for the further reduction of weight, by improved strength of muscle and improved oxidation. The amount and character of this work are matters for individual prescription, but general principles and a line of exercises are laid down in the following pages.

Certain **difficulties** are encountered in the bringing into condition of all persons unused to exercise; and as these difficulties are especially great in fat people, this is the most suitable place to discuss them. These are: the **muscular stiffness and soreness** consequent on exertion; **palpitation** of the heart; a **shortness of breath** out of proportion to the effort made; and occasionally, if the work has been overdone, **fever,** usually of a fugitive character. These effects are greater in the fat because of the extra load which they have to carry, and because of the interstitial fat impeding the full play of the muscles, or actually replacing muscular tissue in some instances. The movements of the lungs and heart are interfered with by surrounding or infiltrating fat. The dissimilation of fat during exercise produces an excess of **carbonic acid gas,** which for the most part has to be removed by the lungs: its retention or imperfect elimination causes breathlessness; and unless the breathlessness is relieved by the cessation of labor, the blood becomes more and more charged with the gas until the work must cease or the worker drops, poisoned by his own breaking-down tissues. Other poisonous substances, of which **uric acid** * and certain imperfectly understood **nitrogenous compounds** (alloxuric bodies) are the most important and typical, are formed in or by the muscles during effort, and these are much more abundantly produced by untrained muscles than by muscles in 'good condition.' The carbonic acid gas is quickly removed through the lungs. The nitrogenous waste is less readily disposed of, and must leave the system by the slower

* It is probable that uric acid is a derivative from the waste products of muscle-work and is not found in this form in the tissues themselves; but however this may be, uric acid and the urates are excreted in great quantity by the untrained or undertrained when doing severe exercise, and the expression is allowed to stand for the sake of simplicity.

path of absorption into the blood and thence by excretion in the sweat and the urine. Some of it is retained in the muscles, producing the stiffness and soreness so familiar after overexertion. If these substances are formed too rapidly or in too great quantity for the excreting organs to deal with, more or less acute **symptoms of poisoning** result, varying from lassitude and local stiffening to an attack of fever. This **fatigue-fever** is sometimes ushered in by a chill and may offer a striking resemblance to the invasion stage of a moderate malarial attack. It may be so sudden and so severe as to prostrate the sufferer almost in a moment, and no doubt some instances of it are diagnosticated as sunstroke when it takes this form.

The fat person who undertakes unwonted exertion is doubly liable to accidents, as he is additionally heated by the non-conducting layer of tissue that enwraps him and he has too large stores of combustible materials that break down readily and must be removed by circulatory and excretory systems that are already working to the height of their capabilities. It is for these reasons that it is necessary to insist strongly on such patients exercising with great moderation in the beginning. This rule is really the safest one for everybody—and for no one more than for the man once accustomed to athletics or hard work, but long idle. On taking anew to sports or exercises, he too commonly thinks that he can plunge at once into great activity, and is sometimes seriously damaged thereby; the injury is usually laid to the particular game which he has been playing, though it should properly be credited to his personal folly. The organic materials from which the fatigue products are evolved are rapidly and completely removed from the body by the steady repetition of exercise, as is shown by the facts that while an untrained man becomes stiff and sore after his work and passes urine loaded with urates, as soon as he gets into condition, indeed as an evidence of his getting into condition, the urine remains clear after even very hard and long-continued effort and the muscles do not become sore. If even then he takes up a different form of exercise, one to which he is unaccustomed and that calls upon another set of muscles, these groups will suffer from after-stiffness and the urine will again show a deposit of urates. This increased proportion of urates begins to show in the urine a few hours after the exercise and continues to be present for from twelve to twenty-four hours. In **gouty subjects** not habituated to violent exercise an attack of gout is sometimes the result of starting in too suddenly at hard work, in consequence of this excessive production of uric acid compounds. Moderation in the first exertions would have avoided the unpleasant effect. With the gradual habituation of the body to effort the urates cease to appear in the urine; at the same time the muscles perform their part without subsequent soreness. This change takes place in a very few days, long before exercise can have wrought any considerable change in the respiratory and circulatory apparatus. Fat men sometimes become able to increase their exercise a good deal without bringing on breathlessness, even before they have lost weight. "The diminution of breathlessness in the trained man . . . . is much less due to the greater freedom of the lungs owing to the removal of fat in their neighborhood than to the lessened production of carbonic acid which results from the disappearance of the provisions of combustible tissue."

The **muscular pains and stiffness** consequent on fatiguing work may be variously dealt with. Athletes and sportsmen have various ways of escaping these discomforts, but a slow course of increasing work, a gradual training, will almost altogether avoid them. It is questionable whether a man in fair general health had not better pay his fine by a day or two's discomfort and get rid of his combustible material by one day's moderate work, a second day of more intense effort, a third day of the inevitable stiffness and lassitude when little can be done,—and thus find himself by the fourth day fairly fit, with little muscular soreness and able to go through pretty comfortably. A more susceptible or weaker man might be advised to take longer over the same process. A **hot bath** and subsequent **massage** will greatly lessen the muscle-soreness. Even rough rubbing of the simplest kind helps to get the fatigue products out of the tissues.

Special Exercises.—Besides the use of ordinary exercises, as already suggested, walking, sparring, swimming, riding a horse or a bicycle, and the various active games, certain special needs of fat patients must be met by the prescription of special exercises to reduce local deposits of fat. These may occur anywhere; but the commonest situations are the abdominal wall, the outer aspects of the hips, and the region between the nape of the neck and the shoulders. Body movements such as Exercises **22, 23, 24, 25,** and **26,** which strengthen the abdominal and waist muscles, have a decided effect in lessening abdominal deposits. The exercises to give the most useful effects should be performed with rigid steady tension of all the muscles concerned in the act. Some emphasis should be laid on the fact, suggested by various authors and recently particularly well put by Madison Taylor, that extension movements are more needed than flexions. Ordinary life requires many lesser movements in flexions but not so many in extension, so that the average civilized individual is physiologically undeveloped in the muscles of the latter group—and exercises in this direction are peculiarly useful for the fat.

Fat people have not, as a rule, very good control of the belly muscles.

The fat stretches the muscles, interferes with their free contraction, and adds by its weight to the difficulty of using them actively and strongly. To relieve them of some of this weight, several plans may be tried.

59.—**Abdominal breathing, supporting abdomen.** Standing, clasp the hands together over the abdomen as low down as they can reach, press firmly, lifting a little. Breathe as deeply as possible, trying to use the abdominal muscles, 'pushing out' with them. Maintaining the hand-clasp, repeat this forced breathing at the rate of eight times a minute. After two or three days of practice in this way, the effort should be made to use the muscles without the forced breathing.

60.—**Forward bending, supporting abdomen.** From the same position as in **59**, fill the chest, bend the body forward from the hips, keeping the back straight. Bend to a right angle if possible, rise erect, exhale. Repeat without lessening the support from the hand-clasp, at the same rate as the previous exercise. Both of these should be kept up daily until good control of the abdominal muscles is gained. When the muscles have been brought to contracting properly, abdominal breathing (No. **11**) without the hand support of the abdomen, and trunk-bend (No. **23**) should be continued. The abdominal muscles should be held contracted during the movements.

Overhead stretching affects other muscles of the trunk as well as the abdominal groups, and is a part of several useful exercises in the class of which **7, 9,** and **10** are examples. The muscles involved should all be used with steady strong effort, as in all exercises for obesity.

61.—**Forward stoop.** Bend from the erect position, dropping the arms, and try to touch the floor. Keep the abdominal muscles rigid by taking a deep inhalation at the start and holding the breath during the movement. The movements should be performed slowly in the early lessons. Afterward they may be done more rapidly. Repeat four to six times.

No. 26 (stoop and twist) (see Figs. 30 and 40) is a more difficult movement of the same sort as the last, affecting waist, abdomen, back, and shoulder muscles, but it needs practice and a certain degree of suppleness, and should therefore not be undertaken until some advance has been made in muscular control.

For **deposits of fat about the waist** and lower ribs the following movement is also used:

62.—**Sidewise stretch, body twist.** Straight standing:—Extend the arms sidewise, palms forward. Stretch hard and, keeping the arms extended, swing the body laterally, maintaining the relation of the arms and chest so that the whole of the upper part of the chest moves together. A light stick supported by the thumb and forefinger of each hand across the back of the shoulders may be used to keep the arms rigid. The swing should be rapid, fifteen to twenty times a minute.

The use of the abdominal muscles alone may be practised in a simple way, as follows:

63.—Abdomen lifting. The patient should be seated on a hard level surface, the legs straight in front, the hands, palms on the floor, supporting and fixing the chest and shoulders. The abdominal muscles are then strongly contracted, 'lifting' the abdomen. The position renders this easier as the weight of the upper part of trunk is carried by the arms. The contraction may be repeated ten to twenty-five times, at first slowly, later rapidly. The exercise not only makes strong use of the muscles involved, but administers thorough shaking to the whole contents of the abdominal cavity. (See Fig. 61, illustrating the use of this movement in cases of lateral curvature of the spine.)

Raising the knee chest-high as if trying to put the foot on a high step is a good abdominal exercise, and may be made a severe one by using the muscles in a determined fashion. **Still running** (No. 21) is good if outdoor running cannot be had. If there be opportunity for outdoor or even for gymnasium running, and the patient is strong enough to do it, it can be made to tell much more both for reduction and for muscular exertion by moving **with very short steps.**

Rowing, especially on a sliding seat, is excellent work for the thighs and abdomen—and a rowing machine in a gymnasium will serve if weather or place do not permit the use of a boat.

These exercises for the abdominal muscles should not cause neglect of other important muscles. If the abdominal groups are overdeveloped, the carriage may be altered for the worse by their shortening, unless the opposing groups have been growing stronger at the same time. When much special abdominal work is done, some special exercises for the back muscles should be added, such as **backward bending, overhead stretching** with dumb-bells, carrying weights on the head, using the **chest-weights** with the back to the machine and bringing the arms overhead and forward; or, of a more general kind, **club-swinging, striking a punching-bag,** and **wood-chopping** will serve as examples.

An unsightly lump of fatty tissue sometimes appears below the junction of the neck with the shoulders about over the vertebra prominens, which patients, especially women, will desire to be rid of. **Massage** is effectual to this end if hard and frequently used, and muscular exertion may be so directed as to aid in its removal by the rubbing and to prevent its return. Of suitable exercises there are several:

Steady slow flexions and extensions of the neck, performed with all possible tension of the muscles, as in No. **32,** are the most important movements. These should be done ten to thirty times in succession, and repeated twice a day. **Upward stretching of the head,** simply the effort to lengthen the neck without elevating the chin, is also useful, and may be done as often as the flexions. **Sidewise stretching of the arms** at shoulder level, palms up (No. **5**), is another movement which helps the desired effect, and may be combined with No. **16 (shoulder thrust).** (See Fig. 27.) The sidewise stretch may be made part of this by making the side stretch at shoulder level, as the arms are being raised, then relaxing and continuing to elevate the arms. This movement is an invaluable one in the **correction of stooping** and round-shouldered positions.

For **fatty deposits over the hips,** besides local sweatings already suggested in such cases and local massage, the same principle of movements is applied—namely, the hard use of the muscles of the part. The following exercises may be prescribed:

Sidewise lifting of the straight leg, the body being held erect.

Sidewise bending of the trunk, No. **24.**

Trunk circling, No. **25.**

Twisting the body from the waist, the lower limbs remaining in a firm standing position, No. **34.**

Circumduction of the knee, standing, and against resistance. The resistance may be applied by another or by the person himself, setting all the muscles of the part in operation so as to make the action difficult. These exercises have been detailed or need no description; the following have not been:

64.—Knee-separating. The patient lying on his back, with the knees well bent, an attendant should place his hands on the outside of the knee-joints and make firm resistance against the patient's effort to separate the knees. The opposition must not be strong enough to prevent altogether the spreading of the knees.

65.—Knee-closing against resistance is the opposite of this movement and does not need further description. Both knee-separating and knee-closing, resisted, may also be done with the legs straight instead of bent, when further exercises for the muscles on the inner and outer aspects of the hips and thighs are needed.

Instead of the **forward stoop** (No. **61**), a difficult movement for very fat persons, the following may be used to affect abdomen, back, and shoulder muscles:

66.—Forward touch with bent knee. From the standing position, stretch the arms above the head, advance the right foot, lean forward till the hands touch the ground in front of the right foot. The right knee must be bent, and the left kept rigid. Return to erect position; repeat the movement, advancing the left foot. (See Fig. 47.)

It is not necessary to detail all the possibly useful exercises for general and local obesity; those given will suggest others, and patients and in-

FIG. 47.—FORWARD TOUCH WITH BENT KNEE, EXERCISE 66.

structors will soon discover which are of most service. Before leaving the subject, it is worth while to repeat certain important matters.

In almost all fat patients the **heart** needs watching. If it has not been weakened by the same causes which have encouraged fat accumulation, the heart is probably at least hampered in its movements by interstitial fat; and until some of this has been removed will not be able to act freely. The lungs will also be impeded by fat deposits, peritoneal or external. All exercises must therefore be most cautiously used at first, and slowly increased in intensity and frequency, or serious damage may be done. Enthusiastic patients forget the facts in their eagerness and are anxious for results like those advertised by the patent-medicine man who can reduce them 'fifty pounds in a month' (why not a week?) 'without danger, diet or discomfort.' The instructor or trainer of such patients should, however, not neglect these points, or disaster will result.

GOUT

It is as a preventive of gouty outbreaks rather than as a remedy for the affection, that exercise is valuable. But to this end it must be constantly and not spasmodically used. The hard-drinking men of former days kept off the gout, possibly unintentionally, by the active lives they led, in spite of their excesses in the matters of port wine and madeira. But when they traveled they rode hard-trotting hacks or drove in a gig over rough roads, and hunting and shooting were their daily sports or, often enough in this country, their daily bread. Thus the attacks of gout were kept under and thus our hardy progenitors either staved the disease off until the inactivity of age left them open to invasion or evaded the seizures altogether for themselves, while bequeathing the constitutional effects to their descendants. Free water-drinking, a restricted diet, restricted in quantity as well as in character, and daily exercise sufficiently active to cause sweating and long enough continued to be moderately fatiguing—these are the only prophylactics. What form the exercise shall take is a matter in which the tastes of the patient may be consulted; only the work must be distinctly active, and on occasion even severe, like tennis, a bout at hand-ball, ten miles on a hard-trotting horse, or twenty minutes with a lively opponent at tossing a medicine ball. The work must be done daily or at least often enough to keep the victim of hereditary gout always in fair training. The gouty patient who suddenly begins to take strong exercise without preparation is not uncommonly subjected to the curious experience of having an attack of his disorder brought on by the physical exertion; and the same thing occasionally occurs when he abruptly ceases exercise after being for some time in the habit of hard work at it. In the former case the result is probably due to the same cause as that which brings about the stiffness ordinarily produced by unaccustomed labor—namely, an accumulation of alloxuric bodies in the blood beyond the ability of the system to eliminate. In the latter instance the elimination has been effectual while physical activity kept all the functions of the body at their best—but the activity ceasing, its stimulating effect on the circulation, the skin, and the digestive tract is withdrawn, and the poisonous substances are less throughly removed; while in all probability the man has kept the appetite for food induced by his previous labors, so that the body is oversupplied with nitrogenous matters.

In fine, it is necessary that the inheritor or acquirer of gout should remember that he is sentenced for life, and that regular activity is the price of his reprieve.

Even in **acute gout** massage and exercise are effectual, though severe, methods of cure, if conjoined with abstinence; but it is almost as difficult to convince gouty patients of the desirability of undergoing so painful a treatment as it is to make them moderate their appetites.

CHAPTER VIII

EXERCISE IN THE TREATMENT OF HEART DISEASE

Schott's System: General Indications; Method and Duration of Treatment; Schott Resistance Gymnastics; After-cure; Effects of the Treatment. Oertel's System: Diet; Dry Heat; Baths; Hygienic Regiminal Measures; Duration of Treatment; Summary.

In any form of heart disease, after the acute attack is past, one of the most important questions to be decided is the amount and character of exercise to be allowed the patient. The rule against exertion, so necessary in the early stages of valvular disease, is too often continued either by inadvertence or overcarefulness when all reason for it is past.

Compensation once established, moderate or even hard exercise, provided it be not violent or straining, is useful, not injurious. The line of safety is passed only when exertion produces distress, extreme palpitation, or breathlessness. In laying down rules, the habits, vigor, and temperament of the patient have to be taken into account. An ambitious and strenuous person, inclined to hurry and do his work with excessive and needless energy, will require restraint and may hurt himself in performing even his ordinary duty. One of hypochondriac and timid disposition may be so fearful of overtaxing his heart that he will not take absolutely necessary exercise. The latter is a more common difficulty in practice than the former, as cardiac sufferers are much inclined to become hypochondriac and apprehensive.

Briefly, it is safe to say that a person who has had a valvular affection may exercise within reasonable bounds, provided that the exertion is moderate at first, is very gradually increased, and that ordinary prudence is used.

It is in the highest degree desirable that cardiac patients should take their exercise in the purest and freshest air, not in crowded gymnasiums. A moderate elevation above sea-level, two thousand to three thousand feet, is therefore an advantage, and such an elevation suits most cardiac patients well, though a few will be found unable to bear it.

Young persons whose health apart from the heart-trouble is good, may ride a horse or a bicycle, row, fence, swim, play base-ball, cricket and tennis, under proper observation at first, and always with the warning that breathlessness or palpitation are signals of danger. As hill-climbing on the bicycle is hard on the heart and especially trying to the rider of a drop-frame machine, it should be avoided, and long or very fast runs must be forbidden. Foot-ball, basket-ball, lacrosse, cross-country running and boat-racing are all too violent to be allowed, even when the compensation is fully recovered. Before a state of repair good enough to permit such activities as those described is attained in a heart broken down by acute valvular disease or dilatation, careful and well-considered treatment will be needed. Young and vigorous subjects of acute heart disease make fairly good recovery under ordinary hygienic and domestic regulations; but older or feebler persons regain their cardiac balance less readily and need all the help that can be given them.

The rapid, weak heart-action which sometimes follows influenza and occurs in general neurasthenic states is rebellious to treatment by rest or drugs. Fatty heart, or rather fatty infiltration, is another form of weak heart, most unsatisfactory to treat by ordinary methods. For sufferers from such conditions as these, no plan of treatment except definite, systematic, graduated exercise will be of much avail. Two types of treatment are most prominent for the cure of chronic heart disease,—the Schott and the Oertel methods,—and of these, their advantages, indications, and counterindications, something must be said before describing them in technical detail.

Schott's System

General Indications

The Schott treatment is most suitable for cases of **dilatation,** especially when the dilatation has resulted from enfeeblement of the heart-muscle. It is less beneficial when the condition has been brought about by violent exertion. It is not to be used to the exclusion or neglect of other suitable measures to lessen excessive arterial tension or undue capillary resistance. The fact that dilatation tends progressively to increase unless its causes are removed should never be forgotten. The relative diagnostic and prognostic importance of rapid pulse, feeble apex-beat, irregularity of action, high or low arterial tension, must all be taken into consideration in prescribing. While remarkable bettering may be seen in many cases, the probability of great and permanent improvement in these, as well as in other cases of disease, will depend largely upon the vigor, natural resilience, and general nutrition of the patient; above all, upon the soundness of his kidneys and blood-vessels.

A distinction of great importance must be made between **fatty degeneration** of the cardiac muscle and **fatty infiltration.**

Fatty Degeneration.—At least two kinds are seen; the first is the change which sometimes follows acute febrile disease, especially typhoid fever, and is no doubt a more advanced stage of the 'cloudy swelling' found in the heart-muscle in severe fevers. This is not properly to be called fatty degeneration. It is fairly amenable to careful treatment.

The second is the true form, and begins in an **atrophy of the muscle-fibers,** with fatty infitration or substitution as a secondary change. Sometimes it is a senile or pre-senile change; oftener it is due to steady drinking and overeating, together or separately, or it follows a myocarditis. Quite often no distinct cause can be assigned, though it is most common in persons of sedentary habits. If the last change be well advanced, it is improbable that any form of treatment can restore the integrity of muscles which have undergone so fundamental an organic alteration. But the inevitable end may be postponed and the evil effects of the disease lessened by careful regulation of the patient's whole life. Gentle general massage will help to keep up the circulation and promote the nutrition, but neither the Schott nor the Oertel treatment is indicated.

Fatty Infiltration.—For fatty infiltration, on the other hand, a great deal may be done. The subjects of this disease are usually overfat and self-indulgent sedentary persons, past middle life. The fat is deposited around the heart, along the track of the coronary arteries, and extends between the muscle-fibers. The heart's action is embarrassed, the apex-beat feeble, dyspnea may be present, and even slight puffiness of the feet and ankles. The **diagnosis** rests more upon the history of the habits of the patient and on the presence of general obesity than on the uncertain and variable physical signs. The disorder is far more common than true fatty degeneration. If the degree of trouble be but slight and the patient co-operate with the physician, great relief may be expected, except in individuals with an unconquerable tendency, generally inherited, to obesity. In mild and early cases treatment on the **Oertel** lines will lessen both the general and the pericardiac adipose deposits. This method is also successful in **moderate degrees of dilatation,** and in the milder forms of **valvular impairment with imperfect compensation.** It is less suited to advanced dilatation and the more severe cases of broken-down compensation from valvular disease. For these, when they are capable of being bettered at all, after rest, heart tonics, and massage have brought about a moderate steadying and invigoration of the cardiac tone, the **Schott** treatment is of more value. The most marked and conspicuous success of the latter method has probably been secured in cases of **mitral stenosis**; results have been least good in **uncomplicated aortic disease,** and it should be altogether forbidden where there is any marked degree of **degeneration** of the cardiac muscle. In the very troublesome cases of **weakened heart** from influenza or other fevers with or without dilatation, and in **functional neurotic disorders,** it is of the greatest usefulness.

To sum the indications up briefly: patients with **want of cardiac tone, dilatation, neurotic** or **functional palpitation,** or **irregularity with mitral disease** which is improving less rapidly than it should or with an incomplete restoration of function, should take a Nauheim course, under strict supervision, and follow it with an after-treatment (*Nachkur*) usually consisting of moderate hill-walking and other exercise, also under medical guidance.

Much wider applications than these have been claimed for the Nauheim methods by its advocates. Dr. Bezly Thorne, in his excellent manual of the Schott treatment, says: "Professor Schott affirms that benefit may be expected to accrue in all cases of chronic heart disease, whether of valvular or parietal incidence, except where the myocardium has reached an advanced stage of degeneration or the vessels are the seat of advanced arteriosclerosis." Doctor Thorne adds that he has himself "been witness of improvement amounting to practical or actual cure in cases presenting the physical signs usually regarded as indicative of the following affections: stenosis of either the aortic or the mitral orifice; stenosis of both; incompetence of either or both with attendant dilatation; dilatation consequent on myocarditis, on habitual hemorrhage, and on constitutional anemia; fatty heart; weakened heart; congenital mitral insufficiency; patent foramen ovale; and angina pectoris of apparently both neurotic and organic causation."

Broadbent considers that in a large proportion of cases of real valvular and structural disease the value and efficacy of the Schott treatment are doubtful, and that as good or better results can be obtained by other methods of treatment. In his opinion, the method shows its best effects in its influence upon cases of functional or imaginary heart disease in neurotic individuals.

These views represent two extremes. The claim of Dr. Thorne probably is too large; he includes at least some conditions which good observers consider are not very successfully treated by the Nauheim regimen; Sir William Broadbent, on the other hand, is too skeptical; and conservative practice may very well steer a middle course between the two. Numerous cases thoroughly studied and carefully recorded by competent men can be cited to show the good results of the salt baths and graduated exercise of the course, when applied to those forms of disease for which it is suitable.*

If the cardiac disorder be of a kind likely to be benefited by such a method, the question next to be considered is whether the patient shall go to Germany for treatment or be cared for at home.

In deciding whether patients should go to Nauheim for treatment, apart from the cost of the journey, the risks of travel and of possible sea-sickness, regard must be had to the individual character and disposition. A person of methodical habit, ready to obey directions exactly and to give intelligent aid to the physician, may pursue successfully a Nauheim course at home; but the doctor must be able and willing to give an unusual amount of personal care and attention to the daily progress, and must have under his orders a well-trained attendant, unless he himself thoroughly understands and can give the movement-treatment.

Patients who wish to direct their own treatment, who are impatient of exact orders as to diet, physical and mental exertion, or who are of the not uncommon type of those who regard that as the best treatment which shall take them farthest from home and be the most expensive, had better be sent to Nauheim. It is easier to lead a precise and methodical kind of life when every one around is doing the same thing and when all the surroundings are arranged with the needs of such patients in view. It is at least doubtful, moreover, whether equally good effects can be had from artificially made baths as from the natural waters.

Method and Duration of Treatment.—For full details of the **balneologic** or **loutrotherapeutic** part of the cure, volume IX must be consulted. It is only necessary to say here that the course of baths and exercises covers from four to six weeks. The baths at first given are with a weak brine solution consisting chiefly of **sodium chlorid** and **calcium chlorid**,† in which immersion is continued for five to eight minutes at a temperature of 92° to 95° F. The strength of the solution is increased daily or

* The numerous records of cases described in full, with diagrams showing the alteration in the percussion area of the heart, the alteration in position of the apex-beat, and the undeniable evidence of skiagraphs which demonstrate marked changes in the cardiac outlines reported by T. Schott (Therapeutic Monthly, February, 1902), Bezly Thorne ("The Schott Methods of the Treatment of Chronic Diseases of the Heart," Philadelphia, 1899), Richard Greene ("The Schott Treatment for Chronic Heart Disease"), T. E. Satterthwait (N. Y. Medical News, Aug., 1901), and others prove satisfactorily the value of the method in suitable cases.

† The Nauheim waters used for bathing contain from 2 to 3.5 per cent. of salts, of which about 82 per cent. is sodium chlorid and about 8 per cent. calcium chlorid. This may be reinforced by concentrated brine (mutterlauge) to any strength desired.

on alternate days, the duration is made greater, and the temperature is steadily reduced; until the latter reaches about 85 degrees, and the immersion lasts for from fifteen to twenty minutes. The patient must remain still in the bath, and on coming out must rest, lying down for from one and a half to two hours. Usually three baths are given on successive days, and then there is an intermission of a day or two.

Baths in water containing **free carbonic acid gas** in active effervescence, and gradually increased in strength, succeed the plain saline baths after a certain period of treatment, according to the condition and needs of the patient; usually about two weeks. In very severe cases they are not employed till later, and sometimes are not prescribed at all. They may be given on alternate days, or with intermissions of one day in three or four.

The **time for commencing the exercises** varies. Patients with extreme weakness of the heart should use baths alone at first for some days, a week, or a fortnight. In cases with less cardiac or general enfeeblement, exercises and baths are begun and carried out simultaneously. At least two hours' rest should intervene after a bath before the movements are used. If the gymnastic procedures are carried out first, the baths may be given after a shorter lapse of time than this. Baths and exercises may be given on the same day or on alternate days; sometimes massage only is given on the bath day, sometimes both massage and exercises. Skilful individualization and modification of plan to meet the progress, favorable or untoward, of the special case, are as necessary in this method of treatment as in any other. Especially must the periods of rest receive due attention.

Schott Resistance Gymnastics.—When expense or other reasons forbid a patient's pursuing the full course, much may be accomplished by exercises alone, though with less rapid improvement than when both baths and movements are brought to bear upon the disease. The movements are all *gentle* 'resistance-gymnastics'; the slight resisting force employed being supplied either by the attendant or by the patient's own muscles. The former is the better plan. In the latter method the patient makes a gradual effort of contraction of certain sets of muscles, at the same time resisting the contraction with the opposing groups of muscles, thus increasing the work done. For example, instead of freely and slowly flexing the arm, the extensor groups are called into action to resist the flexors to the needed extent. This should only be permitted in patients of intelligence and quick apprehension, and not in them until the ordinary resistance by a physician or an attendant has been used often enough to demonstrate to them how the work should be done and what amount of resistance should be offered. To use 'self-resistance' properly requires a little practice to acquire control of the separate muscle-groups. The exercises begin with simple movements and are so arranged as to bring into service in succession nearly every group of muscles in the whole organism. The movements are made **very slowly,** with a **steady uniform motion,** and with a **short interval of rest** (fifteen to thirty seconds) after each; no movement is repeated twice in succession. If there is any distress in respiration or any sense of discomfort about the heart, the patient must rest a short time before further work. The attendant must watch that the **breathing is full and regular,** the natural tendency being to hold the breath during effort. If there is the smallest sign of dyspnea or increased speed of breathing or pulse, the least tendency to cyanosis, sweating or palpitation, the movements should be stopped at once, and if relief is not experienced, the patient must lie down for a few minutes. The **clothing** should be loose everywhere, that there may be no interference with the peripheral circulation.

The patient must not be allowed to think that the exercises are intended to effect any muscular development. In weak persons some gain in this direction may incidentally be made; but the object in view is to produce certain results upon the heart and blood-vessels, and this should be brought about with an almost inappreciable amount of muscular exertion; certainly, without enough to fatigue.

The patient may either sit or stand during the exercise, according to his strength, but some of the movements, it will be seen, must be performed standing. The person in charge stands facing the patient or beside him, as may be needed, and makes gentle resistance to each movement.

It is important that the attendant's resisting force should be used in such a manner as not to impede the circulation in any of the vessels: the hand should either be applied to the part pressed upon with purely flat pressure or, if it is necessary to grasp a limb, this should be done with a light, not a close grasp, and the member should not be encircled by the hold. When the movements are for any reason intermitted, there must be no sudden change, and the patient's limb must be supported by the attendant in its return to an easy position.

The **movements** are as follows:

I. The patient, standing or sitting, extends the arms forward level with the shoulders, palms together, hands held lightly open. The attendant puts his open hands on the dorsal aspect of the patient's wrists, and makes light pressure while the patient slowly separates the arms until they are in transverse line with the shoulders. (See Fig. 48.) The attendant then shifts his hands to the palmar aspect of the patient's wrists and makes light resistance while the arms are returned to the original forward-extended position.

II. With the hand hanging by the side, the attendant supports the arm above the elbow with one hand. The patient flexes the forearm without moving the upper arm, until the thumb touches the shoulder, the operator's other hand resisting with pressure against the flexor surface of the wrist. The reversed movement of extension of the forearm

FIG. 48.—RESISTANCE MOVEMENTS; SCHOTT SYSTEM, EXERCISE I.

is similarly resisted with pressure against the dorsal aspect of the wrist, the upper arm all the while steadied by the attendant's gentle grasp (Fig. 49).

III. The arms hanging, palms forward, are abducted and elevated until the thumbs touch above the head, the attendant making resistance upon the radial aspect of the wrists; the arms are then returned to the original position, with resistance to the ulnar side of the wrists.

IV. The hands with the fingers intertwined, palms toward the body, are held at the level of the abdomen and then raised until they are above the head, resistance being made to the radial aspects of the wrists. In the return movements the attendant receives the wrists in the fork between his thumb and forefinger, with the back of his hands toward the patient.

V. The hands hang by the sides, thumbs forward, palms against the thighs. They are raised forward and upward with the arms straight and parallel until they are extended above the head. The motion is then reversed. The attendant's hands must make several changes of position to keep up a steady resistance during this movement, his fingers at first merely pressing the radial surface of the patient's wrists (Fig. 50, *A*),

FIG. 49.—RESISTANCE MOVEMENTS; SCHOTT SYSTEM, EXERCISE II.

then, as the arms are raised, lightly clasping the wrists with his fingers (Fig. 50, *B*). During the downward movement the wrists are first received as in **IV**, in the fork of the hand; then, when the patient's arms are level with the shoulders, the ulnar aspect of the patient's hand and wrist should rest upon the forefingers and thumb of the attendant (Fig. 50, *C*); and, finally, the downward motion is resisted by the fingers of the attendant gently clasping the ulnar aspect of the patient's wrists. The resistance to this movement Dr. Bezly Thorne says "is the operator's *pons asinorum*, but it should be mastered."

VI. The body is bent forward from the waist, and then straightened

A B C

FIG. 50.—RESISTANCE MOVEMENTS; SCHOTT SYSTEM, EXERCISE V.

up; resistance to the bending is made with a hand on the upper sternum and to the recovery of the erect posture by a hand on the upper dorsal spine, the attendant standing beside the patient.

VII. The body is rotated from the waist, without moving the hips or feet, first to one side and then to the other, then returning to the original position. To resist this, one hand is applied flat upon the advancing shoulder over the claviculohumeral junction, the other clasped over the shoulder which is being drawn back. The attendant will find it necessary to move one or two steps sidewise to maintain his relation to the patient.

VIII. The trunk is bent sidewise as far as possible without moving the feet, to the right, to the left, and to the erect position again. The attendant resists with a hand in the axilla of the downward-moving side, his other hand pressing firmly on the opposite hip.

IX. This is a repetition of **II,** namely, flexion of the forearm only; but in this movement with the addition that the hand is firmly clenched during the motion. First one arm and then the other performs the exercise.

X. This is like **IX,** but with the palm turned outward. The arms act singly in succession. Resistance is made as in **II** and **IX.**

XI. The arm starts from the hanging position, thumb to the front, palm to the side, and moves forward and up to the vertical position. The hand is then turned palm down, and the arm lowered to the side. The attendant resists with one hand clasped about the wrist, substituting the upward pressure of his free hand during the descent of the patient's arm from the vertical position.

XII. The arms are extended backward from the hanging position, parallel, as far as possible without throwing the body forward, and returned. Resistance is made with open-hand pressure during the backward movement, with a light clasp of the wrists during the return.

XIII. Standing by a table or chair, upon which a steadying hand may rest, the patient flexes the thigh on the trunk, and returns the limb to its original position. The movement is then repeated with the other leg. The flexion is resisted by a hand upon the lower third of the thigh, and the return by a hand under the same part. Only the thigh muscles should be brought into play in this exercise, the leg hanging loosely from the knee.

XIV. From the same position as in **XIII** the whole leg is extended forward and upward, and then backward. The resistance should be applied above the ankle.

XV. From the same position as in **XIII** and **XIV,** or supported, if unsteady, by both hands on a chair, the patient bends the lower leg on the thigh and returns it. Resistance is applied above the heel to the upward motion, in front of the ankle to the downward motion.

XVI. Same position as in **XIII.** The patient makes a lateral outward movement of the whole leg to the limit of motion, and reverses it. Resistance is applied at the ankle.

XVII. The arms extended sidewise level with the shoulders are rotated from the shoulder-joint. The attendant resists by lightly grasping the wrists.

XVIII. Flexion and extension of the hand are made on the forearm, returning to a right line with the arm. The attendant supports the arm at the wrist, and resists the movements by pressure on the dorsal or palmar surface of the hand according to the motion.

XIX. Similar flexion and extension of the foot on the leg, with appropriate resistance on the dorsal and plantar surfaces, conclude the series.

It is not always possible or desirable for a patient to perform this whole list of exercises. How far he can go, which exercises should be used and which omitted, whether any should be modified by using them with the patient lying or sitting instead of standing, what the intervals of rest should be, and the amount of resistance to be applied, are all matters for prescription, and indeed, in most cases, for individual trial. Some patients, it will be found, cannot at first do the movements which call into action the larger muscular masses, such as the trunk-flexions or the thigh-bendings.

For example, in cases of **disease of the right heart,** it may be desirable to perform the exercises with the patient lying down; or, if in the erect position, not to increase the pressure upon the cardiac apparatus by motions which raise the arms above the shoulder level, thus hastening by the force of gravity the return-current of blood in the arm veins.

If there be obstruction to the lung circulation, as in cases of **chronic bronchitis** or **emphysema,** the resistance should be the merest touch, and the resting periods between the movements should be lengthened to allow the heart to 'take up the slack.'

It is necessary, besides the most minute previous study of the whole circulatory apparatus, that the physician should personally see the patient's early efforts at the exercises, even if he does not himself administer them. With an imperfectly taught attendant to give them, the patient is in danger, at the worst, of serious injury; at the best, of making little gain. If in doubt as to the attendant's ability, the physician should practise the exercises upon the attendant, in order the better to make clear to the latter the measure of resistance required.

Even those in bad condition are able, with proper rest-intervals and a suitably adjusted resistance, to stand fifteen to twenty minutes of the exercises, and in a very few days to increase this to half an hour. In a few days more the period is again lengthened until the gymnastics occupy as much as an hour.

The **after-cure** by voluntary **active exercise, hill-walking,** and **careful diet** is an integral part of the treatment and designed to fix and render permanent the improvement in the cardiac condition. For this, a modification of Oertel's regimen is suited to many cases. If the patient be not too fat, the extreme restrictions of the diet prescribed by Oertel will not be required. Such changes as may be needed should be ordered by the physician and the progress painstakingly watched by him, throughout this concluding period, as well as in the earlier stages of treatment.

Effects of the Treatment.—Both exercises and baths **increase the vascular capacity** by dilating the arterioles, and thus lessen the heart's work through the diminution of peripheral resistance; if the pulse becomes faster than usual during the bath or movements, the heart is being taxed, not relieved. The **pulse should become slower** after the bath or the resisted exercises than before them and the arteries be decidedly fuller.

The **heart** if dilated should show distinctly **less area** by percussion or auscultatory percussion. The diminution is often as great as one inch in the transverse diameter. This result is due to two causes: first, to the lessening of the amount of blood and of the blood-pressure in the cardiac chambers; secondly, later, to the better contraction of the heart permitted by this emptying and aided by the gain in strength due to this better contraction. The movements should be so limited in number and in the amount of resistance used that the slowing persists for some hours. During the interval between exercise hours the heart again becomes more rapid and weaker, but the improvement should always more than make up this loss. The speed of the heart progressively decreases from week to week till it **reaches a normal rate during the middle period of the treatment.**

A marked **increase of urinary secretion** is usual after two or three days.

Oertel's System

Professor O. Oertel, of Munich, published in Ziemssen's "Handbuch der allgemeinen Therapie" in 1885 an elaborate original system of treatment for "*circulatory disturbances, enfeeblement of the heart-muscle, incomplete compensation in valvular lesions, fatty heart, obesity and changes in the pulmonary circulation,*" founded upon ten years' observation of its usefulness. "The important phenomena [observed in disturbances of the circulation] are purely physical. It is therefore possible to expect to re-establish the hydrostatic equilibrium by mechanical means and by reducing the fluids of the organism. Afterward, or at the same time, consideration can be given to the causes of the circulatory trouble and especially to the repair of the broken compensation." "Fat can be rapidly removed by the oxidation that follows the reduction of the body-fluids."

It is in these words that the author states his thesis and his claims. He adds, "the most important result, however, of this new method lies in the strengthening of the heart-muscle by gymnastic measures, in anemia, in atrophy of the heart, in uncompensated valvular lesions, in degeneration and fatty infiltration of the myocardium."

This treatment is to be regarded in three ways: *first*, as a method for the lessening of adipose deposit wherever situated, but especially when fatty deposits about the heart interfere with its power and action; *second*, as a method for strengthening weak or imperfectly functioning heart-muscle, whatever the cause of the impairment may be; and, *third*, as a mode of life for those predisposed to obesity. While this is not the place for critical consideration of dietetic questions, it is necessary to summarize Oertel's statements and precepts, as the arrangement of food and drink is a vital part of his plan.

Diet.—The special point upon which Oertel lays most stress is the **reduction of the general mass of liquid in the organism,** and the maintenance by the regimen prescribed of the improved balance of the circulation thus obtained, fulfilling in this way both the causal and the prophylactic indications.

The reduction of liquid in the organism is brought about by promoting the loss of fluid through the skin and the lungs. The kidneys cannot be depended upon to give much aid, because they are usually already in a state of chronic congestion, which may readily become an active inflammation if they are overstimulated with diuretic drugs or overtasked by the character or quantity of food taken. If at the same time the amount of fluid drunk by the patient is limited, the losses through the skin and the lungs are not resupplied by absorption from the gastrointestinal tract. **Hot-air baths, steam baths** if well borne, and **sweating by moderate exercise** in heavy clothing may all be used to increase transpiration. If hill-climbing can be added, we increase the respiratory activity also and get rid of much liquid by the lungs. The quantity of water-containing food, as well as the amount of liquid taken as drink, must be strictly limited.

The **measure of possible reduction** of liquid is found in the solubility of the uric acid and urates in the urine. If the urine is clear **when passed** and only becomes cloudy with urates on cooling, the fluid taken by the patient is sufficient. If the urine is cloudy at the time of micturition, or if there is any evidence of irritation of the urinary passages, the liquid must be increased temporarily. Long, steady walking **exercise** with an occasional climb must be taken daily. Beginning with an amount so small that the patient can readily accomplish it, the length of the promenade is increased daily, until the walking lasts for three to four hours. The possible minimum ingestion of fluids having once been ascertained, the patient with corpulent tendencies and impaired circulation must adhere to that minimum—for life!

The next point for consideration is how the circulatory and respiratory apparatus shall be restored to health. The methods by which the blood is reduced in quantity have been suggested. The next **indications** are: the strengthening of the heart and the removal of any fat interfering with its action; the extension of the respiratory field by removal of the passive congestion of the lungs, and of fat which, as in the case of the heart, may interfere with the freedom of pulmonary movement; and the improvement of elimination by the kidneys, or the removal of secondary disorders of these organs, such as are nearly always found in the class of patients under discussion.

Dry heat, administered by the **electric cabinet** or other like forms of application of warmth; by **Roman baths,** in which while the patient is in the third room or sudatorium, sweating is encouraged by massage, rough rubbing, and passive movements, are the measures used in the beginning to reduce the general liquids of the body. Warm douches followed by cool ones, and finally by immersion in the cool bath, conclude each treatment. The length of stay in the sudatorium must be proportional to the patient's strength and to the effect produced. From one to two pounds' weight may thus be lost each time. **Steam** and **vapor baths** are less effectual. Further reductions are effected by the means used for the promotion of oxidation.

The **removal of fat** from on or about the **heart** is effected by the same means as are used against the general corpulence, namely, strict limitation of the fluids taken both as food and drink, the prohibition as far as possible of fatty articles and the carbohydrates, and a corresponding increase in nitrogenous foods to cover the loss of albumin. In obesity, even where there is no fatty infiltration of the heart, there is often pericardial fat enough to hinder free contraction, the diaphragm is crowded by the abdominal fat, interfering with both pulmonary and cardiac movements, and a venous stasis with catarrhal symptoms results. If valvular disease be present in addition, a compensatory hypertrophy will have to be established or restored.

The general **venous hyperemia** is improved, peripherally, by exercise. Centrally, the venous movement is aided by the heart's action and by the aspiration produced by proper expansion of the lungs. Walking on the level at first and later upon gentle ascents increases the respiratory action in both speed and fulness, forces the heart to act more energetically, and thus fulfils all the indications.

When there is a **passive renal hyperemia,** such as is almost always present in heart disease and most markedly so when obesity is added to impaired cardiac action, the lessening of the venous stasis must begin with a **reduction of the liquids of the body.** When this has been accomplished, the kidneys are freed from this congestion and an increase in the amount of urine secreted will be observed to follow, even when very minute quantities of fluid are ingested. To attempt to get increased diuresis by giving more water in such cases is illogical. There is already too great venous pressure; reduce it and the kidneys are enabled to perform their proper functions. When both these organs and the heart are doing their work ill, it may be necessary to begin the treatment by keeping the patient quiet in bed, giving little food and that little as nearly water-free as may be, using laxatives, and inducing sweating by baths or other sudorific measures.

As soon as **exercise** can be taken, the patient should walk, on the flat or up-hill, according to his ability. It is to be remembered always that exertion to have a good effect *must go to the point of producing moderate fatigue.* As the strength improves, the length of the walk and the height of the ascent should be made greater. In brief, exercise causes a determination of arterial blood to the skin, sweating accompanies this, the venous pressure especially in the renal vessels is lowered, and the cardiac and pulmonary activity and the arterial pressure are increased.

The **thirst,** at first annoying, becomes less by custom. It should be combated, too, by washing out the mouth frequently with cold water.

The treatment is best carried out at a **moderate elevation,** 1800 to 2200 feet, as the air is drier and purer at such a height. Ascents should carry the patient even higher than this, 3000 to 3500 feet or more.

Hygienic Regiminal Measures.—When the circulatory troubles have been corrected, it is necessary that the patient should live in a fashion which will prevent a new rupture of the restored balance. Relapses are more difficult of treatment than the original disorders. The heart needs watching to keep its compensation good, the distribution of the blood must be properly maintained without excess of venous pressure or stasis. Fat must not be re-accumulated. These statements point to the **indications:**

1. Keep up the strength of the heart.
2. See that the body liquids are not allowed to become excessive.
3. Prevent the acquisition of fat.

Exercise is as necessary to keep the heart-muscles in good condition as it is for any other set of muscles in the body. The first indication is met, therefore, by working the heart, by walking, by hill-climbing in a slightly rarefied atmosphere, and, if these do not suffice or are not available, by suitable gymnastics and pneumotherapy. Palpitation and breathlessness will naturally occur, but need cause no alarm unless very persistent. The patient should be told if he suffers in this way to stand still and breathe deeply. He should carry a stout stick and use it as a rest, thus fixing the shoulders and giving the chest muscles a point to work from. He should not sit down, as breathing is less free in this position than when erect. In two or three minutes at most he will be able to go on his way.

The second and third indications are to be met by proper diet, that is, articles of food rich in proteid with minimal amounts of fat and carbohydrates, with such a quantity of liquids as is found necessary upon study of the relations between fluid ingested and urine secreted, and of the solid contents of the latter.

Some such line of life as is thus suggested must be maintained at all times, and if it is at all possible, the patient should devote annually two or three weeks in spring and a longer period in the autumn to a strict carrying out of the methods of exercise and diet. Persons who suffer only from obesity without circulatory disease may be permitted, when once cured, a slightly freer mode of existence and a somewhat larger amount of drinkables. But their weight should be watched and the former regimen strictly enforced if they are found to be gaining too much.

Oertel's method having thus been briefly described it is necessary to make some criticism of it, and to suggest the **limitations of its application.**

To prescribe 'exercise' or 'hill-climbing' without any more consideration of the history, age, circumstances, and habits of the patient than is summed up in the vague diagnosis of 'heart disease' is perhaps even more like criminal neglect of duty by a physician than the too common custom of ordering digitalis in the same loose way. The treatment is not suitable for all varieties of cardiac disease, and is not infallible even in those for which it would seem most appropriate. The main defect is that the exercise is performed away from professional oversight. It becomes, therefore, doubly necessary to study the cardiac conditions with every care before the patient is sent on his walks or ascensions, and to make minute examinations, even measurements and pulse-tracings, at short intervals during the cure. When compensation has completely broken down, Oertel's methods are unsuitable; rest is then the first indication. When compensation has been restored but the equilibrium of the circulation is unstable and ill maintained, this form of treatment will hasten the desired hypertrophy.

The full rigor of dry diet is needed only when there are distinct signs of venous congestion, pulmonary or renal, or when obesity is present. The most serious criticism of the system has been directed against this extreme restriction of fluids, and it is certain that harm may thus be done if the day-to-day state of the patient's circulation, digestion, and excretion is not watchfully considered.

It is most important that the **quantity of urine** should be sufficient. Oertel very properly insists that with lowered arterial tension and an abnormal increase of venous pressure—two conditions which are usually present with weak heart-action, especially when it is combined with an imperfect compensation, and most markedly so when the imperfection is in the mitral valves—the urinary secretion is too small and will be increased at once by reversing the circulatory conditions—raising the arterial and lowering the venous tension. It is a common experience to see an increased urinary flow after brisk purging: the cathartic decreases the congestion and permits the kidneys to act. Cardiac and vascular tonics like digitalis and strophanthus often have no effect in augmenting renal secretion until the patient has been purged and the vessels thus depleted. When free secretion has once been obtained, the restriction of fluids should be maintained at a point that will keep the daily urinary flow normal in quantity and free from deposits of uric acid and its salts **when passed.** Adequate kidney activity is a very good test of the heart's performance of its duty.

For proper digestion of food the presence of a certain amount of liquid in the stomach and intestines is necessary. Here again observation will suggest the point at which the restriction should cease. In America at least patients more commonly drink too much than too little fluid with meals, and definite orders should be given to each individual as to the quantity to be taken. A person who habitually throws five or six goblets of ice-water into his stomach with his dinner, if told 'to drink very little' will consider his fluid-taking most moderate if he swallows only a pint and a half. Oertel's average total allowance of fluid is about thirty-six ounces in the twenty-four hours, varying a little with the particular tastes and needs of each patient. The treatment being based on European preferences and tastes, from 6 to 12 ounces of light wine are included, which with most American patients may be omitted altogether, substituting a like amount of water.

The cases that will show the best results are those in which lack of exercise and intemperate eating and drinking have combined to interfere with the heart's action by inducing excessive accumulation of fat.

It needs to be emphatically said that the **hill-climbing** is the keystone of the treatment, without which much less good results can be attained. By this means an immense general effect upon the circulation is produced—by the pumping caused by increased speed of breathing, by the better oxygenation of the blood, by the dilatation of the chest, and ultimately by the strengthening of the heart. Should the anticipated effects not show themselves within a reasonable time, six or eight weeks, for example, resort may be had to **inhalations of compressed air** in order to dilate the lungs mechanically. (See also volume x.) This can be best done after the blood-mass has been reduced by the general treatment and the intrapulmonary blood-pressure lowered. A **half hour's** use of compressed air from **four to six times daily** will suffice, beginning with $+\frac{1}{100}$ atmosphere, increasing slowly to $+\frac{1}{60}$, $+\frac{1}{50}$, even to $+\frac{1}{40}$. In patients unable to walk, this may be used separately from the exercise treatment. In others the exercise regimen may be combined with the inhalation treatment. The latter cannot take the place of physical exertion, as it has no influence on muscular contraction. **A walk of three to four hours** with a moderate ascension during part of that time will produce about the same result in distending the alveoli of the lungs and, in addition, the patient profits by the free sweating, and the active muscular exertion of the cardiac and bodily muscles. Details are very minutely considered in Oertel's monograph in Ziemssen's "Handbuch," and still more fully in the French translation,* to which additions have been made by the

* "Traitement de l'Obésité," etc., translated by Dr. R. Calmette, Brussels, 1886.

translator. The length, elevation, and time of the walks; the speed with which they are to be accomplished; the amount of rest permitted during the promenade; the relation of breathing to the rapidity of the pace—are all subjects for precise prescription.

As for the **duration of the whole treatment,** it depends upon the degree of cardiac and circulatory disturbance. In cases of simple obesity, of simple fatty heart, or of cardiac enfeeblement merely, a single season's treatment, lasting from four to eight weeks, will often be enough to perfect a cure. When there exists an insufficient compensation with a tendency to break down, the patient will have to pursue treatment for several successive years. Indeed, it will be found necessary sometimes, for the maintenance of the improvement, to undergo two or three 'courses' a year.

Summary.—Both Schott's and Oertel's systems go to extremes; both, in the hands of competent persons highly trained and experienced in the application of the methods, have great value; and both need a kind and amount of supervision not often available. In the former, in spite of all assertions to the contrary, artificial Nauheim baths do not perfectly substitute the natural baths. Few attendants have the tact, observation, or training to apply the resistance movements, and it is very rarely possible in this country and under present conditions for the doctor to administer or constantly supervise them in person. The Oertel treatment for its best application needs peculiar climatic and topographic conditions, a certain elevation above the sea, a constant moderate climate, hills or mountains with good paths carefully laid in even and known gradients, and hotels under real medical control, with exact diet schedules correctly carried out. It is enough to mention these requirements for any one familiar with the climate and resorts of the United States to recognize at once that these conditions are not now met in any place in this country. We need not therefore despair of treating properly our cardiac cases. Many patients go every season to Nauheim and other European cures who would be better at home if they would consent to the necessary restrictions and continue treatment for the necessary time—and let it be said, also, if their physicians would or could give them sufficiently exact and constant care. Enough has been said already in speaking of the two systems to indicate the manner in which cases should be selected for treatment. Patients with moderate degrees of incompetence, or with moderate dilatation, and those suffering with functional palpitation and tachycardia, need gentle, increasing, measured gymnastic exercise, combined if possible with some means which shall dilate peripheral vessels enough to lessen the heart's work in forcing the blood through them. Patients suffering from fatty infiltration, general obesity, respiratory insufficiency, and consequent imperfect oxygenation will have their requirements best met by long-continued moderate general exercise, of which the most desirable form is hill-walking sufficiently severe to make considerable demand upon the lungs, and, with this, there must be a dietetic regimen in which quantity and quality will be suited to individual needs, of course, but be generally of a character which will be suited for those with a tendency to accumulate fat.

Formerly a patient with imperfect or easily broken compensation was kept from all exertion and rest enforced upon him to such an extent and for such long periods that the regaining of cardiac force went no further than to establish the work of the heart upon the narrowest possible margin of compensation, so that the organ had no force to spare if accident caused new demands to be made upon its powers. The convalescent was solemnly warned against all exertion for the future, and the heart-muscle thus forever precluded from the strengthening effects of exercise. Whatever criticism of Oertel's plan as a whole may be made, it is to his insight that the newer and better method of treatment is due. Its text may be briefly stated: once compensation has been regained, the heart must be trained by graduated exercises to do as much work as it can without injury. Such work does not include sudden violent exertion, hard running, or the carrying of heavy weights. A person with a heart still weak from recent valvular disease, though competent for its work under ordinary conditions, should not attempt, for example, to lift a trunk or run for a train. Mental or emotional strain is almost as bad, though less easy to avoid. The diet question is matter for a separate treatise and it is only requisite to say here that unchanging general dietary rules cannot be laid down so as to fit all cases, and that the too severe restriction of the quantity of food and of liquid without careful and frequent study of the person's condition may result in serious harm and weaken the patient to such an extent as to render it almost impossible for him to recover. A moderate restriction in the daily consumption of liquid is most necessary in any case of broken compensation, and a less absolute but still strict rule on the same subject is desirable even when there is good compensation, and even though no obesity be present in either instance. Van Noorden suggests as a reasonably safe limit that the total fluid taken should not be more than 1.25 liters, and considers it quite needless to go into the consideration of the amount of water contained in the bread, vegetables, and other food. (See also volume VI.)

Compensation once established by rest, and the dietetic matters regulated, we turn to exercise of the heart for the completion of the cure by permanent improvement in the cardiac power. The form of exercise must be one that can be measured with exactness, that will make no undue demands upon muscles as yet unable to respond to them, and yet will call sufficiently upon the heart and the breathing apparatus to produce the desired effect of strengthening them. Two forms of such exercise are available—the resistance movements of the Nauheim method and the hill-climbing of Oertel's system. The resistance movements already described form an excellent preparatory course, to which the hill-climbing is an invaluable sequel. To get the best results, the precautions suggested in the section on these exercises must be followed. Where climate or other reasons preclude outdoor exercise, various forms of gymnastic work may take its place, though none of them are quite as effective. The several pulley and weight machines, the elastic resistance exercisers, rowing machines, and many of the free movements may supply the need in part. Their chief disadvantages are the tread-mill monotony of the machine work and the indoor atmosphere. The work prescribed must meet the indications already several times stated, namely: (1) it must be capable of gradual and exact increase; (2) it must exercise both the heart and the respiratory apparatus. Neither palpitation nor breathlessness should be caused by the exercises. The occurrence of either would show that the exercise was too severe or was improperly performed, probably done too rapidly. At the first moment that the weather will permit, outdoor work should be substituted for indoor work.

The treatment by exercise and diet should continue from five to eight weeks, or more if the gain in cardiac strength and respiratory capacity is slow, and should, when conditions permit, be repeated after an interval of eight months or a year. It is perhaps too much to expect that patients should undergo a six weeks' course annually, but they will be well repaid if they do so. Compensation being thus re-established and the force of the heart increased, moderate regular ordinary exercise should become a part of the patient's daily life in order to maintain the improvement. Golf, riding, rowing or paddling, hand-ball, medicine-ball, and walking offer a sufficient list from which to choose agreeable and suitable work. If there be a tendency to fat, the restriction of food and drink must be made permanent.

CHAPTER IX

DEFORMITIES

Lateral Curvature of the Spine. Other Postural Deformities, Stoop, Pigeon-breast, Hollow Chest. Examination of Patients: Best Position; Keynote Position. Prognosis. Introductory Exercises. Dress. Corrective Exercises. Duration of Treatment. Prescription for Continuance of Treatment at Home. Pott's Disease. Breathing Exercises; Other Movements. Lordosis and Kyphosis. Care of Infants and Children with Pott's Disease. Flat-foot. Pes Valgus and Pes Planus, Acquired and Congenital: Causes; Movements; Rest; Special Exercises. Spasm.

LATERAL CURVATURE OF THE SPINE AND OTHER POSTURAL DEFORMITIES

Simple lateral curvature of the spine that has not lasted long enough to induce osseous changes can in most instances be arrested, in many cases greatly improved, and in some can be entirely cured, by appropriate exercises. For purposes of treatment, other postural deformities of the trunk may be classed with lateral curvature, since round shoulders, general stoop, pigeon-breast, and hollow chest are all in some degree the results of weakness or wrong action of the muscles. Contraction of the chest with accompanying curvature caused by empyema and adherent pleura is the exception to this rule. It must also be recognized that there are other causal factors in all these conditions, though the muscular ones are the most important. When osseous deformity—change, that is, in the shape of the vertebræ—is present, the case is in so far incurable, but further deformity may be prevented if the alteration of the bones has not been too great. Cases in which the curvature is caused by a shortening of one leg from poliomyelitis with consequent tilting of the pelvis, or by paralysis of the intrinsic spinal muscles or the erector spinæ muscles due to poliomyelitis, must be considered as presenting double conditions for treatment. In the former case it is necessary first to correct the deficiency by a high-soled shoe. In the latter condition, supporting apparatus for the trunk will be required, temporarily in any event, and if the muscles are entirely paralyzed, it will have to be permanently used whenever the patient is erect, to prevent increase of deformity and consequent serious results.

A large proportion of patients with lateral curvature have flat-foot; the result, in part, of the same general relaxation of muscles that causes the curvature—in part, of the sedentary and enfeebling habits which the spinal deformity has enforced. The condition can very readily be treated at the same time with the curvature.

At least three-fourths of the patients with lateral curvature are girls. The most frequent age of beginning curvature, or perhaps one should say the age at which curvature is first noted, is from the seventh to the fifteenth year, covering the years of development of puberty and of greatest rapidity of growth. Careful individual study of the patient is of the utmost importance; and it is well to make records of the conditions at the beginning of treatment for future comparison. Tests of the various muscles involved should be made by observing them in action, and the general development and its deficiencies noted. Sufferers with this disorder are usually ill-developed and soft muscled, conditions which in some are the cause, in others the consequence, of the curvature. In not a few instances a large part of this feebleness is to be laid to the medical advice they have received. There are but two prescriptions ordinarily given in lateral curvature cases; one is to rest a good deal lying down, the other to wear a brace or spinal jacket. These suggestions constitute the first and final resources of many medical men against 'weak backs.' They might be advantageously and briefly amended to read thus: "Rest very little lying down, and never wear a brace."

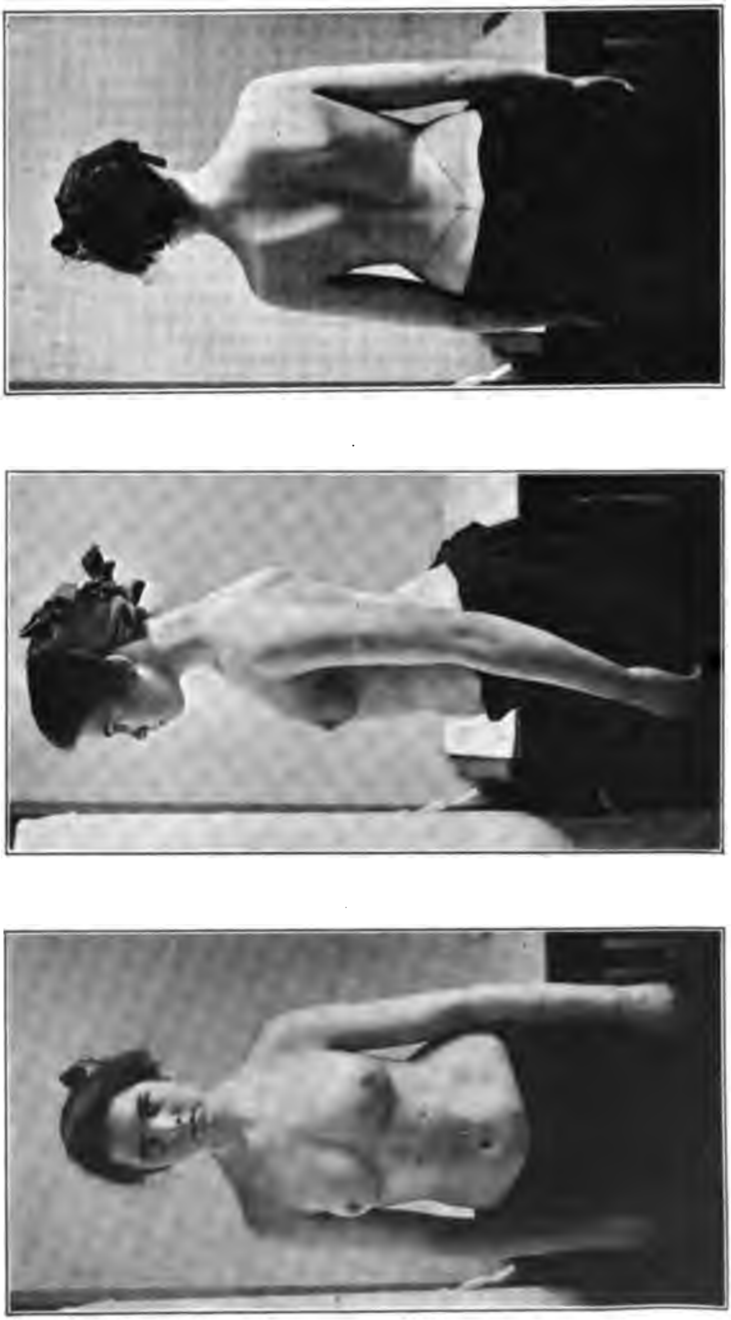
The cause of lateral curvature is weak muscles: absence of use increases the weakness or at best hinders the muscles from growing stronger. The patients have usually much general lassitude, which is cultivated by ordering them to 'rest a great deal.' In all cases certain amounts of rest, either supine or in a suitable and exactly fitting chair which will properly support the spine, should be ordered, but the duration of the rest and the hour at which it is to be taken should be stated precisely, not left to the very doubtful discretion of the patient.

Examination must be made with the patient stripped to the middle of the buttocks. With a skin-pencil or fountain pen, the tips of the spinous processes should be marked from the cervical region downward and lines be drawn from the anterior superior spinous process of the ilium along the edge of that bone to the posterior spinous process on both sides. The shoes should be removed and, if inequality in the length of the legs is observed, correction made by a block under the foot on the short side.

The observer standing behind, notes the character of the curve with the patient in the ordinary unforced attitude; the relative position of the shoulder-blades, to see if there be anteroposterior curvature—as most patients with decided lateral deformity either stoop or show an anteroposterior curve less marked than the normal one; whether flat-foot be present on one side or on both sides and, finally, whether there is osseous deformity (shown by rotation) of the vertebræ or ribs. In examining for this last, the patient must stoop forward, dropping the arms so as to uncover the ribs posteriorly. Inspection should next be made in front as to the relative height of the shoulders and to observe whether the mammæ are level with one another. The body should also be viewed from the sides, to note the amount of anteroposterior deformity, the depth and shape of the chest, and the general standing posture.

Lead-tape outlines of the trunk at several levels, measurements and photographs or sketch memoranda of all these matters, should be made on the spot. A trunk outline printed on slips of paper is a time-saving device for recording these notes. These blanks, with an ordinary tape-measure, a lead-tape, and a spirit-level, will make an outfit for recording conditions in these cases quite as good as the numerous very elaborate and very expensive devices invented by ingenious mechanicians. (See Addendum on "Orthopedic Apparatus.")

The final step in the examination is to discover how complete a correction of the patient's deformity can be obtained by **voluntary effort** or **suspension.** When the bones have undergone no change, a normal position can generally be attained by muscular effort properly directed. If bony deformity be present, its extent will affect the posture more or less, and in like degree the prognosis. Moderate osseous change, of brief duration, may be compensated for, though not overcome, by muscular cultivation. Extreme deformity of old standing can be but little altered. The **prognosis** as to curability will depend more upon the degree of rotation of the vertebræ and upon the general condition of the patient's health than upon the extent of the lateral deformity. For this test of correctibility the patient should try to take the **straight standing attitude,** drawing in the abdomen, throwing back the shoulders, the hands at the sides, palms forward, and the head held erect. Sometimes this alone corrects, or partially corrects, the deformity for the time (see Figs. 52, *A* and 52, *B*), although the patient is usually not able to maintain the proper posture. If this position does not correct, the 'best position' should be sought. It may be found that the spinal curves approach nearest to normal with both arms stretched parallel upward, or with both arms stretched laterally, or with one arm vertically



A *B* *C*

Fig. 51.—Lateral Curvature of the Spine. Usual Position. (See Fig. 52 for corrected positions.)

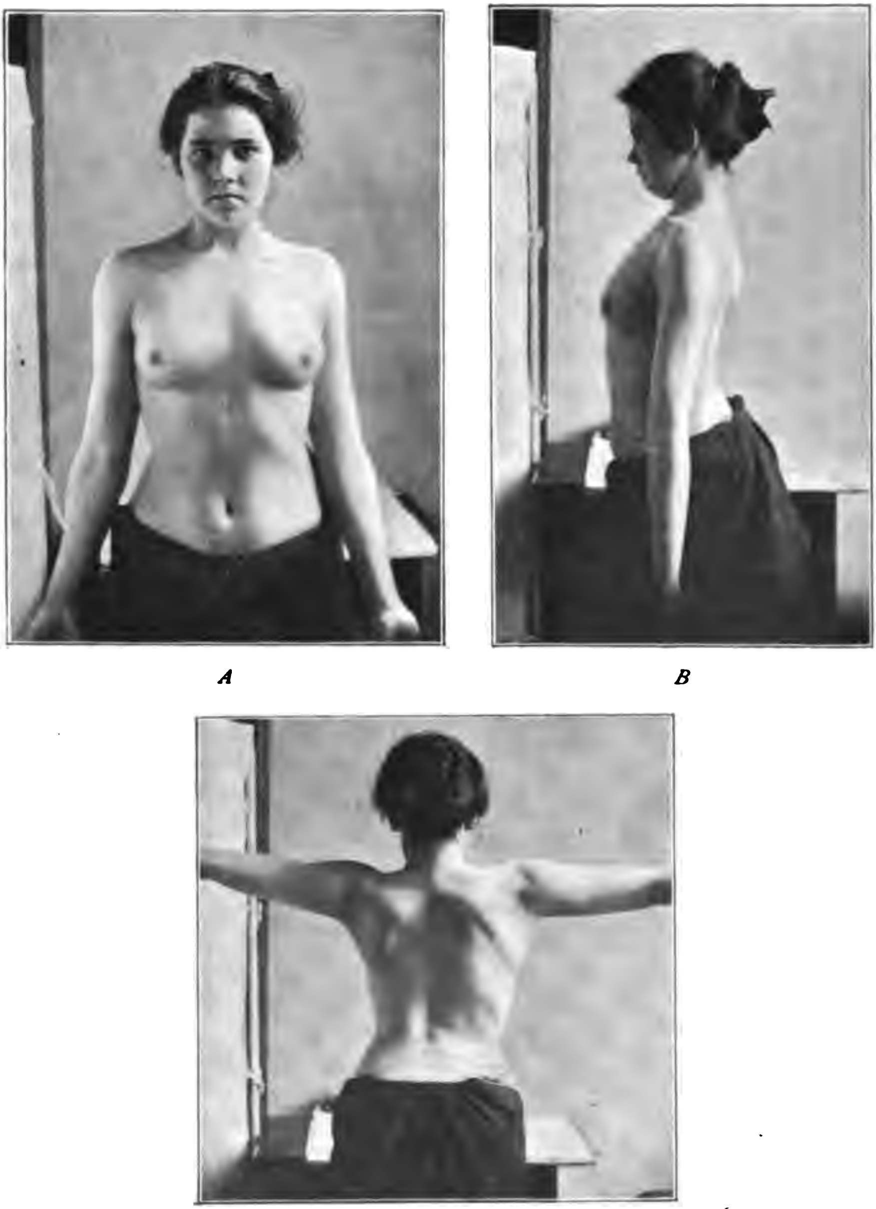


FIG. 52.—LATERAL CURVATURE OF THE SPINE: *A* AND *B*, PARTIAL CORRECTION BY FORCED STANDING. *C*, PARTIAL CORRECTION, LATERAL KEY-NOTE.

extended and the other one holding it at wrist or elbow. Whichever position best corrects the particular spinal deformity is that patient's 'best position' and gives the **key-note** for future exercises. Fig. 51, *A*, *B*, and *C*, illustrates the natural position, Fig. 52, *A* and *B*, forced standing position (with partial correction), and Fig. 52, *C*, *D*, and *E*, key-note positions with more complete correction. The photographs reproduced in

D *E*

FIG. 52 (*Continued*).—LATERAL CURVATURE: *D*, *E*, GOOD CORRECTION, RIGHT LATERAL KEY-NOTE.

Figs. 51 and 52 were made from a patient visiting the Orthopædic Hospital for the first time, so that she had had no practice in exercises, but it will be observed that the key-note position almost perfectly corrects the deformity. When **osseous deformity** and rotation exist or are suspected, examination must be made especially for them. One method is as follows: with the patient standing as straight as possible, heels together, toes out at an angle of 60 degrees, the arms are extended forward with the palms care-

A

B

C

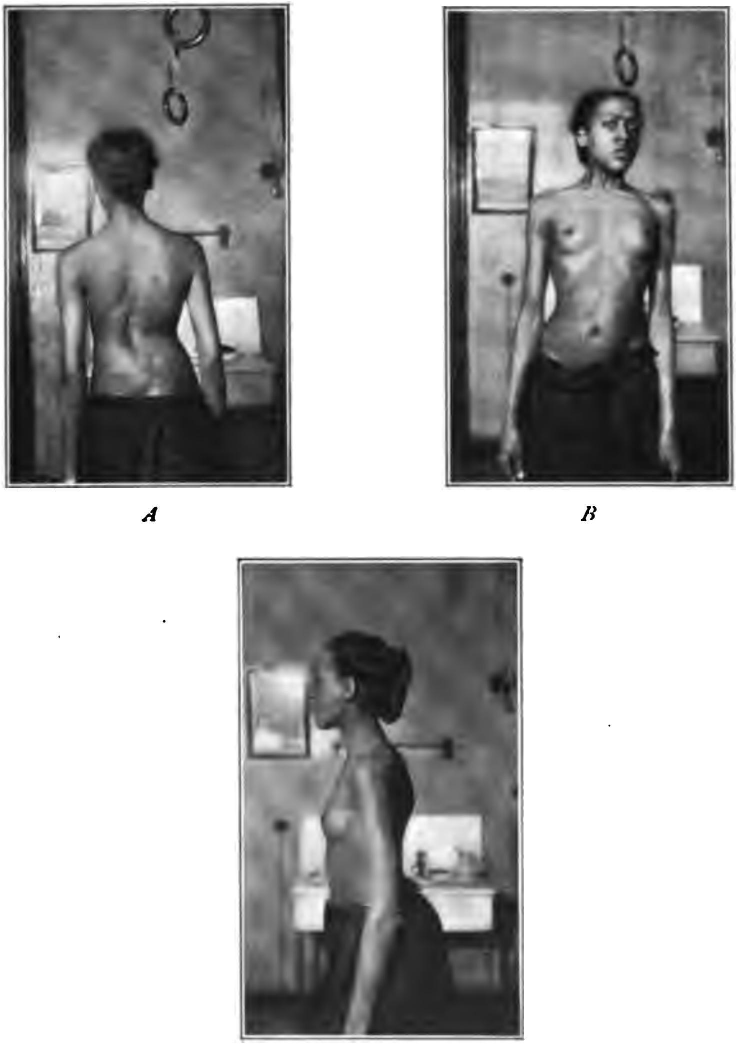
FIG. 53.—BACK-ROD WORK FOR SPINAL CURVATURE. *A*, WRONG METHOD OF USE. *B*, RIGHT METHOD OF USE. *C*, FORCIBLE USE.

fully and exactly placed together, while the observer stands behind the patient. The arms thus extended are first steadily carried up to the vertical position, and after inspection in this attitude the same movement of overhead stretching is repeated with the body bent forward at a right angle to the legs. In this way the degrees of variation of the several spinous processes from proper alinement may be ascertained, the

A B C

FIG. 54.—CORRECTION OF POSTERO-LATERAL CURVATURE BY SUSPENSION. *A*, USUAL POSITION. *B*, SUSPENSION FROM WALL LADDER, MODERATE CORRECTION. *C*, LATERAL SUSPENSION FROM WALL LADDER, BEST CORRECTION.

apices having been previously marked with a pencil. Other methods of exhibiting the amount of rotation will readily suggest themselves, such as by requiring the patient to turn the trunk while the arms are extended forward in the manner used in the movement above described. A plan suitable for an exercise and also for a measure of the extent of possible correction by muscular exertion in anteroposterior curvature is in use in the Orthopædic Hospital in Philadelphia, where it was suggested by one of the masseurs. A stiff wooden rod is applied to the back



A *B* *C*

Fig. 55.—Lateral Curvature: Usual Standing Positions. (For correction see Fig. 56.)

while the patient stoops forward. He clasps the rod above his head and endeavors to apply his back to it as closely as possible from the hips to the head, an attendant meanwhile holding it at the lower end (Fig. 53, *B*). A further effort at correction is made by placing a cross-

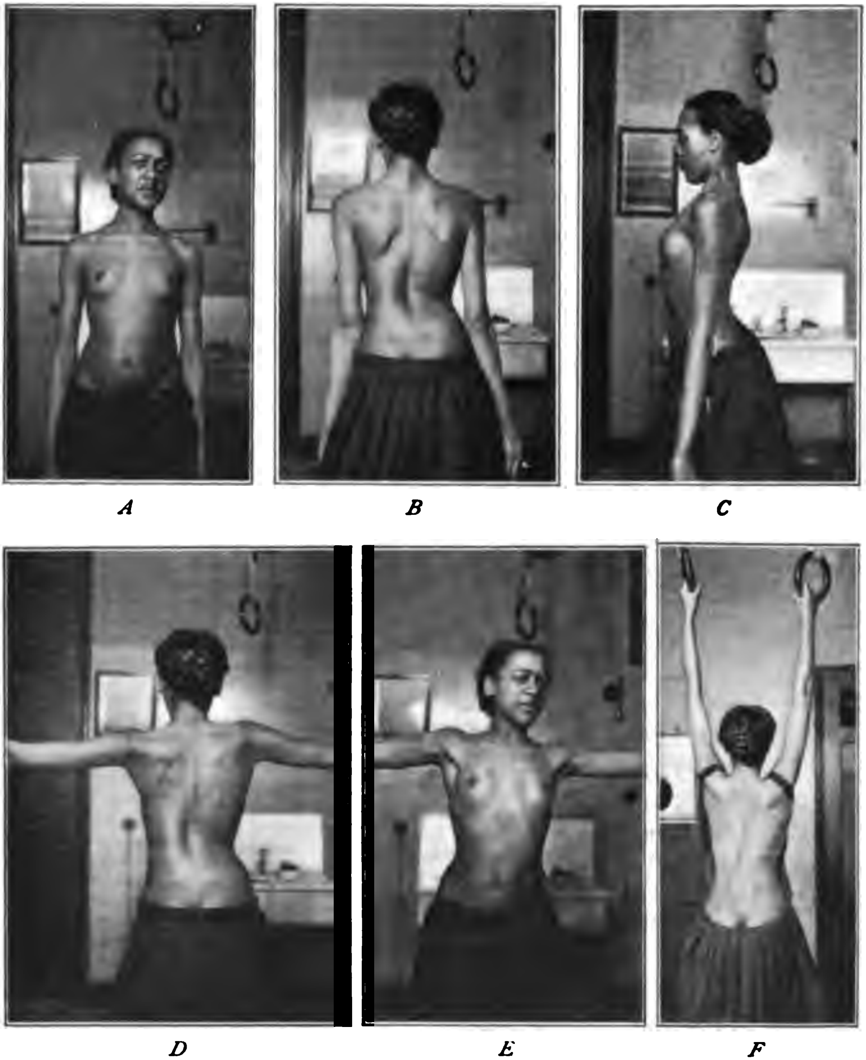


FIG. 56.—LATERAL CURVATURE. (Same patient as Fig. 55.) *A*, *B*, AND *C*, PARTIAL CORRECTION BY FORCED STANDING. *D* AND *E*, MORE COMPLETE CORRECTION BY LATERAL KEY-NOTE. *F*, GOOD CORRECTION BY SUSPENSION.

bar on the rod, at the level of the top of the patient's head. Over this he bends his arms, seizing the rod above his head as before, and then by pressing the elbows down and forward thrusts the shoulders back and the chest forward. (Fig. 53, *C*.) An unexpected amount of correction may thus be secured in some cases. A further description of this exercise is given on page 195. Self-suspension from a horizontal bar (Fig. 54), or, better, from rings, is also used to determine the possibility of correction. In examining the extent to which correction may be made by suspension, one ring should gradually be made higher than the other until the best possible position of the spine is secured. (See Fig. 55, *A*, *B*, and *C*, usual position, and Fig. 56, *A*, *B*, and *C*, forced standing, and *D* and *E*, partial correction by lateral key-note, and *F*, correction by suspension, nearly perfect.) The rings must be high enough for the patient to hang clear of the floor without having to raise the feet. This is the **best single test** of possible correction, and consequently the best basis for prognostication. Finally, the patient should be examined lying prone.

In the various positions efforts at correction of the deformity by pressure with the hands should be tried. Cases in which good alinement and correction can be secured by position, by suspension, or by moderate pressure are classed as 'slight,' with a good prognosis. Those in which correction is only imperfectly made by these measures are 'moderately severe' and the prognosis is less good; though, even in these, some improvement may be expected from persistent muscular cultivation. Cases with active bone disease or chronic disease of the heart or vessels are unsuited for treatment by hard exercises in the manner about to be described. Persistence with milder exercises may in the end attain the same result, but should not be attempted at all while the osseous disease is in active progress. (See page 191 for treatment of Pott's disease.)

The treatment of cases that present no bony deformity is best begun by the prescription of **general active exercises,** as nearly all the patients show some lack of exact control of muscular action on testing them with simple movements, quite apart from the general weakness of their muscular systems. Through all the exercises, and when resting, the best standing position must be insisted upon. This should be watched at home also. If the back is supported from the sacrum to the neck by a chair so padded as to give support at all points, little difficulty will be experienced in maintaining the position when seated. The desk or table used, the incidence of light on book or work, the clothing worn, the character of the bed and its pillows, will all need to be looked after, but their discussion does not belong here. (See volume v.)

Patients are usually found so accustomed to their false attitudes as to be unable to recognize when they are standing correctly. Practice before a glass will help to overcome this. Constant personal attention from the physician or a well-trained attendant is necessary at the beginning. So much attention is needed that each patient must be individually taught and watched by himself, at any rate during the early portions of the treatment. Class work for this reason will not accomplish such good results as individual teaching, though under hospital and dispensary conditions it may often be the only possibility. Two attendants are necessary even for a small class, in order to keep proper watch of movements and positions, one giving the order and illustrating the movements, while the other watches the patients' attitudes from behind or from one side.

General Introductory Exercises for Curvature Patients

We begin with a selection among the general **setting up** and **breathing exercises.** Nos. **4, 5, 6, 7, 12–20,** of the general exercises are suitable for beginners. Not all of them need be used in every case, but only those specially applicable. The aim at first is simply to improve muscular control. Those who are not deficient in this respect may be pushed more rapidly and proceed to heavier work at once. The lessons should last from fifteen to twenty minutes at a time during the first week, and be repeated twice a day; after that they should be increased to an half hour. These first exercises are primarily, as has been said, to gain muscular control, secondly to better the standing position—incidentally improving the anteroposterior curvatures—and lastly to strengthen the general muscular system. By the end of two weeks some change for the better should be observed in the lateral curvature, although the work has not been especially aimed at that deformity. The patient should begin at this time to use dumb-bells, and continue using them when their use is possible in such of the exercises above prescribed as may be suitable to the particular case. The weight of the bells will vary with the age and ability of the patient, but should soon be increased to a maximum somewhat above that suggested in the section on general exercise. They may weigh one-fifteenth of the body-weight and be increased to one-tenth. Each exercise should be repeated until the groups of muscles in use are thoroughly fatigued. After a short rest of a minute or two a new exercise involving different muscles is begun and continued in the same way. When considerable effort is required, as in lowering and raising the whole body in deep-knee bending, toe-rising, forward stoop and like movements, from ten to twenty repetitions will suffice. When smaller groups are called upon, as in arm work, from twenty to fifty repetitions should be ordered. At the end of these two weeks some exercises specially intended to correct the deformity should be begun. These will differ according to the variety of the curvature.

Dress of the Patient

The patient's costume should be of light material and close-fitting enough to allow the instructor to observe clearly the position. The dress used at the Orthopædic Hospital in Philadelphia, shown in the photograph of the class at work, is readily made at home and costs very little, both matters of importance to dispensary patients. It is constructed with an opening down the whole back, of a width sufficient to make the spine visible, and is supported by shoulder-straps only.

Exercises for the Correction of Lateral Curvature

Straight standing exercises, followed by the assumption of the individual key-note position, should begin every lesson. The list of exercises described below offers enough variety to make it possible to select from it exercises suitable for any ordinary case of curvature. Experiment and observation will soon prove which are the best. Some have been already suggested for use as introductory exercises.

1. **Forced breathing,** lying supine, arms by the sides.

2. **Forced breathing,** lying supine, arms laterally extended and stretching.

3. **Forced breathing,** lying supine, arms extended above head in the long axis of the body, stretching.

Each of these is to be repeated four to six times. An interval of a few seconds is enough to allow for resting after each of these movements.

After a few days' practice in these three movements the following may be substituted in order to combine them:

4. **Arm Extension.**—Same position as in No. 1, but with the knees bent to allow the lower spine to become as straight as possible. Extend the arms sidewise and stretch; bring them forward and upward and stretch. Repeat four times, inspiring as the arms are stretched, expiring as they are relaxed.

5. (*a*) **Arm Extension and Flexion Resisted.**—Same position as in No. 1. The movement is begun with the arms close to the sides, the elbows bent and the hands level with the shoulders, palms forward. The attendant standing at the head of the couch clasps the patient's hands and resists the patient's effort at elevating the arms to a vertical position.

(*b*) From the position of upward extension the attendant resists the patient's flexion of the arms.

6. (*a*) **Arm Elevation Resisted.**—Same position as No. 1. The arms are extended parallel alongside the head and the attendant, clasping the patient's hands as before, resists the effort to bring them to the vertical position.

(*b*) Similar resistance is made to the patient's bringing the extended arms forward and downward to the sides, without bending the elbows.

These movements should also be performed with reversed resistance, in No. 5 the patient resisting the attendant's attempt to elevate and then to flex the arms. The two motions, elevation and flexion, should be performed separately with brief rest between. No. 6 is modified in the same way. The resistance should be slight in the first three or four lessons, later increased, and in more advanced stages dumb-bells or heavy bars are used for the same purpose.

7. **Leg Elevation.**—Same position as No. 1. Extend the arms above the head and then raise both legs at once as nearly to a right angle with the body as possible. A little assistance in this movement may be needed at first, or it may be begun by elevation of the legs alternately.

8. **Arm Flexion, Resisted,** Sitting.—The patient is seated upon a firm bench or stool. Only the arm upon the **convex** side of the curvature should be used in this exercise. The hand extended straight to the front is grasped by the attendant and the patient draws the arm toward the body, bending the elbow and keeping the hand at the level of the shoulder. This acts directly upon the vertebræ, and in cases in which they are not yet fixed by alteration in the shape of the bones, overcomes the rotation caused by the deformity. The effect at first lasts during the effort, but if persisted in will permanently affect the position of the bones.

Whether resistance should be made at, above, or below the level of the shoulder is matter for experiment and observation. Standing behind the patient after marking the tips of the spinous processes, the physician will at once see what position during effort is called for.

9. **Arm Extension, Resisted.**—The patient sits in the same position as in No. 8. The arm upon the **concave** side of the deformity is used in this exercise. The arm is flexed at the elbow, the hand, palm to the front, brought close to the shoulder, and the patient pushes strongly against the attendant's opposing hand, until the arm is in full extension forward, at the level of the shoulder. This movement is supplementary to the last one, and its special influence is toward the overcoming of the protrusion of the chest usually found on the concave side of the spinal curve, through the action of the chest muscles.

These two very valuable exercises are due to the ingenuity of Mr. Noble Smith, who suggested them in the "Lancet" several years ago, in a somewhat different form, using an apparatus for elastic resistance. When a good attendant is not available and the patient is intelligent enough to be trusted to work in the right way without oversight, the elastic cords or a chest-weight apparatus may be used. In the latter case, the weight must be as heavy as the patient's strength can move. Care must be taken that the apparatus is not so used as to exercise arm muscles alone. To get the right effect the scapular group, particularly the serratus, must be called upon, these muscles pulling at the chest on the side of the concavity and tending to rotate the vertebræ. A Whitely exerciser is capable of a variety of applications for head, neck, and trunk exercises, as well as those of the hands and feet.

For leg and thorax movements a flat, firm couch about three feet high is needed. A strap across one end provides a means of support for the legs in exercises requiring the extension of the body beyond the end of the couch.

After practice in trunk flexion forward and back, always with the maintenance of the key-note position of the arms, **trunk flexion prone** should be ordered.

10. **Trunk Flexion and Rotation,** Prone.—The patient lies in a prone position with the body from the waist up extending beyond the end of the couch. The feet are held by an attendant or confined by the strap. The patient slowly and steadily raises the upper trunk, bending the dorsal spine as much as possible (Fig. 57, *A*).

In the first attempts at this movement the arms are kept by the side. Later it is done with the arms extended as in the illustration, and when it has been repeated often enough to gain some facility, the key-note position suited to the individual deformity is assumed. In this posture, rotation of the trunk with the body extending beyond the couch as described should also be practised, turning to right or left as may be found most useful (Fig. 57, *B*). These dorsal flexions are repeated three to five times at each lesson.

Again, the prone position on the couch is taken for certain leg movements.

11. **Hip Circumduction,** Prone.—The leg, with the knee straight, is moved so that the foot describes a circle, the foot moving from without inward; then, reversing the movement, the circumduction is performed from within outward. Repeat with each leg six to twelve times.

A combination of trunk flexion with backward raising of the leg is performed in the same prone position on the couch and is useful as an exercise for deficient hip and lumbar muscles as well as for the back (Fig. 57, *C*).

12. **Hip Circumduction,** Supine.—This is the same movement as No. 11, except that the patient lies on his back.

13. **Trunk Flexion and Extension, Resisted.**—The patient sits on a bench or firm stool, takes the best position, and bends the trunk forward, the attendant offering slight resistance. Resistance is also made to the resumption of the upright position by applying the opposing hand to the base of the neck or on the shoulders. Repeat three to six times.

These exercises constitute a sufficient course for two to four weeks if done daily. Weak patients or those undertaking the curvature exercises without preliminary training work, as already suggested (page 181), may require the longer period. Patients already in fair muscular condition and those who have acquired reasonably good control by the preliminary course should at the end of two weeks of daily lessons be able to do somewhat more severe work. This may be given by increasing the number of repetitions of the several movements; or by adding other and somewhat more difficult exercises; or by causing the patients to use dumb-bells or bars in such of the exercises as permit of their use; or by introducing resistance into some of the exercises and increasing the amount of resistance where it is already part of the lesson. For example, the first four movements may be omitted entirely, and curvature exercises Nos. 5 to 9 be performed three to five times oftener than is prescribed on pages 182 and 183, and with an increased amount of resistance. If attendants trained in the resistance-work are not to be had, dumb-bells may be used in the arm movements and shot-bags with increasing weights attached to the ankles in the leg movements, beginning with one pound and going on until three-pound to five-pound bags are used.

In the sixth week of treatment some new exercises of a different character should be introduced; work on the rings or bar, walking with weights on the head, and general dumb-bell or bar movements. Not all of these are needed in every case, but the use of some of them will be serviceable in giving variety and interest as well as in their effect on the general development of the patients.

Dumb-bells used in the wrong way are capable of doing harm. The illustration in Fig. 58, *B*, exhibits a patient pushing up a heavy weight on the right side. The curvature is thereby increased. Fig. *A* on the same page shows the uncorrected position and *C* the patient with the left arm extended carrying the bell, the curvature being lessened quite distinctly by the effort. *D* shows the excellent correction of the deformity obtained by suspending the same patient with the left ring somewhat elevated above the right one.

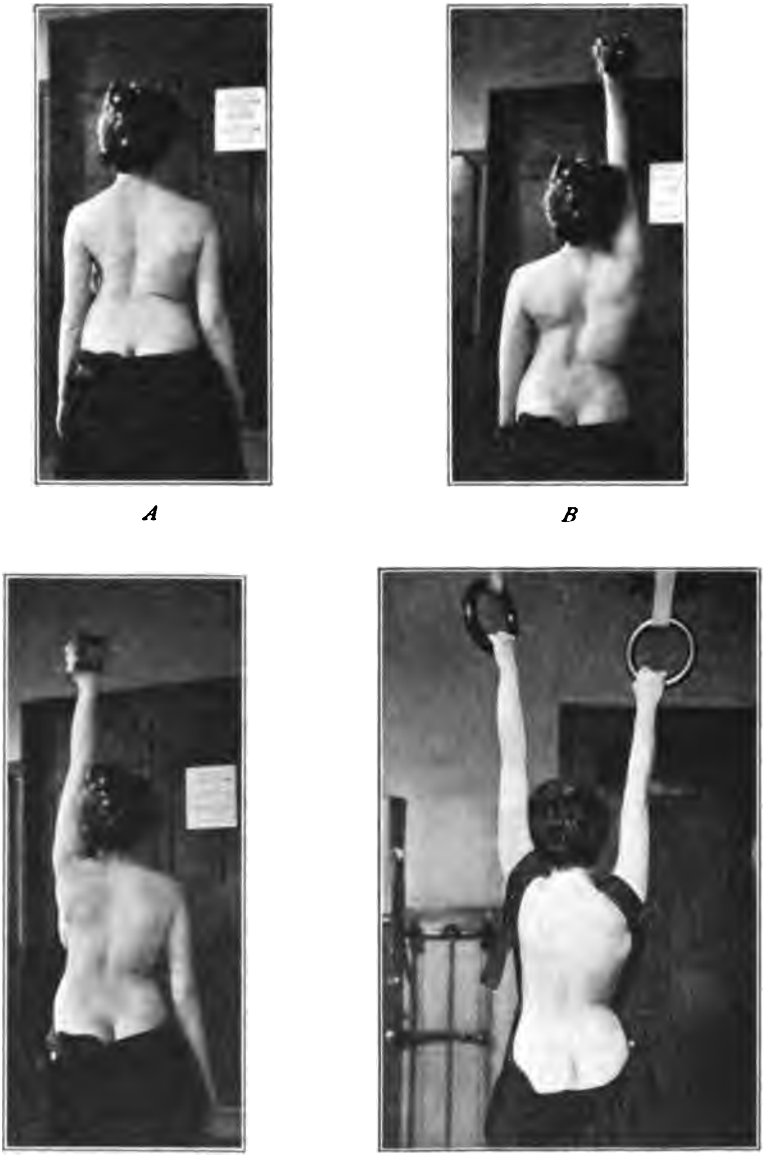
Suspension from the rings helps to straighten the curve in the spine

A

B

C

FIG. 57.—CURVATURE EXERCISES ON THE COUCH. *A*, TRUNK FLEXION, STRAIGHT KEY-NOTE POSITION. *B*, TRUNK FLEXION WITH TWISTING; RIGHT LATERAL KEY-NOTE. *C*, COMBINED SHOULDER AND LEG ELEVATION.



A *B* *C* *D*

Fig. 58.—Correction by Position in Curvature. *A*, Usual Position. *B*, Dumb-bell in Right Hand Increasing Curvature. *C*, Dumb-bell in Left Hand Lessening Curvature. *D*, Good Correction by Suspension.

by the pull of the body-weight, and the exertion of raising the body up and lowering it again is an admirable developer for the hands, arms, and shoulders. A horizontal bar may be used in the same way, but the rings have the advantage of adjustability, as one may be lowered so that the best position of the back is assured. To pull the body up till the chin is level with the rings from three to six times is enough. Shot-bags or crowns carried on the head will add to the work of all the body and leg muscles and help to cultivate an erect carriage. They may be used in class or individual work, the patients performing, while wearing them, such arm exercises as are done with the body erect, and leg movements like toe-rising, knee bending, marching with high raising of the knees, and so on. Drilling with dumb-bells or bars, the weights being increased as fast as the strength of each individual will allow, with continual care about the exact maintenance of the best position, may occupy a few minutes of the exercise-hour, which should always begin and end with the assuming of the key-note position.

The amount of daily work done at the end of the sixth week should be about three-quarters of an hour at one time, with a repetition at home of four or five of the more important exercises, selected according to the needs of each case, and occupying about twenty minutes. The simpler earlier exercises may by this time be omitted altogether, except the respiratory ones, which ought to be a regular part of the daily routine.

It should seldom be necessary to prolong the treatment of favorable cases for longer than three months, and the patients must be instructed in the need of continuing the movements at home at the end of this period.

If the amount and severity of the work here ordered seem great, it must be remembered that muscular development is impossible without working the muscles hard enough to fatigue them. With careful over-sight and a slow day by day increase in the quantity of effort, it is perfectly possible to advance much more rapidly than has been suggested. The first two weeks is the critical period, when real overwork may do harm; and yet even then the patient ought to be pushed pretty nearly to his limit of exertion, though with judgment. Patients directly under the physician's own eye may compress the work of the third to the sixth week into two weeks, if they are found to be improving rapidly in strength; but this should not be allowed to shorten the total length of the course. Three months is enough to work great changes in the curvature and to direct the patient on the road to be traveled; but to do this the lessons must be given daily, and the results will not be nearly so favorable if the pupil is working only two or three times a week. Before leaving the trainer's care he must be instructed in the character of work to be done at home. The importance of regularity in this and of keeping it up for from six months to a year cannot be too strongly stated.

Patients with slight curvature may be discharged, to continue treatment at home, after six to eight weeks. In very severe cases the patient may have to be kept at work and under constant supervision for from four to six months. A day or two's cessation during the menstrual period may be required for women, especially if there be painful or scanty menstruation; in such instances certain movements, such as the hip circumduction and trunk flexions, may be omitted during the continuance of the flow. Ordinary uterine displacements do not counterindicate the treatment.

Home Treatment

A written order describing the exercises to be continued after discharge should always be given. If the case has been successfully treated and the patient has gained as he should in muscular power, fifteen to twenty minutes twice daily will suffice to prevent relapse and further to improve the condition during the six months following. Outdoor sports and activities should also be encouraged in order to fill up the required amount of exertion for health.

An example of such a home prescription follows:

"Breathing exercises, lying down, Curvature Exercises, Nos. 1 to 3, each repeated five times. They should be done in the open air or at least with open windows.

"Curvature Exercises Nos. 4, 5, and 6, performed four times each, with heavy dumb-bells." (The weight of these will be determined by the patient's strength and progress when discharged.)

"Toe-rising (General Exercise No. 20); deep knee-bend (General Exercise No. 19), each twenty times. Sometimes these may need to be done with the arms in the key-note position, but as a rule this is not necessary in the later stages of treatment.

"Trunk flexion, standing, key-note position, four times; setting-up movement (General Exercise No. 5) twenty times. Trunk flexion and rotation (Curvature Exercise No. 10) four times.

"Walking with weight on head (weight stated, according to strength of patient) two minutes, maintaining key-note position.

"Attention must also be constantly given in ordinary walking and sitting to keeping the trunk and head in the best position."

Some patients may need more arm work than is prescribed in this list. For them rings or a horizontal bar can easily be rigged at home, dumb-bell work may be increased, or the elastic cord exerciser used.

If more leg work is wanted, the carriage of a heavier weight on the head during the performance of the toe-rising and knee-bending movements can be ordered; or leg movements with the pulley-weights, with the elastic exerciser, or with shot-bags attached to the legs may be given.

At the end of six months the work may be cut down for the succeeding six months to twenty minutes, or even less, once daily, if the patient can be inspected and certainty felt that progress is favorable. At the end of a year from the conclusion of the first course of treatment the patient should certainly be seen, to determine if further work be needed.

As to the advisable forms of **general exercise** in the form of sports and pastimes to be permitted, much will depend on the tastes and strength of the patient. Some such activity should be prescribed and enforced as a matter of health, and the only caution needed is against overexertion in general, and particularly against any sort of effort which might bring back again the tendency to lateral deformity. For instance, side-saddle riding is not very good for girls who have or have had lateral curvature; but the difficulty may be overcome by using a reversible saddle and riding alternately on the off and near sides or by following the modern fashion of riding in a man's saddle. Tennis is an excellent game, perhaps the very best of all the lighter outdoor sports, suitable to almost every age and every degree of activity, but the arm work is rather one-sided. As it is hardly reasonable to debar any one from it on this account and not practicably possible to become ambidextrous at it, the deficiency should be made up by some special gymnastic work for the less used side. Bicycling, golf, lacrosse, skating, ball-games, rowing, and swimming are all good forms of exercise for these patients, and running and walking, if practised with attention to the carriage of the body, are always suitable. This same care about posture will need to be continued for years, or at least until it has become habitual and does not require effort to maintain it.

During the first weeks of treatment patients often complain of **pain** in the back. Some pain is commonly present even in moderate cases of curvature, and after the withdrawal of the jackets or spinal supports and the beginning of hard muscular work it is in some cases increased, an increase due in part to muscular fatigue. **Massage** in the form of firm stroking and kneading of the back, especially of the erector spinæ groups, will usually relieve it, and should be prescribed as part of the treatment during the first two or three weeks. The best time for its application is directly after the lesson. Roth suggests, as other means of relief, cold compresses applied to the painful spot during the night, and acupuncture in case of severe and persistent pain.

Other hydrotherapeutic measures besides cold compresses will be found useful—for example, the Scotch douche with very moderate pressure or needle douches to the back with rapid alternation of hot and cold water.

POTT'S DISEASE (VERTEBRAL CARIES)

The subject of spinal curvature cannot be concluded without some brief reference to the treatment of suitable cases of Pott's disease, *i. e.*, caries of the vertebræ, small though the number of cases is that can properly be treated by exercise. The term is generally applied to tuberculous disease of the bodies of the vertebræ, and this is the form in which it is usually seen in children. It may occur in adults, and in them the causes are more various, sometimes syphilitic, sometimes rheumatic; and sometimes the disease is one manifestation of a polyarthritis. The treatment of the general condition and the causative disorder need not be discussed. While the active inflammatory process lasts **rest** is required. When this is past, we may estimate the amount of damage and proceed with our attempts at repair. In rare cases forcible correction of the deformity has to be considered: in others a question as to mechanical support must be decided. If the deviation of the vertebræ is very great, half the diameter of the vertebral bodies or more, support must be used as a means of precaution. With cases so bad as this the support will have to be worn whenever the patient is not recumbent; at any rate, till considerable muscular gain has been made by exercise. Especial precaution will be needed in the use of exercises for such patients, and no haste should be permitted. The work should be less than for simple cases of postural curvature and more slowly increased. When the deformity has lasted long enough to have caused partial absorption of the intervertebral cartilages from pressure, still more when the bones have undergone some change from the same cause or from erosion, the curve cannot be overcome. Some compensatory curvature may be established, the trunk muscles of back, chest, and abdomen can be strengthened, and the deformity thus prevented from growing worse.

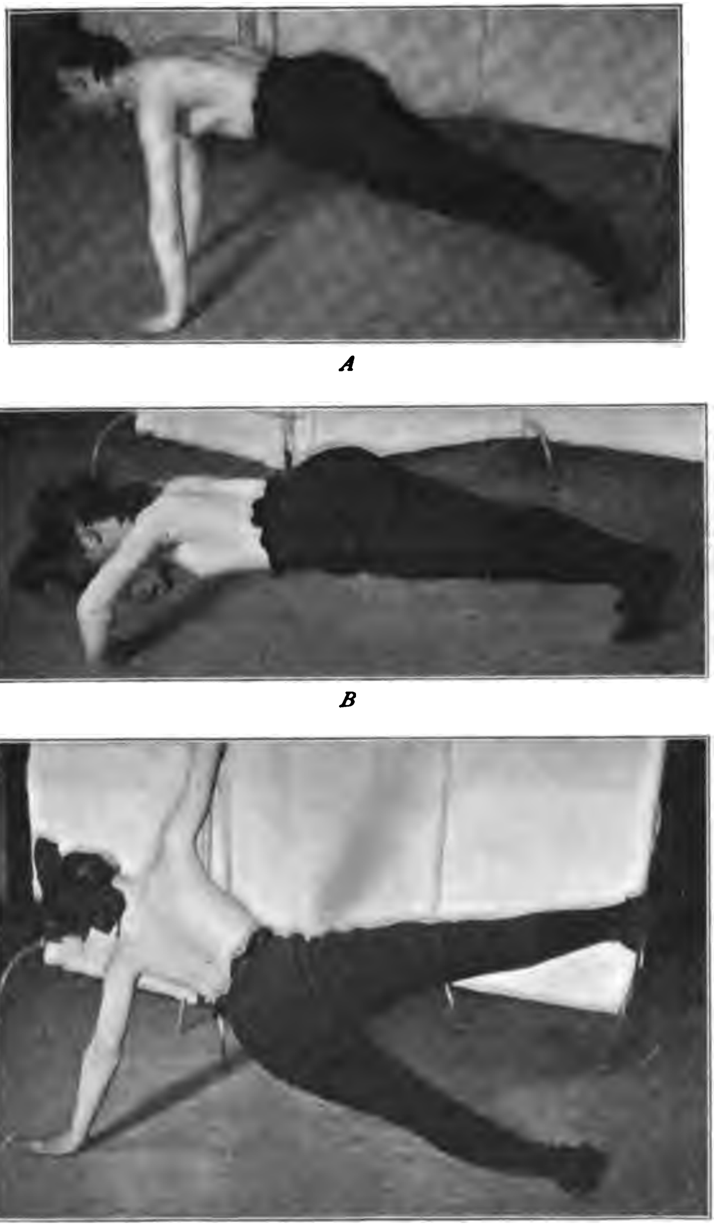
The displacement of the viscera may be considerable in cases with much deformity, the chest-walls commonly move little and expand little, the lungs are often emphysematous and the heart weak. All these conditions call for treatment, and in selecting exercises it will be necessary to decide whether those that will improve muscular condition or those aiming at the bettering of cardiac and respiratory conditions should be first prescribed. **Breathing exercises** have so wide an influence that they may often be of the utmost value by affecting the general health, and they are therefore suitable for almost all cases if not overdone.

For **posterior curvature,** if in the dorsal region, suspension by the hands from the rings or the wall-ladder (Fig. 54, *B* and *C*) will sometimes favorably, though slightly, affect the deformity. A slightly greater effect may be had, if the curvature is not too great to permit of its use, by suspension from the ladder with the back to the ladder, thus getting a pressure upon the prominent vertebræ. The rungs of the wall-ladder are much larger than those of an ordinary ladder, so that they do not give pain by this pressure. This position forces the chest forward and is straining to the arms and chest muscles; hence weak patients should not attempt it.

Forward drop between the hands is an excellent chest expanding exercise and forces the shoulders back. It is performed as follows:

14. **Forward Drop Between the Hands.**—Kneel, place the hands fifteen inches apart on the floor, extend the body and legs, and lower the body as far as possible, keeping the back stiff and the legs extended. (See Fig. 59, *A* and *B*.) Push the body up till the arms are straight, and repeat. Four or five repetitions will be enough for the first few lessons. This number may be increased to ten or twelve as the pupil improves. A like movement, somewhat less difficult, as the arms do not carry the weight of the body in it, may be done between two upright bars, or, where the apparatus is not available, in a narrow doorway. Stand about eighteen inches from the bars or door-jambs, resting the open palms against them, lean forward between the uprights to the limit of motion, keeping the head up and back and the whole body rigid from neck to heels. For special development of one side the floor exercise may be modified by turning to one side, and raising the arm and leg of the uppermost side, keeping them stiffly held for a few seconds, while the limbs of the other side sustain the weight. Re-assume the original position and repeat the turning and extending movement three times (Fig. 59, *C*).

15. **Arm Extension,** Supine.—Lie flat on the back on a flat couch or thin mattress with the knees bent, and lift dumb-bells with the arms stretched above the head. Bring the bells forward to a right angle with the chest, arms fully extended, and return to overhead position. Repeat at the rate of five times in thirty seconds, with full breathing. The movement should be steady and continuous from the raising of the bells off the floor to their return. Repeat five times for the first three or four days, then increase to seven or ten times. The number need not be increased, but the bells may be made heavier up to one-tenth of the patient's body-weight (Fig. 60, *B*).



A

B

C

Fig. 59.—*A* and *B*, Forward Drop between the Hands. *C*, Forward Drop and Sidewise Turn.

Fig. 60, *A*, shows the reason for requiring the knees to be bent. With the legs extended the lumbar region is raised, the abdominal muscles afford the fixed point for leverage, and the work of the arms and shoulders is lessened. In *B* the back is in contact or almost in contact with the couch throughout, and the chief exertion is performed by the upper and posterior shoulder muscles and those of the chest and arm.

A

B

FIG. 60.—CORRECTION OF SPINAL CURVATURE. *A*, ARM EXTENSION WITH BELLS—WRONG POSITION. *B*, ARM EXTENSION WITH BELLS—RIGHT POSITION. CURVATURE EXERCISE NO. 16.

LORDOSIS AND KYPHOSIS

For **lordosis** or forward curvature—an uncommon form, usually occurring as a compensatory curvature in cases of hip-disease and congenital dislocation of the hips—movements should be somewhat different. The abdominal muscles will require attention, and **forward bending; chest-raising, seated; abdominal breathing,** and **abdominal lifting**

(General Exercise No. 63) are types of the suitable exercises. Owing to the causes of this deformity no great degree of correction can be expected, and to overcome the curvature entirely would often be undesirable.

16. **Chest-raising, seated,** is an exercise calculated to develop chest and abdominal muscles (Fig. 61). The patient sits on the floor or a flat, hard couch, with the legs extended. The palms rest on the floor with the arms held stiff so as to fix the shoulders and carry the weight of the upper trunk. While in this position the patient contracts the abdominal muscles and lifts the chest, inspiring fully with each movement. This is to be repeated ten to fifteen times in a minute.

FIG. 61.—CHEST RAISING.

In fixed **posterolateral curvatures** with rotation of the vertebræ the exercises with a straight rod, already described on page 177, are valuable; they are equally of service in simple **kyphosis** when the backward projection is not too great. It has been of most use in my experience in cases of deformity due to contraction of the chest from pleurisy or empyema. The first exercise with it is simple.

17. **Back-rod.**—It is performed by seizing the rod above the head and pressing the elbows to the front. The trunk is bent at a right angle to the legs and the rod applied closely to the back and firmly held by an attendant. (See Fig. 53.)

The exertion is made by the patient, who can measure its severity for himself.

A

B

FIG. 62.—FLOOR EXERCISE FOR POSTERO-LATERAL CURVATURE. *A*, SIDEWISE CRAWL, PRONE. *B*, SIDEWISE CRAWL, WITH SUPPORT AND OPPOSITION.

The first illustration shows the **wrong** method of use of this plan (Fig. 53, *A*). The rod should be **pressed** down by the attendant while the patient pulls it hard downward at his end, as in Fig. 53, *B*. The second and more severe form of application is shown in Fig. 53, *C*. A short cross-bar is laid upon the rod **on** which the patient puts his arms and presses downward, attempting to bring the elbows together to the front, while the attendant holds the other end as in the previous exercise. These movements being severe ones are only to be performed once daily. The same patient is shown standing naturally in Fig. 54, *A*, which well exhibits the serious deformity, and also in the act of suspending himself by the hands from the wall-ladder in Fig. 54, *B* and *C*, the position in the latter illustration, in which he hangs somewhat to one side, giving the best correction.

Another useful exercise for **posterolateral** deformity in which the vertebræ are not so much altered as to render improvement hopeless is the sidewise crawl, prone.

18. **Sidewise Crawl,** Prone.—The patient lies prone on a blanket or hard mattress, with the arms extended above the head, and gradually creeps, a hand's breadth at a time, toward the convex side of the curvature (Fig. 62, *A*). In slight degrees of deformity the weight of the body may make sufficient opposition. In light-weight adults or young children it is best to fix the central point about which the attempt at revolution is made. The attendant presses with his hand or his knee against the convex surface of the chest, also fixing the hip of the concave side with the hand, or using the hand on the chest on the convex side, the knee against the hip of the same side and the other hand on the opposite hip, as in Fig. 62, *B*. In this latter way the motion is confined, as it should be, to the cervical and dorsal region, while some downward pressure on the deformed chest is also exerted. The movement is repeated twice or three times to the possible limit of motion.

POTT'S DISEASE IN INFANTS

For very young children with early stages of Pott's disease, carefully regulated exercises, passive at first and later active, may be used with the patients in bed even when the necessities of the case require them to lie entirely on their backs. Foot, leg, hand, arm, and neck can thus be exercised; the movement should be limited and care taken not to allow the exercise to move the trunk. When the child has had some experience and acquired some dexterity in active movements of the kind, the same exercise can be given against resistance. Of course massage is eminently desirable for such cases; its persistent use may save much trouble with stiffened joints. The exercise treatment of these cases should not be left to nurses. Even competent trained masseurs are too ready to ask more of such patients or to work them harder than is proper. At first the physician himself should perform the movements on the patient and only delegate the duty to others after they have been carefully instructed and he has seen them at work under his direct superintendence.

Summary.—For twenty years past advanced surgical opinion has condemned **steel supports, plaster jackets** and **long recumbency** in the treatment of spinal curvature in adolescents, except when rendered necessary by active inflammatory disease of the bone; yet error dies so hard that many patients are still sentenced to confinement in steel or plaster

FIG. 63.—CLASS-WORK FOR CURVATURE.

cages and, with this, to lasting invalidism instead of recovery. The chief effects of such methods, if long continued, are to get the spine permanently ankylosed in the deformed position and to induce atrophy of muscles by disuse.

The real **indications** are to render the spine more, not less, flexible; to strengthen by exercise the muscles which hold the trunk erect, not to throw them out of service; and to overcome the habitual faulty attitude by effort, not to render it permanent by immobilizing the trunk.

Whatever good results can be looked for in any case must be attained by frequently repeated voluntary correction of the deformity by muscular effort, aided when necessary by external force, by persistent muscle-building, and by improved nutrition.

FLAT-FOOT; TALIPES VALGUS, ACQUIRED AND CONGENITAL

Causes.—A consideration of the degree and cause of the flattening of the anteroposterior arch of the foot must precede treatment. The general condition of the patient is a large factor in its production, as it is less often seen in vigorous people than in those of rickety diathesis, of lymphatic constitution, or badly nourished. An undue and rapid increase of flesh in sedentary persons, relaxation of the muscles and ligaments from illness, especially from rheumatism, the daily necessity for long standing, are among the common predisposing causes. It is important not to confuse acquired valgus—*i. e.*, this flattening of the anteroposterior arch—with flattening of the anterolateral arch. In the latter there is usually a recent callous formation on the ball of the foot, and the spread of the foot at the junction of the phalangometatarsal bones is decidedly increased. Rheumatism of the foot may produce flat-foot, but subacute and chronic rheumatism may be distinguished from flat-foot by the general symptoms, the local signs of inflammation, and often by the presence of rheumatism elsewhere in the body. A weak ankle, with eversion of the foot, produces a condition often mistaken for flat-foot proper, and although less troublesome in its symptoms calls for similar treatment.

In mild grades of flat-foot a **gauze pad** under the arch with a firm strapping of adhesive plaster will support the foot while treatment is carried out, but a **rubber bandage** is more convenient and can be better applied by the patient. **Plates** or '**bridges**' of steel, phosphor-bronze, aluminum, or hard rubber should be substituted as soon as careful examination of the foot has determined the pattern to be used. One of these may at first be simply placed in the shoe and its shape altered as the condition improves. The plate must be so made as to support the astragalus if necessary, as that bone has usually a forward and inward displacement in addition to a downward alteration of position. A flange on the inner side of the plate should be used when the displacement is noted, extending upward far enough to prevent this malposition. **Massage** of the feet in the most thorough and careful manner is of great importance in the treatment, improving the local nutrition, toning the muscles and ligaments, and lessening the pain and tenderness. The exercises should follow the massage immediately, and both should be used at least once daily. If possible, massage should be given twice and the exercises can be used even oftener, especially after muscular improvement has once begun. The movements are directed to the strengthening of the feeble muscles and the consequent shortening of overstretched and relaxed tendons, and like all exercises for such purposes must be continued long enough to fatigue somewhat at each sitting.

Correct Position of Feet.—In order to prescribe proper exercises a study of the 'best position' of the foot is necessary, such as is made in examining spinal curvatures, to determine what muscular actions will produce the nearest approach to a normal conformation in the defective part. Examination of the sole when firmly pressed upon a glass plate is one way of studying both the defects and their correcting postures. Prints of the foot made by lightly smearing the whole plantar surface with charcoal and causing the patient to stand on a piece of blotting-paper may help. It will be observed in the normal foot that strong adduction of the foot raises the natural arch, while abduction decreases its height. In the former movement the astragalus is pushed up by the forcing of the scaphoid under it. In the latter the abducted foot receives most of the pressure upon the inner side of the arch—the weaker part—and this disposition of the body-weight results in turning the sole out and up, if the ligaments and muscles are weak. Upon inquiry it will nearly always be found that patients suffering with flat-foot have had a habit of walking with the toes much turned out. This trick may occasionally be a result of flat-foot, but it is most certainly a contributing cause in many cases; it is sometimes an acquired habit, sometimes an effect of conformation. Physiologically speaking, men should walk with the feet parallel, as Indians do. It is the dancing-masters and drill sergeants who have taught the artificial position. Women naturally turn their toes out more than men, owing in part to the conformation of the pelvis. The parallel position is the stronger one—the support is steadier both when moving and standing, the spring off the toe in the push of the foot on the ground at the beginning of a step is firmer and livelier.

These facts give a hint for treatment both preventive and curative. **Movements of the foot in adduction** should be prescribed. The patient's shoes must permit, or, better, enforce, adduction. Whether heels should be worn, whether a toe-post to keep the great toe adducted should be used, whether the inner edge of the shoe should be a little thicker than the outer to correct the tendency to pronation of the foot, whether indeed the patient should not in the beginning of the treatment be kept entirely off the feet for a time, are questions for decision upon due examination of the individual case. The application of plaster bandages to keep the foot in shape and encourage tendon-shortening is another matter for consideration, but, like the strictly surgical means of correction necessary in severe cases, is outside of the subject as it has to be considered here.

Congenital flat-foot or splay-foot, *pes planus*, usually gives less pain and annoyance than the acquired form. The worst features are the awkward gait which it causes and the fact that it predisposes to the development later in life of the more serious defect of acquired flat-foot.

In ordinary cases the treatment of either form may be summed up as including proper **rest,** proper **exercises,** passive, active, and resisted, and **suitable shoes** and **stockings.** It is not often that patients with the lesser degrees of flat-foot will submit to the prescription of complete rest; private cases can usually be taken in hand before the disorder is painful enough to require the giving up of all activity, and hospital patients cannot usually afford the time, unless their condition is very bad indeed.

Rest.—In order to get as much relief as may be in **moderate grades** of either form of flat-foot the patient should be instructed to sit down whenever possible and to elevate the feet. If it is absolutely necessary for him to stand, he should be told to lessen the strain upon the ligaments of the inner arch by occasionally inverting the feet a little, turning the soles inward and standing upon the outer edge of the feet, maintaining this position for a short time. Further, it will be found to give great relief to practise even momentarily the toe-rising exercise (19), which is not only useful at the time in changing posture and lessening the pain due to constant standing or walking, but a valuable part of the treatment of the deformity.

Special Exercises.—Only a few **exercises** are of use in flat-foot, but these must be exactly performed and frequently repeated. **Toe-rising** (General Exercises No. **19**) should be done many times a day, as often, indeed, as the patient can. **Circumduction** of the foot, active and resisted, is the next useful movement, and may be performed lying or while sitting with the lower leg supported on a chair or with the knee of the exercising leg crossed over the other and held almost straight out. Rotation should be done in both directions. **Inward rotation** of the foot, both active and resisted, should also be performed frequently. **Simple flexions and extensions** of the ankle, active and resisted, are also of use. In prescribing these exercises the patient's strength and condition must be taken into account in the beginning and the movements limited to a number that will cause only moderate fatigue; for example, six to ten in succession of each of the exercises mentioned. They should, however, be repeated frequently enough really to tire the muscles, and as the strength improves, the number of repetitions should be increased. As **special exercises** the patient should be directed to stand on the heels and flex the feet, and after a little practice of this, to walk on the heels, with toes elevated, for a few times up and down the room. Another useful practice is to walk on the outside edge of the foot, with the sole somewhat inverted.

An individual **prescription** for moderate degrees of flat-foot might take this form:

Patient in bed or sitting, leg supported. **First week:** circumduction six to ten times active, five times against resistance; inward rotation of the foot six to ten times active, five times against resistance. Flexion of the ankle ten times active, five times resisted; extension the same. *Patient in straight standing position:* toe-rising in thin slippers or stockings only, ten times. Heel standing, ankle flexion, ten times. Walk on heels fifteen to thirty seconds. Walk on the outside of the foot fifteen to thirty seconds. Repeat the whole set thus three times daily. **Second week:** add five to the circumductions, rotations, flexions, and extensions, and ten to the toe-rising. Walk on the heels and on the sides of the feet forty seconds each. Repeat four times daily. **Third week:** increase the first four movements by five each; perform the toe-rising forty times in succession. By the end of this time enough muscular gain should have been made to allow of still more increase. It is better to do the heel-walking and walking with inverted feet many times a day for short periods than to continue these positions very long at once. With patients in bed or resting to allow the pain and tenderness to disappear, no exercise should be prescribed until the distress is lessened, if not entirely abolished. If no attendant or intelligent relative can be found to apply resistance in the proper way, a fair substitute will be found in performing the prescribed exertions with steady tension by the patient himself on **all** the muscles of the limbs—'self-resisting movements.'

Spasm.—In **severer forms** of flat-foot the **spasm** and **rigidity** will need to be overcome by **massage** and **slow, firm, passive movements.** The attempt to conquer the spasm in this way is usually painful at first, but grows less with repetition. Experiment will decide whether it is best to rub before making motions or to perform the passive movements first and follow with the rubbing. In giving **passive movements** the foot should be grasped with one hand around the upper instep, the thumb pressing the astragalus outward and holding the posterior half of the foot firmly, while the other hand adducts, everts, and flexes the anterior portion of the foot. When the spasm is too strong to be overcome in this way, or should the effort cause too much pain, a methyl chlorid spray to the surface over the calcaneoscaphoid ligament will lessen spasm. The injection of a few drops of cocain solution has been suggested, but this is undesirable in cases in which treatment must be repeated daily. A better plan than either of these is to subject the foot or foot and lower leg to **superheated dry air** before manipulation, in order to relax the contracture of the peronei. With the foot held as described, movement in circumduction, rotation, and flexion should be performed. Massage of the leg and foot muscles, especially those of the sole, the tibiales, and the long flexor of the great toe, should, like the movements, be given several times daily. If the spasm cannot be thus conquered, surgical means must be resorted to, or rest of the limb with good position secured by plaster bandages; manipulation and exercise should be used only after some weeks in plaster have eased the spasm and removed the rigidity. Even bad cases of flat-foot can be put in a fair way to recovery by six weeks of exercises, if five or six minutes four times daily can be given to the work, and it should be possible to effect most perfect cures in three months, so that the patient can do away with plates and bandages altogether. To get so good a result as this of course presupposes that conditions conducing to muscular relaxation, such as malnutrition, can be successfully treated at the same time.

CHAPTER X

PRECISION EXERCISES IN TABES DORSALIS AND INFANTILE SPASTIC PARALYSIS; TRAINING FOR DEFICIENT FUNCTION

Tabes Dorsalis: Movements of Precision. Method of Instruction. Duration of Lessons. Supervision. Exercises for the Lower Extremities, Recumbent; Exercises in the Erect Position; Walking at a Mark; Other Walking Exercises; Sitting and Rising. Infantile Spastic Paralysis: Active Movements. Upper Extremities; Lower Extremities. Summary. Training for Deficient Function.

Movements of Precision or Co-ordination Exercises

One of the most troublesome symptoms in cases of tabes dorsalis is the ataxia, or impairment of muscular co-ordination. This manifestation is probably due to disturbances in the posterior nerve-roots and posterior columns of the spinal cord. Not alone cutaneous sensibility, but also the sensibility of the joints and of the muscles, is affected, resulting in an inability to recognize the positions of different parts of the body or appreciate properly their various movements. This disability may reach so extreme a point as altogether to prevent the patient's walking and performing the simplest movements. By means of suitable exercises it is possible, even in bad cases, to restore in large measure the impaired co-ordination and to re-educate the patient in various movements. It need hardly be said that no influence is by these means exerted upon the lesions or upon the actual course of the disease, except in so far as the patient is made more comfortable and better able to help himself, and certain complications, attendant upon the muscular incoordination, are removed or prevented. The treatment, with this qualification, is **purely symptomatic** and deals only with one symptom, namely, the ataxia. The same general principles are applicable in improving the co-ordination of tabetic patients that are followed normally in mastering unaccustomed movements.

The object to be attained is the performance of the given action with the greatest possible precision and promptitude and the smallest expenditure of energy. The most important factor in the accomplishment of this purpose is **constant repetition.** Good results are of course possible only when the integrity of the entire motor tract, from the ganglion cells in the cerebral cortex to the muscles themselves, is preserved.

The **characteristics of ataxic movements** are their abnormal rapidity, their excessive activity or energy, the continuance of the impulses that lead up to them after the fulfilment of their object, and the occurrence of jerking movements of varying frequency and amplitude. The disorder can in some measure be controlled or compensated by using the guidance of the sense of sight, and its intensity is correspondingly increased by withdrawal of this aid. An additional factor is the associated deficiency in muscular tone, to counteract which greater voluntary effort is required.

Method of Instruction.—The patient must first be shown exactly what is expected of him, and then made to repeat the movement with the greatest possible precision. This will at first and for some time require the controlling guidance of the eyes; and only when sensibility is but slightly impaired, as in mild cases after a considerable measure of improvement has been attained, does it become possible for the tabetic to execute co-ordinate movements with his eyes shut. The progression of the exercises should be gradual and systematic from the most simple to the more complex. The patient must be given close attention, but at the same time he should receive all the encouragement that the instructor can give him.

He should be protected against **fatigue,** as his consciousness of this feeling is often much diminished; the action of the heart has to be watched and the exercises suspended if the pulse becomes unduly rapid, and not resumed until the normal rate has been restored. The lessons should be begun in the recumbent posture, as in this way the lower extremities are freed from the weight of the body and from the necessity of maintaining the equilibrium; and as the patient makes satisfactory progress he may perform exercises in a sitting posture, and thus finally reach the standing and walking work. When a fair measure of control of movement has been acquired, the patient may be put in a class with others, but his first lessons should be given alone and under constant supervision. When exercising in the erect posture, the patient should be guarded against **falling;** and if the knees and ankles are weak in consequence of deficient muscular tone, it may be necessary to provide him with some simple form of orthopedic apparatus or to support him in some other way. The **clothing** should be light, simple, and free; the shoes broad, light, and yet not soft like slippers, as the patients do better with stiff-soled boots that hold the foot firmly. Thin rubber soles are a help, as they prevent slipping.

The **duration** of each lesson should be brief. The constant repetition and the strain of attention required soon induce fatigue, of which, as has been said, the patient may not be wholly conscious, but which may be controlled by observing the pulse. Each movement may accordingly be kept up for from one-half to one minute, and should be followed by a period of rest sufficiently long for heart-action to become normal. The entire lesson, including resting periods, may last about half an hour.

As a rule, two periods of instruction may be permitted each day, and occasionally three. Thus, in the morning, movements may be practised lying down; in the afternoon in the erect posture; while the third lesson may consist in a repetition of one of the others, or in simple walking for ten or fifteen minutes, or in exercises with the upper extremities if the movements of these parts be ataxic.

The exercises should always be **supervised** by some competent person, either the physician himself or a thoroughly trained assistant. The patient should not be allowed to do them by himself, or at least not until they have been learned under careful observation. While not actually impossible at the patient's home, they are more readily carried out in some institution, where the simple apparatus needed is available, as well as ample room. The work requires time, patience, perseverance, and enthusiastic co-operation on the part of the patient. It is of the utmost importance that each movement be executed with precision in every detail, as the importance of the exercises lies chiefly in this very exactness and accuracy. It is not 'doing movements' that helps the ataxia, it is *doing certain movements exactly.* The example of the instructor or that of other more advanced pupils in demonstrating the mechanism of the required act will be found more helpful than any amount of verbal directions. For an average case the total length of time required for instruction in co-ordination exercises need not exceed six weeks, and for intelligent and careful patients even this period may be shortened. Further practice will be needed at the end of this time and the patient should be made to understand that while in so short a course of instruction he can learn how to use his muscles in the right way, to confirm the habit thus acquired he must continue to work regularly for some months. Indeed, most ataxics need to practise a few minutes daily, even after they have been thoroughly re-educated in the co-ordination of their movements.

The exercises which follow have been in use at the Infirmary for Nervous Diseases in Philadelphia, for more than twenty years past, in much the form and manner herein described, modified from time to time as experience suggested or as individual needs demanded. They have the advantage over the more elaborate system formulated by Fraenkel of requiring neither a special gymnasium nor complicated apparatus. In fact, no apparatus is requisite beyond what may be found in any household, though it might be worth while when many patients are treated, to have a pair of steps such as are later described.

Exercises for the Lower Extremities, Recumbent

The patient lies on his back with the legs extended and parallel, and with the head raised high enough to give a view of the parts to be exercised. He begins by performing flexion of the leg and thigh on either side alternately, in response to the spoken direction of the attendant. The movement in flexion is followed deliberately by one in extension in exactly reverse order, but otherwise under the same conditions. In addition, movements in abduction and adduction are practised with the thigh and leg extended and also flexed in varying degree. After these simple and single movements have been acquired they may be variously combined. Each movement must be executed with uniformity and deliberation and not in a jerky or hasty manner, and in order to avoid fatigue and monotony no movement should be repeated too frequently; from twice to four times for each movement will usually be sufficient. The object especially to be attained is **precision** and **promptness** of movement.

The foregoing exercises may be modified by raising the foot slightly from the bed and applying or approximating the heel, both in flexion and in extension, to various points on the other leg, as the patella, the middle of the leg, the ankle-joint, the tip of the foot, any one singly or two or more in succession, in accordance with previous arrangement, or in response to a command at the time; or the heel may be applied to the attendant's finger placed upon any part of the other leg or upon any other point touched by the finger; or, finally, the heel of one foot may be placed in the palm of the attendant's hand held in different positions. The leg may be successively flexed and extended while the thigh is kept flexed, and finally with the thigh extended.

Modifications of some of the foregoing movements may be introduced by performing them with the ankles and knees in contact. In the several ways indicated it is possible to devise an almost unlimited number of exercises, choosing particularly such as will lead to a restoration of the muscular movements of everyday life.

In cases of **profound ataxia,** in which the so-called **paralytic state** exists, the movements must be extremely simple at first. Thus, one or several toes may be flexed, extended, abducted, adducted; the thigh may be flexed, extended, abducted, adducted, rotated; the foot may be flexed, extended, inverted, everted, rotated; or the leg may be flexed and extended with the patient prone.

In **mild or early cases** the exercises in the recumbent position may be omitted if the patient is still able to walk fairly well, but in patients in bad enough general condition to make it advisable to put them through a 'rest treatment' these forms of movement, together with the ordinary passive movements of the lower limbs, form a necessary preliminary course to getting a tabetic out of bed.

The uses of **massage** in this disorder have already been described. (See page 52.) It may perfectly take the place of that active exercise afoot which for most ataxics is undesirable. If a patient who is receiving massage is to have lessons in co-ordinate movements, an hour should be chosen for them as remote as possible from that of the manipulation. Unless the ataxia is very great, it is seldom worth while to spend time on exercising in the sitting posture, so after a few days of training in movements while recumbent we may proceed to those which are performed in the erect attitude.

Exercises in the Erect Position

The sense of balance being imperfect, owing chiefly to the impaired muscular sensibility and control, the earlier efforts at training the patient in exercises while erect should be directed to the improvement of this function. They should be performed on a smooth but not slippery floor, or the shoes worn must have rubber soles to give a grip and lessen the chance of slipping. No risk should be run of impairing the patient's confidence by a fall. A fall is doubly dangerous to ataxics from their want of power to save themselves by rapid and accurately directed muscular effort, and on account of the danger of arthropathies from comparatively small injuries. To give a feeling of security the patient should in the beginning stand with his back close to the wall with a stout chair or table near, or on either side, upon which he can lay a hand if he sways or is afraid of falling. These supports are only to be used in case of need. The attendant should be near enough to give help if it is wanted.

Straight Standing Position

Particular attention must be given to the position of the head and neck, remembering the tendency of ataxics to watch their feet, a tendency which should not be indulged after the very earliest lessons, nor indeed until the patient gains confidence. The assuming of the proper station is to be enforced as the starting-point of all exercises. As has been said in speaking of this position in the section on general exercises, it is not desirable to insist on the conventional drill attitude with heels together and toes turned out. The base of support is better with the feet nearly parallel and separated six to ten inches, the exact outward angle of the toes and the distance apart of the feet being left to the patient's own experimental discovery of what is his most comfortable and solid position. Straight standing should, however, be insisted upon to the extent of requiring the body to be held erect and the shoulders moderately thrown back, and, after two or three days, the head kept well up with the eyes forward.

It is worth remarking that no one's balance is perfect at the moment of first rising from bed, and that a minute or two's interval for the circulation to accommodate itself to the altered position is necessary even in the healthy. Still more will it be necessary to allow an ataxic patient the intermediate sitting posture first, and even after this a half minute's time to 'get his feet under him' before beginning his lesson.

1. **Standing on One Foot.**—Standing near a wall, as described, the first lesson after instruction in the proper general carriage of the body should be to ask the patient to raise one foot a little from the floor and hold it so for a few seconds. After it is replaced, a moment is allowed for poise to be regained, and the same effort is made with the other foot (Fig. 64, *A*). A slight modification at a little more advanced stage is to order the foot raised higher, not merely just elevated enough to clear the ground.

This exercise and the straight standing are enough to practise for some days, if the patient is having massage and is getting fresh air by driving or walking a little.

Each exercise may be repeated five or six times at each lesson with short intervals, and three or four lessons given daily. If it is not possible to do this under supervision, intelligent patients may repeat their lessons at home, provided that careful instructions are given and every precaution taken against accident.

2. **Thigh-raising.**—Raise one leg slowly, flexing the knee, and place the foot on a stool or on the rung of a chair. Remove it, reassume standing position, and repeat with the other foot. When this is readily done, the foot may be raised higher and placed on the seat of the chair, or, the thigh being flexed to a right angle with the body, the leg is extended on the thigh and gradually lowered—a sort of imitation of the 'goose-step' of the Prussian recruit (Fig. 64, *B*).

No further exercises should be added till these are done easily in their several forms, a point which may be reached in a few days in favorable cases, and not for two or three weeks in less favorable ones.

3. **Leg-backward.**—Standing erect, one leg is extended backward as far as possible without bending the body forward. Repeat the same movement sidewise.

4. **Trunk-bending.**—Bend the body slowly and steadily forward, backward, and sidewise, with brief rest erect after each movement.

5. **Straight-stepping.**—From the erect position, and carefully sustaining the straight carriage of the head and body, advance one foot a short

A, Exercise 1. *B*, Exercise 2.

Fig. 64.—Exercises for Ataxia.

pace, without throwing the weight of the body on the forward foot. Withdraw the advanced foot and repeat with the other.

As the patient shows improvement, this exercise is to be modified by requiring the weight to be thrown forward on the advanced foot; then the step is made a longer one without the weight being thrown forward. The next order is to take the long step *with* the weight on the advanced foot, and, lastly, the patient is required to take the weight off the rear foot as if he were about to advance it to complete his stride. (See Fig. 65, *A*.)

This **single-step exercise** may be varied or added to by requiring the patient to take short steps sidewise, and as he grows more proficient to stand on one foot, cross the leg of the opposite side in front of it, and lower the forward foot (Fig. 65, *B*) until he is standing with his legs crossed. These several exercises should be repeated until they are done without hesitation, faltering, or notable unsteadiness, and not until this has been attained should any further change be made.

A, Exercise 5. *B*, Exercise 5. *C*, Exercise 6.

Fig. 65.—Exercises for Ataxia.

All these standing and single-step exercises should next be practised **with closed eyes.** A day's lesson at this point, supposing that progress had been satisfactory, would consist in a repetition of these five exercises, performed first with open eyes, then with the eyes closed. As the patient improves in balance and station, and further movements of more complicated character are added, these simple early exercises may be omitted in order to shorten the lessons.

Instruction is next given in **line and pattern walking.** In a room permanently devoted to the work patterns may be painted on the floor, or in a private house laid down in strips of inch-wide white tape.

6. **Line-walking.**—This consists in walking a straight line with short steps, stepping on the mark or tape, putting one foot directly in front of the other, with the heel of the forward foot touching the toe of the rear-most foot (Fig. 65, *C*). With increasing proficiency the patterns are varied by making long and short curves, angular and figure-of-eight shapes. The patient should be able to do this freely and with moderate speed in a very few lessons if all has gone well with the previous practice.

Walking at a mark may be introduced at this point.

7. Mark a point on the wall at a distance of ten or twelve paces and direct the patient to walk straight to it, pointing at it with his finger and touching it on arrival within reach. He must walk with freedom and with eyes fixed on the mark. Having reached it, he should wheel steadily and walk back to his starting-place.

8. **Wheel and Kick.**—The patient standing erect, heels together and head up, in the attitude of attention, which he should by this time be able to maintain, is directed to wheel at the word of command on one foot, raising and kicking out the other leg as he turns. Reverse the order and the action.

9. **Obstacle-walking.**—Wooden blocks six inches wide by twelve inches long, and two inches thick, are placed on their long edges eighteen to twenty inches apart, and the patient walks over them; at first they are set in a straight line, then in curving patterns. An ordinary octavo book makes a good substitute for the block.

In gymnasiums a ladder laid on the floor may be used, the patient placing the feet between the rungs in walking.

10. **Stair-walking.**—In view of the difficulty usually experienced by tabetics in ascending and descending steps, special practice in this is worth while. It is safer, if practicable, to provide a series of two or three steps with a stout rail on each side, with an easy rise of not more than five inches and a broad tread. The steps must be narrow enough to bring the side-rails within easy reach of both hands. If the stairs of a private house are to be used, they should be well lighted and have strong baluster-rails on both sides if possible. With these the patient practises going up and down stairs, at first with open eyes, afterward with the eyes shut. In descending he should be careful to point the toe downward and touch the stair first with it, not to step down on the flat of the foot, as with the former precaution the jar is lessened.

Sitting and Rising

Co-ordination and balance are always worse when the patient first rises from a seat, and this suggests further exercise in **getting up** and **sitting down.** A firmly fixed and stiff chair should be provided of a height proportioned to that of the patient. In beginning to rise, one foot should be somewhat advanced and the other a little withdrawn, so that when the erect position has been reached, the feet will be well separated laterally and one rather in advance of the other, this attitude offering the firmest base of support. In preparing to rise, the body should be inclined a little forward and the muscles of the legs brought under control by fixing the attention on the act to be performed, and then the tension gradually increased so as to call upon all the muscles in proper succession. In sitting down the whole procedure is reversed. No haste or jerkiness should be permitted.

When, as is rarely the case, the **trunk muscles** are affected by the ataxia, a series of simple exercises may be devised to reach them, such as bending forward, back, and sidewise, twisting the body, sidewise stretching with the arms extended, picking up small objects from the floor, with or without words of command. These scarcely call for extended description.

When the **upper limbs** suffer from the ataxia, which also seldom happens except in late stages of the disease or in those very exceptional instances in which the symptoms of tabes first appear in the arms, appropriate educational movements are easily framed. They should proceed, like those already described, from the simpler to the more complex, making sure that each one is well done before a new one is added. Such exercises as bringing the fingers of the two hands in contact in a definite succession, from a position with the arms forward or laterally extended bringing a finger-point to the ear, eye, nose, or mouth, and touching a marked spot on a table or wall with the arm at full stretch, will serve to begin with.

For more advanced practice the picking up of small objects of different shapes, arranging in patterns articles like dominoes, putting pegs in certain holes in a marked board (for which a cribbage board answers well), or the placing of marbles in stated order in a board with receptacles for them such as is used in some table games, are all useful plans. When these tasks have been learned and successfully practised, still more complicated efforts may be made, such as are involved in tracing patterns or in free-hand drawing of simple patterns, playing jackstraws, or writing with pen or pencil.

If the interference with the use of the upper extremities be due to impaired cutaneous sensibility, the gain made will be much less than when the trouble is due to the loss or impairment of muscle-sense. If the lost skin-sensibility can be improved or restored by hydrotherapy, electricity, and massage, then fair results may afterward be attained by educational exercises.

Besides the formal lessons the patient should practise various small acts pertaining to ordinary life, such as making his toilet as far as possible, buttoning his clothes, adjusting his necktie, feeding himself, etc. Those who have played musical instruments should be encouraged to take them up again. Card-playing also can be recommended as a means of training the co-ordination of the hands.

It is thought that some of the derangements of the **ocular** and **laryngeal muscles** and of the **muscular mechanism of the bladder** may be ataxic in nature, and from this point of view certain simple exercises in the movements of the eyes, systematic respiratory, articulatory and singing exercises, and systematic evacuation of the bladder may be recommended.

A word of **warning** must be added both concerning precision movements and other forms of exercise, whether early or late in the treatment, and whether carried out indoors or out-of-doors. The fact that ataxics have often lost all sense of muscular fatigue makes it needful to caution them very seriously as to the evil results that will follow **overexertion,** as they have not the ordinary warning of tiring muscles to hint to them when to stop. Moreover, ample time should be allowed for rest after each set of movements. Patients who are already able to ride on horseback can take their outdoor exercise in this manner without bad results if they ride quietly, but this is not to be recommended to those who have not been in the habit of riding before becoming ataxic.

Prognosis

The degree of improvement in co-ordination that can be brought about in cases of ataxia by means of systematic muscular re-education varies greatly in individual cases, and depends in a measure on the conditions present—such as the degree of sensibility remaining, the degree of hypotonia, and the natural dexterity of the patient; but no case need be approached without hope of betterment, and the brilliancy of the results attained is at times remarkable.

For the attainment of the best results enthusiastic **co-operation** on the part of the patient is absolutely necessary, and with this must be conjoined unlimited patience on the part of the instructor. The exercises for the most part should be practised under the supervision of the physician or a trained attendant. In the worst cases it may be necessary to continue the treatment for months or even years. In instances in which ataxia has not yet appeared, the exercises may be useful in hindering its development.

Treatment of Tabes by Suspension.—Though perhaps it does not properly belong to the consideration of the treatment of tabes by exercise, it is yet worth while to mention here that **suspension,** once too indiscriminately used for every ataxic case, and now too much neglected, has distinct value in suitable cases. It should be tried when other means fail to relieve persistent pain. The patient should never be left alone during the suspension and the pulse should be watched. It is best to support part of the weight by the elbows, as suggested by Weir Mitchell. This lessens both the discomfort and the danger of the method.

INFANTILE SPASTIC PARALYSIS

In the treatment of this disease, as was said on page 53, the best plan is to begin with massage and movements and to work with these so long as any improvement can be made. When nothing further can thus be gained, the surgeon's assistance should be sought. After he has done what is possible by extension-splints, forced hyperextension, tenotomy, and tendon-transplantation, recourse must again be had to massage and instruction in co-ordination.

Active Movements.—In the early treatment it is best for the physician to superintend the movements in person. Each case requires separate consideration; each will tax to the utmost the ingenuity, the resource, the patience, of the doctor. General principles may be laid down, but precise rules of wide application cannot be enunciated in cases with such infinite variety of possible combinations. It is useless to attempt co-ordinate work with very young children, with imbeciles, or with cases so bad as to have lost control not only of muscular movements, but of the bowels and of the bladder. The same verdict may be pronounced on those with active extreme athetoid movements, often found with excessive irritability of temper and a minimum of intelligence. Putting these cases out of the question, the degree of improvement to be expected will depend on the persistence and ingenuity of the attendant, the mental capacity of the patient, and the grade of the disorder.

In order to gain the patient's best assistance, **the work must be made**

interesting. The movements must be performed with the utmost slowness. Excitement interferes with this and also disturbs the patient's concentration and accuracy of motion, so it must be guarded against. For this reason, among others, it is best that a person well known to the patient should be in charge of the work, at least at first. The general direction of the movements should be in opposition to the spasm or deformity. If the contracted muscles are of the flexor groups, as happens oftenest, the exercises should be chiefly in extension, though it is necessary to do some work upon the contracting masses in order to gain control of them.

These principles must govern every lesson.

Certain minor difficulties are encountered in treating cases after tenotomy, tendon-transplanting, or splint-extension, from the stiffness and pain due to the operations. This must be overcome by massage and by passive movements, even if they are distressing at first. Massage is in all cases a desirable preliminary to co-ordination lessons, and some hints on its use will be found in the chapter referred to.

Upper Extremities.—The simplest lessons for the limbs consist in making an effort to place a hand or foot where ordered, or to touch a point on a table or board. Starting with these, progress may be made through such exercises for the hands as picking up different colored or shaped articles, either at command or in a stated order, next to ranging various objects in patterns, and as the control of the muscle improves kindergarten exercises in weaving, plaiting, and the like are given. Short lessons in such work should be alternated with longer periods of **large, free, simple movements** of the arms, done with all possible steadiness and *very slowly*. These exercises should be, at first, for the most part in the direction of extension. Most of the patients will have to use some support in walking through life, so every effort must be made to **strengthen the grasp** of the hands to enable them to hold a stick or a crutch firmly. Frequent closing of the hand ('making a fist'), flexion and extension of the wrist, circumduction of the wrist, close grasping of a round object like a rubber ball, carrying moderate weights—as a dumb-bell or a flat-iron—in the hands, and the use of chest-weights are good preliminary movements. As strength and control improve, the exercises should be increased in complexity in order to improve co-ordination, until finally the patient arrives at work requiring such minute and accurate ordering of the movements as clavier or dumb-piano practice. With children able to read, a cheap typewriter may be made useful for finger-practice and will fulfil the indication already suggested of interresting the patient. When control is once fairly good, exercises for strength should be added, using heavier dumb-bells, pulley-weights, and so on.

Lower Extremities.—In the legs the adductor muscles display the most spasm and often the base of support is so narrowed by the resulting approximation of the feet as to put additional difficulties in the way of walking. **Standing exercises** with attention to good position of the feet should precede attempts at locomotion. **Training in bed** should be begun during the course of the treatment by massage in much the manner used for tabetics. In the standing exercises support will be needed to give confidence at first. A supporting belt, well fitted and well padded, attached by ropes to easy-running pulleys traveling on a metal bar hung from the ceiling, is an excellent plan, but seldom available for private patients. The wheel-crutch, originally devised for Pott's disease cases, is portable and useful. But whatever mechanical support is used in the early stage of treatment must be cast aside as soon as possible, and the patient be encouraged to stand alone. When he stands fairly well, **walking exercises** should begin, simple at the start, but growing in complication as he gets better. Walking over small obstacles, walking sidewise and backward, must be diligently practised. Patterns may be drawn on the floor or foot-prints painted which the feet must accurately follow. A ladder laid on the ground furnishes an excellent method of practice for pupils well advanced in their education, the feet being set down between the rungs.

The whole treatment requires infinite patience, endless attention to small details, and painstaking ingenuity. According to the original condition of the patient in muscle, mind, and general health, from one to two years will be needed to teach moderately good walking. Meanwhile improvement, of course, will be making in other directions, and there is usually a mental gain at least as great as the physical one.

Summary.—The time perhaps seems long, but there is certainly no other method of treatment which can approach this in results. The summary may well be repeated again: daily massage alone for some weeks; then massage and passive movements; then, if all is going well, massage followed by slow, active movements, lying down; next, like movements, sitting; practice in straight standing, at first supported, soon unhelped; co-ordinate movements, graduated from the simplest to the most complex over many months, with massage during the whole time as a preliminary to the exercises.

Other Forms of Paralysis

The applications of movements and massage in the treatment of paralysis from nerve injury, of contractures from spinal and cerebral paralysis, and of paralysis agitans have been sufficiently dealt with in Part I, chapter II, and need not be repeated here.

TRAINING FOR DEFICIENT FUNCTION

The methods which have gained such extraordinary success in the careful re-education of ataxic, spastic, and paralytic patients have been applied also with remarkable results in many other functional deficiencies. Some of these have already been detailed. Others need to be mentioned, although some of them are of so special and elaborate a nature as to demand volumes for their adequate presentation. For example, it is impossible to give even an outline, in such a work as this, of the way in which **deficient, backward,** and **imbecile children** are trained to varying degrees of usefulness. It must suffice to say that the earlier stages of their teaching are wholly occupied with mechanical instruction, until they have learned, by infinitely small advances and frequent repetition, the use of their muscular functions. Awkwardness, general want of control of direction of movement, imperfect speech, lack of power of attention, are all attacked by the teacher, one by one. A simple form of military drill, marching, and light gymnastic work succeed one another as the patients advance in ability. The importance of training the brain through the training of the hand, so emphatically taught by Seguin, is now well recognized. The tasks are progressive, beginning for the youngest and most backward with the simplest kindergarten games and such training in attention and comparison as can be had from the selection of articles of various shapes and colors, picking out like objects from miscellaneous jumbles of several kinds of things, putting together simple patterns, using colored wools with perforated cards, plaiting, and similar work. As improvement in manual dexterity takes place the method is changed from time to time to meet individual needs and new conditions. "The working hand makes strong the working brain," the motto of the Pennsylvania School for Feeble-minded Children, expresses the principle upon which the whole system is founded. As the child becomes more apt, drawing, Sloyd work, modeling, carpentry, and other manual occupations are added, and outdoor games and sports are encouraged, while a certain amount of formal drill and calisthenic work is kept up. Frequent rearrangement of classes must be made so as to keep the most responsive and most rapidly advancing pupils together. Class-work with these subjects has the advantage of stimulating rivalry, and is therefore better, except for the most deficient children, than solitary teaching. For details of the systems pursued by different instructors the reader must refer to special works on the subject, which are many and good, in English, French, and German.

A warning is not out of place as to the ease and rapidity with which these patients relapse into indolence and stupidity when the wholesome stimulus of class competition, the regular hours, outdoor activities, and the daily drill and oversight of a well-managed institution give place to home-life, in which, however healthy in many respects, the precision, the discipline, and the intelligent watchfulness of the school are wanting.

Successes for which miraculous scarcely seems too strong a word have been made in the training of **congenitally blind and deaf children.** Not only such cases as those of Laura Bridgman and Helen Keller, in which devoted teachers succeeded in educating the remaining functions to the highest point, are meant, but the more recent instances which Urbantschitsch and Keller have published. The former, by a system of exercises for training the hearing, has given patients who were pronounced totally deaf the ability to hear, if not perfectly, at least well enough for many of the ordinary purposes of life. Keller, of Vienna, has reported the case of a boy born blind and not treated until he was seven years old. The external visual apparatus was perfect, and the defect of vision was supposed, therefore, to be due either to absence of the cerebral visual centers or to some defect in the development of the nerves conducting visual impulses. No more helpless form of blindness could be imagined. Whether the successful result was due to substitution of function in some unknown way or to the stimulating effect upon the deficient nerves of the effort at seeing, is, of course, mere matter of conjecture.

It is undoubtedly true in cases of paralysis, notably so in infantile poliomyelitis, and to a less extent in paralysis from apoplexy, that the effort to use the paralyzed part, many times repeated, has an effect upon the nerves. Whether the attempt thus to send a message along the nerves opens a way, so to speak, or whether the concentration of attention forces defective nerves to perform their functions, we are ignorant. The method pursued is much the same in all such instances. Keller, for example, began by trying to attract his patient's attention with a strong light. After a time the child became able to tell when, in a dark room, a light moved before him. This point having been reached, various colors were placed in the light, next different objects, and finally, after long practice, it was found that colors and objects could be recognized by daylight. At the time (in 1901) when the report was published the patient was learning to read, having attained the ability to discern lines, patterns, and letters.

The possible applications of such a plan are infinite, and many ways of utilizing the suggestions which it holds out will occur to every thoughtful physician, from training to lessen nervousness to education in regularity of bowel movements.

PART II

PHYSICAL EDUCATION BY MUSCULAR EXERCISE

BY

LUTHER HALSEY GULICK, M.D.,

DIRECTOR OF PHYSICAL TRAINING, PUBLIC SCHOOLS OF GREATER NEW YORK; PRESIDENT OF AMERICAN PHYSICAL EDUCATION ASSOCIATION; CHAIRMAN OF PHYSICAL TRAINING COMMITTEE, LOUISIANA PURCHASE EXPOSITION; CHAIRMAN OF NATIONAL BASKET-BALL COMMITTEE; MEMBER KINGS COUNTY MEDICAL SOCIETY, AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, AMERICAN ECONOMIC ASSOCIATION, ETC.

PART II

PHYSICAL EDUCATION BY MUSCULAR EXERCISE

CHAPTER I

EXERCISE AND DEVELOPMENT

General Aim. Exercise and Evolution. City and Exercise. Occupation. Schools. Balance between Neural and Muscular Expenditure. Special Classes. Exercise in Accordance with Function. Physiology of Exercise: Effect on the Muscle-cell; Effect on the Body as a Whole; Special Effects of Muscular Exercise; Position during Exercise; Physiologic Load. Neurologic Considerations: Moderate and Excessive Exercise; Physical Exercise and Cerebral Development of the Brain; Fatigue; Co-operation among Contiguous Nerve-centers; Muscular Contraction and Psychic Activity. Limits of Specialization in Exercise; Somatic Harmony; Competition. Dosage of Exercise.

General Aim

For our purposes muscular exercise may be considered from three viewpoints:

1. In relation to its use as a **definite remedial measure** in a few pathologic conditions.

2. In relation to the **development** of the individual in **structure** and **function.**

3. In relation to **general somatic vigor.** Somatic vigor is the essence of that power of resistance which the organism shows to the invasion of disease. It is well known that the power of resistance varies much in the individual from time to time; pathogenic bacteria will at one time be destroyed promptly, while at another they will gain a foothold and multiply.

Disease must be avoided by the prevention of inoculation; but, what is of equal importance, it must be averted by the maintenance of such bodily vigor that the maximum of resistance will be offered by the organism itself.

Special Considerations.—The physician has three questions to answer about muscular exercise:

1. What specific exercises will be effective in given **pathologic states?** Under this head I discuss nothing here. It is my province to examine the general effects of exercise together with the detailed effects of specific exercises and sports. The application of these effects to the treatment of disease will be found elsewhere in this volume (Part I, Section II).

2. What character and quantity of exercise are needed for the growing organism, to insure **balanced development?** Physicians must pass upon the claims of various systems of gymnastics that are offered for adoption by schools, as well as upon the necessity for, and the character of, work outside of school. It is hoped that the data given will be sufficient for full and intelligent answers to these questions.

3. What exercises are best adapted under various conditions, such as age, sex, and the like, to render most active the **general somatic life** of the individual? This question I hope to answer with some degree of definiteness.

I am aware that some of the more important conclusions here set forth are not in accord with the accepted doctrines of many teachers of physical training; yet these views will be seen to have their justification both in clinical experience and in biologic science. While I shall in the main confine my work to conclusions and their practical application, certain **preliminary considerations** need to be stated, to form a rational basis for the practical directions that follow.

Exercise and Evolution.—Those conditions under which the body was given its present size, shape, and structure are in general the conditions adapted to maintaining the fullest functional activity. During the unnumbered years of evolutionary time, muscular exercise in labor, war, or the chase has been one of the major elements of human experience. Upon neuromuscular ability the race has depended for survival, even when its ancestors were in a condition of development yet more elementary than that of savage life. A biologist, having brought to him a human body and being asked for a statement of its functions from an examination of the structure, would say that both in form and function the organism must have been adapted to a life of considerable muscular exertion; that this appeared, first, from the proportions of the muscular system; that the lungs as well as the heart indicated far more capacity than would be needed for a life exclusively or even largely sedentary; and, finally, that the nervous system was designed predominantly for the initiation or control of muscular movements. The health of such an organism depends upon the balanced co-operation of all its parts. These parts have become adjusted to a certain general balance in the activities of the nutritive, neural, and muscular tissues. No argument is necessary to the evolutionist to show that the necessity for muscular exercise has been constant and predominant throughout the whole history of the life of the species; that it has been so constant and so large a factor in adjustment to the total environment as to have had a chief share in determining the character of the organism itself; and that those conditions which have been decisive in determining the form and functions of the organism are the conditions in which it functionates the best.

The argument for muscular exercise from the standpoint of evolution is thus the strongest that can be presented. The environment of the organism cannot be changed in other respects with impunity. Man has become adapted to breathing air of a certain approximate constitution, and he is at his best in this environment. He has become measurably able to carry his environment with him with reference, for instance, to temperature, and somewhat with reference to light; but the general fact remains that perfect adaptation to environment is most definitely related to health.

City and Exercise.—Man has by conscious direction so utilized artificial coverings as to be able to maintain a certain thermic environment in spite of variations in the natural temperature of the atmosphere. The time is rapidly approaching when he must generally take as consciously under his direction the matter of muscular exercise, because the process of civilization is taking away from him those natural demands for muscular exercise which have been its efficient cause during the ages of evolution. The conditions of human life in civilized countries have changed more since the development of the steam-engine than they had for thousands of years previously. In the United States the proportion of steam power to manual labor is represented by a steam-engine of 11½ horse-power to every male adult inhabitant. The bulk of the heavy work in the civilized world is done by machinery and not by human muscles. There is still a good deal of muscular work performed, but it is decreasing rapidly. It is least among the most civilized peoples, and among these peoples is least among the most civilized classes. The management of machinery demands not muscular force, but muscular skill and intelligence.

Occupation.—In connection with this specialization, there have arisen a whole group of so-called **diseases of occupation,** some of these related definitely to the specialization itself—such as writer's cramp.

In the handling of machinery the tendency is to have individuals make comparatively few movements many times. The more general activities of early farm life called for a far more varied set of muscular movements. For example, personal experience on the farm for a short period embraced the following forms of exercise: driving the cows home and milking them, caring for horses and stables, sharpening tools, handling hay and grain with pitchfork, driving a horse-rake, digging potatoes, cleansing large milk cans, making wooden handles for tools, dish-washing, building rail fence, chopping wood, helping with cross-cut saw (two men), working on a threshing-machine, hoeing weeds in a potato patch, husking corn, sawing wood with a buck-saw, repairing in wood-work, helping to build a stone fence, digging out woodchucks, hunting gray squirrels, and a multitude of minor exertions that slip the memory. Let these activities be compared with those of the mill operative who "tends a machine" of some kind, or with those of the salesman in a store, or the clerk in a bank, and the contrast becomes evident.

Finally, it is to be remembered that the process of urbanization is a progressive one, needing continually greater attention from the physician. In 1790 considerably less than 4 per cent. of the population of the United States lived in cities and villages. A general comparison with the present condition is hardly fair because of the immense tracts of sparsely settled country that have been acquired since then; but in spite of this, the census of 1900 (Abstract of Census, page 38) shows that only 59.8 per cent. of the population are now classified as living in country districts. The change from 96 per cent. to 59.8 per cent. in one hundred and ten years is instructive. The lesson is still more dramatically told by a study of the urban growth in some of the more stable eastern States Massachusetts has only 8.5 per cent. in country districts, Connecticut 25.1 per cent., New Jersey 29.4 per cent., New York 27.1 per cent., Rhode Island 5 per cent.

Schools.—Another process that is rendering conscious attention to muscular exercise necessary is the growth in school population, and the increase in the length of time during which children go to school. In 1840, out of a total population of 17,069,453, there was a school population of 2,025,565, or 11 per cent. In 1890, out of a total population of 62,622,250, there was a school population of 14,768,965, or 23 per cent. The normal life of the child is one of steady activity during the waking hours. We are taking away for five hours a day a large part of this activity. It will be shown further on that exercise is fundamentally related to growth, so that the harmfulness of this lessening of exercise by school limitations during the early years of life is readily seen. Not only is muscular exercise decreased by school life, but pressure is brought to bear to increase the attention to psychic things. Thus, there is a coincident decrease in muscular expenditure and an increase in lines that are purely neural.

Intercommunication.—There are further factors that are changing the balance between the neural and muscular expenditures of the body; for instance, in modern life the growth of the news-communicating agencies, shown not only in the tremendous increase in the postal service, but in the development of the telegraph, the telephone, and the daily press. Two kinds of results may be traced to these sources:

1. A vast increase in the amount of business done in a given time, without any decrease in the necessary expenditure of thought. That the modern business man accomplishes a vastly greater quantity of business than his ancestors did in the same length of time is as evident to those who are familiar with modern conditions as it is impossible to set forth statistically.

2. News-communicating agencies bring us into contact with the whole world as never before, and thus emotion, which is a peculiarly exhausting form of psychic activity, is stimulated. The daily press deluges our minds with the tragic occurrences of the world. Then, again, the development of city life diminishes the amount of sunshine that the average individual will get, and in most cases also the quantity of fresh air. The tremendous growth in the use of drugs affecting the nervous system reflects a corresponding increase in disorders of that system. The increase in women's diseases with the progress of civilization, and the decrease in the muscular work of women, are more than mere coincidence, as is shown by the comparatively robust health of women who do regular physical work; even when it is carried on to the extent found among female acrobats working in circuses, we still find great health and vigor, contrasting markedly with the health of women whose lives have but little of muscular activity. Attention has frequently been called to the inferiority of stock born and bred in the conditions of city life. This was first pointed out by Rousseau, and has been since stated repeatedly. It appears that the city is a sort of biologic furnace which in the course of three or four generations pretty thoroughly burns up vitality, and that the addition of country stock is essential for the perpetuation of family life in the city.

General Results.—All these differences coincident with civilization and the development of the city are disturbing the balance of expenditure between the neural and muscular systems. In muscular exercise there is the neural element, but in mental and emotional activity there is not the muscular. The result is a new balance in the total activity of the body, a different environment with reference to activity from that which the organism is adapted to, or has previously had.

Special Classes.—Let us now note a little more in detail the different classes in the city with reference to their physical activity. The **workers in factories and shops,** handling machinery for approximately ten hours a day, make an immense number of movements of a more or less uniform character. The **clerical classes**—bookkeepers, stenographers, salesmen—have considerable walking to do, handling goods, going on errands, and the like. Most of them do no work that involves deep breathing or quickening of the circulation. Their muscles do not have a physiologic amount of labor from one month's end to another, except the small muscles involved in writing or similar occupations. We find them as a class with sunken chests, small arms, more or less round-shouldered, and with but little physical endurance or muscular strength. The cardiac muscle is not specially vigorous. **Business men** lead lives that are largely sedentary. The burden of their work is done at the desk. Such men are often fat, with protuberant abdomens. They have even less muscular labor to perform than the clerical class. Women who work in factories have already been considered. Women who do **domestic service** have sufficient muscular activity of varied character, and so far as this element is concerned nothing is needed. **Mistresses of households,** while they are about a great deal, do so little work involving activity of the large groups of muscles that these muscles are rarely in a condition of normal vigor. **Manual laborers** in a community are comparatively healthy.

The object of the discussion so far is to show that in civilized communities the environment that has been making during untold ages for the present shape and functions of the human body has so changed that the normal requirements of daily life for muscular activity are insufficient to keep the organism in that condition of vigor necessary to the best health; and hence that to maintain the body in conditions of health and vigor, **conscious attention** to this factor of environment is of increasing necessity.

FUNCTION MAKES STRUCTURE

This, the well-worn formula of the evolutionist, may be applied in two directions. First, it implies that to produce any given effect upon the structure of the organism, we should institute exercises that are calculated to achieve the desired perfection of structure. Secondly, it implies that except under certain pathologic conditions, the kind of exercise best adapted to produce the balanced and healthful development of the body as a whole or of its parts is, in the main, the kind of exercise for which the part exercised is best adapted.

The first point needs hardly more than the statement. Leaving out of account pathologic cases, if the heart is to be increased in structure we prescribe gradually progressive exercises that make a greater demand on the heart, with the result that it is gradually built up to meet this increased demand. Upon this is founded the special work of Oertel, Schott, and others. If the muscles of the upper extremities seem to be deficient in size, we prescribe exercise that demands the functioning of these muscles, and we expect the function to be the indirect agency that shall produce growth and structure. If we find the muscles of the back of a growing girl flabby and poorly nourished, with the spine in the early stage of scoliosis, the first indication is to increase the power and efficiency of the faulty muscles. This is accomplished by increasing the function of the parts, and the structure rapidly follows the function. This general law applies not only to the development of muscle-tissue, but to other tissues as well. It has been shown that the bones of both horses and men that do work in which power is demanded have a heavier specific gravity and a greater density of structure than the bones of those engaged in less laborious occupations.

The second application of this formula is that **the body as a whole, and each of its parts, is best exercised in accordance with its natural function.** The far-reaching character of this principle is not easily seen at first glance. The upper extremity is obviously adapted for the handling of objects. The great range of movements allowed by the shoulder-joint as contrasted with the hip-joint, the structure of the forearm as compared with the leg, allowing not only flexion and extension, but pronation and supination in the arm, the more delicate structure of the hand, the independence of the phalanges, the more differentiated nerve-supply to the muscular tissue—all point to a difference in function in these two organs: the lower extremity as a whole being adapted for power, the upper extremity for varied action, delicacy, quickness of movement, and the like. It is true that the upper extremity may be trained so that the weight of the body shall be handled by it alone for considerable periods. This is done by performers on the horizontal bar, the German horse, rings, and the trapeze; but it is a departure from the normal function of the arms and results in limitation of the movements at the shoulder-joint, the stiffening of the ligaments of the hand, and general perversion of function. On the other hand, it is possible to train the legs to exercises of great skill and delicacy; jugglers who learn to handle objects with their feet while lying on their backs accomplish this result; but in neither case are the results worth the labor expended. They are not in line with the natural functions of the organs, and the best development of each part of the organism is related to its natural function. Our aim should be not to see what each part can be trained to do, but to get each part into its normal condition. The body can be trained to do and to endure many things that are not only useless, but harmful. Because a man can learn to walk on his hands is no sufficient argument for men to adopt that mode of locomotion; because the shoulder-joint can be made to resemble somewhat the hip-joint is no reason why it should be made to do so; so that, excepting conditions dependent upon pathologic states, it may be safely said as a general proposition that the exercise of the body as a whole, and of its parts in particular, should be related to the natural functions of the part.

Vis naturæ.—With normal heredity and normal environment the individual will develop a balanced organism. The constant tendency of the organism is to develop along suitable lines. Upon the germ plasm is written the law of development of the individual. Environment may hinder or accelerate this development: if it is one-sided or otherwise perverted, the results will be abnormal, but the essential character of the protoplasm cannot be altered. This fact is of supreme importance in the **physical education** of the young. It has been customary to measure the various parts with great exactness, and then to attempt to prescribe exercise that shall meet the specific needs of each part, as shown by its deviation from the average of the species. Theoretic reasoning as well as experience shows that such work is generally useless. What is needed in normal cases is to supply normal conditions of food, rest, exercise, sleep, and the like. That which is a perfectly symmetric body for one person will not be so for another. When the deviations from the average are so marked as to be pathologic, or when there is specific disease that must be combated, the conditions are somewhat different. What are now referred to are the smaller differences, which are entirely normal. For instance, the fact that the left arm is a quarter or even half an inch less in girth than the right arm is not a matter for special consideration. If both arms be given vigorous work, they will become equal not only in measurement but in power as well. This I have repeatedly demonstrated upon both the growing and the full-grown organism. It is commonly said that the girth of the neck and of the flexed upper arm and of the calf should be the same, and some have spent much time in the endeavor to secure such measurements; but more basal than such artificial conception of symmetry is the standard of development contained in the germ plasm of each person. If vigorous all-round exercises produce such measurements in the individual, they are then the best for that individual. If not, the endeavor to secure them is prejudicial rather than helpful. In subjects of so-called nervous temperament, with long, rather slender bones and small joints, the muscular proportions differ from those in whom opposite conditions obtain, and the attempt by means of artificial standards to force individuals of these two types into the same physical form is most unwise. We may demand similar functions from the bodies of the two, but the proportions of the body will take care of themselves. It is our business to furnish a suitable environment and demand the normal functions. Natural tendencies may then be depended upon to render the structure normal, or at least to give it that type best adapted for the life of the individual.

PHYSIOLOGY OF EXERCISE

The contraction of a single muscle involves three major elements: activity in the **motor center,** a **nerve-current** to the muscle, **contraction** of **muscle-fibers.** Let us note the general effect of exercise in these three divisions.

Effect upon the Muscle-cell.—The contraction of the muscle-substance is accomplished by a mechanism as yet beyond ultimate analysis. Energy is expended. Some of the highly complex cell-constituents are broken down and extruded. The cell at once proceeds to absorb from the surrounding plasma additional food materials, particularly carbohydrates and oxygen. Thus, muscular activity results in the constant change of some of the essential elements of the muscle-cell itself, which is kept in a state of increased efficiency proportionate to its use. Both the number and the size of muscle-cells are increased by exercise. The sarcolemma appears to be slightly increased in strength. The growth in this, the fibrous part of the muscle, is well shown in the toughness of muscles taken from animals that are heavily worked as compared with those that are not so worked, or with the flesh from animals that have never been worked hard; the fibers being coarser and heavier, the tendons thicker and less yielding, the whole muscle firmer.

General Effects of Muscular Exercise

The absorption by the muscle-cells of oxygen and carbohydrates from the blood plasma has immediate and ultimate effects upon the body as a whole. When muscular energy is expended, the blood is altered in constitution. Such blood flowing through the respiratory center in considerable quantities causes **increased respiratory movements.** All the muscles of respiration are thus brought into immediate and often vigorous action, even the accessory muscles being called on promptly when there is particular need of rapidly augmenting the oxygen supply. The blood circulating through the lungs makes up its oxygen tension, the added activity of respiration changes the air in the lungs, with the result that during exercise the percentage of oxygen in the lungs is greater than usual. The contraction of the muscular fibers squeezes the lymph-vessels and the smaller veins so that blood and lymph are pressed onward toward the heart. This, together with stimulation of the centers governing circulation in the medulla, causes **increased cardiac activity.** The quickening and deepening of respiration also are effective in the aspiration of the thorax. By these various means the circulation of the blood is at once markedly stimulated, and the arteries supplying the muscles exercised are immediately somewhat dilated. We thus have a completely adjusted mechanism for augmenting food-supply and eliminating waste. The muscle-cell eliminates the products of combustion in the form of carbon dioxid and of urea or some of its antecedents. These are carried away by the circulation, which is now accelerated, the carbon dioxid being eliminated by the lungs, the urea by the kidneys. The greater consumption by the cell of carbohydrates and proteids affects the organism in ways that are somewhat analogous to the enlarged need of oxygen, but instead of causing oxygen hunger there is produced **hunger for food.** Through the influence again of the vasomotor system, the whole digestive tract comes eventually into a state of heightened activity, in part owing to the increased blood-supply, but chiefly to direct neural stimulation. The consciousness of hunger is more marked, and gradually the normal individual will be led to eat more food as certainly and as definitely as he is prompted to breathe more air. A third group of activities is due to the **heat** evolved by the rapid combustion in the muscles. This is kept down by the dilatation of the superficial arteries and capillaries which increases surface radiation. At the same time the sweat-glands are influenced through the sympathetic nervous system to operate with more or less vigor, throwing sweat upon the skin. The evaporation of this sweat cools the body, and is a potent factor in preventing the rise of the body-temperature. Thus, through muscular exercise, the **function of respiration, circulation, nutrition, and excretion** are all profoundly affected, and the heat-controlling mechanisms of the skin and sweat-glands are stimulated to greater action.

Special Effects of Muscular Exercise.—Let us now examine somewhat more in detail certain special features of bodily exercise.

Every muscle tends to contract, even during rest. This is due to two causes: the elasticity of muscle-tissue, and a certain amount of stimulation that is constantly being sent to the muscle. The tension is greater when the muscle is healthy and when its proper nerve-center is in normal state, than when other conditions obtain. Again, the strength of this contraction varies directly as the strength of the muscle; thus, when the pectorals are developed out of proportion to the trapezius and other muscles, the normal pull of the pectorals will overbalance the pull of the trapezius and rhomboidei, with the result that the shoulders will be drawn forward. When the flexors of the fingers are developed far more than the extensors, the fingers will hang in a semiflexed position. The tendency of much of the gymnastics of the heavy type performed on gymnastic apparatus is to develop the flexors not only of the arms, but of the trunk, more than the extensors, with the result not only that the hand is nearly contracted when at rest, the elbow hanging partially flexed, but the shoulders are drawn forward, the spine is bent, and the ribs are depressed by the action of the recti and the two obliques. In order to preserve the balance of power between the flexors and extensors of the arms, and particularly of the trunk, it is necessary to give approximately twice as much work to the extensors as to the flexors. Thus, in doing work with the pulley-weight apparatus, a person should spend approximately twice as much time facing the apparatus as with the back to it.

Muscles and ligaments tend to assume the position during rest that they occupy during exercise. If, for instance, the muscles of the forearm are exercised vigorously in a contracted position, as they are in rowing, when the man is through rowing his fingers will stay almost flexed; and if he rows day after day for a good while, only with difficulty can the fingers be wholly extended. The muscles that contract the fingers have overbalanced the extensor muscles, and are holding these fingers in the flexed condition. On the other hand, the back of a coal-heaver is an illustration of muscles that are stretched, and at the same time strong. The coal-heaver has developed a powerful back, but he has used his back in the bent condition, so that while he has great masses of muscle upon his back, it is difficult for him to straighten himself, and after some years of such work he cannot do so at all. The parts have become so accustomed to the bent position that they retain it permanently.

Thus, **the position taken during exercise** is of the greatest importance. If a person takes pulley-weight exercise with the spine in a forward position, the ribs depressed, and the chest flat, that very exercise will tend to make this position a permanent one; and yet this is exactly the position that uninstructed individuals commonly take in gymnasiums when doing pulley-weight work. Again, work on the parallel bars, particularly the bent-arm work, is usually taken with the spine flexed, and with the ribs in a depressed condition, the pectorals being in active contraction, as are also the muscles of the abdomen. The tendency is to perpetuate in the individual the form held during the exercise. We are all familiar with those who have done a great deal of such parallel bar work, and have observed the flatness of their chests in spite of the large development of the greater pectorals.

The general effects of exercise are in relation to the number of foot-pounds of work performed. By the general effects of exercise are meant the effects upon the heart, lungs, digestive organs, nervous system, and general cell-metabolism. We shall not here consider the effects of extended attention, or concentration of mind; that will come later on. We are now considering merely the general effects of exercise upon the body. I may extend my index-finger as many times as possible, until I am thoroughly exhausted, without producing any great effect upon my heart, lungs, or digestive organs; although I may produce an effect upon my nervous system from the exhaustion that would supervene from excessive work. The exercise of so small a muscle has comparatively little effect upon the great organic functions of the body. The amount of mental effort put into the exercise does not appear to be directly related to the activity of the heart and lungs. If I stoop down and raise myself I am not at all fatigued, but I have done that which has an immediate effect upon the body as a whole. The heart is increased in action from five to twenty beats in the minute, and the breathing is accelerated, even by a single movement of this character; there has been comparatively little nervous, but a great deal of muscular, expenditure. Such an effort might be equal to a hundred foot-pounds of energy, whereas the most vigorous effort of my will might not suffice to perform a hundred foot-pounds of work by the contraction of the small muscle referred to before—the extensor indicis. In seeking, then, the general effects of exercise upon the body, we must exercise those groups of muscles with which it is easiest to perform large amounts of work. These are obviously the great muscular groups of the body—the flexors and extensors of the thigh, and the muscles of the back, abdomen, and shoulders. These five groups include by far the strongest muscles in the body. Upon their exercise we must chiefly depend for effect upon the vital organs. Exercise of the muscles of the forearm and upper arm is somewhat effective; but so much inferior are these muscles in size and power to the other muscles referred to, that great reliance cannot be placed upon them. When muscles contract, we can foretell to a nicety how much effect there will be upon the heart and lungs, if we know the number of foot-pounds of energy to be expended. This is our most valuable criterion. Because of their greater natural capacity for skill, as well as because of the more showy character of their work, it is common in gymnasiums to find chief attention given to the development of the arm muscles. The fallacy of this is easily seen.

Physiologic Load.—There is a load for each muscle, and for each group of muscles, under which it can do its maximum of work. This we call its physiologic load. It is the load under which the greatest effect can be produced upon the organism. If the element of time is considered, the load must be altered to correspond. There is thus a physiologic load for each muscle for each length of time. It has been demonstrated that muscle will contract more vigorously and effectively when it is pulling a certain load than it will when contracting free; thus, the advantage of working against a weight of some kind. This weight can usually be the weight of the body in some form or another, except in the case of the arms, which are not well adapted to handling the weight of the body. For the arms we use apparatus in order to bring about this contraction under a load; and the longer the exercise is to last, the lighter we make the load. It is not sufficient that we shall contract the upper arm so many times; it must contract under a given load in order to secure the proper physiologic result.

Exercise a Factor in Promoting the Circulation of Fluids in the Body.—In this respect it is second only to the contraction of the heart. In the great muscle-groups of the body the lymph circulation is chiefly carried on by the contraction of the muscles. These press upon the lymph-spaces and urge the lymph on. The circulation of blood, as well as of lymph, in the abdominal organs is accelerated by exercise and by deep breathing. When the diaphragm makes large excursions, the abdominal organs are alternately pressed upon and released. The valves in the large veins are so arranged that the fluids can only go in one direction. Thus, it is clear that the relation of deep breathing to the circulation of blood in these organs is intimate. This indicates the great limitations imposed upon the health of the abdominal organs by anything that restricts the breathing, and one of the reasons why **deep breathing** is so effective in bringing about a state of vigor in the whole organism. Deep breathing seems to increase the freedom with which the return flow of the blood from the head is effected. This perhaps is not a major effect, but it certainly should be reckoned with.

The quantity of oxygen absorbed—that is, taken from the air of the lungs into the blood plasma and into the hemoglobin—varies in proportion to the need of oxygen in the body far more than in proportion to the quantity of air inhaled and exhaled at each breath. One may by deliberate effort breathe with rapidity and amplitude. The result is that the air in the lungs is more free from carbon dioxid than is usual. This, however, will not raise the oxygen absorption in the body. The oxygen tension in the blood plasma remains measurably constant. The way to increase oxygen absorption by the tissues is to do work that increases the breaking-down of oxygen compounds. Thus, there is more demand created for oxygen, deep breathing results, and this deep breathing is effective in the promotion of oxygen absorption. We thus see the fallacy of expecting to rejuvenate the tissues of the body by voluntary deep breathing. Such deep breathing may have useful effect in strengthening the accessory muscles of respiration; or by means of the wide excursions of the diaphragm moving back and forth the abdominal contents and thus affecting the vigor of these organs; but its usefulness is not primarily related to increased absorption of oxygen.

Effort on the part of individual muscles requires the fixation of the thorax and thus increases intrathoracic pressure. This effectively prevents the return of the blood to the veins leading into the thorax, and produces a passive congestion, which is most noticeable in the head. The staring eyeballs of a person making a vigorous effort, lasting a number of seconds, are familiar to all. The filling up of the great veins in the neck and head merely indicates the process that is going on all over the body.

Agitation of the body tends to accelerate intestinal peristalsis and hepatic circulation. This is noticed in the effect that riding a hard-trotting horse has on those of sedentary habits. For this reason running is more effective than bicycling in its effect upon the abdominal organs. Extended movements at the waist are also effective in their relation to the abdominal organs, the three factors being as already mentioned: increased peristalsis, increased circulation of contained liquids, stimulation by means of the wide excursions of the diaphragm.

Position of the Thorax and Curve of the Spine during Exercise.—When the dorsal region of the spine is flexed, the ribs are depressed, the chest is flat and the amount of space for the heart and lungs is less than when the opposite conditions obtain; the difference in the anteroposterior diameter in the two positions being often as much as three-fourths of an inch. When the trunk is thus cramped, the heart becomes embarrassed and irregular during severe exercise far more quickly than when the ribs and spine are both extended. This may be due primarily to the interference with respiration and circulation. Another point that has been demonstrated clinically is that the flexed position of the spine and the depressed condition of the ribs are associated with a less active process of digestion and feebler peristaltic activity. It is thus of fundamental importance, when we wish to secure the general effects of exercise upon the body, that such exercise be taken with the spinc in the erect position, and the ribs well everted. The tendency during much of exercise, unless there is special instruction, is to stand or sit in the flexed position. This should not be allowed.

NEUROLOGIC CONSIDERATIONS

Automatic and Voluntary Exercises.—Movements that are made with regularity and constant force are soon taken in charge by the lower neural centers. They are directed by the hind-brain, or possibly by the upper centers in the spinal cord. This frees not only the upper motor centers, but the seat of consciousness as well. Fatigue is more closely related to exhaustion of these upper motor centers, or even of the consciousness, than to exhaustion of the muscle-cell. Movements made automatically have far more effect upon the body in proportion to the amount of fatigue they produce than have those exercises demanding constant attention. The comparative fatigue of walking upon a smooth road and upon railroad ties placed at uneven distances is a familiar example of this principle. The automatic nerve apparatus does not become fatigued readily. The general effect upon the body, and the effects upon the muscle-cells, the digestive organs, the organs of circulation and respiration, etc., are, however, not affected by the source of the neural stimulus to muscular contraction—they are the same whether the exercises be automatic or voluntary. A typical example of a rhythmic exercise is bicycling at a moderate gait over a reasonably smooth road after one has become thoroughly familiar with riding. The somatic effect of the exercise is the same as when one is riding in a narrow track, but in the latter case constant attention is demanded and fatigue rapidly supervenes. Thus, physicians who have to do with individuals who are, as a whole, in need of muscular exercise, but who are already partially exhausted neurally, often have occasion to make large use of rhythmic exercises.

The relation between neural and muscular expenditure is not constant. Every increase in rapidity of movement calls for proportionally more neural energy than muscular energy. This is well illustrated by a person starting in the hundred-yard dash: the waiting with attention strained for the pistol-shot, and then the immense rapidity of the start, demand more neural energy many times over than does getting up the same degree of speed more slowly. It also demands, of course, more muscular energy to overcome inertia, but the neural demands are far greater in proportion than are the muscular demands. One starting a number of times in succession may become so fatigued that the hands will tremble violently when the muscles are still comparatively fresh. This is exceedingly important in the application of so-called **calisthenic drills.** When one wishes the individual to follow the commands of the leader the instant they are given, a far higher degree of attention is demanded than when he may follow more slowly. A teacher of gymnastics who is anxious that his class shall present a creditable appearance will constantly insist that the commands shall be followed instantly. This is unfortunate for the pupil who already has the least tendency to neural fatigue. It is harder, too, on adults or the middle-aged than on young persons, because reaction-time is slower in the former classes. After a drill or a set of exercises has been memorized so perfectly that conscious attention is no longer needed, the conditions, of course, have changed; but pupils in the gymnasium do not usually reach this condition. For this reason, from the standpoint of the general effects of exercise, it is important that there shall not be great haste in the following of commands, and indeed it is preferable that there be but **few commands,** but that the work be done largely by **imitation;** that being the more direct, simple, and neurally least expensive, form of instruction. In recommending patients to take exercise in gymnasiums, great care should be taken as to the character of the teaching with reference to these points. When the patient is primarily deficient in muscular strength or digestive ability, but has no tendency toward neurasthenia, the indications do not preclude the utilization of exercises made upon command. But in the far more common cases among urban residents, in which there is a tendency to nervous exhaustion, exercises of this character are usually, if not always, injurious. I have seen many patients injured rather than benefited by them.

Moderate and Excessive Exercise.—Another consideration in the comparison of neural and muscular expenditure involved in a given exercise relates to the effect of **moderate** as compared with **extreme activity.** The law will not hold in regard to extremely light loads; but leaving the latter out of consideration, the larger the muscular load, the greater the comparative nervous effort in the expenditure involved. It is true that even the mechanical effect of lifting 25 pounds one foot twice, is not quite the same as that of lifting 50 pounds one foot once, and hence the effects upon the muscle-cells and the viscera differ in these two cases. But there is a still greater difference in the effects upon the nervous system. More neural energy is demanded to cause the muscles to contract once with the 50-pound load than to contract twice with the 25-pound load. This matter is therefore important with reference to the same class of persons mentioned under the preceding head. They should be given moderately heavy work, but of sufficient duration to accomplish the result, rather than be made to accomplish results with a few large efforts. A common and useful test is to notice the hands when held with fingers extended and free from each other, the arm being held away from the body. If the fingers are trembling, there has probably been too much effort. One may do considerable work, in small doses, without producing this effect; but even a moderate quantity of work in one or two large doses will quickly induce it, and it is then often followed by sleeplessness and indigestion.

Of how much importance is physical exercise in the development of the brain? From one-third to one-half of the brain surface is concerned in making muscles contract, definite areas being in relation with definite muscles or groups of muscles; but this does not prevent these parts of the brain from being used in other ways also. Although we know but little about the function of the different portions of the brain, we do know that it is necessary to have muscular exercise of any group of muscles, if the corresponding nerve-center is to be developed. Careful examinations have been made of the brains of subjects who had very early lost a limb, and it has been shown that the brain-centers normally active in the management of the muscles of the amputated limb were never developed. Hence, if the full development of the entire motor area of the brain is to be achieved, the muscular functions of the body must be exercised to their full capacity. Not merely must each muscle become powerful, but the faculties of co-ordination and control must be developed. These appear to be even more closely related with the finer organization of the nerve-structure, than is the exhibition of power.

There are some nerve-centers having to do with muscular contraction that ripen, without ever having the subordinate muscles in active operation; for instance, the respiratory center. The new-born babe finds its respiratory apparatus, neural and muscular, in perfect condition for operation. It may be that when a sufficient number of thousands of years have passed, the whole brain will be in the condition in which the respiratory and a few of the other brain-centers are now. Physical education then will be *nil*, and we shall look to physical exercise merely as a hygienic measure to insure health, all the neuromuscular mechanisms ripening and coming into perfect function through the inheritance from countless generations of ancestors. At the present day, however, varied muscular exercise is absolutely indispensable in the development of the brain; and upon the right development of the brain is dependent the large bulk of our psychic activities.

Fatigue.—The subject of fatigue must interest all physical trainers. Muscular fatigue, as we usually speak of it, is our consciousness of the partial exhaustion of the motor centers controlling the muscles that have been worked. In ordinary life we do not often experience genuine fatigue of the muscle-cell; but this is not the only form of fatigue. When certain brain-centers are fatigued, we can then turn to other centers, centers concerned with other muscular groups, and operate them. When these in turn are fatigued, we can call on still others; but long before there comes the exhaustion of the motor elements for all the muscles, there is another fatigue that supervenes, so that muscles that have not been concerned in the activity cannot be operated with either power or accuracy. This is not due merely to the presence in the circulation of the 'fatigue stuffs' produced by the exhausted muscles or by their nerve-centers, although this is undoubtedly an element. If we call this **will fatigue,** it then becomes of importance to find the point in the training of the muscular system at which the maximum of benefit to the physical organism can be secured without appreciably lessening the power of the individual as shown by his ability to will. It is a matter of common observation that there is no form of exertion so exhausting as emotional activity. Excitement and worry are prime factors in the production of exhaustion. We shall consider later on—in the detailed study of various exercises—their emotional aspect; thus, the difference in effect of an exercise such as sparring when it is done face to face with an opponent, and when the movements are done alone. We shall leave the consideration of this point for treatment at that time.

Co-operation among Contiguous Nerve-centers.—One of the most potent arguments for a large amount of exercise during young manhood is that **nerve-centers may draw power from neighboring nerve-centers.** Conversely, it has been shown that exhaustion of contiguous motor areas may come through the efforts of a single center so small as that governing the flexor indicis, if this activity be kept up long enough. All are familiar with the fact that extreme exhaustion in one line incapacitates us in others. This may be partially explained on the ground of fatigue stuffs being poured into the blood-current; but the far more rapid recovery of animals when these fatigue stuffs have been produced outside the body and then injected than when they have been produced in the body, would be in line with the clinical observation already mentioned. Thus, we see the great importance of the thorough development of the motor area of the brain. Men of intellectual ability may not have well-developed muscular systems; but it is rather unusual to find men of extended intellectual capacity for work during many years who have not during adolescence engaged in vigorous and extended exercise. The motor brain seems to be a sort of battery furnishing power for intellectual labor; but it furnishes endurance rather than force. The natural interests of young men in exercises of an extreme character would indicate to us that there is some organic need of such exercise during these years, for we cannot think of such instincts having arisen spontaneously; they must have arisen by natural selection and therefore meet a demand in the individual.

The **kind of exercise** demanded during the succeeding years of the life of an individual must be related to his changing characteristics throughout these years. In recommending exercise of the neuromuscular apparatus from the standpoint of motor education, we must first ask the question: What is the condition of this apparatus? We know that the brain, spinal cord, and muscles of the new-born infant are in a far different condition from those of the adult. We know that its capacity for muscular activity not only differs from that of the adult in power, but even more so in control. The comparatively recent efforts of the neurologists have, however, given us ample ground for procedure; although, hitherto, the physical trainers have taken but small notice of this most important series of facts.

The general **order of development** of the motor centers seems to be as follows: first, are developed those that have to do with functions already reasonably perfect at birth—respiration, circulation, sucking, crying, and other movements that need no particular training. The motor centers for the control of the skeletal muscles develop in the order of their distance from the trunk; thus, shoulder before elbow, elbow before wrist, wrist before fingers. There is some overlapping, but in the main the progression is of this character. At birth the child has perfect grasping movements, but the independent control of the fingers comes comparatively late. It is not done with readiness until after seven in most children. This order of development is merely that shown in general by embryologic investigations. Those movements that are racially the most elementary or the most early, come first in the individual. The interest that the child shows in special forms of activity is an excellent guide to the order of development of the motor activities.

This order of development of the nervous system is important with reference to **educational gymnastics,** because otherwise they are abnormal. Nothing but disaster can be expected if we attempt to force motor education out of its natural order. The education of any part is best done when that part is ripening. If this is accomplished, the part may be further perfected at any time during later life. If it is not accomplished, the part can never be made to reach its highest development by later education. The development of the motor areas for the trunk takes place during the first two or three years of life. The arms and legs are pretty well under control at the age of five or six. The interest of boys in marbles; in all forms of machinery; in throwing, shooting and similar exercises, indicates the growth of the finer motor areas between the years of seven and twelve. The interest of girls during the same years in sewing and playing with dolls, which involve the finer activities, is an indication in a similar direction. The activity of the speech center begins early, but has its greater development within the first three or four years. When special attention is given to specific exercises demanding skill in distal groups of muscles before the more proximal muscles have been trained, we often find neuroses supervening. Dr. Hartwell has made extended studies in regard to stammering and stuttering in this relation. In former days those destined for a musical career were put at their special work—for instance, on the violin—at as early an age as four; but experience has shown that such education ought not to be begun until the child is seven or eight years of age. This experience is in accord with the neurologic fact just mentioned, that the motor centers for the fingers and wrist begin to acquire special activity after the age of eight years. The selection of voluntary exercises for the development of this neuromuscular mechanism ought, then, to be practically completed before the boy or girl reaches the teens, for the apparatus is pretty well developed by that time. Gymnastics, so called, affect chiefly the larger groups of muscles. The finer groups concerned in independent finger movements, activities of the larynx, facial and tongue movements, are not trained by gymnastics; their exercise must of necessity come in other ways. The playing of games of children, as we shall see later on, involves the discipline of these motor centers; thus, gymnastics to be of the greatest educational value ought to come during the first three or four years, or at least the first six or seven years, of the child's life; but for many reasons it is obviously absurd to attempt to have children during these years do gymnastic work. We are thus driven to the conclusion that the primary object of gymnastic exercises, such as are prevalent in our gymnasiums, cannot be solely that of neuromuscular education, and that for this process of education we must depend upon other agencies than voluntary gymnasium work.

Muscular Exercise and Cerebral Hygiene.—As we have seen, the absorption of oxygen by the blood plasma and the digestion of foods are both related to muscular activity. The constitution of the blood, then, is related definitely to muscular activity. The power of the heart and the healthy tone of the arterial system are both related to the quantity of muscular exercise. These points have much to do with normal, healthy cerebral activity. A vigorous heart, a respiratory system that performs its functions effectively, digestive organs that keep the blood rich in tissue-forming and energy-expending elements, form the material basis for cerebral health.

Muscular Exercise and Vasomotor Hygiene.—The vasomotor system has been called the hub around which organic life revolves. The control of the blood-supply of the body appears to govern not only activity, but emotion as well. The vasomotor system appears to be the basis of the emotional nature, bearing somewhat the same relation to emotions that the brain does to intellect. This is in accord with the observed facts that insanities are prone to begin with perverted feelings, and that the wild delusions of religious devotees, hallucinations, and the like are more frequently found among those who have not had vigorous muscular exercise than among those that have had such exercise. A balanced activity of the vasomotor system is secured only when it is called on for its normal functions in connection with the regulation of the blood-flow to muscles in vigorous use. In those who take but little muscular exercise the vasomotor system is far more liable to irregularities. One who does mental work and neglects to take exercise is likely to have cold hands and feet. Sane notions in regard to daily activities are thus related to a vigorous functioning and balance of the vasomotor system.

Muscular contraction appears to be closely related to the genesis of many forms of **psychic activity.** Not only do the vasomotor and muscular systems express the thinking, feeling, and willing of the individual, but the muscular apparatus itself appears to be a fundamental part of the apparatus for these psychic states. Without the muscular system, the necessary material for psychic activity cannot be provided. The three processes of **thinking, feeling,** and **willing** are more or less closely connected with a rehearsal, both neural and muscular, of the acts by which the original material for the mental process came in. As G. Stanley Hall puts it: "We think in terms of muscular action, more or less remote, and all the parts that were concerned in the original activities are more or less active in the thought. Nerve currents are constantly going to the muscles and coming from sense organs, all being a part of the thinking apparatus." If this be true, the fulness of the neuromuscular experiences during early life would appear to be related to the opportunity for later psychic range. This is borne out by the fact that both in animals and in men the scale of intelligence corresponds to the number of possible muscular co-ordinations. The more complicated the neuromuscular apparatus, the higher the intelligence. It is true that the individual profits mainly by racial inheritance of all these complicated mechanisms; but even so we may expect to find that the individuals who live a life of psychic activity have been, on the whole, those who during early life have had a rich and full experience of muscular co-ordinations. It is not difficult to perform a few simple experiments to illustrate this point. If one repeats the alphabet as rapidly as possible, it takes about four seconds. If, now, one thinks the repetition of the alphabet, but without making any muscular movements, it takes approximately the same length of time. During the severe effort to repeat as rapidly as possible one becomes conscious that the mechanism involved is the same as when repetition is actually done. One can feel the latent movement—if I may use the expression—of the larynx, lips, and tongue. To think the alphabet in terms of writing, takes about the same length of time that it actually does to write it. Thus, the speed of muscular movements is related definitely to the speed of our thinking; and this rule, moreover, is one of those that "work both ways." It is not, however, merely in reference to the intellect that the muscular system is important. The sensibilities, or feelings, or emotions are definitely related both to muscular and to visceral states. We are accustomed to think of the expression of the body, particularly the expression of the face, as merely the outward manifestation of the inward state. The modern psychology, however, is telling us that this muscular contraction is a necessary part of the feeling itself, and that when the muscular expression of the feeling can be inhibited, the feeling itself is not the same. Rage is not rage until it expresses itself in muscular action of some form. It may be merely in the stiffening of the whole body, the clinching of the hands, or the forcible compression of the jaws. When we come to the regal faculty, the will, modern psychology again asserts that will must express itself in terms of muscular activity, and that power of the will in its origin bears a relation to firmness of muscle, to power of muscular contraction.

SPECIALIZATION

One of the natural tendencies of boys, girls, and young men is to specialize in certain forms of interesting muscular activity rather than to take exercise that symmetrically develops the whole body. This is perhaps best shown by the college athlete, who not only specializes in baseball but even in a single position on the nine; or he may specialize in pole-vaulting, throwing the hammer, running the mile, or any other of the numerous athletic events. In the gymnasium he may specialize in any single group of muscular performances, although these are not so attractive to the average man. There has been far more condemnation of such specialization, together with pointing out of its evil results, than there has been critical study of its nature and advantages. In the light of evolution it is hardly to be supposed that such general interest should have arisen without there being some useful element in it. The argument relative to the place of specialization in physical training can only be constructed upon the general place of specialization in evolution. Specialization is at the root of all evolution. It is only when the early forms of animal and vegetable life begin to set apart cells for special activity that they begin to rise in the scale of efficiency and intelligence. Certain groups of cells that have been specially developed for the performance of certain actions perform these actions far more efficiently than would otherwise be possible. This is to the advantage of the organism as a whole. For this reason we find a constantly increasing specialization going on in the human body. The various tissues are made up of cells that have become so highly differentiated from the elementary form, which has been most faithfully preserved by the amœba, that it is with difficulty they are recognized as its descendants; but all of them are merely emphasizing certain functions that were common to the original cells. This is no less true of the contractile muscle-cells than of the coordinating brain-cells, or the connective-tissue cells. Thus, the whole development of the individual has been related to specialization. This holds not only with reference to the body, but with reference to the development of intelligence and feeling. The individual as a whole also tends to specialize. It has been the common practice among physical trainers to endeavor to overcome this natural tendency toward specialization. It has been said that the left arm should be trained to be as strong and as skilful in every way as is the right arm. The practice that has been given to the perfecting of the right arm in penmanship, in playing the violin, in working with machinery, and in all directions that demand skill, must now be divided by two, in order that the left arm shall be as well trained as is the right. But even this would not accomplish its end, because in most persons the neural apparatus governing the left side of the body does not have the capacity of the right-hand side for finer organization. The ages of evolution have brought to man as compared with woman special ability for throwing. I have repeatedly endeavored to train the left side of the body to throw a ball as readily as does the right hand; but even with the best training the ordinary man will still throw with his left hand in the same way that a woman does with her right hand. But, even if we should succeed in the endeavor to perfect the left hand correspondingly to the right, what would be the gain? It would be at a large cost of skill on the part of the right hand. The individual as a whole would not be more healthy or more efficient. He would have two members both able to do the same thing, and yet rarely has he need for but one of them at a time. This illustration must suffice to indicate some of the limitations of the usefulness of all-round training.

The Limits of Specialization.—The limit of specialization in the cells of the body is easily seen. The nutritive ability of the cell must never be interfered with. Any other function or every other function may be altered or largely lost through specialization; but the ability to convert inert matter into proper cell-substance must be retained by every cell that continues to live, and the highest degree of specialization is intimately concerned with this fundamental organic requirement for life. We find this same fundamental organic need conserved in the specialization of the individual as a whole. Any degree of specialization that does not violate this fundamental condition of nutrition, does not seem to be at variance with the best needs of the organism as a whole.

In what ways may specialization in athletics or gymnastics interfere with this fundamental, nutritive ability of the organism? It may interfere with the respiration, so that the blood is not kept free from carbon dioxid, and the tissues of the body rapidly degenerate because not supplied sufficiently with oxygen. Thus, specialization which leads to the breathing of bad air, or to faulty positions of the thorax, violates our fundamental condition. Specialization that interferes with the circulation by producing hypertrophy or irregular action of the heart, such as we find when that organ is compelled to work under pressure, likewise violates our fundamental condition. When the energy of the system is drafted off to such an extent through muscular channels that the more fundamental centers, which have to do with organic life, are deficient in power, a condition of asthenia supervenes that is not to be tolerated. This we often find in individuals who have been overtrained. But when these fundamental conditions are conserved, when the specialization does not interfere with respiration, circulation, digestion, or the control of the organic life through the nervous system, it is not only harmless but eminently desirable.

Somatic Harmony.—Bodily symmetry is not so desirable as **bodily harmony.** The body is symmetrical when the two halves are precisely alike in form and function. This we never find; even the two sides of the face are different; the two sides of the brain are different; the limbs are never precisely alike, and in function they vary even more than they do in structure. The most perfect statues are non-symmetrical. Figures of faces in which the two sides are made exactly alike appear to be lifeless. Differentiation even here has its fundamental significance. **Harmony** exists when the different parts are so related to one another as to produce a whole in which each part is exactly adapted to perfect co-operation with every other part. This is the highest ideal.

If one attempts to judge any form of athletics with reference to this standard, one must ask, first, Does it violate any of the fundamental conditions of organic life? or, to put the question positively and more fairly, Does it favor the fundamental conditions, the fundamental necessities of respiration, circulation, nutrition, and nerve action? If it favors these, it is useful from the physical standpoint. If at the same time, it interests the individual, it is probably useful from a psychic standpoint. It is a matter of comparative indifference that a man should always jump from the left foot, or that he should use his tennis racket with the right hand, or that he should always do the wolf vault to the right and the flank vault to the left. These activities do not interfere with the organic necessities of life, and they do favor the contraction and relaxation of muscles which we have seen to be associated with healthful living. Exercises that do interfere with the somatic life must be avoided, as has been already pointed out. To make the left arm equal in measurements to the right may not even please the esthetic sense, it certainly is but little related to health and vigor; but to put the thorax in that condition in which the heart and lungs shall operate most freely is a matter of the greatest importance. To keep the spine in that position in which the abdominal organs shall all be maintained in normal site and relation is also of great concern, and yet in past years we have given far more attention to the mere matter of equalizing muscular measurements or muscular strengths, and but secondary attention to the larger matters which are related to the somatic life of the individual.

To state the case concretely: A man may specialize in any form of gymnastics or athletics that he pleases, so long as a judicious balance is maintained between the various nutritive functions of the body. Good respiration, good circulation, good digestion, healthy but not extreme nervous activity, are the desiderata, and will be considered more in detail later on. To illustrate now by undesirable specialization: we should prohibit exclusive specialization in such exercises as the hundred-yard dash, pole-vaulting, running high or running broad jumping; and in work on parallel bar, horizontal bar, and like forms of activity. The former group of exercises calls for too much nervous expenditure, and not enough of steady exercise; while the latter calls for development of the shoulders at the expense of the parts below the hips, and fails to provide sufficient respiratory exercise, the result being a lack of development of both circulatory and respiratory systems.

Competition.—One of the evils most commonly decried in connection with athletics is excess in competition. A judicious balance must be observed here. When the individual is suffering from any form of nervous exhaustion, competition is unqualifiedly bad; for it increases the nervous expenditure in ways already indicated, but to a heightened extent. When it is for other than neural purposes that the individual is to exercise, competition may form a stimulus that will maintain interest for long periods in work which otherwise would be dropped. Thus, sparring or bowling can sometimes be relied on for exercise when other equally valuable forms are not sufficiently attractive to the individual to induce him to persevere in them. A moderate degree of competition will help rather than hinder the ordinary man. The extreme competitions such as are seen in intercollegiate contests, cannot be defended upon physiologic grounds; for overexertion is far more common in such connection than in any other related to physical training.

Dosage.—Only general considerations need to be discussed. Exercise is too severe for the best results to be achieved if the performer does not completely recover from the incident fatigue during the subsequent night. The more nearly normal and vigorous the condition of the patient, the larger and more infrequent may be the dosage; the less habituated to exercise, the smaller and the more frequent the dose.

It is my practice, when working for the **general vigor** of a patient who is entirely under my direction, to divide the daily exercise into five or six doses. Each period has exercise of some particular type, although all are related to the requirement of general somatic vigor rather than to any technical skill. On rising, fifteen minutes of **deep breathing exercises** are often taken. The patient lies flat on the floor and breathes as deeply as possible ten times, then rests ten seconds. This is repeated four or five times. Then with each inhalation the arms are raised to a line through the shoulders. This tends to help the lateral expansion of the chest (Fig. 66). The same number of movements is carried out as in the former case. After this the arms are raised vertically, which assists inspiration, and, as before, the movements are repeated four, five, or six times (Fig. 67). The arm movements give the variety necessary to avoid tedium. The total effect of such a group of exercises is considerable, and unless the patient is already vigorous, his muscles will be rendered sore. One should ordinarily begin with a quarter of

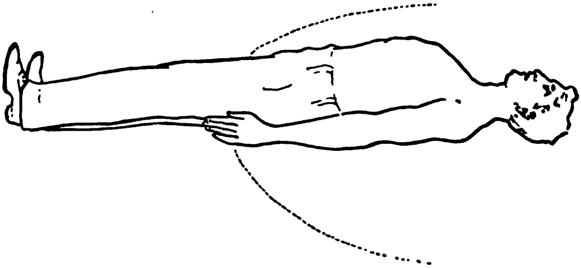


FIG. 66.—EXERCISE TO WIDEN THE CHEST.

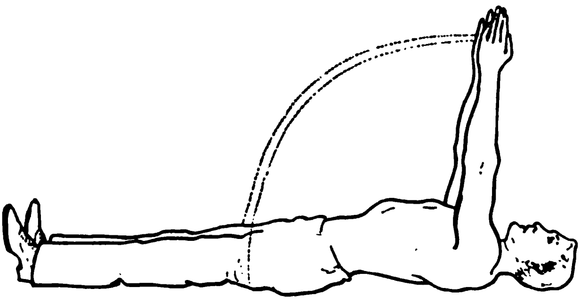


FIG. 67.—EXERCISE TO DEEPEN THE CHEST.

this amount, or even less, and by adding a few exercises each day, work up to the full dose in the course of two weeks. During these movements the patient has vigorously exercised the chief muscles of the trunk, and has definitely stimulated the circulation through all the abdominal organs. At first he will very probably be rendered dizzy. He should work more slowly under these conditions, and a few days will remove the difficulty.

The object of the supine position is to extend the spine, as this favors the expansion of the thorax. The muscles that hold the trunk erect are also freed from activity, and this also allows increased mobility of the ribs.

At about ten in the morning a series of short fifteen-second, **slow runs,** each run followed by absolute rest, will steadily increase the general strength. In the beginning of such exercise great care must be taken that the heart is not overtaxed. This exercise should be followed by a bath and rest. In the afternoon a long, slow **bicycle ride,** or a game of **golf,** is useful. The doses in running may be steadily increased till three or four miles are covered daily at a steady dog-trot.

The general principle consists in beginning well within the ability of the patient, and by steadily increasing, small doses, at frequent intervals, to train up the whole organism to greater power. This general principle can be adapted to the daily requirements of life, as to business, meals, etc. A routine of **gymnasium exercise** with pulley-weight or other apparatus may well take the place of one period of exercise, although exercise out-of-doors is generally more useful than work indoors.

Often patients wish work of a vigorous type prescribed that will enable them to do all they can in a few moments. The evils of this are that the neural expenditure will usually exceed the muscular; sufficient time is not taken to allow the thorough flushing of the parts with fresh lymph, and the immense benefit of long-continued forced or full breathing is lost. In such cases the individual has merely added to his daily work a certain amount of muscular labor. In all cases in which bodily health and vigor are sought this is a dangerous experiment, and will probably result in still further reducing the stock of vitality. It must be remembered that muscular labor, like all other forms of exertion, is expensive, not recuperative, of energy. Muscular exercise is useful, then, only when the organism has both time and power to rebuild the tissue broken down by it. To add muscular exercise to the daily routine of one already overworking is bad therapeutics. In my own experience it has resulted in hastening the oncoming of the general disability which it was intended to prevent.

In order, then, for muscular exercise to be useful in the case of overworked persons, the following conditions must be fulfilled:

1. **Sufficient diminution of other work,** so that the organism is free to devote its energy to the constructive processes that should follow exercise.

2. **The adaptation of the quantity of the exercise** to the recuperative powers of the individual. This will be found to be a constantly increasing quantity.

CHAPTER II

MATERIA GYMNASTICA; SPORTS AND GAMES; SYSTEMS OF GYMNASTICS

Walking and Running; Calisthenics; Pulley-weight Exercises; Heavy Gymnastic Apparatus Exercises; Track and Field Athletics; Athletic Games; Wrestling, Boxing, and Fencing; Bicycling; Golf; Horseback-riding; Bowling; Rowing. Relation of Physical Exercise to Age and Sex. Baseball, Cricket, Hockey, Shinney, Basket-ball, and Football. Characteristics of Hygienic Gymnastics: School Gymnastics. Training Medically Considered: 1. *Condition;* 2. *Habit;* 3. *Strength;* 4. *Endurance. Systems of Gymnastics: German Gymnastics; Swedish Gymnastics; English Physical Exercises; Delsarte; Sargent; Emerson; Young Men's Christian Associations.*

Let us now examine briefly the characteristics of the chief forms of general muscular exercise available for ordinary use. The following classification may serve for practical purposes, although open to theoretic objections:

1. **Walking and running.**
2. **Calisthenic exercises**—Indian clubs, dumb-bells, wands.
3. **Pulley-weight exercises.**
4. **Heavy gymnastic apparatus exercises.**
5. **Track and field athletics.**
6. **Athletic games.**
7. **Wrestling, boxing, fencing.**
8. **Bicycling.**
9. **Golf, horseback-riding, bowling, rowing.**

1. Walking and Running

In many gymnasiums formal marching is much affected. In order that the command may be obeyed promptly, close attention is necessary, and although in the course of time obedience becomes automatic, this condition is rarely reached in the ordinary gymnasium. Whenever great precision is demanded, particularly when the commands are to be executed with absolute uniformity, close attention to the orders is necessary.

Hence, as the chief effects of this exercise are neural, it should not be indulged in by patients who are nervously overworked. Simple marching without complicated commands or movements, especially without rapid movements, appears to be unobjectionable from the physiologic, as well as from the psychologic, viewpoint.

Walking is the form of exercise most generally utilized. The effects vary according to speed, duration, and the character of the ground passed over. When the walk is not too rapid for the natural swing of the leg to bring the foot forward at the completion of each step, it is a very moderate exercise. The support of the pelvis upon the legs in alternation is an entirely automatic process; cardiac activity is somewhat, but not greatly accelerated; and the respiration is quickened in proportion to the energy expended. The objection commonly raised against walking as a general exercise is that the arms are not used, and that the muscles of the trunk receive no exercise. During rapid walking, on the other hand, the arms are used continuously; at each stride the pelvis is slightly rotated in order to lengthen the stride; the psoas magnus and the long head of the rectus femoris are called into active operation in pulling the thigh forward, while the action of the same muscles is needed to pull the leg forward, particularly at the end of the step. The general discussion under the head of specialization has shown that exercise of all the muscles of the body is not indispensable, but that the important element is the exercise of large groups of muscles. This is accomplished to a large extent by walking, particularly by walking as rapidly as four miles in the hour. When much exercise at this rate seems inadvisable, the same result can be attained by interrupting the walk with frequent rests. This point has been discussed under the head of dosage.

The agitation of the body at every step tends directly to stimulate the functions of all the abdominal organs. In this respect, walking far excels bicycling, in which the body is relatively motionless being supported on the tuberosities of the ischium. When the patient can utilize the advantages of a hill, walking can be made even more effective than on the level. There is no better or quicker way of modifying the great organic functions of respiration, circulation, and digestion than by walking up a grade. This should be done with frequent rests in order to prevent embarrassment of the cardiac or pulmonary systems; but for reasons already discussed under dosage it is important that the exercise be sufficient to call for steady, conscious effort.

The effects of **running** differ from those of walking somewhat in kind, but even more in degree. In running at any ordinary rate of speed the leg does not have to be pulled forward at each stride; and, on the other hand, the up-and-down motion of the body is greater in running than in walking; thus, the effect upon the abdominal organs is greater, the energy expended is greater, and the effect upon the general system is more marked. The increased activity of the diaphragm also stimulates the circulation of blood in the abdominal organs. Running should not be pursued to the point of circulatory or respiratory embarrassment, not only because of the effect upon these organs themselves, but because at this point great effort of the will is necessary to force the individual to continue; it is thus neurally exhausting. The maximum of general effect is secured by a series of short runs with complete rest between, rather than by walking slowly for a long distance. **Rapid running** so quickly exhausts the organism as to be but little suited for general exercise.

Alternate slow running and walking meets so many of the conditions of general exercise, both negative and positive, that I am confident it will have a large place in the future as it has had in the past in general exercise. It is not of prime necessity that the muscles of the arms be greatly exercised. Slow walking with running brings into play the general activities of the body in an excellent way. In gymnasiums having no running track it is possible to have a large number running on the gymnasium floor by means of what is called 'maze running.'

2. Calisthenics

Although it is convenient to classify together the different forms of calisthenics, they vary much in respect to each other. The primary consideration is in regard to the movement of the trunk. If the legs and body remain stationary, the apparatus and arms alone are moved. The exercise in this case is then generally of a moderate character, and dependent more upon skill than upon strength. On the other hand, when the whole body is moved, the exercise acquires a far more vigorous character, although it may still retain its characteristics in regard to the demand of skill. When the body remains stationary, and in each hand is a light wooden dumb-bell or Indian club, the muscular exercise is insignificant. If the movements are complicated and follow each other with speed, the neural expenditure is large. Those forms of exercise which one is most likely to see in girls' schools are often of a beautiful character, done with grace and precision, but are little adapted for the purposes of hygienic exercise or the stimulation of the general functions of the body. They depend more upon memory, upon skill, upon instant attention, than upon muscular power. When, however, the body is swayed or swung at each movement, there is added to the slight weight of the apparatus the weight of the whole body. When the floor is touched with the dumb-bells at every fourth movement, no matter what the other movements may be, it means that the weight of the body must be raised approximately 18 inches, which implies a considerable degree of muscular labor, and therefore secures the general effects of exercise.

Exercises with calisthenic apparatus may be difficult, first, because of the muscular effort demanded; second, because of the accuracy with which the movements must be executed; third, because of the demands made on the attention and on the memory. It is therefore difficult to pass on the value of calisthenics as a whole. When the desideratum is the general effect of exercise upon the individual, the drill should primarily call for exertion of the large groups of muscles of the legs and trunk, and not primarily for either accuracy or memory or attention. In prescribing exercise and in recommending a course of gymnastics this point should be kept clearly in mind, for serious nervous collapse has often been accelerated by means of exercise the primary effects of which were not muscular but neural. Calisthenic exercises prepared for exhibition purposes must almost of necessity be of this latter type; for they are more beautiful, and appeal to the public mind in a way that the more vigorous but less accurately executed movements of a larger type cannot. The movements should be performed by the leader and then imitated by the class rather than done to command, when it is desired to increase the muscular and decrease the neural expenditure. When calisthenic drills have to be memorized, it is again unfortunate for the individual who wishes to escape neural expenditure. I have seen prescribed for a group of young ladies calisthenic exercises that took twenty-three minutes to execute. These movements were done to count, each person keeping the count in her own mind. After a certain number of counts each movement was changed without any command from the leader, each pupil depending upon her own memory to execute the proper movement. Thus, to the comparatively insignificant amount of muscular exercise demanded by the particular drill in question, there was added a somewhat complicated intellectual operation, which is exactly what is to be avoided. The general effects of exercise are to be attained by calisthenic drills only when the great muscles of the back and thighs and of the shoulders are brought constantly and vigorously into action.

In **Indian club** work, when the clubs are light and swung without movement of the body, there is little effect upon the organism as a whole. Swinging **heavy Indian clubs,** however, that cannot be handled by the small muscular group of the hand and forearm, is accomplished by the larger groups of the trunk and shoulder, the hand and wrist in this case being merely used as prehensile organs. Exercise with clubs of a heavy character cannot, of course, be so complicated as it can be when the clubs

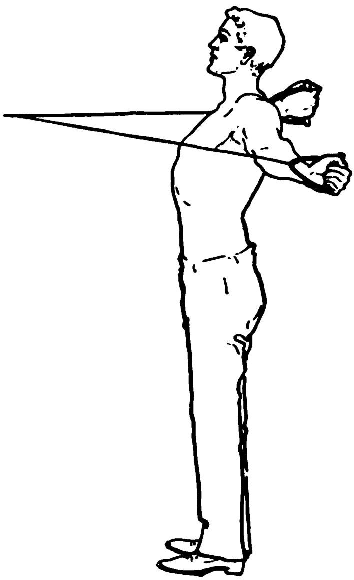


FIG. 68.—EXERCISE FOR DORSAL MUSCLES.

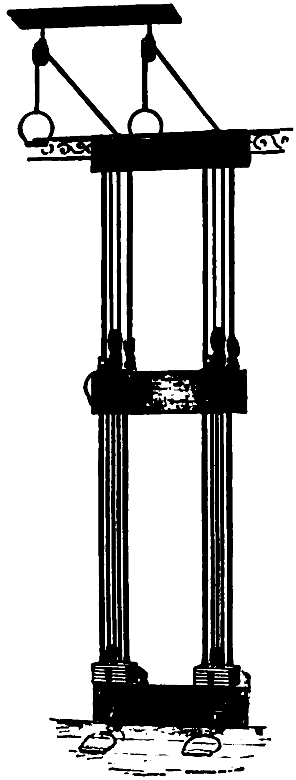


FIG. 69.—PULLEY WEIGHT.

are light; thus, we increase the muscular and decrease the neural effect by such a change. Hence, work with heavy Indian clubs has more general effect upon the body than work with light clubs.

3. Pulley-weight Exercises

There is a large class of gymnastic machines the central element of which is a weight attached to a rope that passes over a pulley. To the distal end of the rope is affixed a handle or some other means of attachment to the individual. The weights are usually variable, depending upon the load that it is desired to give to the muscle and the size of the muscular group to be exercised. The general object of all pulley-weight exercises is to isolate **special groups of muscles.** This end is largely, although not entirely attained. The so-called **Zander machines** used most extensively in Sweden accomplish this end more perfectly than any others; but they are used so exclusively in connection with medical

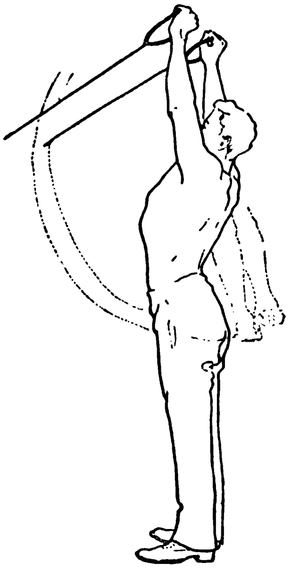


FIG. 70.—EXERCISE FOR SHOULDER MUSCLES.

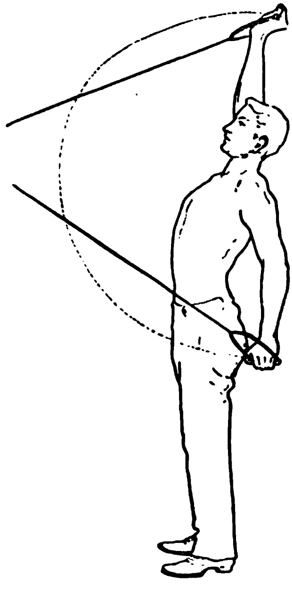


FIG. 71.—ALTERNATE ARM-EXERCISE.

gymnastics that they should be considered under that head. (See page 132.)

The pulley-weight exercises deserve to be viewed by themselves. They exercise muscles in **anatomic groups,** rather than in such combinations as are found in the ordinary gymnastic and athletic exercises. Putting a dumb-bell to the floor and lifting it again is a single operation physiologically, but anatomically it involves the co-operation of most of the large groups of muscles of the body.

The object of isolating the muscular groups is that each may be given precisely that load which is best adapted for its own development, and thus to produce the maximum of effect upon it. Another reason is that when exercise is of a local character, it is possible for the vasomotor system to direct to the muscles involved a larger blood-supply than is possible when many groups are exercised at once. The dilatation of arterioles supplying groups of muscles in exercise is effective only when there are not so many groups exercising at once as to demand the bulk of the blood-supply. In the latter case all that can be done is, by means of increased cardiac activity and the limitation of the blood-supply to the abdominal organs, to send a greater proportion of the total quantity of blood to the muscles in general. This accelerates the general circulation of the body. It thus appears that the food-supply of

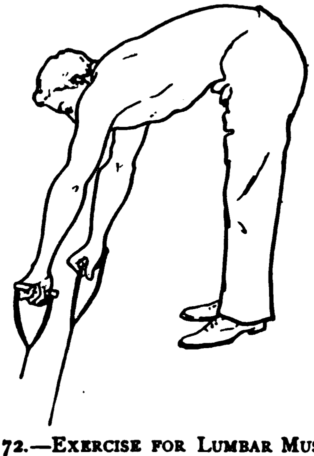


FIG. 72.—EXERCISE FOR LUMBAR MUSCLES.

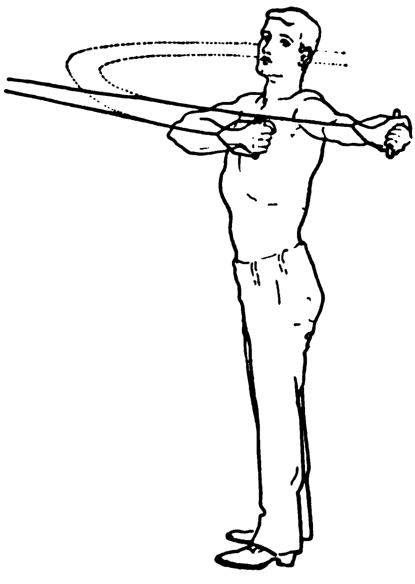


FIG. 73.—EXERCISE FOR BACK AND WAIST.

any given group of muscles may be temporarily increased more rapidly when this group is exercised alone, as is done by pulley-weights, than when it is exercised coincidently with a large number of other groups. In the movement referred to—stooping to the ground and rising again—muscles belonging to both sides of the trunk and to all the limbs are brought into play. The result is an increase of the circulation throughout the whole body. This, however, does not correspond to the degree of local physiologic effect that is produced when these same groups are exercised separately. We thus see the primary indication for the use of pulley-weight machines. They are excellent to **develop weak parts,** to bring into activity muscular groups that for some particular reason are behind their fellows. It is possible in connection with the various attachments of these pulley-weight machines to exercise almost any of the larger groups of muscles of the body and limbs. By taking them in rotation, all the muscular groups may well be exercised in succession.

There is, however, another way in which these machines may be used with a resultant effect that is quite different. In using a dumb-bell advantage is taken of the downward pull of gravity to furnish work for the muscles. In the same way exercises of a general character may be done with these pulley-weight machines, the difference between them and the dumb-bell being that with the former the pull is lateral instead of vertical. A ten-pound dumb-bell is equivalent to a ten-pound weight on the end of a rope, but in the case of the pulley-weight the pull is

FIG. 74.—PARALLEL BARS.

exerted in a horizontal direction. This fact may be taken advantage of in altering some of the muscular leverages of the body by one of the so-called 'chest-weight' machines. These are pulley-weight apparatus in which the handle is approximately at the height of the shoulders. Let a person stand sideways to one of these machines and take the handle with the proximal hand, pull it to the floor, extend it along the floor as far away from the machine as possible, then lift the handle as far vertically as possible, and ultimately let the handle come back to its original position. In this we have a movement as general in its effect upon the muscles involved as any done with the dumb-bells. The effect upon the muscles of the trunk differs, however, in that the effort involves far more of a lateral pull than when it is merely gravity that is being resisted. Such an exercise is not a movement of muscular isolation, and it therefore produces the general effects of exercise upon the body and its organs. There are, moreover, mental reasons for the use of such apparatus. Many patients require that something shall be done which appears impressive. The power of **suggestion** is most potent even in the attainment of physiologic results from exercise. (See also volume VIII and volume X.)

One of the most common difficulties in connection with the use of these machines is the tendency of most individuals to stand with the thorax in an unphysiologic position while going through the exercises. In prescribing such exercises particular attention must be given to this point. The spine should be kept rigidly erect, with the thorax in the so-called active position.

The use of pulley-weight exercises appears to be but slightly expensive from the neural standpoint, far less so than more complicated exercises

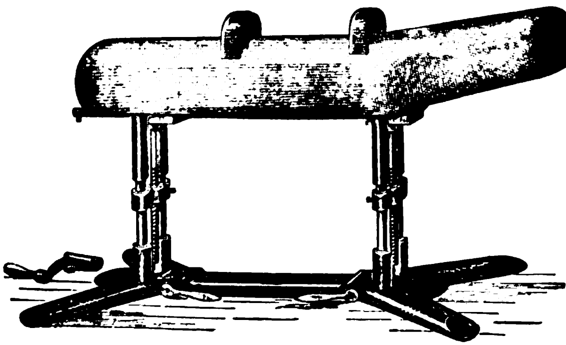


FIG. 75.—GERMAN HORSE.

requiring less muscular effort. This indicates one direction of their usefulness. Business or professional men wishing a general exercise, or one preliminary to general exercise, may be given a series of movements that shall in quick succession exercise the chief muscular groups of the body, and thus prepare them gradually for more vigorous exertions.

4. Heavy Gymnastic Apparatus

It is somewhat difficult to characterize the whole subject of apparatus work, as it varies not only with the kind of apparatus used, but also with the way in which it is used. In general we may say that the object of the apparatus is to afford a stationary support or base of operation for the body. Gymnastic work is thus in contrast with calisthenics, in which the apparatus is moved while the body remains relatively stationary.

Let us examine, first, apparatus exercises in which the individual is engaged for from ten to twenty seconds continuously. During this time the weight of the body is supported almost continuously by the arms. On the rings or horizontal bar, or suspended ladder, the arms are largely overhead; on the horse, or low bar, the arms are held downward; but in both cases the weight is supported from the shoulders. It is the general agreement that such exercise persisted in continuously for a long time leads to enlargement of the shoulder and strengthening of its ligaments, limitation of the freedom of its movements, and the pronounced development of the flexors of the fingers so that the latter are usually held in an almost flexed position. Referring back to one of our original propositions, that **function makes structure,** we see that the supporting of the weight of the body with the arms has resulted in so changing the shoulder-joint as to make it better adapted for the handling of the weight of the body, in this respect becoming more like the hip-joint. If we admit that each part of the body should be exercised in accordance with its natural function, we should condemn such exercises; for the arms have been developed through the handling of objects other than the body. In their natural state the muscles of the arm and chest are competent to hold the body temporarily, but not to do the work demanded of them in heavy gymnastics.

If, now, we use the apparatus somewhat more as an obstacle to get over or around than as something to rest upon, each exercise lasting but a second or two, we shall change the character of the work, and shall overcome the difficulties referred to. It is perfectly physiologic to have the arms support the body for a moment, as in vaulting or climbing, in which the arms and legs are used alternately. This brings us to the **desirable type** of apparatus work, which affords variety without lessening the general effects of exercise. The result is obtained by a larger number of exercises of a more moderate character. Lifting a weight with the two legs is as much exercise as raising it with one arm. The same number of foot-pounds of energy is expended in the two cases. When the weight is raised by the legs, large masses of muscle are used—the work is thus done easily; when it is done by one arm, comparatively small masses of muscle are engaged, hence it is done with difficulty. It is not to be understood that exercises involving more than momentary support by the arms should never be used. An individual who has worked for a year or two will naturally develop in accordance with the growth of his own strength and aptitude. A man with small hips and light legs will do readily what a man of different build could not accomplish without unwise straining. In general, however, more substantial and better results, especially as to the heart and lungs, are achieved by quick apparatus work with momentary arm support than by exercises under the opposite conditions.

5. Track and Field Sports

Actual competition differs much from training. That which I shall speak of now is the result of the exercise that a man gets who practises moderately. Track and field sports correspond to the more elementary activities of savage life—running, jumping, throwing, and the like. They involve psychic characteristics that differentiate them from gymnastics. There is a joy in doing them that is not usually found in gymnastics.

The quantity of exercise to be derived from any given sport is so limited that sports do not appear to be suited for general exercise. It is difficult for a high jumper to do enough high jumping alone to get general exercise out of it. The jumping is not interesting unless it is high enough to involve an effort in each jump. If it is so high as this, then it is more an exercise of will, co-ordination, and nerve-force than of muscle. A man coming from such exercises, especially when they have been extreme, will find his hands trembling, and will show other signs of neural rather than of muscular fatigue. It may be said that a man should simply make moderate efforts, that he should make none of the extreme efforts that call for the undesirable neural expense. The answer to this is that the formation of such habits is detrimental to the real contest; that the man who trains himself to run slowly will form habits of running slowly, so that he will never be able to run with greatest speed.

Training for **long-distance running** is an exception to much of what has been said about track and field sports. This sport calls almost exclusively for general, rather than for local exercise.

If a man will run quickly through a variety of sports—jumping a little, putting the shot a little, pole-vaulting a little—and not try too hard in any one, he will get a good deal of exercise out of the pastime. But the number of men content to do this is small. Young men before they are twenty-five, who are in the period of final ripening of the neuromuscular mechanism, thoroughly enjoy the keen competition of these sports. For such individuals, it is my belief that the sports themselves are beneficial.

6. Games

It is not possible to characterize the physical activities of games as a whole. They vary from the intense labor involved in football to the almost exclusively intellectual occupation of chess. We are not now concerned with the more intellectual games; we have to do with those which involve muscular power. The amount of work that can be done without fatigue during games is astonishing. This is especially evident when one considers the fatigue that results from the same amount of muscular work done under the immediate control of the conscious will.

Basket Ball.—There is no game that demands more varied and constant muscular exercise than basket ball; hence, we must note its qualities. The muscular work demanded by basket ball is varied; the large muscles of the back are contracted frequently in stooping; the muscles of the abdomen are exercised vigorously every time the individual starts to run; the arms are in constant motion handling or endeavoring to handle a light object, occasionally in defending the body from running into a piece of apparatus; the legs are in constant and varied activity, and there is great call for action of the heart and lungs; there is much agitation of the abdominal organs. In these respects, basket ball is an ideal exercise. The game has a minimum of local effect. We rarely find muscular groups built up by basket ball, although the game calls for the activity of nearly all of them. It does put them all in a condition of vigorous functioning ability, but it does not usually increase tissue. It does increase the power of the circulatory and respiratory apparatus. The game, when played under conditions of intense competition, involves a strain on the attention, exceedingly rapid starting and stopping, so that the neural expense is great; it is here that basket ball experts chiefly suffer. Before a person is able to play well enough to be a member of a team in which there is intense competition, he has played for a sufficiently long time to become somewhat habituated to it; still the nervously exhausting effects are common. It should be recalled that the game is expending these efforts in lines to which the race, if not the individual, is accustomed; and that accordingly nothing like the same effect is produced by an equal degree of concentration here, as it would be if spent in other lines. This point is important, but has possibly not been much considered heretofore. The same degree of concentration and effort directed in most other lines would quickly exhaust the individual. Even in basket ball few persons are able to stand two intense games a week.

When the game is played rapidly, the organ that is the most overworked appears to be the heart, and it is doubtful if this difficulty can be obviated without altering the game as a whole. Allowing one minute's rest for every five minutes of play might help, but even here the absolute quantity of work done by the heart remains the same. For a person who shows any sign of nervous exhaustion, the intense competition of any such game as basket ball must prove unqualifiedly injurious. If we remove the more intense competitions, and use more of the recreative element, we achieve an excellent physiologic, neural, and psychic result.

This discussion of basket ball may perhaps serve to indicate the **general characteristics of useful games,** and the way in which one can arrive at conclusions in regard to their usefulness. The following questions answered about any given game will give useful information:

Does it involve frequent contraction of the great muscular groups of the body? Does it demand moderate efforts? What are its effects upon the heart and lungs? Does the game keep the chest in such a position as to interfere in any way with the functions of circulation and respiration? Are the various series of contractions intermittent, so that the muscles have time to recover their tone, and are not overcome by fatigue? Is the danger of competition such as will lead men to excessive expenditure? Are there any parts of the body that are so called into action as to render their development excessive? Is the game adapted to the stage of life of the individuals for whom it is designed?

7. Wrestling, Boxing, Fencing

Putting these exercises in the order of muscular strength, and the inverse order of skill demanded, we say, first, wrestling; second, sparring; third, the various forms of fencing. Actual work in any of these three is so dangerous, and accidents are so common, that only practice or training, as distinguished from contesting, is to be considered as available for exercise.

Wrestling is so much a matter of weight as to be done always in classes, and it is but rarely that a man of one class is fitted to compete with those of a heavier class. The individual efforts are great; they follow each other rapidly, and the exercise therefore violates some of our fundamental laws. It may not, however, be at all out of place to have wrestling movements done in pairs in gymnasium work, no throws being allowed on the floor, holds and breaks alone being counted. The great interest that most people have in these exercises is evident to all. It is to be explained upon the hypothesis of their importance from the racial standpoint. No other exercises are so likely to be associated with anger, because, I suppose, anger was associated with fighting in the beginning; and it is only one of the achievements of modern civilization that a great battle can be fought without personal animosity between those in charge.

Sparring.—Anger has been associated with fighting so long that one instinctively comes into a state of mind of belligerency and readiness for anger even when practising sparring. Sparring demands more from the nervous system and less from the muscular than does wrestling, although both of these demand much from the heart and lungs.

Fencing demands a maximum from the nervous system, and not a great amount from the muscular system. The thighs are held in a position that is fatiguing, more from holding the positions than from the active exercise involved. This static contraction of muscle is far more expensive than contraction with relaxation, because it demands the steady innervation of the groups involved, as well as because it does not favor the circulation of the blood and lymph. Those who fence much acquire a more or less marked scoliosis, a lowering of one shoulder, and an undue development of the fencing arm. The attention must be held in fencing as in no other exercise. It must never for a moment be relaxed. The movements must respond with the greatest speed to the direction of the will. Thus, we get the maximum of neural expenditure with a comparatively small amount of muscular work. This does not appear to obtain in practising the **single-stick** drills and other exercises, which are really calisthenics done in the form of fencing, but appear to be more interesting than most other forms of calisthenic exercises.

Thus, with reference to track and field athletics as well as these three combative exercises, it may be possible to secure gymnasium work from them that shall be definitely interesting and valuable on account of the psychologic setting of these activities in the history of the race.

8. Bicycling

So soon as the wheel has been thoroughly mastered, riding becomes largely an automatic process. The chief labor is accomplished by the extensors of the thigh and leg. These being large groups of muscles, the circulation and respiration as well as the general nutritive activities of the body are stimulated, the acceleration being directly in proportion to the number of foot-pounds of energy expended. Pursued at a moderate gait, and for moderate distances, bicycling is in many respects an ideal exercise. So soon as the speed becomes extreme, as with all other exercises, we find neural expenditure becoming great, for the motor centers must be consciously stimulated and the attention must constantly be given to the work itself. This is equally true when the exercise is unduly prolonged. When one becomes accustomed to the wheel, riding from ten to fifteen miles daily, at the rate of seven to eight miles an hour, over a good road, is moderate exercise. Riding more than twelve miles an hour even on a good road is rather severe exercise. Since the production of saddles that allow the weight to be sustained by the tuberosities of the ischium, objections that formerly obtained in regard to the wheel have been largely removed, and thus do not need discussion here. One respect in which walking and running are better than bicycling is that the trunk is agitated far more by the former exercises than by bicycling. Thus, circulation in the abdominal organs is stimulated more in the one case than the other.

9. Golf

One of the forms of exercise now coming into great popularity is golf. It needs no extended discussion, for its advantages and limitations are manifest from previous discussions. It involves considerable time spent out-of-doors, hence is exceedingly advantageous. It involves a large amount of walking; the attention is constantly engaged, and is thus kept from reverting to business and other cares. This is a great point in its favor. The exercise involved in it, while somewhat extended, is of a moderate character. It is thus evident that there are few exercises that afford such excellent opportunities for middle-aged men and for women of all ages, for whom more severe exercise would be out of the question. Its great advantage is that interest in it is maintained for years.

Horseback-riding

The peculiar effect of horseback-riding is due to the up-and-down motion of the horse, which agitates the abdominal organs. This is effective in proportion as the gait of the horse is hard or easy. The necessity for the balancing of the trunk while gripping the saddle with the knees, gives to the rider the general effects of exercise. In its effect upon the abdominal organs, notably the liver, we get marked results from horseback-riding. The gait most active therapeutically is, of course, the **trot**. There is a kind of delight that many persons take in this exercise that is in its favor, and must be borne in mind in ordering it.

Bowling

This is a form of exercise often exceedingly enjoyed by business and professional men, although not so much so by young men. Unfortunately, the ventilation in bowling alleys is usually poor. The exercise is moderate and in the main excellent, although it is of a somewhat one-sided character. I have failed to see any unfortunate results from bowling even when it is indulged to some excess. The interest in the game is such as to warrant its being used as a general form of exercise.

Rowing

Ordinary rowing in a row-boat differs markedly from the effects of rowing when it is done in a shell on sliding seat and at racing speed. In the former case, it may be classed as a general exercise of moderate severity, with particular effect upon the forearm, shoulders, and back. In the latter case it is an exercise of great severity, with chief effect upon the thighs, back, and forearm, and particularly upon the heart. For purposes of general exercise, this latter style of rowing may be left out of account. The one important point to be kept in mind in connection with ordinary rowing is that the back should be kept flat; for in this condition alone are the heart and lungs operating to the best advantage.

Relation of Physical Exercise to Age and Sex.—Let us now consider the application of the whole foregoing discussion in relation to age and sex. Let us follow the needs of the growing organism from infancy to old age, observing the place that muscular exercise has in each period. In general, it may be said that the importance of muscular exercise decreases with every succeeding year of life. The infant without muscular exercise would fail to develop fundamental physical as well as psychic qualities. All that is needed for the exercise of the infant is opportunity. Freed as much as possible from the restraints of clothing, the infant should be allowed to play freely for considerable periods every day. The instinctive play of mothers with their children seems to be an entirely rational process, an agency which through natural selection has tended toward the development, and hence the survival, of the young. The study of these instinctive mother-plays form an interesting commentary on the order of development of the child's neuromuscular system and his sense organs. They are, however, done by the mother without any conscious educational purpose.

Soon the play instincts of the child lead it into experimentation with all the objects at hand, and in all available ways. It will play with sand, with blocks; will run, will throw. The order of development of these plays is, in the main, a definite and logical one, from the simple to the complex, from central to peripheral movements. During the first six or seven years of life the child will take ample exercise if given opportunity to do so. All that is necessary is to furnish the implements. It is far better to have these implements of the kind that allows the child to exercise his own constructive instincts than to give him complete toys, such as railroad trains, wind-mills, and the like. No possible scheme of physical training can do as much for the child as his natural play; for his natural play is the result of selection working through the unfathomable ages of evolution. At about seven, games come to be of predominant interest to children, particularly games involving the element of competition. It is here that the various forms of tag are developed, such as 'cross tag,' 'prisoner's base,' 'black man,' and the like. Elementary games of ball, 'hide and seek,' 'duck on the rock,' games with marbles, 'leap frog,' begin to be attractive, and the child develops an interest in track and field sports. The care of land and the love of animals is accentuated during this period, and the instincts for hunting and fishing usually assert themselves. This period represents the ontogenetic acquirement of those capacities that precede the dawn of even barbaric human life. It represents a stage in which the individual depended upon individual combat for existence. During these years the physician will have to be careful that the number of hours taken for school work does not so encroach upon the hours of play as to render these racial achievements impossible. The boy or girl who has opportunity for the playing of games, who has a sufficient number of playmates, and sufficient space to play, will be found to develop suitably. Cities are being built up so compactly, however, that it is becoming necessary to make special efforts to get playgrounds. This is already being done in most of the large cities, and the movement will be favored by all who consider the organic requirements of the individual during this stage of life. Play is far more important for the child's development than formal school educational gymnastics during these years. Through these plays, bodily skill as well as vigor of heart and lungs is gained, and the muscles are called upon for constant and varied activity. It is true that they do not seem to have the logical development that can be found in systematic gymnastics, but I believe that this is only a seeming lack. If one considers the plays and games of boys and girls during an entire year, he will find a progressive and most complicated and elaborate scheme. It is true that during the marble season boys will play but little else than marbles, but the season is soon over. It is followed by top season, or kite season, or some other sport. These sports have a seasonal rotation, and occur every year with more uniformity even than the seasons. The time for marbles or tops can be predicted with far more accuracy than can the arrival of robins or the advent of spring. If one looks at the range of sports covered in this methodically haphazard fashion for a year, it will at once be evident that the curriculum of sport is a rather complete one. It will be evident that the child during the year has had exercises for skill of hand, quickness of eye, the development of the muscles of the trunk as well as of those of the limbs;

that heart and lungs have been given vigorous training; and, in fact, the whole organism has been called into play in a way that is entirely impossible by gymnastics. We have already seen that gymnastics deal largely with the chief muscular groups. The neuromuscular plays of boys and girls include not only all the muscular combinations developed by gymnastics, but the finer muscles of the hand, of the face, and of the larynx as well. Play also includes an emotional development and a training of the will; it involves self-control and the development of those instincts of competition and self-reliance which are basal to the development of character. Gymnastics seem more logical, but are in reality far less so.

The human embryo in coming to term, passes in gross outline through the life-history of the race from the amœba up. Conscious human guidance is not only unnecessary but would be injurious in the endeavor to guide the development of the cells. The developing embryo does not start directly toward the adult human form. It pursues a most circuitous route. This is equally true in regard to the child's development after birth. Nature's forces are competent to lead to the full development of the body whenever they are given the opportunity to do so. One element that must be conserved by human consciousness is the environment favorable to play which civilization constantly tends to remove. Human society has developed far more experience than has become incorporated in the neural structure of the individual. Thus, conscious education in matters that relate to elements learned during the civilized life of the race must be taught by society, and schools are therefore a necessity; but the basal elements of education—the development of the body, of the feelings—may be trusted wholly to nature. She needs but the opportunity. The embryo of the chick is enveloped in the shell. In many respects it would be fortunate if the play life of the child could be similarly enveloped in a shell, so that civilization could not take away that which has been its means of development from time immemorial. City life is bringing large numbers of children close together. This is in itself not wholly normal; hence, there must be a kind of supervision of plays to prevent the evil effects of such undue crowding. This, again, merely represents the effort to supply nature with her customary environment.

Approximately at puberty, interest culminates in the great Anglo-Saxon sports of **baseball, cricket, hockey, shinney, basket ball,** and the like. These great games are played in teams in which the individual is subordinated to the whole. They represent a later evolutionary stage than do the games of the preceding period, which are individualistic.

They are interesting to the physician because of their physiologic character. They represent the extreme form of muscular exercise—extreme not only with reference to individual efforts, but extreme in duration. The extreme example is found in **football.** Not only does each individual make many efforts of as powerful a nature as possible, but he makes them rapidly, so that a rare degree of endurance is demanded even in an ordinary game. A man without special training cannot play even four or five minutes without becoming sore. It is my opinion that these extreme forms of exercise are related to the final toughening of the individual for the achievements of life. They represent the final ripening of the muscular system and its development into full functioning ability. They represent also that development of the large motor centers of the brain which is certainly related to the capacity for continued severe intellectual labor during subsequent years. In the light of its immediate effects, I do not believe that football is justifiable. In the light of its relation to the development of power, I believe that it is justifiable where it can be suitably controlled and limited; but many individuals have attained these same effects through severe manual labor on the farm or in the shop without the physical or psychic dangers attending certain phases of football play. It is only fair to add that an analysis of football accidents shows that they are in the main due to (1) playing when one is not in training; or (2) allowing boys to play against those notably heavier than themselves; or (3) allowing those to play who are too young, too slight, too weak, or too awkward. Mass plays and tripping always involve some degree of danger. In some way, however, every adolescent ought to do muscular labor of considerable severity for a considerable period. Is it not interesting to note that these severe exercises are brought about instinctively by nature through the tremendous interest in athletic sports during these adolescent years, and that these activities take the general form of the combats of savage tribal life?

After the age of twelve, it will be necessary for the physician in many cases to order **special exercise.** The intellectual life is commencing to be of dominant interest to boys and girls. Public opinion, as well as the lack of opportunity, may prevent them from gratifying the instincts which, as we have seen, lead to bodily development. The physician will often have to say that the boy or the girl must be given opportunity for exercise. Out-of-doors exercise is best, and it should be more or less in accord with the native interests of the period. Camping out in primitive style, with hunting and fishing and many other savage occupations, seems to be an ideal form of physical life. But that which is most desirable is usually least possible; it often happens that for lack of place and time the individual cannot take advantage of the natural instincts. Under these conditions, what is to be done? The individual must work in a gymnasium. Under what conditions will the best results be attained? How may the exercises be so ordered as to bring the greatest advantage to the individual?

This brings us to the consideration of the characteristics of gymnasium work when done predominantly from the standpoint of health.

CHARACTERISTICS OF HYGIENIC GYMNASTICS

1. **The day's exercise should begin and end either with work for the smaller groups of muscles, or with graded work for the larger groups of muscles.** Thus, the heart and lungs are gradually led up to and away from the severest effort. The muscles themselves are not suddenly called on for their most intense work. This is the fundamental idea contained in the Swedish "day's order." It may be true that we terminate actual gymnasium work with the maximum of effort, as by a run, or a basket ball game; but it must not be forgotten that following this is the walk to the dressing-room, the bath, the rubbing down, the quiet dressing and sitting around, and the going about one's business. The entire curve showing the intensity of effort must take these details into consideration.

2. **Each part of the body should be exercised in general according to its natural function.** This refers to the quantity as well as to the character of the work. Thus, the great muscular groups of the body should do a large amount of hard work. The heart and lungs should be called on for activity, the arms and shoulders should be called on for skill and quick work, the legs for power and endurance. As the individual advances in strength and power from year to year, more and more weight may be handled to advantage. This is the normal progress of individual growth and development, and no absolute standard can be fixed. While in the individual unaccustomed to exercise, the body should not be supported by the arms for any length of time, the same caution does not necessarily apply after one or two years of effort. In most cases this prohibition would take away work on the high horizontal bar from the first year.

3. **Each individual muscular effort should be well within the capacity of the performer.** It not only should be absolutely moderate, it should be relatively moderate. That which is moderate for a strong man would

be excessive for a weak man. For a man who has just come to the gymnasium moderate work would be needed, which would be absurdly insufficient for a man who had done a year or two of work.

4. **There should be a large number of individual exercises. Thus, the sum total of the work done may be considerable.** The stronger the person, the stronger the effort that he can make to advantage. It is thus important in invalids to begin with minute doses, and to proceed by steadily increasing stages toward work that will demand and obtain the larger activity desired. Again, the individual thoroughly accustomed to exercise will derive but little benefit from such minute doses; the doses must be adapted to the degree of strength and habituation of the individual.

5. **So far as possible, the exercise should correspond to the psychic needs of the stage of development of the individual who is exercising.** Thus, the needs of adolescents are not the same as those of business or professional men. The fundamental psychic characteristics of each group must be constantly kept in mind. The play of adolescents represents great needs that cannot safely be ignored, as they are intimately associated with the deepest interest of the individual. Whenever it is possible to introduce simple elements of competition with adolescents, it is well to consider the advisability of doing so, as this is the natural period for competition, and the great interest that is aroused in contests should be jealously guarded.

6. **It is important that exercise be considered constantly with reference to the position of the trunk.** For this great lesson we are indebted, as already stated, to the Swedes. We cannot afford to play games or do exercises in which the trunk is thrown into a position that embarrasses the heart or lungs. The organic functions of respiration and circulation are too important to be interfered with in any way. It must be remembered that the body tends to assume during rest the position it took during exercise; and we must constantly endeavor during exercise to keep the trunk, the ribs, and the spine in that position which we wish them to maintain all the time.

7. **The degree of memory and attention demanded from the pupils should be minimized.** Thus, they should not do much work that demands the committing to memory of long series of exercises. The teachers should constantly do the remembering for their pupils, teaching the exercises by example rather than requiring the pupil to remember them. The rest of two or three seconds between the movements of the dumb-bell drill to observe a new exercise is beneficial to the heart, which beats rapidly during such work in most individuals. The degree of attention

demanded should be enough to keep the mind from other work, and yet should not be of the strained or voluntary character that is demanded in following intricate calisthenics.

School Gymnastics

In this connection it is well to consider briefly the characteristics of such school gymnastics as should be universally introduced. We have already seen that the normal development of the body may be left to nature if a suitable environment be provided. The demands of school life are that children shall remain measurably still for five hours a day, most of the time seated at a desk. In most schools the desks are not adapted to the length of the spinal column and of the arms and legs of the individual, so that unsymmetrical sitting postures are constantly assumed, and growth of the body is correspondingly unsymmetrical. The constant sitting still deprives the muscles of that activity which we have shown to be natural to childhood. By insisting on quiet, we have interfered with nature in two ways: first, by taking away a great deal of time that she usually gives to exercise; and, second, by keeping the child for long hours in a more or less unnatural position. The aim of school gymnastics must be to remedy these two alterations of the environment which are rendered necessary by the demands of civilization. This combating of the effect of the school desk upon the body can best be done by a few minutes' vigorous exercise of the large groups of muscles at frequent intervals. Except when the ventilation in the building is perfect, the windows should be opened at the end of every hour and the pupils should all be given vigorous exercise for two minutes. These exercises should be especially directed to the maintaining of a correct carriage and to the vigorous exercise of the large muscles of the back and thighs. There will naturally be introduced accessory movements of the arms and legs to add variety and increase the interest. The essentials of school gymnastics are correct carriage of the trunk and exercises calculated to strengthen the back and thighs. This will involve increased cardiac and respiratory activity. Such a scheme of exercise as this does not involve difficult exercises nor expert teachers; they can be carried on by the regular teachers. They do not make a very heavy demand on the time given to definite intellectual achievement.

On the other hand, the attempt to secure by school gymnastics complete motor education must fail because of the limited time that under the best of conditions can be given to gymnastics during the school period, as well as because of the limited range of material available as compared with that available during play. The complicated motor development which forms the basis of later skill in life, even including that of an intellectual character, comes chiefly through the development of the hand, lips, tongue, and larynx. The development of the hand, as shown by Dr. Seguin and others, is of the greatest importance; hence, in motor education, manual training, Sloyd, marbles, work with jack-knife, tools, and machinery,—all seem to have a definite and important place. They are basal to education in the individual as they have been in the race. The object of school gymnastics is to combat the effects of long sitting at school desks. For true motor education, we must depend on play and manual training. Children out of school hours must be given full opportunity to play. In school they must be given opportunity to combat the special conditions presented by sitting still at the school desk. **Scoliosis** is far more common among girls than among boys. It is rarely found among those who have a fair degree of muscular development of the back. Such simple school exercises as we have proposed will in my judgment largely prevent scoliosis in the developing child.

TRAINING MEDICALLY CONSIDERED

It is no part of this treatise to consider the general subject of training from the standpoint of the athlete. We aim to consider those conditions with which the physician may have to deal. The subject may be considered under four general heads: (1) The physical condition of the individual; (2) the special athletic habit that is to be formed; (3) the muscular power involved in the exercise; (4) the endurance demanded. In training for any object whatever, these four points must be kept constantly in mind. Each of them will affect markedly the character and quantity of the work that the individual should do.

1. **Condition.**—It occurs frequently that an athlete is overworked so that there results a condition technically known as 'staleness'—*i. e.*, the expenditure of the body exceeds the income. The income of the body is related not only to the amount of food ingested, but also to the capacity of the several cells of the body to convert this food into active protoplasm. The individual can always eat enough if the food is available; but all individuals sooner or later find a limit to their capacity of converting food into protoplasm. I do not know what the nature of this limitation is, but believe it to be fundamentally a neural one. This condition of staleness will come far more quickly in some persons than in others. Its first premonitory sign is a decrease in weight. Less buoyancy is felt; work is less enjoyable; each effort takes a greater exertion of

the will. This matter of condition is one of supreme importance from the medical as well as from the athletic standpoint. Every athlete should come to his contest at the very summit of his ability and feelings. This he cannot possibly do if he is overworked. Good feelings are indicative of good strength. The slight extra degree of skill that can be secured by excessive training will never compensate for the loss that comes to the one who is overtrained. If the overtraining is serious, break-down may result; boils are apt to form, and diarrhea sometimes sets in. In former days athletes were far more apt to be overtrained than they are at present; but even now nervous men are prone to be overtrained. One should do every day a little less, rather than a little more work than he can recover from at night. It is a common error of beginners to do all that is possible every day, and to endeavor by force of will to make up for lack of condition. Day after day they force themselves through the exercises that have been laid down for them, even though the muscles remain sore, and they feel increasingly disinclined for the athletic work.

A man should feel like doing his work. He may overwork in two ways: by doing so much in one day as to demand several days for recuperation; or, more commonly, by doing each day a trifle more than he ought to do. In the latter case he adds each day a trifle to the fatigue, and soon comes into a state in which he is liable to colds or any disease that may be prevalent. His whole system is in a condition of depleted vitality. He has but little power of resistance either to unfavorable environment or disease. Overtraining is rendered more probable when emotional or mental strain is added to physical work. It is a common and advantageous practice for the athlete to refrain almost entirely from severe exercise for one, two, or three days immediately before a contest; he thus comes to it with the greatest degree of freshness and vigor.

2. **Habit.**—In every athletic exercise a certain degree of skill is demanded, the acquisition of which consists in the formation of certain habits. A man will never do his best in any sport until he has learned to do it unconsciously, until he is able to put his whole attention into the muscular effort. In the running high jump, for instance, so long as a man has to pay attention to getting the right step, to making the spring from precisely the right spot, to turning his body at the critical moment, he will not jump high. When, however, he has learned all of these points so that he does not have to think about them, he can put his whole effort into the jump itself. He will then do his best. His jumping must become largely an automatic process. His mind must be reserved for the effort itself. This formation of habits is entirely a neural process; it does not relate to strength. The habit is formed not by a few extreme

efforts but by many moderate ones. This illustration from the high jump is not unique; the same general truth underlies all sports. Even in such a matter as long-distance running, the gait must become automatic before the individual can do his best. An illustration of the way in which habits are formed may be taken from the sport already referred to—the running high jump. Let the stick be placed at such a height that it can be easily cleared by the athlete, and let him make this jump a large number of times each day. Eventually starting from a certain distance from the stick, the athlete will find that his feet come with automatic precision into just the right place and that his last stride will carry him into exactly the position for jumping. Gradually the stick may be raised, but it should always be well within the jumping ability of the performer. During the early part of the training, the endeavor to jump as high as possible will surely get the athlete into bad habits. What is imperative in the early stages is the formation of **style.** This can only be done by constant, persistent repetition. Gradually the athlete will be able to put in increasing effort, and thus to jump his best, and still preserve his style. It is the custom among the uninitiated to jump as high as possible every day. The bulk of the trials thus are at heights that are not cleared, with the result that the individual never is able to jump as high as he should and as he could learn to jump by the other method. These general principles apply to all branches of sport in which skill is required.

3. **Strength.**—The development of strength must follow that of habit. Strength, like habit, requires constant and persistent exercise, and is acquired by performing many moderate movements rather than a few excessive ones. The development of the muscle-groups involved in any given form of activity is achieved by the daily persistent exercise of that group rather than by occasional excessive exercise. In most athletics sufficient strength is acquired by practising the exercise itself; occasionally—as, for example, in throwing the hammer—special work can with advantage be given for the development of the back and the sides of the trunk.

4. **Endurance.**—This relates not only to capacity for long-continued exercises, such as long-distance running, but also for the repetition of a single exercise like that of high jumping, which must be repeated a great many times. It involves respiratory and cardiac capacity, and, equally with these, power from the motor centers. Endurance in long-distance running is most often found in those with long trunks. This I believe is related to the larger space afforded for the heart and lungs. Let us picture the central operations in a man beginning to run rapidly: the

large and powerful muscles of the legs, thighs, and trunk are contracting with great force and frequency. Steps are being taken approximately at the rate of four a second. Each step is about six feet in length. At this rate he is running 100 yards in 12½ seconds. The large muscles involved press the blood contained in the veins toward the heart, which in turn immediately contracts with greater vigor and rapidity, forcing a return current of blood into the arteries. The blood from the muscles is thrown into the lungs. The pulmonary capillaries are dilated a trifle more than usual, which limits somewhat the total superficial area of exposure to the contained air—a condition of temporary embarrassment supervenes, known as being 'out of breath.' The muscles of the legs soon ache, and the runner lessens his speed. The heart beats with increased rapidity, gradually a balance in respiration and circulation is restored, and the individual comes to what is known as 'second wind.' One of the objects in training is to make this preliminary process as rapid as possible. It is possible for most athletes to reach a state of training in which there is no initial embarrassment. The whole apparatus meets all the demands made upon it and operates with force and vigor until the motor centers are too much exhausted to permit of the exercise being continued. Such endurance is acquired only by practice. Generally that practice is best which is most nearly analogous to the exercise involved. In training for rowing, endurance is often acquired by running, because running demands less attention than rowing. If the individual rowed enough to gain all the endurance that is needed, he would probably do the latter part of it in a slipshod way. This would make toward the production of bad habits. There should be no rowing except when it is done with the very best possible stroke. This general principle of *doing exercises only when they can be done best* is an important one, and must constantly be kept in mind.

SYSTEMS OF GYMNASTICS

Up to this point we have been considering the general principles underlying the use of muscular exercise as a therapeutic agent. Let us now examine in brief the various **gymnastic systems.**

German Gymnastics.—In the latter part of the last century there was much interest aroused in educational circles through the work of **Gutsmuths,** who was a broad-minded, scholarly teacher of gymnastics. Early in this century, **F. L. Jahn** began a most active propaganda in favor of general physical training. He was a patriot and felt that the salvation of the nation depended upon the building up of a strong people, and in physical training he saw a major means to this end. His primary interest in physical training was a national or political one. He is known as 'the father of German gymnastics.' His work was largely based upon that of Gutsmuths. The exercises used and the apparatus devised were chiefly of the spontaneous kind: running, climbing, throwing, jumping, wrestling, sparring, swimming, were all vigorously practised. There gradually arose the pieces of gymnastic apparatus—the German horse, parallel bars, and horizontal bar. Teachers and pupils alike strove to invent new exercises. There was no special physiologic study of the effects of these exercises. The empirical result was seen to be good. A little later in the century a pedagogue arose by the name of **Spiess,** who systematized and classified all of these exercises, particularly all the exercises that could be carried on in the school-room. He is known as 'the father of German school gymnastics.' His influence has been profound upon the whole system of German gymnastics, removing them from the plane of natural and spontaneous exercise to the rigid observance of schemes and plans. The exercises were arranged with reference to their adaptability to the school-room rather than upon a physiologic basis.

In the middle of this century there was a considerable influx into this country of Germans—embracing political exiles and others—who maintained their individuality. They organized societies for the carrying on of German gymnastics, and the German **Turnvereins** of to-day are the continuation of these societies. They have gradually departed somewhat from the corresponding societies in Germany, but not in essential matters. Much emphasis is laid on exercises performed with various types of heavy apparatus. Thus, we see a great deal of work upon the horizontal bar, the parallel bars, the German horse, and the like, which when unwisely used result in the physique and carriage of the so-called typical gymnast: his shoulders are often pulled forward through the overdevelopment of the pectorals; his chest is not large but has large muscular masses upon it; his shoulders and arms are superbly developed, his legs only passably so. His carriage in walking or running is usually rather heavy. In all exercises involving the support of his own body by the hands he is thoroughly at home, while in running, jumping, pole-vaulting, boxing, wrestling, and particularly in exercises of endurance, he is uncomfortable. The gymnasium exercises of a given individual in the course of an evening's work are arranged primarily upon physiologic principles. The German Turnvereins have been more successful than any other organization, except the Young Men's Christian Associations, in maintaining institutions for the carrying-on of popular gymnastics. The character of their work is related to the German temperament—American young men do not usually remain members of their societies long. German gymnastics are essentially national in character; they involve patience and thoroughness, they demand hard work and continuous effort; but they do not seem to afford the opportunity for the kind of sport which is the national heritage of the English-speaking people. The German is almost exclusively individualistic in his gymnastics and athletics, while the Englishman and American go in very largely for team games.

Swedish Gymnastics.—Early in the century a man of rare scholastic ability, **P. H. Ling,** awoke to the importance of physical training, particularly, though indirectly, through the work of Gutsmuths. He eventually located in Stockholm, and worked out several different schemes of exercise. The one with which his name has been most prominently identified was a plan of exercises for schools—the so-called **Swedish educational gymnastics.** He also laid the basis for the Swedish movement cure, Swedish military gymnastics, etc. The groundwork for this scheme was physiologic. Exercises always follow each other in a definite order, the reason for this order being their effect upon the body in various ways. The plan is strictly progressive, the movements being arranged in groups in a sequence of difficulty. Thus, if we should put in ten parallel columns the ten chief groups of exercise, and arrange the exercises in each column in the order of their difficulty, beginning with the easiest and ending with the most difficult, the first exercise of each group would form the first day's exercises, the second day would be devoted to the second exercise in each group, the third day to the third exercise, and so on. Thus, each day would see an advance upon the preceding day, and yet the sequence of the exercises and their physiologic relations to one another would not alter from day to day. The curve of effort was studied most carefully. The pupils were all to be exercised in the regular dress of the school-room between two study periods; thus, they could not exercise sufficiently to make them perspire, which would necessitate a change of clothing. The exercises had to be adapted largely to the school-room. The biologic science of Ling's time was exceedingly crude; and for this reason, as well as on account of the characteristic of Ling's mind, much of his physiology is fantastic.

The **three essentials** of Swedish gymnastics are:

1. **The day's order,** which is the physiologic sequence of the exercises carried on each day.

2. **The gymnastic progression,** which is the sequence of the movements from day to day.

Of these two I have already spoken.

3. **The movements are always done to word of command,** and are not learned by imitation. The reason for this last point is that the will of the pupil may be wholly engaged, and thus better execution secured.

Ling intended, and most of his pupils have maintained, that these educational gymnastics form a complete system of physical education designed to bring all of the bodily powers to healthy maturity. From this standpoint Swedish gymnastics are not defensible, for they lay insufficient emphasis upon endurance, that capacity of heart and lung, which we have seen to be of great importance. Furthermore, they require the constant voluntary attention of the pupil, and are thus as far removed as possible from free play. It should be said, however, that Swedish gymnastics were never designed to take the place of free outdoor play.

The most modern authority on these gymnastics, however, has taken a far more defensible position in regard to Swedish gymnastics than have his predecessors. He maintains that the fundamental object of the school gymnastics is a corrective one, designed to combat the effects of the school desk upon the organism. He maintains that sitting at a desk four or five hours a day develops a tendency for the spine and shoulders to assume an abnormal position, and that Swedish gymnastics have their chief claim to consideration because of the stress laid upon the proper carriage and movements of the trunk. He also admits that Swedish gymnastics should lay no claim to be a universal plan of neuromuscular education.

The details of the day's order and of the gymnastic progression have also been modified in ways that the earlier teachers of Swedish gymnastics would have called radical. Whatever may be thought of these details of Swedish gymnastics, the following general conclusions will probably be accepted by most authorities:

1. That Swedish gymnastics do secure good carriage of the trunk; and that they are adapted to combating the evil effects of the school desk upon the pupil.

2. That they do demand close attention from the pupil, and hence must not be regarded as in any sense recreative in their character. They cannot take the place of play. They demand the same quality that study does—attention.

3. That they do not afford, nor is it claimed that they afford, a general plan of physical education.

English Physical Exercise.—In considering this different type of gymnastic exercise, we shall inevitably appear to place Swedish gymnastics and English gymnastics upon the same plane, whereas they cannot justly be placed upon such a plane. The German gymnastics are popular and universal. They are carried on not only in the schools, but by the German Turnvereins wherever German people are found; whereas the Swedish gymnastics are largely the product of governmental activity. There is a strong, new movement in Sweden for carrying on popular gymnastics; but the popular characteristics of these gymnastics are more like the German system than they are like the Swedish educational gymnastics. In England, on the other hand, the exercise is largely carried on not for the sake of the exercise, but for the sake of the sport. To be sure, there are gymnastic societies. For many years there has flourished in London a German Gymnastic Society, which has done splendid work, and there has gradually grown up a school of English gymnasts who follow the German lines very closely. There is also another group who have followed the Swedish principles, and are carrying on a more or less successful work.

For all that, the great bulk of the physical training carried on in England is not to be characterized as gymnastics at all. The English school-boy, with his long vacations and frequent holidays, improves his time not by gymnastics, but by athletics. His characteristic games and sports and exercises are running, jumping, throwing, wrestling, boxing, cricket, football, lawn tennis, hunting, fishing, horseback-riding, rowing, mountain-climbing, and so on. These exercises furnish conditions more similar to those under which the body was developed in evolutionary times than do the more or less artificial exercises of the gymnasium. Each part of the body is exercised in accordance with the way in which it is developed; the heavy work is done by the legs, work demanding speed and agility is done by the arms; the arms do not support the weight of the body for long periods as they often have to do in systems of gymnastics. It is true in theory that in the gymnasium all of these exercises—or at least exercises demanding similar qualities of body and mind—may be carried on; but as a matter of fact it is well-nigh impossible to realize this aim.

Thus, if we compare the typical all-round German gymnast with the typical all-round English university athlete, we find a real contrast. The typical English athlete is the man who has never given particular attention to muscular development of any kind. He is fairly strong, is erect and graceful. He is a fleet runner, and has splendid endurance. He rides horseback; can spar and wrestle. He has played his game of football, and has rowed on one of the many crews in his university. He is quick, hardy, can take care of himself in an emergency, is used to handling himself in a crowd. He cannot do any particular gymnastic feats with skill, nor is he much interested in them. During later life he will drop his active participation in most of the more strenuous sports; but he will ride, play golf, swim, row, and will always maintain a keen interest in these things. The typical gymnast who has worked for a period of years in a gymnasium has powerful arms and shoulders; the individual fibers of the muscles stand out prominently; he has a powerful grip. The muscles upon his chest and shoulder-blades are prominent. His chest appears large; but this may be due rather to excessive muscle than to the position of the ribs; the thorax is rather flat from repeated severe exertion of the abdominal muscles. The muscles of the legs are vigorous, but are light in proportion to the development of the shoulders and arms. He can do almost anything on the apparatus when suspended by his arms, but he cannot run for long distances, and is not graceful as a walker or jumper. He is not particularly interested in athletics; football he regards as brutal. He is not accustomed to handling himself in a crowd. All his exercises for years have been with reference to handling himself as an object rather than with handling other things or persons as objects. The fundamental difference between gymnastics and athletics appears to be that in athletics the results to be sought are objective, they relate to number—as to space in jumping, time in running, etc.; whereas, in gymnastics they relate more to the form in which the movement is done and hence are subjective. The athlete competes against time and space—the gymnast in self-control.

Delsarte.—The system of gymnastics which is known by this name is one of the most unsatisfactory to discuss that the teacher meets. Delsarte was a Parisian; his aim was to train the individual so as to be able to express the most fully by means of the body all emotion and thought. He devised no system of gymnastics, although he did have certain movements which, he maintained, aided much in securing perfect control of the body. Thus, his school is essentially a school of expression, and in no essential respect a school of physical training. Followers of his, particularly in this country, have taken exercises taught by himself or by his pupils, and have constructed from them a so-called system of gymnastics; and one of the most prominent has even gone so far as to teach a system of 'Delsarte for health.' The work done is good, the results are excellent; but in what respects they can be called 'Delsarte,' I do not know.

There has also grown up a school of **society gymnastics**—how to stand, how to sit, how to go upstairs, how to carry the arms and hands, how to carry the head and neck in the most approved style, etc. Much of this is excellent, but cannot rightfully lay claim either to the name of Delsarte, or to be a system of physical training.

Sargent.—The most original contribution to physical training that has been made in America is that of Dr. Dudley A. Sargent, of Harvard University. There had previously been in use in one or two places machines in which a rope passing over a pulley had a weight attached to one end and a handle to the other. Pulling on this handle in various positions was utilized as a means of muscular exercise. Dr. Sargent took this undeveloped mechanism, and differentiated a large number of machines adapted to exercising nearly all of the chief muscular groups of the body. The weight attached to the rope is made variable so as to be suited not only to the size of the muscular group to be exercised, but also to the strength of the one exercising. These machines have come into exceedingly wide use, and no American gymnasium would be considered complete to-day without some of them. Their usefulness seems to depend upon the following facts, already discussed more in detail: Muscles can be built up more rapidly when exercised separately than when large numbers are exercised together, for they can be better supplied with blood and lymph when exercised a few at a time. The use of the apparatus is not attended by danger of any kind; they are adapted as well to the exceedingly strong as to the exceedingly weak. The variety of exercise involved is considerable. By means of intelligent use of the various machines it is possible to develop nearly all of the muscular groups of the body, and hence many have maintained that this is a perfect system of physical training. But it must not be forgotten that the general effects of exercise are far more important than the local effects upon individual groups of muscles. A man may be perfectly developed in the way suggested and still have but comparatively little strength of heart or capacity of lungs, both of which are of more importance than great muscular development. Then, again, the development of muscular power in the way suggested does not aid particularly in the acquirement of those capacities for co-ordination—those acquired reflexes, that are so prominently demanded in athletic sports and that give to the individual more perfect control of his body. Those who have developed themselves to the full extent by means of these machines, having become the modern strong men of the college, are not as a class men who are able to use their strength either for continuous periods—such as distance running—or in ways that demand skill—wrestling, boxing, and the like. They have simply developed great power of individual muscular contractions.

The mistake of supposing such development to be an universal system has not been made by Dr. Sargent himself, for he is an earnest advocate of other forms of muscular exercise as well.

Emerson.—Mr. C. W. Emerson is one of those whose work is far better than was its formulation. Among teachers of physical training he is not recognized as an authority. His work is that of the head of a school of oratory. The aim of his scheme of gymnastics is to give to the individual control of the body. It is also claimed that in acquiring this control a superb carriage is cultivated and the conditions for health are actively maintained. His system consists of a comparatively small number of exercises which are repeated from day to day and from year to year. These exercises are all done without apparatus of any kind. The two principles upon which his work depends are not usually understood, for they have not yet been stated with the force which they deserve. He was the first one in America to emphasize the great importance of the **position of the trunk** with particular reference to the health of the contained viscera. He has long maintained, and his position has been sustained by modern investigators, that visceral prolapse to a slight extent is more or less common in all individuals whose chests are relaxed and whose abdomens are protuberant. He has shown further that the position in which the spine is erect and the ribs in the so-called 'active position' favors the return of the thoracic and abdominal viscera to their normal positions, and thus tends to restore their normal functions. The unscientific way in which this thought has been stated has prevented its author from receiving the credit for it which he deserves.

His other major thought is that a comparatively few exercises, all of which tend to give to the individual **control of himself**—poise, balance, and the like—and all of which also tend to put and keep the trunk in the best possible condition, are better than a far greater number of exercises which cannot be done equally well. He therefore says that the best progression in the physical training of the pupil is a progression in excellence in the performing of these exercises.

It is thus seen at once that Emerson's is not a general system of physical training. It does not aim at cultivating endurance nor does it achieve the general effects of exercise. It aims to give good carriage and graceful control of the limbs. These two ends are accomplished with considerable success, as many of his pupils will bear witness.

Young Men's Christian Associations.—During the last thirty years there has been gradually developing in the Young Men's Christian Associations of the United States, partly by the process of natural selection and partly by deliberate effort, a scheme of gymnastics specially adapted to the conditions which obtain in these Associations. They now have about 500 gymnasiums with upward of 100,000 active members. The general plan of exercise carried on in most of these gymnasiums is as follows:

1. The day's work begins and ends either with work for the smaller groups of muscles, or with gradual work for the larger groups; thus the heart and lungs are led gradually to and from the severest effort. In many cases the actual gymnasium work terminates with the maximum of effort, such as a run; but it must not be forgotten that this is followed by the bath and dressing, rubbing down, and the like. A curve that shall show the intensity of effort must take this into consideration.

2. It is the aim to exercise each part of the body in general accord with its natural functions. This refers to the quantity as well as to the character of the work. The arms are not allowed to support the body on the gymnastic apparatus for long periods at a time, and there is comparatively little of the so-called heavy gymnastics.

3. Each individual muscular effort is well within the ability of the performer.

4. There is a large number of individual exercises, so that the sum total of the work done may be considerable.

5. In so far as possible the exercise corresponds to the psychic needs and stage of development of the individual. Thus, the needs of adolescents are not the same as those of business men. Competition is deliberately and intelligently used in a restricted way.

6. Great emphasis is laid upon the position of the trunk. This is with special reference to the effects upon the contained viscera.

7. The amount of memory and attention demanded from the pupils is minimized. Thus, there is little or no committing to memory of series of long exercises. The whole trend of the work taught is toward athletics rather than toward gymnastics. Games are used exclusively. The gymnastics that are taught partake more and more of the character of athletics. Thus, on the parallel bars and the German horse few exer-

cises are used in which the body is supported by the arms, but many in which the apparatus is regarded as an obstacle to be overcome in various ways.

DANCING

A separate paragraph may be devoted to the subject of dancing, partly because dancing is the only or the principal form of active physical exertion taken by a comparatively large number of persons during certain months of the year, and partly because of the scanty recognition it has received from systematic writers on therapeutic exercise. Its abuses need not be dilated upon; its uses are to be recognized.

Dancing has from the earliest times been a considerable factor in the physical life of many persons, and its evolutionary and sociologic significance should not be overlooked. The pleasurable features of the exercise and the associated influence of music are no mean factors in its physiologic and hygienic effects. The dancing-schools have been efficient aids in teaching good posture of the body and grace of movement. Dancing itself, consisting of a very large number of movements of the larger groups of muscles of the body, is an excellent exercise from the physiologic standpoint. Heart, lungs, digestion, as well as muscular tissue, are all involved.

There is slowly but surely coming into our secondary schools and colleges a recognition of dancing as a bodily discipline. I refer not to society dances, but to the old folk-dancing, much of which involves bodily movements. This is excellent, and will enrich the physical training program, making it increasingly effective and at the same time increasingly interesting.

ADDENDA

ORTHOPEDIC APPARATUS; CORRECTIVE MANIPULATIONS; PHYSICAL METHODS USED IN OPHTHALMIC THERAPEUTICS

ADDENDA

ORTHOPEDIC APPARATUS; CORRECTIVE MANIPULATIONS; PHYSICAL METHODS USED IN OPHTHALMIC THERAPEUTICS

ORTHOPEDIC APPARATUS

BY JAMES K. YOUNG, M.D.,

PROFESSOR OF ORTHOPEDIC SURGERY IN THE PHILADELPHIA POLYCLINIC; CLINICAL PROFESSOR OF ORTHOPEDIC SURGERY IN THE WOMEN'S MEDICAL COLLEGE OF PENNSYLVANIA; INSTRUCTOR IN ORTHOPEDIC SURGERY IN THE UNIVERSITY OF PENNSYLVANIA AND ASSISTANT ORTHOPEDIC SURGEON TO THE UNIVERSITY HOSPITAL

So much prejudice against the use of orthopedic apparatus exists both in the public mind and among certain physicians that it is necessary to understand clearly at the outset the conditions indicating such appliances, their uses and their abuses. Improved surgical procedures, massage, exercise and corrective manipulations have, it is true, diminished, and may be expected still further to diminish, the necessity for resort to mechanical supports and correctives in the treatment of deformities. Nevertheless, apparatus still play a considerable part in orthopedics; either as temporary aids to more radical measures, or in some instances as remedial appliances, in others as necessary permanent palliatives. In the following pages brief descriptions will be given of those forms most commonly used at the present day, together with such simple directions as may facilitate their selection and application in suitable cases.

Orthopedic apparatus should either be ordered by the surgeon, or the measurements should be taken under his personal supervision, and the same care should be exercised in their selection as in the choice of any other surgical instrument. Instrument-makers should not prescribe for patients suffering from deformities. This is an evil practice that has grown out of the habit of some surgeons of referring cases to them without specific directions. Least of all should patients be permitted to select their own apparatus, as I have known to occur on more than one occasion. In a recent instance a lad of sixteen selected from a catalogue at an instrument-maker's a spine brace that took his fancy, and wore it for some time. He was suffering from traumatic kyphosis associated with lateral deviation, a combination of affections that would have puzzled an experienced surgeon, and which requires great care in the selection and fitting of a suitable apparatus.

The apparatus should be specially constructed for the patient and adjusted and readjusted when necessary; in no instance should the patient be fitted to the apparatus. As Hennequin remarks, "The apparatus, no matter what it be, is of no value unless applied by the proper person." It should be worn with a definite purpose and should be removed when its use becomes superfluous, and the surgeon should not neglect its frequent readjustment. Lightness, strength, and neatness of design should be studied by the surgeon in his selection of apparatus; and every effort should be made to improve the patient's personal appearance and relieve his hypersensitive mind by making the deformity as inconspicuous as possible. Those who do not come in contact with the deformed do not appreciate the keen mental anguish which these unfortunates suffer. It was this state of mind that led Gloucester, when bewailing his fate in his sad monologue in "Richard III," to exclaim,

> "Deformed, unfinished, sent before my time
> Into this breathing world, scarce half made up,
> And that so lamely and unfashionably
> That dogs bark at me as I halt by them."

To acquire the necessary skill to order orthopedic apparatus the surgeon must have special training, which is only to be had in institutions specially devoted to the care of orthopedic cases and equipped with an instrument-maker who does the work under the surgeon's personal supervision. The orthopedic surgeon of to-day should be thoroughly qualified in every department of medicine, and especially skilled in anatomy and general surgery, as well as in mechanics. This branch of surgery most nearly resembles ophthalmology. The oculist has to refract, perform operations, and treat diseases of the eye; the orthopedic surgeon has to fit appliances, and he also has to operate and treat orthopedic affections. The relationship which should exist between the manufacturers of orthopedic apparatus and the orthopedic surgeon should be the same as that which exists between the optician and the oculist, and I look forward with hope to the day when orthopedic prescriptions shall be filled by the instrument-maker in exactly the same manner as lenses are made by the optician according to the oculist's prescription. Orthopedic surgery is a specialty of recent growth as compared with ophthalmology, and those who practise it are encountering the same difficulties that were experienced by oculists a quarter of a century ago.

Orthopedic surgery has profited as much as general surgery by the signal advances in the technic and scope of surgical procedures made possible by the introduction of anesthesia and antisepsis, and even more by the recent development of the art of radiography.

Throughout this article the object will be not so much to treat the subject historically or exhaustively, as to describe and explain the uses and *raison d'être* of such apparatus as have been tested and approved by the most successful specialists in the treatment of bodily deformities. The principles underlying the selection of special apparatus will be given; but as the indications for their use would swell the article beyond the limits prescribed, the most suitable appliance in each individual case will merely be mentioned, the reader being referred for further information to treatises on orthopedic surgery.*

GENERAL DESCRIPTION

Orthopedic apparatus may be used with three objects in view: **retention, reduction,** and **ambulation.**

Orthopedic Materials

Many materials are available for the construction of apparatus, the most useful of which are steel, iron, aluminum, phosphor bronze, wood, plaster, hard rubber, and papier maché. Wherever possible the **finest steel** should be used, because it combines great strength with a minimum of weight; its use has reduced the weight of apparatus to ounces instead of pounds. The use of iron is responsible for the great weight and clumsiness of many appliances, and the term 'iron' used by the laity in derision is in many instances a correct appellation. This material has been used chiefly because it lends itself readily to manipulation and because there is less danger of the apparatus breaking while it is being fitted to the parts. **Phosphor bronze** has a very limited use; and **aluminum,** which promised so much at one time, has not been found available

* Young: "Orthopedic Surgery," Philadelphia, 1894.

on account of its brittleness. **Wood** is very little used except in the preparation of corsets and to reinforce plaster-of-Paris dressings. **Leather** in its prepared state is, next to steel, the most useful material. **Celluloid** and its different preparations are useful for pads and coatings, and for flat-foot springs, for which purposes **hard rubber** is also of great service. In the padding and construction of apparatus **chamois, blanket, hair cloth, cork dust,** and **curled hair** are used.

Mechanism

It is advisable, before describing the special orthopedic appliances employed in the treatment of individual cases, to give an account of the mechanical parts that enter into their construction. Of these the uprights, joints, stirrups, and bands are the most important.

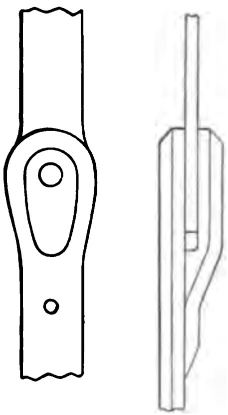


FIG. 76.—SIMPLEST FORM OF FREE JOINT.

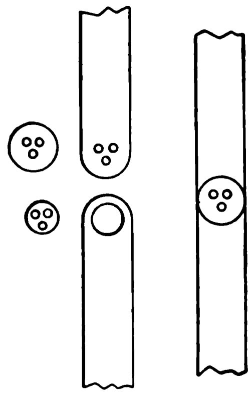


FIG. 77.—FREE JOINT—ANKLE-JOINT.

Uprights.—The uprights form the main part of all braces, being made of flat pieces of steel from $\frac{7}{16}$ to $1\frac{1}{2}$ inch (1 to 4 centimeters) wide and from No. 19 wire guage to $\frac{1}{4}$ inch (7 millimeters) thick. The outer edges of the uprights should be beveled or hollowed out, so as to diminish the weight without reducing the strength, and at the same time to add a finish to the brace.

Joints.—The simplest contrivance by which the parts of braces can be connected is a **free joint.** In its most simple form this consists of two pieces connected by means of a pin (Fig. 76) which permits motion in two directions, as on a hinge, but does not permit any lateral movement. Unless the two arms are strengthened in some way they very soon wear, and accordingly the method of constructing them in two parts, spoken of as the male and the female, is usually adopted. The female part is sometimes made in a separate piece and riveted to the upright; but it is better to have it forged in a solid piece with the upright, as this adds

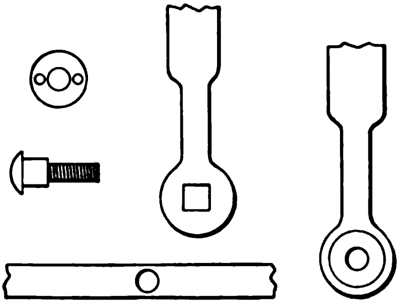


FIG. 78.—FREE JOINT—HIP-JOINT.

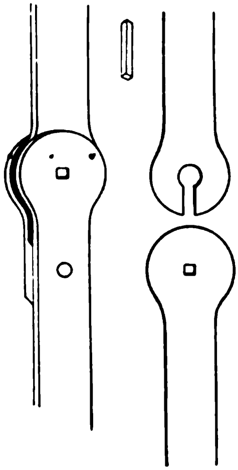


FIG. 79.—DETACHABLE JOINT.

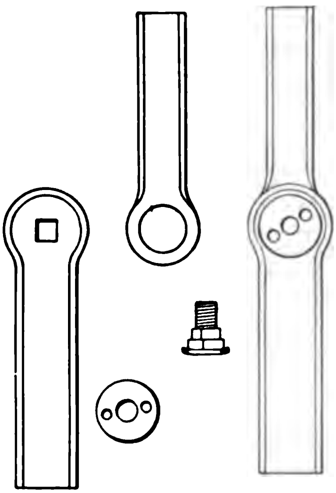


FIG. 80.—DETACHABLE JOINT.

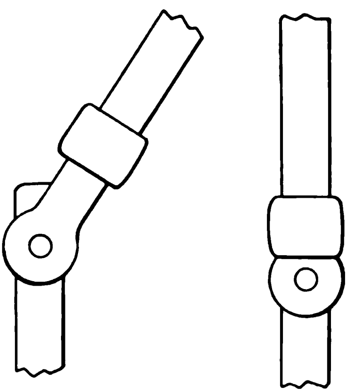


FIG. 81.—RING OR DROP CATCH.

strength and durability. Sometimes free joints are very elaborate in their construction, as when several pieces are used to make the joints more secure (Fig. 77, Ankle-joint, and Fig. 78, Hip splint).

Detachable joints can be attached separately or together at will. They are usually constructed on the principle of the French lock, so common in surgical instruments. The only serviceable forms of the many that are to be found in the market are those shown in the illustrations (Figs. 79 and 80).

The **ring** or **drop-catch joint** (Fig. 81) is the simplest in construction, and therefore less likely to get out of order than any other. It is designed to fix the articulation to which it is applied, so that greater pressure is exerted by the appliance, as in the case of bow-legs or knock-knee. The knee-joint is held immovable during walking, but bends when the patient sits down.

FIG. 82.—RACK AND PINION EXTENSION JOINT.

The **rack and pin extension joint** (Fig. 82) is a very useful device for setting the apparatus at a given point and securing it readily in that position, and for applying pressure or extension at a certain point, as in the Sayre knee splint, the Taylor long traction splint, and the Scarpa shoe for club-foot.

The **universal ball-and-socket joint** (Fig. 83), which permits movement in many directions, is used to advantage in appliances for torticollis and for cervical caries of the spine, as well as in the construction of some forms of the Scarpa shoe for club-foot. In its simplest form it is a free joint in the widest sense of the word.

Fixed Joints.—The term 'fixed' or **'stop joint'** is in a sense paradoxical, since the word 'joint' signifies movement and cannot at the same time mean its opposite, 'fixation'; but the term is commonly applied to certain mechanical devices for fixing or 'stopping' a free joint, such as a pin, which limits the movement at the point where it is driven in. One of the overlapping portions of the jaw may be removed, and the pin inserted in such a manner as to permit one-half, one-quarter, or three-quarters movement. When these joints are used in the construction of apparatus for club-foot to limit the movements in certain directions, they are sometimes spoken of as **equinus** or **calcaneus joints.** A free joint is sometimes converted temporarily into a fixed joint by cutting out a portion of the overlapping bar and inserting a screw or pin for a time. The pin may be introduced on the outside or upon the inside of the joint, but it is less likely to injure the clothing if it is introduced on the inside. The screw or pin may be taken out again at any time and the joint restored to its original condition. Special joints are also constructed in a variety of other ways, one of which consists in bending both bars of the apparatus backward; another method consists in fixing the joint by adding to the upper bar a segment so constructed as to limit the movement at the joint (Fig. 84).

Sector splints represent a variety of fixed joints. The simplest in construction is that used by myself, which consists of a semicircular or crescentic plate of steel fastened (welded) to the uprights of a free joint before the pin is inserted (Fig. 85). By means of holes bored at certain points the appliance can be adjusted at any desired angle.

The **Congdon joint** is a useful fixed joint which can be locked and unlocked at will by means of a bar passing across the front (Fig. 86). It is particularly efficient in cases of infantile spinal palsy when it is desired to fix the joint for locomotion and allow the limb to be flexed in the sitting posture.

Extension joints (Figs. 87, 88, and 89) in their simplest form consist of two overlapping pieces of steel secured with screws placed at intervals. They are usually added to apparatus in order to permit of extension as the child grows. The **abductor hip-joint of Shaffer** is a hinge-joint which permits of movement in one direction with limitation by a screw.

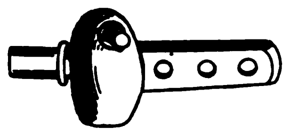


FIG. 83.—UNIVERSAL BALL-AND-SOCKET JOINT.

Stirrups.—Leg braces are attached to the shoe by means of stirrups. These are best made with a long tongue attached beneath the shank of the shoe. In some instances they are made separable from the brace, which can then be attached to different pairs of shoes. The best forms of detachable joints have already been spoken of in the paragraph devoted to joints.

Bands.—The bands of all braces should be very carefully fitted. At the upper part of the thigh they frequently have to be made sloping or beveled. Any difficulty experienced in fitting bands about the pelvis may be overcome by curving the band upward or downward, so as to fit over or under the crest of the ilium.

Springs.—Steel springs are used to apply traction or pressure, as for the correction of bow-legs and in certain deformities associated with club-foot. These springs should be made of the **finest tempered steel** in order to combine strength with lightness. **Toe-elevating springs** are used in cases of equinus. Springs are also used about the knee-joints and hip-joints in cases of flexion of the joints and in cases of false ankylosis and infantile palsy. The strength of the spring may be increased or

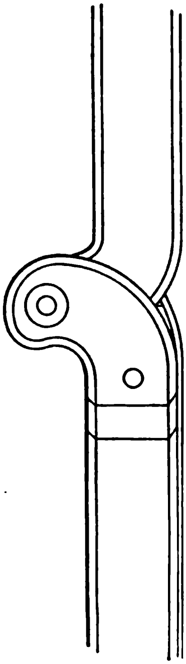


FIG. 84.—SPECIAL JOINT ALLOWING LIMITED MOTION.

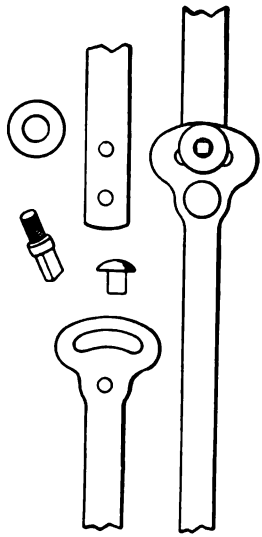


FIG. 85.—SECTOR SPLINT—SIMPLEST FORM.

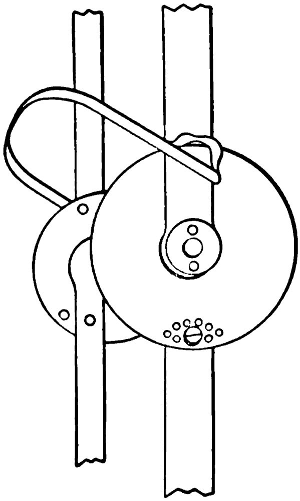


FIG. 86.—CONGDON JOINT.

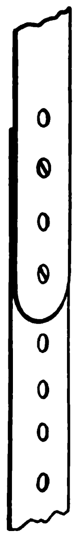


FIG. 87.—EXTENSION JOINT—SIMPLEST FORM.

decreased at will by bending; and as steel springs are more durable and less affected by age and climate than elastic bands, they are preferred by some surgeons. They are not so generally used in this country as might be supposed. **Spiral springs** are sometimes substituted for elastic webbing, as in the Gregory-Doyle apparatus for residual varus and for club-foot. For the latter condition the strength of the spring may be increased by means of a ratchet and key which brings the coils closer together. **Rubber springs** have been used very extensively in the treatment of paralytic deformities and when flexion is to be overcome. They consist of flat or round bands, and in some instances rubber tubing, attached by means of a chain to the apparatus, as in Sayre's club-foot shoe. Sometimes the bands are attached with catgut, as in the Willard club-foot shoe. Rubber muscles are used for the correction of torticollis.

Pads.—Pads of various sizes and shapes are used to **make pressure** for the correction of deformities. They may be round, oval, or square, and are attached to the apparatus in such a manner as to make pressure over the most prominent point of the deformed part. When pressure is applied to one part of the body, it is usually necessary to apply counter-pressure to the opposite side at one or two points. Thus, in the treatment of bow-legs, a large square pressure pad is applied over the deformity at the outer side of the tibia, and two smaller pads to the inner side of the knee and ankle respectively.

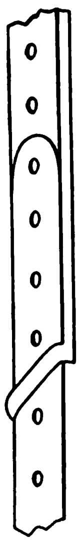


FIG. 88.—EXTENSION JOINT.

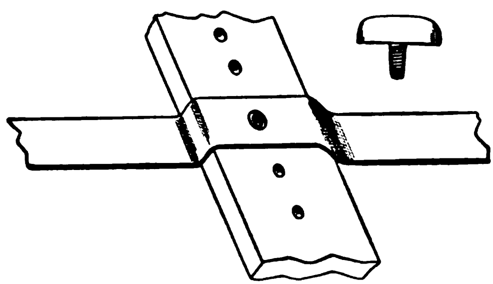


FIG. 89.—EXTENSION JOINT.

The manner of padding and covering of apparatus is important. The best material for padding is **blanket** or **felt** of good quality; and **leather** or **kid** is to be preferred to chamois for covering. The proper covering of apparatus necessitates a good deal of hand-work and therefore involves more expense, but the satisfaction of wearing well-made appliances well repays the buyer for the additional expenditure.

Buckles and Straps.—In leg braces the buckles are usually applied on the outside so as not to interfere with the other member in walking. The buckles should be of a good quality, and lacquered or plated to prevent rusting. Many different forms of sliding buckles have been introduced from time to time, but the old-time buckle with tongue has never been entirely superseded.

The **straps** should be of the best quality of oak-tanned leather; the strength may be increased by 'pounding' the leather on a piece of iron with a mallet.

The **webbing** used in orthopedic apparatus is the same as that used for military accoutrements. It is made of very **closely woven linen or cotton,** materials which combine great strength with lightness. Silk, leather, and other materials have at times been substituted for webbing, but webbing of good quality is much more satisfactory. Military webbing can be bought in different widths varying from ½ inch to 2 inches (1.5 to 5 centimeters). Webbing of very good quality, finer than military webbing, can now be obtained from dealers in materials for ladies' garments. In the best quality of military linen webbing the ribs run diagonally across the material.

Orthopedic Bandages

1. **Pressure Bandages.**—The ordinary roller of muslin or flannel is used for making pressure, for the application of hard fixed dressings, and for holding certain appliances in place. Silk elastic in the form of pads, which are usually attached by means of leather straps, is sometimes used for making pressure. The knee-caps and pressure pads used in the treatment of curvature of the bones may be made of the same material.

2. **Adhesive Plaster.**—Several different kinds of adhesive plaster are on the market, the best of which are **Maw's moleskin plaster,** manufactured in London, and **Shiver's swansdown plaster,** manufactured in Philadelphia. These are made of diachylon plaster spread upon heavy canton flannel, and the adhesive substance is so bland that the dressings may be worn from six to eight weeks. These adhesive plasters are used for making traction in the treatment of joint diseases. For this purpose they are cut like a many tailed bandage, which can be applied to the part in the same manner as a Roman sandal (Fig. 90). The adhesive plaster dressing is held in place with a muslin roller bandage.

3. **Couch or Bed Bandages.**—Couch or bed bandages are usually

applied in the form of **slings** or **pads** for the purpose of making pressure. They are employed for lateral curvature and sometimes for the treatment of hip-joint disease when lateral traction is desired. The sling may be made of leather or canvas well padded and so applied that the weight of the body makes counterextension. The sling is applied to the most prominent part of the deformity so that the body rests upon it, the upper and lower portions of the body making traction by gravity.

4. **Hard Fixed Dressings.**—Hard fixed dressings are often used in orthopedic practice and may be made of plaster-of-Paris, sodium silicate, glue, wood, paper, gutta-percha or rubber, felt, and the like. It may be well to call attention to some of the points that are often neglected in applying plaster-of-Paris dressings. **Cheese-cloth** is at the present time found to be the best foundation for these bandages, and **White's dental plaster,** manufactured in Philadelphia, is the best material. The bandages are best preserved by wrapping them in paraffin paper and dipping the package in wax, after which it is wrapped in paper and sealed in a pasteboard box. This makes a convenient package that will keep indefinitely.

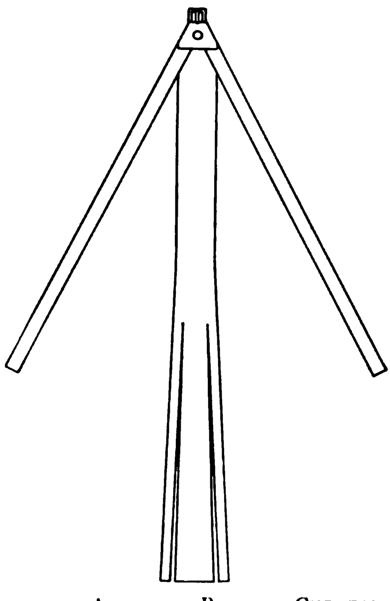


FIG. 90.—ADHESIVE PLASTER CUT FOR MAKING TRACTION.

In applying plaster-of-Paris bandages I now use cold water without any salt or alum, and find it very satisfactory. The plaster remains smooth, and the bandage does not 'set' too soon to admit of its being properly applied. While applying the dressing great care should be exercised to avoid pressure with the thumbs or other objects that would make dents in the plaster, which might afterward be painful to the patients. For the same reason all corns and callosities should be removed from the part to which the plaster is to be applied in order to avoid pressure pain.

The removal of the plaster-of-Paris dressing may be facilitated by laying a strip of soft metal on the cheese-cloth foundation before the plaster bandage is applied; but if plaster shears are used, this precaution is superfluous. The ease with which the dressings may be applied can be increased by the use of supporting stools, such as the 'dressing stool,' which is a modification of the Billroth plaster stool.

Sodium silicate dressing is used for fixing the part in its corrected position after operation, but is seldom used as a corrective dressing. After operations it is less satisfactory than plaster, because of the long time required for hardening. Cotton or gauze bandages are covered with the silicate by means of a brush, or the powder may be rubbed into the dressings with the hands. Over the silicate or 'water glass' dressing an ordinary plaster-of-Paris cast should be applied and allowed to remain for several hours, until the water glass has hardened. The waterproof qualities of the silicate make it useful for small children and in certain regions of the body.

Mensuration

Measurements are to be made with a **steel tape.** The diagram upon which the measurements are marked may be a sketch of the apparatus, or may consist of lines drawn upon an outline of the part. For leg apparatus the inside measurement only is taken, from the sole of the foot, at the point where the sole of the shoe would be, to the ankle-joint; from the ankle-joint to the knee-joint, if the apparatus is to be carried just above the knee; and from the knee-joint to the upper edge of the top band of the apparatus, if it is to be carried to the upper third of the thigh. If the body is to be included in the apparatus, both the outside and inside measurements of the thigh must be taken in order to mark the position of the hip-joint. The **points taken for the joints** are: the center of the ankle-joint, which is about half an inch above the top of the malleolus; the center of the knee-joint, which is best obtained by flexing the joint and marking the central point. The full length of the brace should also be marked on the order. The **circumference** of the leg should be taken above the calf, and at the junction of the lower, middle, and upper thirds of the thigh, according to the position of the bands. If the apparatus extends to the waist, the circumference of the pelvis should be taken at a point midway between the crest of the ilium and the top of the trochanter. The apparatus for a lower extremity is sometimes attached to a body apparatus, such as a brace or corset. The necessary measurements for this corset are the circumference of the pelvis, waist, and bust, the length of the apparatus above and below the waist-line, and the outlines of the curves taken with a lead strip.

Outlines may be made from measurements obtained with a lead strip —cyrtometer—or by placing the part on a sheet of paper and drawing the point of a pencil around it, the points where bands or straps are to be attached being marked at the same time. Such outlines are very useful in cases of knock-knee and bow-legs (Figs. 91, 92, 93, and 94).

The **method of taking outlines** of parts with the lead or tin strips is as follows: The strip is flattened out and then bent into the desired shape

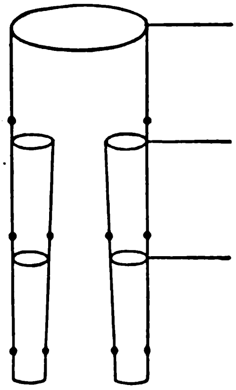


FIG. 91.—OUTLINE FOR MEASUREMENT OF BOW-LEGS BRACES.

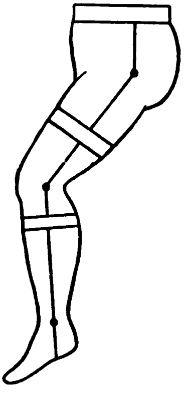


FIG. 92.—OUTLINE FOR MEASUREMENT OF BOW-LEGS BRACES.

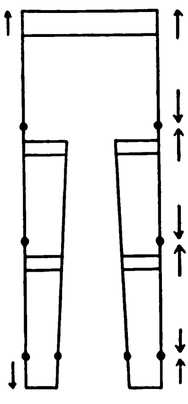


FIG. 93.—OUTLINE FOR MEASUREMENT OF BOW-LEGS BRACES.

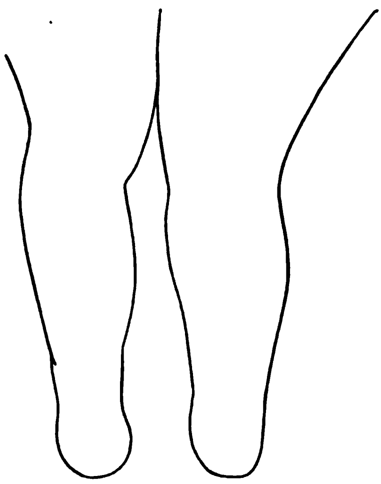


FIG. 94.—OUTLINE OF BOW-LEGS.

with the hands while it is on the body. It is then laid edgeways upon the paper, and the outline is obtained by tracing the inner edge. Outlines of the spine in cases of lateral curvature may be taken with the body in Adam's position. The lead strip is applied to the back at the lower angle of the scapula and carried from left to right, these points as well as the spinous processes being indicated on the drawing. An outline of this kind should also be taken of the lumbar region. In taking the outline for the Taylor spine brace the lead is applied longitudinally along the spine between the spinous and the transverse processes of the vertebræ. This tracing is made upon press board, which is cut out and applied to the same region for verification and record. The lead strip is always used in taking the outlines for the Thomas hip splint, the patient being in the prone position. The outlines of the posterior surface of the leg and body are taken just above the malleolus to a point on the level of the axilla or just below it.

In order to economize space the measurements taken for the individual braces to be described later will not be given in full. These are matters that cannot be learned from books, but must be acquired by actual experience.

Free-hand drawing is very useful in recording measurements, and a certain knowledge of mechanical drawing is essential in ordering apparatus.

In **measuring for shoes** the outline of the foot is always taken with the stocking on and the patient in the erect posture. To this are added the circumference of the ball, taken around the metatarsophalangeal articulation; of the instep, taken about the metatarsal joint; of the heel, taken about the greatest prominence of the heel and the highest point of the instep; and of the ankle, taken at a point six inches above the heel.

In ordering shoes for special cases it is always necessary to indicate whether the vamp or front part of the shoe should be high or low, and whether the shoe should be 'open to the toe.' For most special shoes a steel shank is ordered to strengthen the shank of the shoe, and this is particularly necessary when apparatus is to be attached to the shoe. For club-foot shoes a steel arch is ordered for the inner side of the great toe, about the position of the metatarsophalangeal articulation, in order to keep the foot from turning in. Sometimes an elastic strap is added to the shoe, as, for example, in the treatment of club-foot.

When the feet are very much deformed, special lasts have to be made, and great difficulty has been experienced in providing proper lasts for this purpose. The lasts should be copied from a cast of the foot, made by placing the foot in a special box and filling the box about one-third full; after this has hardened, the foot is removed, the partial cast is oiled, and the foot is reinserted and the box completely filled with plaster. A cast may also be made by placing the foot on the side and taking one half at a time; or by attaching oiled silk or linen thread to the foot before the plaster is applied, and then using these strings to cut the plaster before it has hardened. The last method is quite simple and is employed for taking casts of stumps of amputated parts for making artificial limbs.

Cork or other material is used for making one sole higher than the other, and should be built into the shoe at the time of manufacture; for, although a cork sole can be added to any shoe at a trifling expense, the result is not satisfactory. Special shoes are frequently ordered for painful affections of the feet, the painful portions being relieved by making depressions in the sole, or by adding pieces of hardened leather, increasing the height of the counter, and other devices. When the heel is painful, great relief is sometimes obtained by hollowing out the heel of the shoe. Hair insoles and rubber heels and soles are sometimes a great comfort to patients suffering from painful affections of the feet. Sometimes shoes are manufactured with the sole separated from the heel by softer leather, as in the Willard and Gemrig club-foot shoes. The soles and heels of shoes may be beveled on the inner or outer side, according to special indications. Very great difficulty is often experienced in obtaining proper shoes for patients, so that orthopedic surgeons as a rule order them from special shoemakers. Persons suffering from deformed feet are hypersensitive and their footwear should therefore be selected with great care.

Measuring Machines for Scoliosis

For the purpose of recording the degree of deformity and the result of treatment in lateral curvature it is necessary to resort to scientific methods of measurement. The simplest and best method is by means of the lead strip already referred to, and, in addition to this, free-hand drawings are all that are necessary in office practice; but more accurate means are desirable from time to time for the purpose of record and scientific study. These include at the present time some thirty-five different methods, which are shown in the table on page 304,* modified from Hoffa.

Two measuring machines require special notice here: the improved delineator and the rod scoliosometer.

The Improved Delineator.—This is an amplification of the Weigel and other machines of the same pattern, and is so constructed that outlines of the body may be taken either in the horizontal or in the vertical

* Young: University Medical Magazine, Feb., 1898.

plane. The tracings may be made either with a wheel or with a stylet, and the personal element enters into the taking of these as of all outlines of the body (see Figs. 95, 96, 97).

TABLE OF SCOLIOSOMETRY

I. Pliable reproduction.	(1) Plaster cast. (2) Model bandage (Beely).	
II. Perspective drawing.	(1) Free-hand drawing. (2) Photography.	
III. Measuring.	(1) Simple measuring of the body.	Measuring band. Calipers. Spirit level.
	(2) Outside measuring of the body.	Pliable metal band. Scoliosometer (Heineke). Scoliosometer (Mikulicz). Simple co-ordination apparatus (Weil). Measuring apparatus (Bigg). Disastroptometrie (Roberts). Scoliosometer . . { Zander. Bradford.
VI. Profile drawing.	(1) General surface measuring.	Cyrtometer. Lead strip.
	(2) Special surface measuring.	Tin strip (Roth). Rod cyrtometer . { Beely. Elkinton. Glass table (Bührings). Scoliosometer (Grameko). Tachygraph . . { Rausch. Weigel's. Camera obscura (Schildbach). Notograph . . . { Virchow Elkinton. Scoliosis gauge (Barwell). Scoliosometer . . { Schulthess. Scudder. Thoracograph . . { Beondetti. Socin and Burkart. Schenk.

The Rod Scoliosometer.—This is an amplification of the scoliosometer of Beely, but is improved by being attached to an upright and by having a plane with a chart attached, also connected with the upright. Two fixed points upon the spine, the seventh cervical vertebra and the top

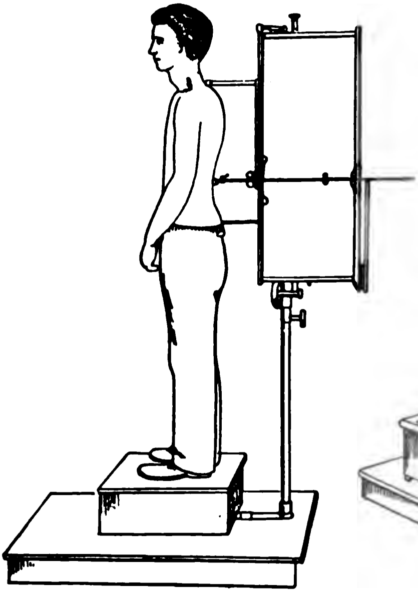


FIG. 95.—IMPROVED DELINEATOR FOR SCOLIOSIS.

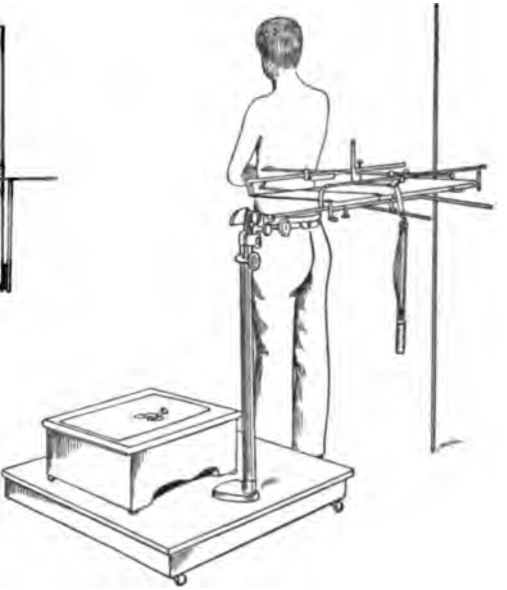


FIG. 96.—IMPROVED DELINEATOR FOR SCOLIOSIS.

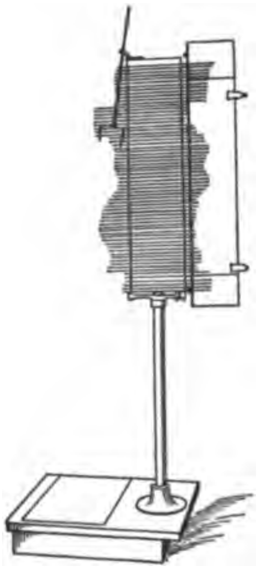


FIG. 97.—ROD SCOLIOSOMETER.

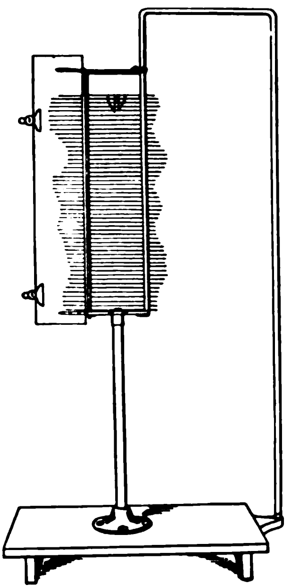


FIG. 98.—ROD SCOLIOSOMETER.

of the coccyx, are used for adjustment. The rods are adjusted singly to the deviations of the spine and the tracing is made upon the chart, which has square rulings upon it. This method is less valuable for horizontal outlines (see Fig. 98).

SPECIAL APPARATUS

POTT'S DISEASE

During the first part of the treatment the patient stays in bed, and **extension appliances** of some kind are employed. The ordinary leather head-piece used in the Sayre extension is frequently utilized for this purpose by adding a small steel yoke between the two rings to which the rope for the extension weight is applied (Fig. 99). A neater and more elegant head appliance is made of webbing, and is known as the **Hilliard extension.** The bed treatment of Pott's disease is simplified, and the comfort of the patient and his attendants is very much enhanced, by the use of a **bed-frame** of some kind. A square frame of wood or iron, preferably jointed gas-pipe, is covered with canvas and provided with attachments at the head for wheel extension. Upon a bed-frame of this kind a patient may be kept for a long time; continuous traction may be maintained; and the patient may be moved from place to place with a minimum of discomfort. The frames are sometimes mounted on carriages or go-carts so that the patient may be taken into the open air. The same methods of head extension may, if desired, be employed in the **ambulatory apparatus; Sayre's jury mast,** for example, is a serviceable appliance; but personally I prefer to use a **chin-rest appliance,** of which there are several models in general use. The **chin-rest of Shaffer,** attached by the universal joint,

FIG. 99.—HEAD-PIECE—EXTENSION IN POTT'S DISEASE.

is the most elegant of its kind, but I find a less expensive form, which I am in the habit of ordering for my poorer patients, almost as satisfactory, although it lacks the advantage of fixing the head at certain points and its various parts are less elaborate.

The appliances used in the treatment of Pott's disease of the spine are of two different forms, the corset and the spine brace. The **Taylor spine brace** is the one I prefer (Fig. 100). Since its first conception this apparatus has undergone a great many modifications, so that the original

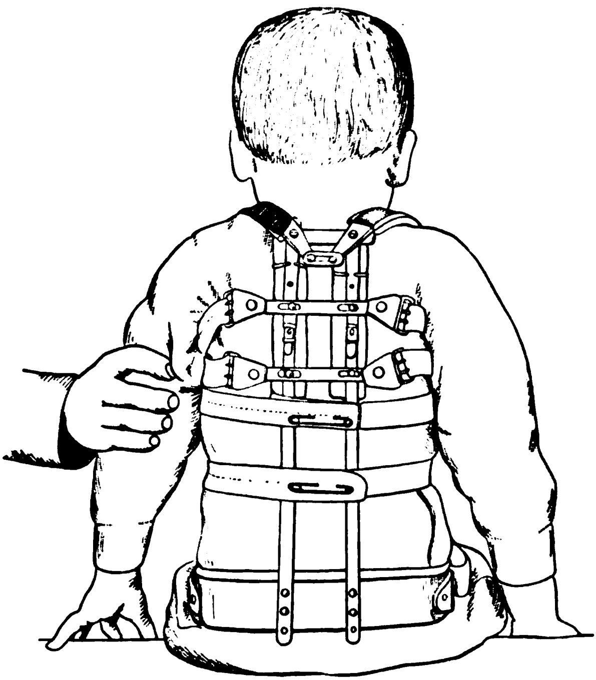


FIG. 100.—TAYLOR SPINE BRACE.

model is scarcely recognizable in the apparatus employed at the present time. The original apparatus extended only to the axilla. The upper part of the apparatus has been added since, and many modifications of the band have also been suggested and employed. It is asserted by some that the shoulder-pieces ordinarily employed in the Taylor spine brace push the shoulders down, and that the weight of the brace is sustained by the shoulders. In practice it is found that when the apparatus is correctly made and fitted, the shoulders are pulled upward and slightly backward. Instead of the brace resting upon the shoulders, as has been theoretically suggested, the difficulty with the Taylor spine brace has been in most instances that it rides up, and in some individuals this is so marked that perineal straps have to be added. It is also said by some that the shoulder-straps should pass from the back part of the shoulder around the axilla and upward, instead of passing in the opposite direction. In my opinion a properly constructed Taylor spine brace meets all these objections and fulfils all the requirements of a supporting and protecting spine brace.

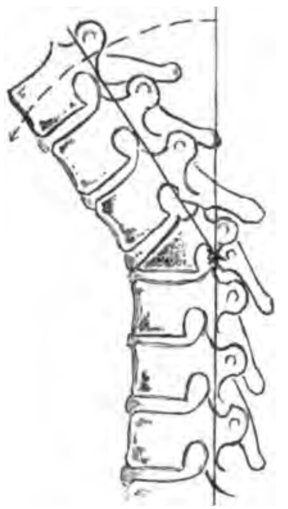


FIG. 101.—ILLUSTRATION SHOWING BACKWARD TRACTION AND FIXATION IN APPLICATION OF BRACE.—(*Roberts.*)

The fact is frequently lost sight of that the ruling principles in the treatment of Pott's disease by means of apparatus are backward traction and fixation for the protection of the spine. This is well shown in the illustration (Fig. 101), taken from Roberts.

The lower part of the brace in the region of the **band** and the band itself have been variously modified to satisfy certain indications. In the original apparatus the **pad plates** were not hinged; but in the earlier modifications the advantage of having them hinged appears to have been recognized. Softer steel may be used at first in order to fit the brace to the deformity more easily, and the harder tempered steel and uprights can afterward be adjusted to the pad plates. The pad plates should be placed between the spinous and transverse processes of the vertebræ, the distance between the uprights being equal to the distance between the transverse processes.

Various materials have been used in the construction of the pad plates, the best of which are **powdered cork** and **hard rubber.** Whatever material is used should be as firm in consistency as is compatible with comfort; and as much pressure should be made upon the deformity as the skin will tolerate.

The shoulder-pieces in the Taylor spine brace should start high up on the shoulder and pass well forward, instead of starting about the upper border of the scapula, as is the case in some braces. The advantage of having these shoulder-pieces high is that the pressure on the front of the arms is lessened.

For cases of dorsal spine disease I have found what I call the 'crib-frame' a very valuable addition to the treatment. This consists of a wooden frame covered with a network of heavy cording, which prevents the patient from assuming the vertical position and relieves the spine of any superincumbent weight. The **prone couch** is also found to be of considerable service in dorsal affections. It may be made from a Morris chair with the back turned to the floor, the patient lying upon his face, resting upon the back of the chair, and the upper part of the body being on the seat.

The **fitting of the spine brace** is very important. The following rules should be given to patients or care-takers: The apparatus must be worn constantly. The brace should be removed morning and evening in the following manner: the patient lies face down, the straps are unbuckled, the brace removed, and the back washed and bathed with alcohol and powdered with talcum powder; the brace is then reapplied by buckling the bottom buckles first, second the shoulder-straps, third the top bands of the apron, and finally the two bands of the apron which control the abdominal part, all the straps being buckled as tight as is consistent with comfort. The patient must never sit up without the brace. The brace should be examined several times daily to see if it is properly applied.

HIP-JOINT DISEASE

The incipient and acute stages and temporary exacerbations should be treated in bed. **Extension** is applied by a weight and pulley, which can be attached to the end of the bed, the foot of the bed being elevated; or, what is better, the patient may be placed on a **fixation frame** made of gas-pipe and covered with canvas. This frame admits of the patient's being carried about without disturbing the traction.

The deformities of the hip occurring during the course of the disease are met by additional appliances for elevating or adducting the limbs (Fig. 102). As soon as the apparatus that is to be worn by the patient after he gets up is ready, it may be applied while the patient is still in bed if the acute symptoms have disappeared.

The appliances used in the ambulatory treatment of hip-joint disease may be divided into two classes, of which the Thomas fixation hip splint and the Taylor traction brace are the respective types.

The **Thomas hip splint** consists of a posterior iron bar passing down the back of the limb and attached to a body band. A half-band passes above the knee and another above the ankle. In the original Thomas brace the latter was covered with leather, and the body band terminated in rings which were secured to the body by muslin bandages. The posterior bar is always placed upon the band, one or two inches above the median line. The principle of the Thomas hip splint is fixation, and the rule insisted upon by Mr. Thomas that the body part and the limb part should be parallel, but upon different planes, must be carefully observed in the manufacture of this apparatus. As used at the present time, the splint is attached by means of bands and straps; a high patten applied to the other foot, and the patient walks upon crutches (Fig. 103).

When patients can receive the proper care and attention, the **Taylor traction hip splint** gives the greatest satisfaction. The traction is applied by means of adhesive plaster cut in convenient strips, and covered with a muslin roller. If the skin becomes irritated from contact with the plaster, a heavy stocking may be substituted; by means of stout

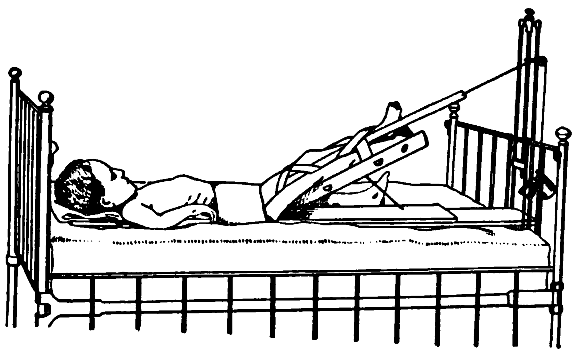


FIG. 102.—APPLIANCE FOR ELEVATING OR ADDUCTING LIMB.—(*Children's Hospital, Boston.*)

webbing or leather straps and buckles, sewed on the sides of the stocking, the latter is connected with the brace. The traction splint is composed of a pelvic band with a provision for the attachment of perineal straps, a steel upright containing a ratchet, and an attachment for a knee-cap at the knee. Perineal straps should always be used, and the knee-cap should always be applied to the inner side of the knee (Fig. 104). The traction brace should be used in connection with crutches and a high shoe during the first part of the treatment, which usually lasts from six months to a year. After this, if there are any exacerbations, the traction brace may be used for a year or eighteen months without a crutch, at the end of which time the straps may be loosened and the apparatus worn as a protective appliance until the termination of the disease.

The **rules for putting on and caring for** the traction hip splint are as follow:

The apparatus is to be worn constantly. The brace should be applied while the patient lies flat on his back; the pelvic band is slipped into place and buckled; the perineal straps are buckled on in front and the extension straps attached to the buckles upon the leg extension. The key is then turned until the perineal straps are as tight as they can be worn, and the knee-pad is buckled upon the inner side of the knee, taking care not to roll the leg in doing so. The sole of the foot should never touch the foot-piece of the splint.

Fig. 103.—Thomas Hip Splint.

Fig. 104.—Taylor Traction Hip Splint.

When the splint has been **removed** for any purpose, gentle traction should be applied to the leg until the splint has been replaced. The groin should be washed daily with soap and water and bathed with alcohol; talcum powder prevents chafing. The splint is not to be left off without the surgeon's permission. The patient should be made to lie down for three hours daily.

DISEASES OF THE KNEE-JOINT

The apparatus used in the treatment of tuberculous disease of the knee-joint are the Thomas knee splint and the Shaffer extension knee splint.

The **Thomas knee splint** (Fig. 105) consists of two uprights surmounted by an ovoid ring set at an angle of 45 degrees and thoroughly padded which supports the weight of the trunk on the tuberosities of the ischium. The lower end of the brace is finished with a leather covering or cross-piece for walking purposes. Above and below the knee the brace is attached to the leg by means of leather pads and supported above by a band of webbing passing over the opposite shoulder. A high shoe upon the opposite foot raises the body in such a manner that the sole of the foot of the affected limb does not touch the ground.

Fig. 105.—Thomas Knee Splint.

In the **extension knee splint of Shaffer** (Fig. 106) and others the principle of the old Stromeyer knee splint has been improved upon and amplified in such a manner as to apply traction to the knee-joint without crowding the head of the tibia. Extension is applied by means of adhesive plasters cut with tails and applied above and below the knee-joint on each side. In some cases plaster-of-Paris is applied to the knee-joint, and sometimes a cast is worn inside the Thomas knee splint. **After excision of the knee** a fixation knee splint should be worn to prevent deformity.

DISEASES OF THE ANKLE-JOINT

In ankle-joint disease **fixation** is sometimes effected by means of leather or plaster-of-Paris. Traction is quite as important in diseases of the ankle-joint as in disease of other articulations, and can be best attained with the **Foster ankle brace** (Fig. 107) or some of its modifications. Adhesive plaster is used to apply the traction to the upper part of the leg, and the shoe itself makes the traction downward.

LATERAL CURVATURE OF THE SPINE

In the treatment of lateral curvature there is a tendency at the present time to discard all apparatus and rely entirely upon gymnastics and massage. (See pages 170 to 190.) When the patients are seen early, this suffices in a large number of instances; but in the severe forms the deformity often increases in spite of skilful treatment, and apparatus must then be worn.

Almost all braces used in the treatment of lateral curvature are planned upon the model of the Sheldrake apparatus. The **Shaffer brace** consists of a waist-band hinged in the back and connected in front by webbing to a continuous steel band with pins and slots. To this are attached two uprights, one on the low side surmounted by a crutch, and another upright, a little posterior to the axillary line on the high side, provided with a pressure pad, the pressure being applied by webbing

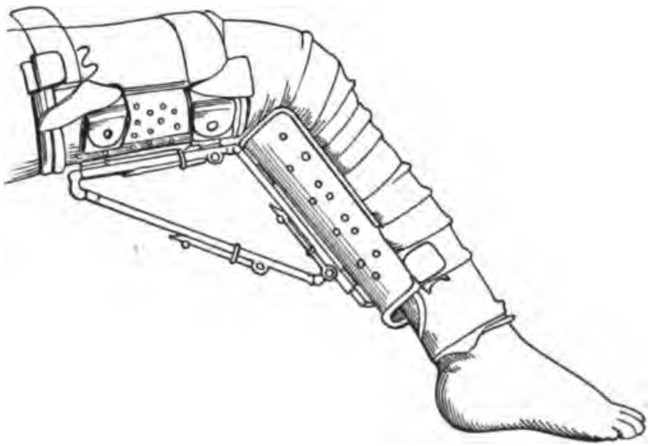


FIG. 106.—EXTENSION KNEE SPLINT OF SHAFFER.

passing over the crutch on one side to the pad on the other side across the front and back of the body. From the waist-band four uprights, two in front and two behind, pass downward and are connected by webbing.

The **Gefvert brace** is more suitable for the severe cases. The main parts of the apparatus do not differ from the Taylor spine brace already described. The principal mechanism of this brace consists in an additional upright, to which are attached a crutch for the low side and a pad for the high side, both of which are operated by elastic webbing attached to the pelvic band.

In mild cases I have found great satisfaction in using **reinforced corsets,** consisting of ordinary long corsets strengthened with special steels and having a crutch upon the low side. In all apparatus for lateral curvature the shape of the crutch is very important, and I prefer one which is comparatively flat and has a posterior as well as an anterior curve.

INFANTILE SPINAL PALSY

The principles upon which the use of apparatus for infantile spinal palsy is based are very imperfectly understood. There are two reasons

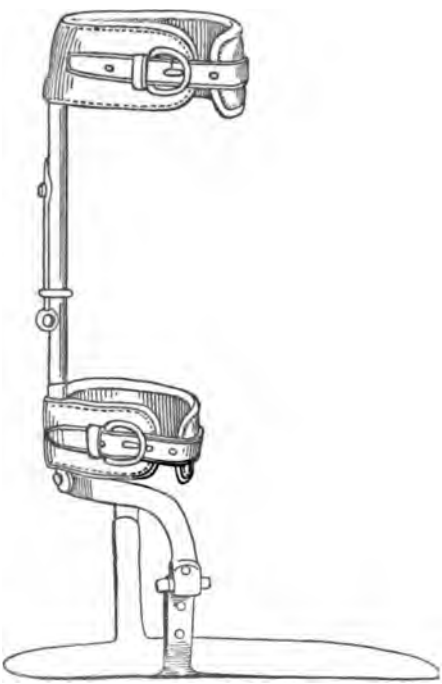


FIG. 107.—FOSTER EXTENSION ANKLE BRACE.

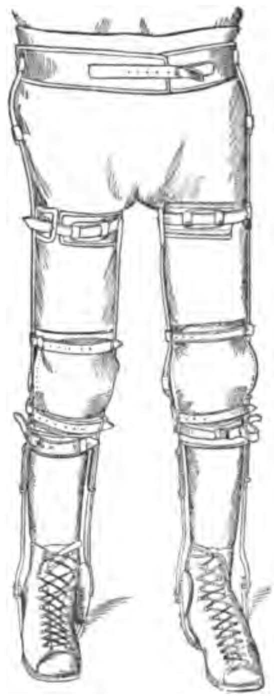


FIG. 108.—BRACE FOR INFANTILE SPINAL PALSY.

for the use of apparatus in the treatment of deformities resulting from this disease. The first is to **prevent deformity:**

"'Tis not enough to lift the feeble up, but to support him after."

The second is to **fix the joints.** The apparatus is particularly valuable at the periods when growth is most rapid, between the ages of seven and fourteen, so as to prevent deformity at this time. The deformity is produced by three factors: (1) the stretching of the muscles at the time of the attack; (2) the action of the sound muscles in opposition to the paralyzed muscles; (3) the growth of the bones and joints, the paralyzed muscles remaining the same length. This latter element cannot be overcome by the use of apparatus and frequently requires operation; but the apparatus will aid in overcoming the second element and in preventing deformity. Fixation of the joints is very important in order to enable the patient to walk. The limbs should be placed as nearly under the body as possible by operation; and the use of apparatus and the fixation of the joints are essential to locomotion.

FIG. 109.—TROLLEY.

FIG. 110.—WHEEL-CHAIR.—(*Willard.*)

The **apparatus** used for infantile spinal palsy may extend only below the knee; it may extend to the upper part of the thigh, or it may include the pelvis or the entire body, according to the degree of deformity present (Fig. 108). In the severest cases, if the arms are good, patients may be encouraged to use their legs and so increase the power of the muscles. This may be accomplished by the use of the **trolley suspension apparatus** devised by Willard, which consists of a leather (body part) attached by leather straps to a yoke suspended from a trolley which runs the length of the room (Fig. 109). **Wheel-chairs** of special construction are also used for this purpose (Fig. 110).

The **joints** of all apparatus for this condition must be fixed by stop-joints or spring catches of different kinds, and the movement of the part should be limited by stop-joints and the use of rubber muscles. The muscles that are partially paralyzed should merely be reinforced, not entirely superseded by the rubber muscles.

The **degree of disability** present in the individual may be determined by certain tests. If the patient can support the body in the kneeling position, the hip-joints are not badly paralyzed and the apparatus will not have to be carried above the hips. If the patient can support the body in the standing position with the knees fully extended, the apparatus will not have to be carried above the knee-joints unless 'back knee,' due to the hyperextension of the knee-joint, be present. The amount of deformity in the leg may be determined by the relative position of the feet and the degree of club-foot that may be present.

Many patients object to the use of braces, but these objections may be overcome by using apparatus as light as is consistent with strength and as little conspicuous as possible. In mild cases the apparatus should be made as short as possible and the amount of apparatus worn be reduced gradually as the patient improves. I have frequently seen patients discard apparatus on account of its weight and inconvenience, and later be obliged to return to it on account of increased deformity. If the worst of the deformity produced by this disease is remedied by operation, the apparatus will not be so objectionable. It will be necessary in most individuals suffering from unilateral paralysis to equalize the length of the limbs by the use of a cork sole, which, if it does not exceed ¾ of an inch in thickness, may be built into the shoe.

INFANTILE CEREBRAL PALSY

In this affection apparatus is not so much used as in the preceding disease. The joints are fixed from the tetanoid spasm of the muscles, and the object of the apparatus is to correct deformity. The severer deformities require division of the contracted tendons; and if apparatus be worn, the joints should be fixed at first with catches, which may afterward be discarded. The **wheel crutch and trolley support** described under infantile spinal paralysis are equally applicable to this class of cases.

TORTICOLLIS

Except for the paralytic variety, apparatus is not of very much benefit in the treatment of torticollis. An appliance of hardened leather or papier maché is the best, and should be made over a cast of the part and fitted with great care. I have found the **Taylor brace** with chin-rest useful in the treatment of these cases.

RACHITIC DEFORMITIES

Knock-knee, Bow-legs, Curvature of the Diaphyses

Many rachitic deformities may be corrected by apparatus if it be applied at a very early period. The rule is now very clearly established that apparatus to be of any service in the treatment of these affections must be applied before the age of three-and-a-half, or four years, if the disease be of the infantile variety. In the adolescent cases the apparatus should be applied as soon as it can be made. The two indications are **correction** and **prevention.** The corrective appliances are placed upon the most deformed part. Counterpressure must be applied on the other side at equidistant points above the point of pressure. Braces for the correction of knock-knee should be carried to the upper part of the thigh and connected by a pelvic band so as to avoid the danger of fracture, which I have known to occur in some of these cases from falls. Another advantage of carrying the apparatus to a waist-band is that it may be used to turn the foot either out or in according to the deformity.

Since the deformity which produces bow-legs may be seated in the upper or lower part of the leg, or affect the entire length of the bones, the apparatus must be constructed so as to correct these different deformities. In all apparatus for the treatment of either knock-knee or bow-legs the knee-joints must be fixed either temporarily or permanently, for otherwise the limb will be bent and the pressure removed. Apparatus for the treatment of these affections are of two kinds—those which are used at night for correction, and those which are used in the daytime to prevent increase of the deformity by the superincumbent weight.

In the treatment of **anterior curvature of the tibia,** which is the principal curvature of the diaphyses, a large pad or strap should be carried across the deformity in front and attached to the apparatus by straps. Unless this apparatus is applied at a very early period, before the age of two and a half years, it will be unproductive of benefit. If the deformities due to rickets are not corrected before the fourth or fifth year, operation will be necessary. Beginning six weeks after the operation, an apparatus to prevent the recurrence of the deformity should be worn from one to three years.

CLUB-FOOT

The treatment of club-foot has been so much improved of late by operative methods that the use of apparatus is not so much resorted to as formerly for the correction of the deformity, but it is always needed to prevent relapse. Many cases of club-foot may be cured by the use of apparatus alone if they are taken immediately at birth and treated thoroughly for a period of one year to eighteen months. I have in this way cured a number of children, but difficulty is experienced in securing the co-operation of parents or care-takers. The **best apparatus** for the cure of club-foot without operation is undoubtedly that of **Shaffer,** which is constructed upon the same principle as the Scarpa shoe, but very much amplified.

FIG. 111.—CLUB-FOOT WALKING SHOE.

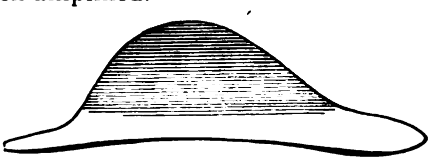


FIG. 112.—FLAT-FOOT SPRING.

The apparatus used for the treatment of **congenital club-foot** after one year, and after operation has been performed, is a specially constructed shoe known as the **club-foot walking shoe** (Fig. 111). This consists of a stout leather low vamp shoe strengthened with a steel arch and steel shank. A stirrup connects the uprights with the shoe, and a stop-joint at the knee prevents hyperextension. A pressure pad at the outer ankle and an elastic strap from the little toe to the outer upright prevent relapse.

FLAT-FOOT

In addition to the **exercises** employed to improve the condition of the weakened muscles, it is usually necessary in flat-foot to **support the arch.** This may be accomplished by special **shoes,** the heel and sole of which are raised on the inner side, or in which a heavy leather counter is carried up to support the inner side of the foot. Reliance is usually placed upon **flat-foot springs** or **plantar arches,** which are made in many different forms. The pattern introduced by Roberts is the one that I have found most satisfactory. It consists of a plantar plate with the inner portion raised in such a manner as to support the dislocated astragalus. It is usually made so as to give the foot a certain degree of elasticity and prevent jarring during locomotion. To avoid corrosion by perspiration, hard rubber is sometimes used for a coating, and in some instances hard rubber is used in the manufacture of the spring (Fig. 112).

FIG. 113.—TRACTION APPLICATION FOR CONGENITAL DISLOCATION OF THE HIP AND ABSENT TIBIA.

FIG. 114.—ABSENCE OF LOWER EXTREMITIES. —(*Shoemaker.*)

Aluminum and celluloid and their preparations are sometimes employed at the present time, and have been found satisfactory.

CONGENITAL DISLOCATION OF THE HIP

The many appliances which have been constructed for the cure of this affection furnish a keen satire upon the orthopedic art.

The most serviceable appliances consist of some apparatus that makes traction and at the same time exerts pressure upon the deformity. The attempt to cure this deformity by straightening the body is illogical, although this has been the principle upon which some appliances have been constructed. At the present time the deformity is best treated either by the Lorenz functional method, or by the **operative** or wet method; and it is only after treatment by one or the other of these methods that apparatus is used. I have obtained the best results from the use of a **traction apparatus** similar to the Taylor traction brace with a large pressure pad across the buttocks. Another form of apparatus that has been

FIG. 115.—APPARATUS FOR ABSENCE OF LOWER EXTREMITIES.—(*Shoemaker.*)

used with some benefit consists of a corset and thigh-piece constructed of hard leather and having a stop-joint at the hip-joint. After reduction by the Lorenz method plaster-of-Paris casts are used from nine to twelve months, after which an everting leg brace is used until two years after the operation. (See pages 327 to 343.)

PERVERTED DEVELOPMENT

The deformities of the lower extremities produced by lack of development, particularly the absence of parts, require consideration here. For **absent tibia** a leg brace of some kind would support the patient and, as in the case shown in Fig. 113, if there is also **congenital dislocation of the hip** with absence of a part of the femur, the brace should be carried to a pelvic band to which perineal straps are attached.

Total absence of both lower extremities would seem to be a condition that no form of apparatus could alleviate; but the accompanying illustrations (Figs. 114 and 115) show that very serviceable apparatus can be constructed for this grave anomaly. This patient was under my care for some time, and assured me that the artificial limbs which she used seemed to be a part of herself, and that she felt as if she were putting her own feet to the ground in walking.

ABDOMINAL SUPPORTS

Abdominal supports of different kinds are necessary adjuvants in the treatment of pendulous abdomen, gastroptosis, enteroptosis, floating kidney (nephroptosis), splanchnoptosis (or general sagging of viscera), and appendicitis.

These supports vary greatly according to their several uses and indications. They may be made of surgical rubber, elastic webbing, silk webbing or cotton webbing; at times it may be necessary to make them to measure.

In the treatment of **pendulous abdomen, splanchnoptosis, gastroptosis,** and **enteroptosis** abdominal bandages correctly applied are of the greatest assistance, as they relieve traction and aid in replacing the dislocated organs while general nutritive treatment and skilful massage and exercise are being employed to strengthen the faulty muscles and restore the natural supports of fat and flesh.

In **floating kidney,** unless nephrorrhaphy or nephrotomy is indicated, bandages are beneficial. Stengel has recommended the use of a kidney-shaped **pad** which is designed to make pressure upward, backward, and to the right or left. Much ingenuity and skill have been displayed in the measuring and fitting of corsets for this affection. The indications are:* To elevate and maintain the prolapsed viscera; to correct functional derangement and improve the general nutrition.

According to A. E. Gallant,† the corset must reach down to the pelvic bone, must exert maximum pressure over the suprapubic area, must curve in at the waist line to sustain the kidney, fit snugly over

---

* "The Rational Treatment of Movable Kidney and Associated Ptoses"; Ther. Gaz., July, 1902

† International Jour. of Surgery, Feb., 1903.

the hips and at the waist, and loosely above that part, and be cut low and full in bust as desired.

The measurements must be accurately taken in the recumbent position, and the corset must be applied in the semi-opisthotonos posture and laced from below upward. A corset made and applied in this manner will, it is stated, give the wearer a graceful, healthful, and fashionable figure, will elevate and support the viscera, and immobilize the ectopic kidney.

It may also be applied in pendulous abdomen, adiposis, as a post-partum binder after celiotomy, and for young girls as a prophylactic against Glénard's disease.

After abdominal section, for whatever cause performed, an abdominal bandage should be worn for six or eight months to prevent ventral hernia; and after **appendectomy** the wearing of a well-fitting silk elastic support with an oval hard-rubber pad for at least a year is recommended by the best surgical authorities.

There are many orthopedic appliances for minor deformities which do not belong within the scope of this article. These may be found in works upon general and special surgery.

ORTHOPEDIC MACHINES

Correcting Machines for Lateral Curvature

It is interesting to observe that although more than two hundred and fifty years have elapsed since the introduction of correcting machines in the treatment of lateral curvature, their popularity extends back only a decade. The cross of Heister (1700) was succeeded by the apparatus of Levacher (1786), but it was not until 1821 that Heine introduced the stretching bed with elastic straps, and it was not until 1889 that Bardwell introduced the bands from which the present machines have been evolved. The correcting machines in use at the present time include two types: the Hoffa machine, based on the principle of self-suspension with pressure, and the Beely apparatus (Fig. 116), in which pressure is applied by means of straps and bands, with or without self-suspension. The Hoffa type has reached its highest development in the improved machine of Weigel (Fig. 117). The Beely machine has been greatly modified and improved by Radike * and by Beely himself (Fig. 118). These machines are particularly useful for correcting the rotation in the severest cases of lateral curvature.

* Zeits. f. orthoped. Chirurgie, Band vii, p. 28.

Gymnastic Apparatus

The gymnastic apparatus that is most used in the treatment of orthopedic affections consists of rods, stall bars, boom, high plinth, and low plinth.

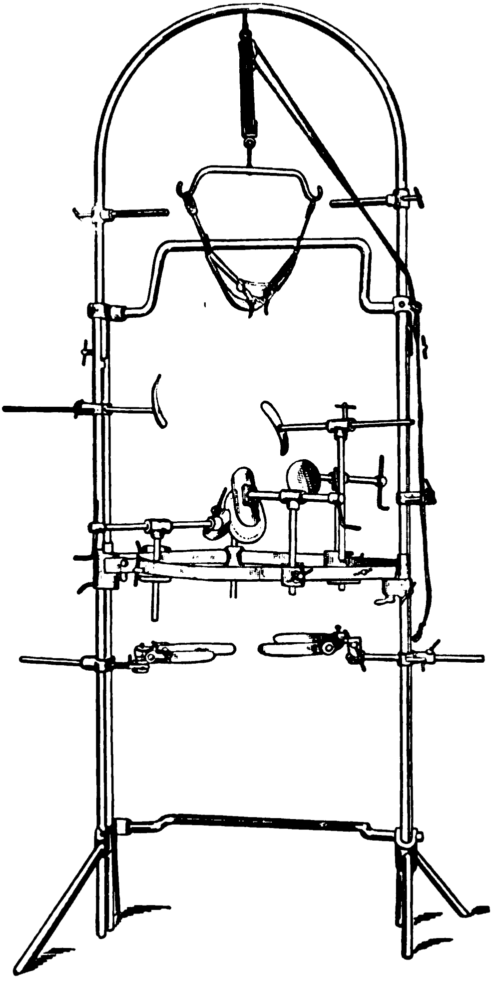


FIG. 116.—WEIGEL-HOFFA CORRECTING MACHINE FOR LATERAL CURVATURE.

Rods.—The rods are wooden dowels of different lengths used by the patient and operator in performing certain passive and active moments.

Stall Bars.—The stall bars used for remedial gymnastics do not differ from those used in ordinary gymnastic work, but in order to economize space they are sometimes combined with other apparatus, such as the boom.

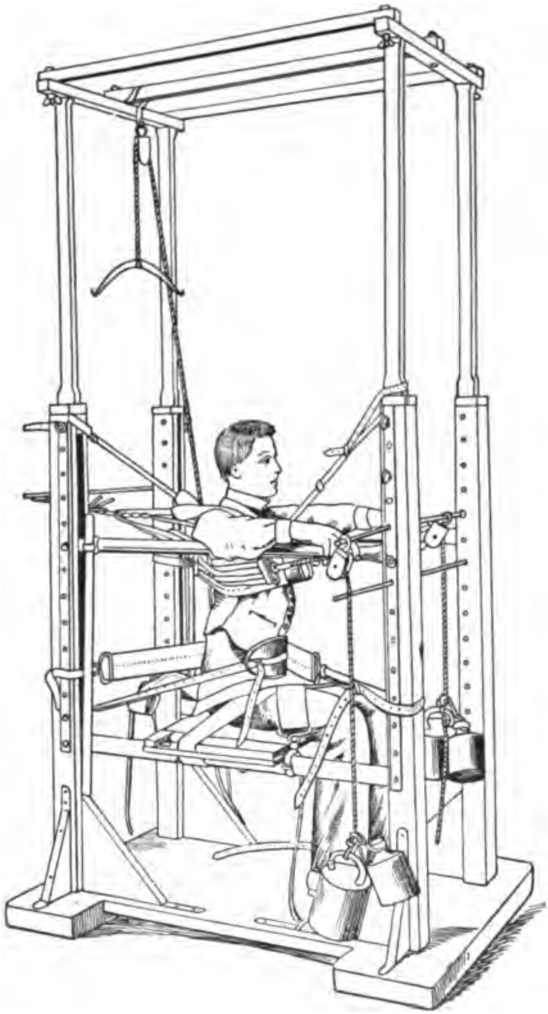


FIG. 117.—BEELY CORRECTING MACHINE FOR LATERAL CURVATURE.

Boom.—The Swedish boom is too well known at the present time to require description; but the portable boom is the one most used in the treatment of orthopedic affections, and consists of a shorter boom than that usually employed in gymnasiums; it is attached to uprights fastened to a platform.

High Plinth.—The high plinth is the most useful of all the Swedish gymnastic apparatus in the treatment of lateral curvature. The patient is fixed to the apparatus by straps and the movements may be either active or passive, rods being generally used in the treatment.

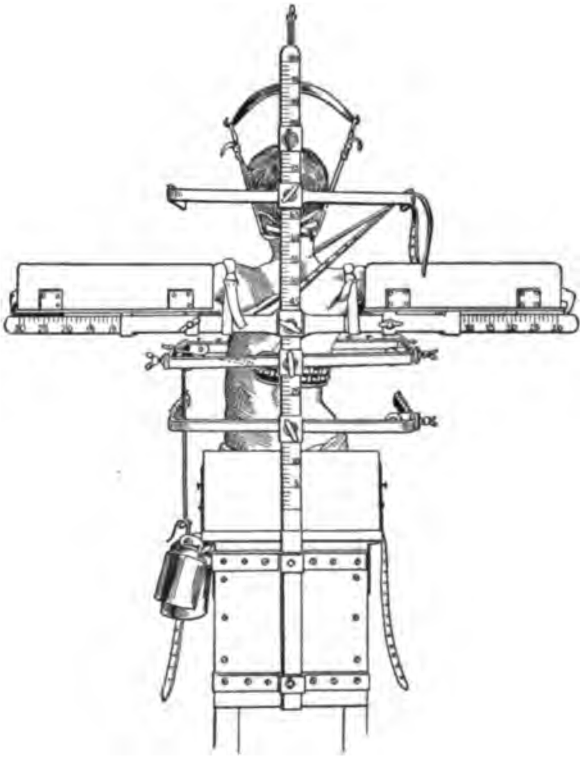


FIG. 118.—RADIKE-BEELY CORRECTING MACHINE FOR LATERAL CURVATURE.

Low Plinth.—The low plinth is rather limited in its application in the treatment of lateral curvature and nervous affections. It is used to give exercises, active and passive, for the adductor and abductor muscles, as well as certain movements for the spinal muscles, and occasionally, though rarely, for the abdominal muscles.

CORRECTIVE MANIPULATIONS IN ORTHOPEDIC SURGERY

BY H. AUGUSTUS WILSON, A.M., M.D.,

CLINICAL PROFESSOR OF ORTHOPEDIC SURGERY IN THE JEFFERSON MEDICAL COLLEGE; EMERITUS PROFESSOR OF ORTHOPEDIC SURGERY IN THE PHILADELPHIA POLYCLINIC; ORTHOPEDIC SURGEON TO THE PHILADELPHIA HOSPITAL; EX-PRESIDENT OF THE AMERICAN ORTHOPEDIC ASSOCIATION, ETC., ETC.

Field of Corrective Manipulations

The field of corrective manipulations in surgery—by which are to be understood those methods in which the corrective force is applied by the **hands of the operator** to the exclusion of mechanical and other aids—includes a long series of conditions, among which fractures and traumatic dislocations are to be numbered; while among those pertaining especially to orthopedic surgery mention may be made of bow-legs, ankylosed joints, and congenital malformations such as torticollis, club-foot, and dislocation of the hip.

CONGENITAL DISLOCATION OF THE HIP

The Lorenz Operation of Bloodless Reduction, Retention, and Weight-bearing

The methods of procedure for correction of congenital dislocation of the hip have been brought to their present perfection during the past fifteen years. In 1829 Dupuytren announced his conviction that this condition was not only incurable, but that even palliation was impossible. For nearly sixty years this statement was accepted and no attempt was made to do more than overcome the shortening by the use of high-soled shoes or the application of some form of brace. In 1887 Buckminster Brown, of Boston, reported a case showing that the luxation might be overcome by the use of long-continued extension in recumbency. William Adams, of London, was at the same time devoting attention to recumbency without extension, with resulting arrest of the progress of the deformity but without restoration of function. Schede, of Hamburg, long relied upon mechanical support by the application of various forms of braces. In 1890 Hoffa, of Würzburg, first directed attention to his cutting operation, and statistics rapidly accumulated showing that this formerly hopeless deformity was curable. Lorenz, of Vienna, became interested and was an advocate of the Hoffa cutting operation. This he modified by making an anterior incision instead of the posterior incision of Hoffa, thereby avoiding some of the disadvantages of the operation. Lorenz continued to employ the cutting operation until 1892, when, in suitable cases, he abandoned it for the bloodless method of reposition which has since been known as the Lorenz operation of **bloodless reduction, retention, and weight-bearing,** to distinguish it from his cutting operation. His first paper on the non-cutting method was published in the "Centralblatt für Chirurgie," No. 33, 1895. At the International Congress of 1897 he reported 160 cases with only 5 relapses. Since then the method has been resorted to more or less extensively by orthopedic surgeons all over the world, and has been further developed by its author. It is not too much to say that failure to appreciate the full details of some of the essential features of the more recent modifications made by Lorenz has prevented the accomplishment of the ultimate results that were expected. Many who have witnessed the consummate skill of Lorenz have realized that their own previous use of the method was defective in one or more particulars. The selection of appropriate cases, application of accurate methods of procedure, and avoidance of attempts to change or improve Lorenz's technic will greatly increase the percentage of successful results. Lorenz's elaborate study of the conditions as ascertained by the large number of cutting operations which he performed,—a study stimulated by the realization of the unfavorable results that too often followed that operation,—together with his vast experience in over fifteen hundred bloodless reductions, might well justify the opinion that the adoption of his technic *in toto* is preferable to premature attempts at alteration or modification. These 1500 cases referred to, show a large percentage of permanently successful results with practically no mortality.

J. Jackson Clarke, of London, in the "Practitioner" for March, 1903, has this to say: "The subject of the treatment of congenital dislocation of the hip, including Lorenz's method, was brought prominently before the British Medical Association in 1901. It is to be regretted that Professor Lorenz was not at that time invited to demonstrate his method at the meeting, for it is evident to those who have seen Lorenz operate that the surgeon who introduced the subject at the meeting had never really performed Lorenz's actual operation at all, and, hence, though many interesting details of his experience in performing the open operation were communicated by Mr. Burghard, all his criticisms and disappointments with regard to Lorenz's treatment are of no account. For another reason the missed opportunity of introducing Lorenz's work to the profession in this country is to be regretted: it would have forestalled and nullified the distasteful outpourings of the lay press, which were the inevitable consequence of Lorenz being summoned to cross the Atlantic for the purpose of operating on the only child of a very wealthy American citizen. I am convinced that to no one can this newspaper activity have been more distasteful than it was to Lorenz, whose work was distorted and misrepresented by it."

Paci, of Pisa, previous to 1892 tried unsuccessfully to reduce a congenital dislocation of the hip in an adult, and by some is referred to as having originated the procedure which Lorenz perfected. Lorenz clearly proved its applicability to suitable cases and established its permanency and freedom from the mortality which followed the Hoffa operation. To Lorenz, therefore, belongs the credit of discerning the limitation of the application of the method to early childhood before gross changes in the joint have occurred, and for the elaboration and perfection of definite details of procedure. He perceived that his bloodless method is not always suitable in the case of patients that have been allowed to walk until the age of seven or eight years, because gross changes in the structures composing the joint have by that time become permanent. Those cases of seven or eight years' duration or longer are usually capable of a permanent cure only when recourse is had to the cutting operation; but very much of the severity of that operation would be rendered unnecessary if the bloodless method were first efficiently practised.

Technic

No preliminary treatment is necessary or desirable except such as may put the child in the best possible physical condition. After all preparations are made and anesthesia induced, the child is placed in the recumbent position upon a strong, steady table of suitable height (Fig. 119). The **appliances** that are to be held in readiness are shown in the illustration (Fig. 119). From left to right are seen the **pelvic stand** attached to the end of the table by a screw-clamp, the **soft-rubber plate** to protect the genitalia, the **pad,** 2 × 4 × 6 inches, made of a folded sheet and firmly bound with a surgical roller bandage, the **yarn rope,** the **small stool** or bench, and the **trochanteric block.**

Assuming that the **right hip** is to be reduced, the assistant stands on the left side of the patient with his right hand upon the pelvis, while the left hand firmly grasps the left thigh. (See Fig. 120.) He should constantly aim at holding the pelvis in a position to resist the manipu-

FIG. 125.—LORENZ METHOD. STRETCHING ANTERIOR MUSCLES (MODEL).

FIG. 126.—LORENZ METHOD. REDUCTION BY MEANS OF THE TROCHANTERIC BLOCK AND LEFT THUMB OF THE OPERATOR (MODEL).

the thigh, with the knee fully extended, into a position of extreme hyperextension.

The patient is again placed recumbent and the trochanteric block placed between the great trochanter and the pelvis and used as a fulcrum. A second assistant may advantageously hold the block in place (Fig. 126). The thigh with the knee bent is carried to flexion and then to abduction while the femur is being rotated. This forces the head of the bone forward over the lip of the acetabulum and into

FIG. 127.—LORENZ METHOD. FORCIBLE EXTENSION BY THE USE OF THE YARN ROPE AND SHEET-LOOP, WITH PERINEUM PROTECTED BY THE RUBBER PAD (MODEL).

the socket. The accomplishment of reduction is clearly apparent. The sound of the head jumping into the acetabulum is not the only evidence of replacement, as the position of the head in its new position can be readily seen beneath the stretched adductor tendons. Further distinct evidence of replacement is afforded by extending the leg, when the head of the femur will escape from the acetabulum and resume its former position. It can again very readily be reduced to its correct position by the appropriate manipulations. This shows the necessity for the long-continued maintenance of the thigh in the position in which reduction was accomplished—which is expressively termed 'the **frog** position.'

It sometimes happens that the manipulations thus far described fail to bring the head down into the acetabulum owing to the presence of certain resistant tissues. It then becomes necessary to resort to the use of the **yarn rope** (Fig. 127). This rope should be made of strands of yarn laid loosely together without twisting. It should be four yards long and two inches thick. When used, it is looped into a clove-hitch placed around the ankle. A second assistant makes strong and steady traction on the leg. Resistance is afforded by means of an ordinary sheet with opposite corners knotted to form a loop. One end of the loop passes over a corner of the operating table while the other passes over the groin and perineum in such a manner as to oppose the traction made upon the yarn rope. To avoid uneven pressure and injury to the external genitalia the parts beneath the sheet are to be protected by a piece of rubber one-fourth of an inch thick. A convenient size is four inches square. While the assistant is exerting traction on the yarn rope the operator rotates and manipulates the femur in such a way as to direct the head into the acetabulum, at the same time directing the assistant as to the amount of traction to be exerted and the time of its application.

The **time** required to effect reduction varies with the age and conditions existing in the patient and the skill of the operator. Usually reduction will be effected in from ten to thirty minutes.

When the reduction is completed, it is necessary to **fix the leg** firmly in the position in which it was reduced. This, as already stated, is known as 'the frog position,' the thigh being flexed and strongly abducted.

Fixation.—This is best accomplished by plaster-of-Paris bandages. No attempt to improve upon the skilfully elaborated technic of Lorenz should, or need be, made.

A pair of stockinette or wool drawers is placed on the patient. Inside each drawer-leg should be inserted a strip of surgical roller bandage about three feet long. This is allowed to lie loosely inside the cast next to the skin and is used to give a daily dry rub as a substitute for a bath.

The child is raised and placed upon a convenient form of sacral support with the shoulders resting upon a small bench of sufficient height to correspond with the position of the pelvis (Fig. 128). Careful inspection will show that the head of the femur is in its proper place. The legs are held fixedly in position by a second assistant during the application of the bandages. Sheet cotton, such as is used by dress-makers, is applied around the leg and pelvis to a thickness deemed sufficient to protect the patient. This is compressed and made to fit snugly by the use of gauze bandages. The ends of the surgical roller bandage already referred to, are brought together as shown in figure 131. This is a convenient rubber that removes itching beneath the cast, and its use adds greatly to the comfort of the patient.

Plaster-of-Paris bandages, as used by Lorenz, are 6 inches wide

FIG. 128.—LORENZ METHOD. MODEL SHOWING THE USE OF THE PELVIC SUPPORT AND SMALL BENCH IN APPLYING PLASTER-OF-PARIS. This does not show the frog position in which a normal hip cannot be placed.

and 8 yards long. They are made of crinoline, into the meshes of which the best dental plaster has been rubbed by hand. These bandages are immersed in very hot water three at a time. When thoroughly wet, they are squeezed free from the excess of water and passed to the operator and assistant, who rapidly apply a sufficient number to embrace thoroughly the entire pelvis, thigh, and knee. The genitalia are completely covered in order to make the edges strong (Fig. 129). The seemingly unnecessary application of plaster is for the purpose of increasing the

About the third or fourth day the child, with the aid and encouragement of the nurse, should be taught to extend the knee. At first such movements will be resisted, but gradually the voluntary efforts will be successful and the leg will be brought to full extension. About the fifth day the child should be encouraged to get upon her feet and to attempt walking in the rather awkward position produced by the cast. Repeated efforts will be necessary, but in unilateral cases fairly

FIG. 131.—UNILATERAL CONGENITAL DISLOCATION OF HIP. Cast applied by Lorenz at Jefferson Medical College Hospital.

FIG. 132.—SAME AS FIG. 131. Showing manner of adjusting the body in walking, while maintaining the frog position of right leg.

good locomotion will be achieved in the course of a week. Bilateral cases take somewhat longer. When the reduction has been accomplished the more the patient uses the leg in walking, the better will be the ultimate result because of the action of the head in deepening the acetabulum and becoming more strongly fixed in its new position.

Radiograms are here shown to indicate the gradual changes in the position of the femurs in a case of bilateral dislocation in a child aged two years at the time of the reduction by Lorenz at the Jefferson Hospital, December 11, 1902. Figure 133 is a reproduction of a radiogram taken two months before reduction. The contrast between a normal and a dislocated hip in a unilateral case is well shown.

The first cast should be allowed to remain in position for a period

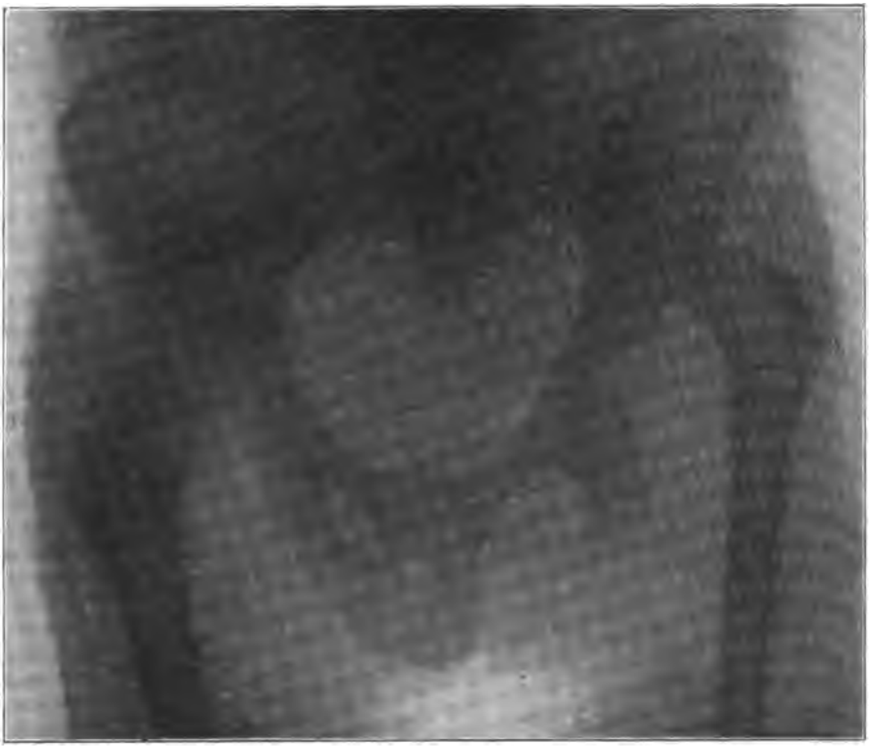


FIG. 133.—RADIOGRAM BY DR. GEORGE F. PHALER. Unilateral congential dislocation of hip, showing the contrast with the normal hip.

of six months (Fig. 135). Its removal can easily be accomplished by placing the patient in a bath-tub partially filled with warm water. After the plaster has become softened throughout, it can readily be cut with a John Ridlon plaster-of-Paris pocket-knife. The skin should be washed with soap and water and bathed with alcohol, great care being observed not to disturb the position of the hip. After the bath the second cast may be applied in the same manner as the first except for

FIG. 134.—RADIOGRAM BY DR. W. M. SWEET. Patient aged two years. Bilateral congenital dislocation of the hip. Operation done by Lorenz at Jefferson Medical College Hospital.

FIG. 135.—SAME CHILD AS IN FIG. 134. Radiogram by Dr. S. A. S. Metheney, six months after reduction by Lorenz.

the position of the leg, which should be brought down toward extension until arrested by slight resistance (Fig. 136). The careful exercise of judgment is required in deciding just how much change of position should be made, but ordinarily a little less abduction and a little less flexion can safely be secured. An attempt to secure too great a change of position may throw the head out of the acetabulum. Each change of the cast becomes a critical occasion; and it is often fraught with danger, only to be avoided by exercising great care and deliberation.

FIG. 136.—SAME CASE AS IN FIG. 134. Radiogram by Dr. W. F. Manges seven months after reduction by Lorenz. One side appears to be higher than the other, but this is caused by the position of the patient's body.

The second cast is to be allowed to remain in position for one month, when a further change of position with a new cast must be made (Fig. 137). The same method of treatment is continued until the leg is fully extended in its normal position. This result can usually be accomplished in about nine months (Fig. 138). With each change of position and cast, the activity and freedom of movement of the child are increased.

After the abandonment of the final cast **massage** of the legs, thighs, and gluteal region is desirable, preferably done by the operator. (See

Part I.) The development of the muscles should be encouraged by such forms of exercise and remedial movements as are indicated. (See Parts I and II.) During the first week of freedom from the restraint of the cast, the patient should not be allowed to stand or walk, since the muscles of the hip are incapable of safely sustaining the strain of unguarded movements. This condition soon passes away. The muscles that were torn or stretched at the time of the reduction must be trained to usefulness and co-ordination in their new relationship.

FIG. 137.—SAME CASE AS IN FIG. 134. Radiogram by Dr. W. F. Manges, eight months after reduction. Legs still everted and slightly abducted.

Dangers of the Operation

In cases in which there is excessive resistance it sometimes becomes necessary to resort to greater force than is indicated in favorable cases, in order to bring the head down to the acetabulum. This can often best be accomplished by the use of the yarn rope, to which reference has already been made. (See Fig. 127.) The danger is present of unduly tearing structures that have already lost the protection afforded by the muscles that must of necessity be torn or stretched. This clearly indicates the necessity for the exercise of great skill and care in the manipulations.

The femur may be broken or an epiphyseal separation take place, necessitating the postponement of manipulations until repair in proper position has been effected, when reduction may again be attempted. Necessarily it often presents greater difficulties than at first. The ischium may be broken in stretching strongly resistant hamstring muscles. These accidents, however, are unusual in dextrous hands when young and suitable patients are operated upon.

FIG. 138.—SAME CASE AS IN FIG. 134. Radiogram by Dr. W. F. Manges, nine months after reduction. Feet *not* everted, showing a perfect anatomical and functional cure. Patient's body is not lying perfectly straight, which gives the appearance of one hip being higher than the other.

Selection of Cases

The age suitable for correction ranges from one year to seven years in single dislocations, while in cases of double luxation the age limit is from five to six years. Occasionally in single dislocations the limit may reach nine years. It is important that the child should be taught cleanly habits before correction takes place. Otherwise constant soiling of the cast will render it unbearable, while constant wetting will render it soft and useless.

Prognosis

In over one thousand cases Lorenz obtained permanent anatomical cures in 60 per cent. of single luxations, while the percentage of functional cures is, of course, greater. In bilateral cases the percentage of successful operations is lower than in the unilateral form.

Obstacles to Success.—The principal factors that resist restoration and maintenance are alterations in the bones as well as changes in the fibrous and muscular structures about the joint. The longer a patient has been allowed to walk with these abnormal conditions existing, the greater will be the resulting structural abnormities. The head of the femur loses its normally round shape and becomes elongated or oblong. The neck also undergoes changes. The acetabulum becomes shallow or obliterated and may be filled with fibrous or cartilaginous material. The capsule is stretched, thickened, and contracted, assuming a condition known as hour-glass contracture. The ligamentum teres is elongated and thickened and sometimes by its size presents the only obstacle to restoration of the head to the socket. The muscles that are shortened are principally the adductor longus,—with the magnus and minimus often as additional factors,—the hamstring muscles, and the tensor vaginæ femoris.

Mortality.—The mortality is *nil* in patients of proper age and in suitable condition for the operation. The very few deaths that have occurred between the ages of one and seven years have been caused by the anesthetic or other conditions that would have produced a fatal result under almost any other procedure and cannot be taken as indicating that the operation is unduly severe.

The unforeseen dangers that may be encountered are illustrated by a case reported by Wilson and Rugh * with an elaborate autopsy by Coplin:

The patient, aged seven and one-half years, was the oldest of three children. She was never a robust child or a hearty eater, but seldom complained of illness. When nearing two years of age she began to walk, and the family physician, Dr. I. A. Fries, recognized dislocation of both hips. She was placed under various forms of treatment, including extension and braces, until March 10, 1902, when she was presented at the Orthopedic Department of the Jefferson Medical College Hospital. The hips were very freely movable, and on standing the femoral heads and trochanters stood out prominently. They could be drawn down to the acetabula but not opposite. Muscular control was good but the muscles were weak. There being no counterindication apparent, bloodless reposition was advised, and assented to by the parents after the dangers were outlined to them.

The patient entered the Jefferson Hospital on March 17th, and was operated upon the following day at eleven o'clock. As soon as abduction was made in the tearing of the adductors, the skin over these prominent muscles where mas-

* American Medicine, May 16 and 23, 1903.

sage was used began to tear, showing the low state of vitality present; but at the time the significance of this was not realized. The same thing occurred on both sides, and, moreover, wherever pressure was made by the hands, or means of reduction, a blue mark appeared.

While the hamstrings were being stretched something was heard to snap, and it was thought to be the tendons of the semitendinosus or semimembranosus muscles, but this was evidently when the ischium was fractured, although it did not seem like a bone breaking. When traction was made on the femur a tearing

FIG. 139.—RIGHT HIP-JOINT. A, thickened capsular ligament. B, capsular ligament at point of maximum thickening. C, ligamentum teres occupying the greater part of the acetabulum; the notable elongation is shown by the relaxed ligament extending to the head of the femur. D, the leader from D is over the line of fracture in the neck of the femur; the point of separation does not show, as it is covered by periosteum. E, fracture of ischium; the periosteum has been divided, showing oblique line of separation. F, second fracture of the ischium; the periosteum is intact and the line of fracture indicated only by the slight darkening due to subperiosteal hemorrhage.

sound was noted and was supposed to be the Y-ligament, but evidently the femoral neck was fractured instead, although it could not definitely be recognized at the time. After twenty-five minutes' work by both operators the head was thought to be placed on the acetabulum, as the leg could not be straightened at the knee, and this sign is given by Lorenz as the evidence of replacement.

The child's condition seemed good and it was decided to attempt the reduction of the left hip at once. No greater difficulties to reduction appeared in the left leg than were encountered in the similar stages with the right, but the skin likewise gave way over the adductor tendons. The strong resistance of the hamstring tendons induced the operators to cease further efforts after fifteen minutes, when it was realized that reduction by the bloodless method was impossible without unduly prolonging the manipulations that were made. It was decided to place the legs in the best possible position for the repair of the torn structures and subsequently to resort to the intermediary operation of cutting down upon the joint and stretching the capsule and removing such other obstacles as might be found.

The patient did not react and died twenty-two hours after the operation. In the light afforded by the very careful postmortem examination made by Dr. Coplin in the presence of the staff of the orthopedic department, it may be noted that this was a case in which replacement could not have been attained without removing the ligamentum teres, and that there was no way of predetermining the existence of the obstacles to the bloodless reposition (Fig. 139).

The main factor was the length and size of the ligamentum teres, which more than filled the acetabulum on each side, and therefore the sign which indicates reduction—that is, the slipping out of the head from the acetabulum as the leg is brought into an extended position—was absent. While this one factor, *i. e.*, the ligamentum teres, was sufficient to have prevented reduction, the very thick capsule was elongated and had a tendency to fold in between the head and the acetabulum, again preventing the clear sound that occurred in other cases when the head, it is believed, entered the acetabulum.

Just when or how the three fractures occurred it is impossible to determine, for while something was felt by the operators which was unusual, it did not suggest the breaking of bone, but closely resembled the tearing of fibrous tissue, and was so considered at the time of operation. The tearing sound was communicated to the operator who was holding the pelvis as well as to the one who was manipulating the left leg. It was a diffused sound and its origin could not be located. Twice this occurred, but a third fracture which was found postmortem cannot be accounted for. The bone-ends in all three fractures were in close apposition, clearly indicating that if death had not ensued, repair would have taken place in favorable position. That no fracture occurred on the left side is due to the fact that the attempt at reduction ceased in about one-half the time spent upon the right leg, in realization of the inexpediency of continued efforts. The torn skin over the adductor tendons was accepted as an indication of the low vitality of the patient, as this did not occur in any other case, although several patients had had ecchymotic spots of quite large size for varying periods of from one to two weeks.

As to the force used, it can only be compared with that used in other cases. It may fairly be characterized as skilful in application and of much less degree and shorter duration than in some of the other cases. The forcible manipulations appeared to be suitable to the conditions and there was no recognizable counter-indication. The previous condition of the child gave no distinct evidence of her deficient vitality, and it would seem as though the methods employed at reduction were less responsible for the death than the anesthetic; although the entire procedure must be considered.

The pathologic conditions found in the lungs and kidneys, which gave decided indications of very recent origin, could be caused by ether anesthesia for one and one-half hours. Pneumonia following ether is sufficiently common in cases in which the operative procedures are of a mild character. Whether acute nephritis is likewise a sequel of ether intoxication is still a disputed point with pathologists; but the evidence in this case is strongly affirmative.

CONGENITAL TORTICOLLIS

When the unnatural posture of the head is caused by a contracture of the sternocleidomastoid muscle of one side, this being the most frequent form, it may be corrected by appropriate manipulations.

The patient is placed on a suitable table in the recumbent position and anesthetized (Fig. 140). The operator grasps the head between his hands and turns the head so that the chin will point toward the shoulder of the affected side, rendering the muscle of that side tense. Additional corrective force will usually cause the contracted muscles to elongate. If this does not occur, the operator holds the head in the best possible position, as determined by the previous manipulations, while using forcible massage upon the muscle by kneading and hacking near its clavicular attachment. When sufficient correction has been obtained,

FIG. 140.—MANIPULATIVE CORRECTION IN A CASE OF TORTICOLLIS. The sternocleidomastoid is being stretched, while the assistant resists by holding the clavicle.

fixation is secured by the application of plaster-of-Paris with the head in a somewhat over-corrected position. This plaster cap should embrace the head except the face, the neck and shoulders, with a portion running under the axillæ.

Three or four weeks are ordinarily sufficient to obtain union of the torn portions of the muscle, when the plaster cap may be removed.

Developmental movements should be instituted to secure co-ordination of the muscles in their new relations.

The method is applicable to young children under seven years of age. In older patients the muscles are too resistant to tear without considerable risk of serious injury to the surrounding tissues.

FLAT-FOOT

Flat-foot offers a good field for corrective manipulations in overcoming the acquired ankylosis resulting from the long-continued altered positions in which the bones have been placed. It is manifestly impossible to induce muscular development around stiff joints. It is first essential to establish full motion preliminary to physical culture. Manual manipulations can be employed with great benefit in many cases (Fig. 141).

FIG. 141.—PATIENT WITH FLAT-FOOT, IN POSITION FOR CORRECTION BY MANIPULATIONS.

The heel is held fixedly between the thumb and index-finger, which are placed upon the lateral aspect of the os calcis, while at the same time the palm is pressed upon the posterior superior part of the bone. The other hand is used to draw down the toes and the distal extremities of the metatarsal bones. The thumbs should press upward under the middle of the arch of the foot. Very great force can quite easily be exerted in this manner, often beyond the patient's endurance. Alternate relaxation and application of corrective force will be most effective. This will gradually loosen the fibrous attachments that resist over-correction. No anesthetic is required except in severe cases, or when it is found difficult to obtain the co-operation of the patient.

FIG. 142.—PATIENT WITH FLAT-FOOT, SHOWING THE POSITION OF CORRECTION OVER THE OPERATOR'S KNEE.

Still greater manipulative force, when required, may be exerted upon a flat-foot by using the knee as a fulcrum as shown in figure 142. The operator's hands are placed on the posterior aspect of the os calcis and over the tarsometatarsal articulations, changing the direction of pressure as the exigencies of the case may demand.

In still more rigid cases far greater force can be exerted by resorting to the method of Dr. J. T. Rugh, whereby the supplemental force of the operator's legs is utilized in the position shown in figure 143. The hands are used to control the force and to add special features as the case may require. The right hand is used with fingers pulling on the outer aspect of the os calcis, while the wrist is pushed against the plantar surface of the foot. The other hand is used on the dorsum of the foot in such a manner as to assist in the correction of the deformity and in bringing about relaxation of the joints.

FIG. 143.—RUGH'S METHOD OF FORCIBLE CORRECTION OF FLAT-FOOT BY OPERATOR'S HANDS AND KNEES.

SCOLIOSIS

The field of corrective manipulations in scoliosis is extended, and the method obtains most satisfactory results when persistently carried out. The object sought is to overcome the acquired fixation resulting from the prolonged faulty position of the vertebral column and ribs, in order that the muscular system may be developed. The bare statement that muscles cannot be developed when the joints affected are rigid renders sufficiently clear the importance of primarily obtaining a spinal column that approaches the normal in its latitudes of motion.

The simpler **methods** of manipulation are as follow:

1. The patient is seated upon a chair without a back and, in the usual type, that with the convexity to the right, the left shoulder being depressed, the operator places his left hand upon the left side of the patient just below the scapula. In order to secure greater fixity of position of his hand, his elbow should be braced against his pelvis. With his right hand he grasps the patient's uplifted left arm close to the shoulder. In

of the patient by placing his left hand upon the left crest of the ilium, while his right hand is placed upon the right shoulder-joint of the patient and is used to guide the patient as she allows herself to bend laterally into the position shown in figure 146. This lateral bending is allowed gradually to increase in extent by the weight of the patient's head and arms until the maximum amount of lateral bending has been obtained. The operator now, with his hands still in the position that they formerly

FIG. 146.—SCOLIOSIS:—SECOND POSITION OF THE CORRECTIVE MANIPULATIONS OVER THE OPERATOR'S KNEE.

occupied, holds the patient and leans forward in such a way as to cause his right shoulder to press upon the left axilla of the patient, thus markedly increasing the lateral bending, and at the same time to produce rotation of the spine by carrying the patient's left shoulder further backward until her face looks directly upward. This position is well shown in figure 147. The operator's right hand under the patient's right shoulder controls the movements. This manipulation can be repeated two or three times a week. The intermissions are utilized by having the patient perform such gymnastic movements as will tend to this position he is enabled to apply direct corrective force in the manner clearly shown in figure 144. Very great force is not essential. It is the slow corrective force that obtains the best result. The patient's pelvis may be fixed to the chair, when needful, by means of a bandage. Ordinarily, however, it is sufficient for the patient's feet to grasp the legs of the chair.

FIG. 144.—SCOLIOSIS :—POSITION OF UPRIGHT CORRECTION BY MANUAL FORCE.

FIG. 145.—SCOLIOSIS :—FIRST POSITION OF THE MANUAL CORRECTIVE METHOD OVER THE OPERATOR'S KNEE.

2. A method applicable to still more rigid cases is that shown in figures 145, 146 and 147, in which the knee of the operator is used as a fulcrum, while the hands apply the power in correction. The patient is seated with the operator seated directly behind her. The patient raises both arms to clear the shoulder-blades from the field of pressure as well as to extend the spines by voluntary effort. The operator fixes the pelvis

increase the muscle force and co-operation, for further description of which see the article on scoliosis in Part I of this volume.

It is extremely rare for patients to complain of any pain or annoyance in the application of this method when the force is exerted slowly and gradually. Every movement is guarded and under the direct personal control of the operator. The method has marked advantages over any of the more or less cumbersome mechanical appliances that are

FIG. 147.—SCOLIOSIS:—THIRD POSITION OF THE CORRECTIVE MANIPULATIONS OVER THE OPERATOR'S KNEE. The operator's right shoulder is making downward pressure upon the patient's left shoulder.

used for this purpose, in that the operator can feel with his hands and shoulder just what is being done, and instantly relax, or in his judgment carry the manipulations still further.

The one **disadvantage** lies in the endurance required of the operator; for although the force exerted in obtaining correction is not very great, that necessary to carefully maintain the position of the patient may be a severe tax.

BOW-LEGS

The very soft condition of the bones in young children who have acquired bow-legs and other distortions of the lower extremities renders them susceptible to easy correction by mechanical force exerted by the hands of the operator. No great difficulty is encountered as a rule. It is not usually necessary to employ an anesthetic, as the operator can soon win the confidence of a child and apply the corrective force that

FIG. 148.—MANUAL CORRECTION OF BOW-LEGS OVER THE OPERATOR'S KNEE.

is necessary to overcome the deformity without producing pain or losing the co-operation of the patient.

A convenient method of applying force to bow-legs is that in which the operator uses his ligamentum patellæ as the soft fulcrum against which the greatest convexity of the bow-leg is placed (Fig. 148). His hands placed one at the knee and the other at the ankle apply gradually such force as may be required to overcome the bow and over-correct the deformity. This can usually be accomplished without fracture, and often without even tearing the periosteum or other fibrous material.

The bones are sufficiently soft to yield very easily and the legs can be placed in almost any position that the operator desires. Occasionally shortening of the tendo Achillis is present, when it may be necessary to stretch the muscle; but it is rarely, if ever, necessary to resort to tenotomy in order to obtain sufficient elongation of the gastrocnemius.

Another convenient method of accomplishing the same result is that in which the ordinary surgical roller bandage is used as a fulcrum, the hands being used in very much the same lines of force as already described (Fig. 149). This is particularly applicable to older and more resistant cases. It is not generally necessary to resort to fixation appliances of any kind for correction in mild cases. The patient should be encouraged to run about naturally and normally, thereby increasing the general health and strength.

FIG. 149.—MANUAL CORRECTION OF BOW-LEGS OVER A SURGICAL ROLLER BANDAGE.

In the more severe cases it occasionally happens that a greenstick fracture is produced, when it will become necessary to resort to plaster-of-Paris for three or four weeks until sound union has been obtained.

The legs will naturally have a tendency to bend again upon use unless prevented by the application of steel braces in such form as the individual requirements of the case demand.

The great advantage to be obtained by this method is the entire correction of the deformity throughout the length of the bones instead of producing a fracture by which the long previous curve seems to receive correction, but only through the production of two shorter curves united at the point of break. Usually the best results are obtained by the repeated application of corrective force without anesthesia during a period of three or four weeks.

CLUB-FOOT

Manual force, rightly, skilfully and persistently applied, will give far better ultimate usefulness of the foot in cases of talipes than can be attained by any other corrective measure. The dangers lie, however, in modifying the shape of the still very soft bones of the tarsus by the use of undue pressure. The occurrence of cicatrices made by tenotomies may often be avoided, and the more or less extensive atrophy of the muscles from disuse that is associated with the application of many forms of braces will be avoided. After the application of the force a few times by himself, the operator may usually instruct the mother in such way that she can readily apply this force from time to time during the day, very much to the advantage of the child. The hearty and intelligent co-operation of the mother is of greater importance than would appear to those unfamiliar with the details of such cases. To obtain this co-operation means ultimate success, and perhaps the failure to secure it may often account for the incomplete corrections seen in adult life. It is of primary importance that in making corrective manipulations upon the feet the knee of the leg operated upon should be flexed to very nearly a right angle to prevent rotation of the hip instead of correction at the tarsus (Fig. 150). The child is seated upon the mother's lap with the knee bent. The operator is seated directly opposite. Assuming that the left foot has equino varus, the operator places his right thumb above the external malleolus, while his fingers grasp the internal aspect of the os calcis and, during the process of subsequent manipulations, are enabled to overcome the varus condition of the heel. His left hand is used in such a manner as to keep the toes and metatarsal bones all in their parallel relationship with each other. His thumb placed on the dorsum of the foot still further aids in maintaining the correct relationship of these long bones of the foot. With his hands in the position shown and described in figure 150 he is enabled to

FIG. 150.—MANUAL CORRECTION OF CLUB-FOOT. Patient showing right method of holding foot for manipulations of the varus. The knee is flexed.

over-correct the foot as to its varus, and also by changing the direction of motion to overcome its equinus. If the equinus is of more marked degree, it may be necessary for him to change the position of his hands as shown in figure 151, so that his left hand will firmly grasp the leg just below the bent knee. His right hand with the fingers under the plantar surface of the foot are used to bring the foot into a position of dorsal flexion, in which he is materially aided by his right thumb placed over the dorsal aspect of the astragalo-tibial articulation.

Fig. 151.—Correction of Club-foot:—Method of Holding the Foot for Corrective Manipulations of the Equinus. The knee is flexed.

In figure 152 an erroneous position of the hands of the operator is shown. The disadvantage lies in its inefficiency and in the pain that is given to the patient. The leg is extended, the left hand grasps the leg below the knee which must make very extensive pressure on the fibula and tibia in order to prevent rotation when force is applied to the foot. This is unnecessarily painful, and is otherwise objectionable. The right hand of the operator has the patient's foot in his grasp in such a way as to bring all the toes closer together, thereby changing their normal relationship with each other. Any corrective force applied with the foot so grasped would be inefficient because of the change in the position of the long bones of the foot, and it would likewise be unnecessarily painful to a child not anesthetized.

Fig. 152.—Incorrect Method of Holding the Foot for Manipulative Correction of Club-foot. The knee is extended, allowing the hip to rotate, thus destroying the corrective effects upon the foot.

ANKYLOSIS

In no field of work is a correct diagnosis more important than in ankylosed joints about to be submitted to manipulative methods for correction. Not alone should precise knowledge be obtained as to whether or not there is bony ankylosis, but it is likewise necessary to know definitely what pathologic process has caused the loss of mechanical function. Joints that have become ankylosed from tuberculous disease can be subjected to traumatism in breaking up ankylosis only at the serious risk of relighting the former tuberculous process, or of breaking or tearing structures that are soft and not capable of withstanding the force. Such cases are therefore unsuitable for correction by manipulative methods. On the other hand, joints that have become rigid from acute inflammatory processes are capable of obtaining more or less ex-

FIG. 153.—MANIPULATIVE CORRECTION OF ANKYLOSIS OF THE SHOULDER. Model showing Rugh's method of fixation of the scapula.

tensive latitude of motion when such methods are resorted to for the purpose of breaking up inflammatory adhesions and bringing about conditions favorable for the establishment of muscular co-operation.

Prolonged general **anesthesia** is not often necessary; when the manipulations are painful or the patient resists unduly the corrective movements, ethyl bromid or nitrous oxid with oxygen may be employed cautiously.

The method of fixation of the **shoulder** shown in figure 153 was, I believe, originated by J. T. Rugh, in 1891. The scapula is fixed by the right thumb of the assistant, while the outer border is held by means of the clasped hands under the armpit of the patient. In this position the patient is held firmly against the assistant's body while the operator, with his left hand placed upon the left shoulder of the patient, proceeds to make corrective manipulations by means of his right hand grasping the bend of the elbow. The arm may be carried to a full position of acquired extension, forward bending and backward bending, followed by rotation approaching as closely as possible the normal motions of the joint. The extent to which manipulative measures may safely be

FIG. 154.—MANIPULATIVE CORRECTION OF ANKYLOSIS OF THE ELBOW. Model showing the position of the pad beneath the humerus and the positions of the hands of the operator and assistant.

carried in any individual case can only be determined from the operator's knowledge of the resistance, its character, and the manner in which it yields to the skilful force which he will apply or wishes to apply when he finds that the conditions render it necessary.

In applying correction (Fig. 154) to break up adhesions of an ankylosed **elbow,** the entire humerus should be supported by a thick soft pad arranged in such a manner as to allow the joint to be free, so that the olecranon will not be pressed upon when full extension of the arm is obtained. The assistant places his right hand upon the head of the humerus, making downward pressure; while with his left hand he grasps the lower end of the humerus as close to the joint as he can without interfering with the manipulations of the operator. The operator's hands are employed as follows: The right hand grasps the wrist-joint and applies a great amount of leverage force, aided and controlled by his left hand placed close to the elbow.

When increased flexion is attempted, the assistant should apply resistant force with his left hand close to the elbow of the patient. When the operator makes extension of the arm, the assistant will resist with his right hand upon the upper end of the humerus. When the operator applies rotation, the assistant will resist by both hands grasping the humerus.

The most convenient method of manipulating an ankylosed **wrist** is that shown in figure 155, in which the elbow is flexed to a right angle, the forearm grasped by the operator's left hand as close to the wrist as possible without impeding its movements. The operator's right hand grasps the patient's hand with the fingers slightly flexed and proceeds to make motions in the line of flexion and extension, applying such force as his judgment dictates in obtaining an approach to normal function.

FIG. 155.—MANIPULATIVE CORRECTION OF ANKYLOSIS OF THE WRIST. Model showing the position of the hands of the operator.

The **hip** is the most difficult joint in the body upon which to apply corrective measures in cases of ankylosis. This is due, first, to the long lever of the femur; and, second, to the great difficulty in fixing the pelvis of the patient so as to prevent motion thereof when the femur is moved in various directions. A very convenient method of securing this end is that shown in figure 156, in which the patient is placed recumbent, with his buttocks at the end of a table. A protecting pad is placed over each anterior superior spine, and a broad strong surgical bandage is so applied as to bind the pelvis firmly to the table. Parts of the bandage must pass over the pubes and down under the end of the table in the form of a T in order to facilitate still further the fixation of the pelvis. When this bandage is applied in the manner described and with very great firmness, an assistant is needed only for the purpose of holding the sound leg of the patient, thereby assisting somewhat in the fixation of the pelvis. The operator places his left hand anteriorly upon the hip so as to locate the force which he will apply with his right hand placed underneath the lower end of the femur, the knee being allowed to flex. In this position he is enabled to make increased flexion to such limit as may be possible. Further extension is obtained by reversing the posi-

FIG. 156.—MANIPULATIVE CORRECTION OF ANKYLOSIS OF THE HIP. Model showing method of fixing the pelvis to the table and the positions of the operator and assistant.

tion of the operator's right hand; but this is usually very easily done after a considerable amount of increased motion in flexion has been obtained. Rotation of the joint will be obtained by placing the operator's left hand upon the patella and with his right hand grasping the ankle of the patient, the knee not being flexed. Internal and external rotation and circumduction to such limit as is possible without the use of undue force may thereby be produced.

FIG. 157.—MANIPULATIVE CORRECTION OF ANKYLOSIS OF THE KNEE (FLEXED). Model showing position on the table and the action of the hands of the assistant. Increased extension is about to be made, which will elevate the lower end of the femur.

FIG. 158.—MANIPULATIVE CORRECTION OF ANKYLOSIS OF THE KNEE (EXTENDED) (MODEL). The hands of the operator are placed for increased flexion, thereby forcing an elevation of the upper end of the femur which the assistant resists.

In ankylosis of the **knee** the patient lies recumbent with the popliteal space resting upon the end of the table. A large soft pad prevents injury to the popliteal vessels. An assistant maintains fixity of the position of the femur by such disposition of his hands as is shown in figure 157. The operator controls the corrective force with his left hand upon the knee, while the extensive leverage of the leg is used by his right hand grasping the ankle. When the operator produces increased flexion, the upper end of the femur will be thrown upward unless controlled by the assistant's left hand. In making still further correction in the line of extension the assistant must hold the lower end of the femur in position with his right hand. This, possibly, is still more clearly shown in the change of position of the hands of the operator and his assistant in figure 158. The leg being in a position of extension and about to be flexed, the operator is about to make downward pressure on the ankle of the patient while he resists with his left hand placed underneath the knee of the patient. The assistant is resisting this movement in the femur by the position of his left hand.

FIG. 159.—MANIPULATIVE CORRECTION OF ANKYLOSIS OF THE ANKLE. Model showing position over end of table with a pad to protect the back of the leg, and the manner of holding the foot and ankle.

Ankylosis of the **ankle** is under the control of the operator without the necessity of an assistant. (See Fig. 159.) The end of the bed is guarded by a soft cushion on which rests the posterior aspect of the leg. The operator's left hand grasps the ankle just above the malleoli in such a manner as not alone to resist the force which he is going to exert, but also to localize its application in the ankylosed joint. His right hand grasps the metatarsal bones, enabling him to make upward pressure or dorsal flexion and lateral motion as may be required. If further efforts are needed in the line of plantar flexion, he changes the position of his hand by placing it upon the dorsum of the foot.

PHYSICAL METHODS EMPLOYED IN OPHTHALMIC THERAPEUTICS

BY WALTER L. PYLE, A.M., M.D.,

ASSISTANT SURGEON TO THE WILLS EYE HOSPITAL, PHILADELPHIA; ASSOCIATE MEMBER OF THE AMERICAN OPHTHALMOLOGICAL SOCIETY; FELLOW OF THE COLLEGE OF PHYSICIANS OF PHILADELPHIA, ETC.

AMETROPIA

The now almost universal recognition of the part often played by **asthenopic reflexes** in the causation of chronic ill health, no less than the great progress recently made in the treatment of ocular anomalies by physiologic and physical methods, render it desirable to present for the nonspecialist a brief outline of these methods, together with simple means for the detection of visual and oculomotor affections. Especial attention has been given to the diagnosis and correction of errors of refraction and the treatment of muscular imbalance and amblyopia by orthoptic and visual exercises.

Refraction of the Eye

In order to effect perfect vision all rays of light proceeding from a distant object and entering the eye at rest must pass through the refractive media and be united exactly on the retina. An eye in which the refracting surfaces (the anterior surface of the cornea and the anterior and posterior surfaces of the lens) and the intraocular media (the aqueous, crystalline, and vitreous humors) fulfil this condition is normal and is called **emmetropic.** In such an eye distinct, reduced, inverted images are formed on the retina. Any fault in the dioptric system of the eye causes a blurring of the image by the formation of circles of dispersion or diffusion. An eye not having the power to unite accurately on the retina all rays of light from an external object is called an **ametropic** eye.

Emmetropia is the condition in which the eyeball is normal. In the schematic diagram (Fig. 160) *E* represents the posterior surface of the emmetropic eye, wherein the rays of light are focused at *a*, a point exactly on the retina.

Hyperopia is a condition in which the eyeball is too short or the refracting media are too weak, and the rays of light focus behind the retina. In the hyperopic eye (Fig. 160, *H*) the rays are focused behind the retina and a blurred image is formed in front of the focus at a_1. Hyperopia is corrected by a convex lens, which converges rays of light and shortens their focus (Fig. 161).

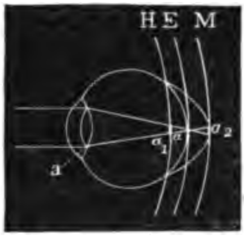


FIG. 160.

Myopia is a condition in which the eyeball is too long or the refracting media are too powerful, and the retina is behind the focus (*M*, Fig. 160). Here a blurred image is formed at a_2 behind the focus. Myopia is corrected by a concave lens, which diverges the rays and thus prolongs the focal distance (Fig. 162).

Astigmatism is a condition in which the focus of the eyeball may be either in front of or behind the retina, or both, but by different amounts for two or more meridians of the eye. In figure 163 the meridian V V is normal, focusing at V′ exactly on the retina. The meridian at right angles, H H, is hyperopic, focusing at H′, behind the retina. In this condition a point of light is focused as a blurred line. Astigmatism does not depend on the length of the eyeball, but on the curvature of the cornea or rarely that of the crystalline lens. Astigmatism is corrected by a cylindric lens (Fig. 164) with its axis at right angles to the faulty meridian (Fig. 165).

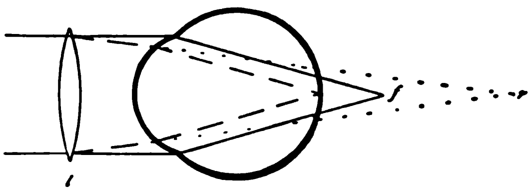


FIG. 161.—DIAGRAM SHOWING A HYPEROPIC EYE FOCUSING PARALLEL RAYS OF LIGHT AT *f*, BEHIND THE RETINA; AND *l*, THE CONVEX LENS, WHICH, CONVERGING THE RAYS TOWARD *r*, CAUSES THEM TO BE FOCUSED EXACTLY ON THE RETINA, THUS CORRECTING THE HYPEROPIA.

Accommodation.—Rays of light coming from a distant object—that is, beyond six meters (20 feet)—may be considered, for practical purposes, as parallel, and the normal eye at rest gives them such convergence that they are brought to an exact focus on the layer of rods and cones in the retina. Rays from a nearer object approach

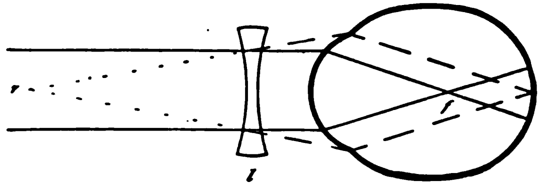


FIG. 162.—DIAGRAM SHOWING A MYOPIC EYE FOCUSING PARALLEL RAYS AT *f* IN THE VITREOUS; AND REQUIRING THE CONCAVE LENS *l*, WHICH WILL CAUSE THEM TO DIVERGE AS FROM *r*, IN ORDER THAT THEY SHALL BE FOCUSED EXACTLY ON THE RETINA.

the eye with a divergence so considerable that they cannot be focused on the retina by the simple refractive properties of the dioptric system of a normal eye. However, to obviate this difficulty the eye has the faculty of increasing its refractive power in order to give increased convergence to the rays coming from a near object, and this change in the eye is called **accommodation.** By means of accommodation all reading, writing, sewing, and other near work is made possible. Again, by accommodation, hyperopic and astigmatic persons below middle age are enabled to secure useful vision with their optically defective eyes. The power of accommodation is greatest in early life and gradually diminishes until about the age of forty, when reading, writing and close work at the ordinary distance, become uncomfortable. At about seventy-five years the accommodation is practically lost.

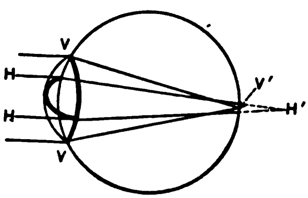


FIG. 163.—THE COURSE OF RAYS IN SIMPLE HYPEROPIC ASTIGMATISM. H H pass through the hyperopic meridian.—(*Thorington.*)

Mechanism of Accommodation.—It is commonly believed that accommodation is effected in the following manner: The ciliary muscle contracts, thus relaxing the suspensory ligament of the lens and allowing the inherent elasticity of the lens to act and push forward the anterior surface, which, by becoming more convex, increases its refractive power. The posterior surface of the lens scarcely alters in shape. This view is not accepted by Tscherning, who maintains that the ciliary muscle in contracting increases the tension of the suspensory ligament, and thus induces bulging of the lens anteriorly outward, and hardly at all toward the periphery. However, all theorists believe that ciliary contraction is the important factor in accommodation, although they may differ as to its mode of action. Associated with the act of accommodation is a simultaneous contraction of the pupil. The elastic power of the lens is due to a peculiar watch-spring arrangement of its fibers. Figures 166 and 167 represent the condition of the eye at rest and during accommodation.

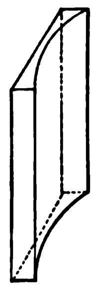


FIG. 164.—CYLINDRIC LENS.

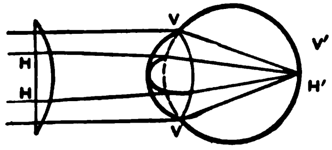


FIG. 165.—CORRECTION OF THE RAYS H H BY A CYLINDRIC LENS.

Asthenopia (Eye-strain)

Few eyes are optically perfect, yet most persons below middle age with a moderate degree of hyperopia or astigmatism have apparently normal vision both for distant and nearby objects. By constant use of the ciliary muscle the crystalline lens is so altered in shape that the optic defects of the eye are corrected. It is because of this compensatory ciliary strain that the use of some cycloplegic drug such as atropin or homatropin is necessary before testing patients below middle age for correcting lenses. So long as the power of accommodation remains, vision is not markedly disturbed. However, if the subject's occupation is confining, if the general health fails, if the laws of personal hygiene are ignored, and particularly when there is a neuropathic tendency, the incessant nervous loss in continued ciliary strain produces a chain of local or reflex symptoms collectively known by the term **asthenopia.** Myopic

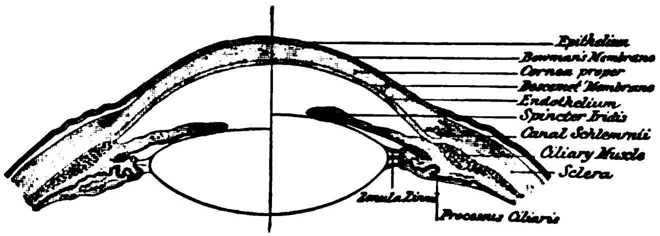


FIG. 166.—COMPARATIVE DIAGRAM SHOWING THE CHANGE IN THE SHAPE OF THE CRYSTALLINE LENS DURING ACCOMMODATION. THE LEFT SIDE SHOWS THE LENS AT REST.

subjects are not free from asthenopia, as they are usually astigmatic or anisometropic as well, or the focal distance of their eyes is so short as to necessitate great strain on the muscles of convergence in close vision.

Asthenopic Reflexes.—As a causative factor in the production of headache, eye-strain is most important. Anorexia, dyspepsia, constipation, heartburn, nausea and repeated attacks of vomiting represent some of the gastric reflexes. Amenorrhea and dysmenorrhea are menstrual anomalies sometimes caused by eye-strain. Insomnia, nightmare, chorea, nocturnal enuresis and even epileptiform seizures have owed their existence and perpetuation to uncorrected eye-strain in some form. The multiformity of the effects of eye-strain can be thoroughly realized only when it is understood how vital the function of vision is to every act, emotion, and thought. The visual apparatus is in the closest connection with the other higher nervous mechanisms, and the slightest disturbance of the visual portion may produce irritation in the entire motor, sensory, and psychic systems. Happily, the manifold effects of eye-strain, so long ignored, are now being appreciated and recognized.

Local Symptoms of Asthenopia.—Besides the reflex symptoms, which are often remote and only brought out by careful questioning, the patient complains of inability to read or sew for any length of time; the print runs together, there is heaviness of the lids, and often excessive lacrimation. Local congestion soon produces conjunctivitis or blepharitis. It is needful to examine the refraction in all cases of chronic conjunctival and palpebral inflammations, instead of carelessly dismissing the patient with a time-worn formula for an ointment or a lotion. So long as uncorrected ametropia exists, there will be recurring attacks of inflammation. It is believed by many oculists that long uncorrected eye-strain is a prominent factor in the causation of many cases of simple chronic glaucoma and senile cataract.

A peculiar law in asthenopia is that the local or constitutional reflex symptoms are in direct proportion to the debility or neurotic tendency of the patient. A vigorous man may, by accommodative and muscular effort, overcome ametropia to such a degree as entirely to mask the condition and such a patient may pass all his life without experiencing a single uncomfortable reflex symptom; on the other hand, a nervous schoolgirl or a neurasthenic woman may suffer the severest headache or be the victim of anorexia, nausea, dyspepsia and other constitutional disturbances, from the slightest astigmatic error. There is also sometimes noticed an **interchangeability of reflexes.** When the vision continues normal in spite of ametropia, reflexes are present; if the vision suffers, reflexes are less conspicuous. Intense local symptoms are also usually unattended by severe reflex symptoms and vice versa.

Presbyopia or old-age sight is the physiologic failure of accommodation beyond the point of comfortable reading. Every person over forty-five years with normal or hyperopic eyes should wear lenses for reading and other close ocular work. Presbyopia is corrected by convex lenses which must be strengthened every few years. The presbyopic correction must be used in addition to any distance-correction. Old persons cannot wear the same lenses for distance and for near, and must employ two pairs of lenses or the bifocal lenses (Fig. 176). Myopic persons, although unable to see distinctly at a distance, may be enabled, by their increased refractive power, to read without lenses in old age.

The Diagnosis of Eye-strain.—Inasmuch as the effects of uncorrected ametropia are so manifold, while the connection between cause and effect is so often obscure, it is desirable to have, for use by those who do not possess or need the elaborate armamentarium of the oculist, some ready means of diagnosticating eye-strain or of eliminating its influence in a troublesome case; particularly if there be present any of the symptoms known to be associated with asthenopia.

The following is a simple plan of procedure in such cases:

The only articles required are: (1) A series of **test-letters** so arranged that they subtend an angle of five minutes at varying distances from 20 to 200 feet—6 to 60 meters. (2) A **reading-card** of type whose letters subtend the same angle at shorter working distances. These cards may be procured for a merely nominal sum at any optical store. Samples of the ordinary test-types are shown in the folded sheets following page 394, the numeration being in feet instead of meters.

The large card of test-letters is fastened to a hook or nail about 6 feet —2 meters—from the floor, and 20 feet or, roughly speaking, 6 meters, from the chair in which the patient is seated. The letters of the 20-foot (6-meter) line are about on the level with the patient's eye. The card must be well illuminated by daylight or artificial light. The 20-foot (6-meter) distance is not necessary, a somewhat closer range will answer, but in this case it must be borne in mind that the patient should read correspondingly smaller letters. Each eye should be examined separately. Pressure upon the covered eye should be avoided, and both eyes should be kept open during the tests.

The patient being seated facing the card, his attention is directed to the test-letters. Covering the left eye with a small card, one asks him to read on the card as low down as possible, keeping both eyes open. Note is made of the lowest line read correctly or nearly so. Then the right eye is covered and the left tested in a similar manner. To register the findings we use 20 as the numerator and the number indicating feet, at the side of the lowest line read, as the denominator. This gives the visual fraction. For instance, if the line marked 40 (that is, consisting of letters subtending an angle of five minutes at 40 feet—12 meters) is the lowest one read by the patient, his visual fraction is $\frac{20}{40}$. The symbol $\frac{20}{20}$ indicates normal visual acuity; any fraction below $\frac{20}{20}$ indicates defective vision. In case meters are used instead of feet on the test-card the numerator will be 6 and thus $\frac{6}{6}$ will be the symbol for normal visual acuity.

It must be borne in mind, however, that the mere fact of the patient's reading the $\frac{20}{20}$ or $\frac{6}{6}$ line is no assurance of the absence of refractive error. He may be hyperopic and astigmatic (if he is young, to a very considerable extent) and still read the $\frac{20}{20}$ line by means of accommodative effort. Indeed, as already explained, it is this extra strain of accommodation that causes the distressing asthenopic symptoms. To determine definitely, examination under mydriasis is necessary. If the patient already wears glasses and with them cannot read with each eye separately $\frac{20}{20}$, he should consult an oculist. If there is considerable discrepancy of vision in the two eyes, there is great likelihood of eye-strain.

When the symptoms cannot be traced to any other cause, especially if the patient uses the eyes excessively or viciously, or when the symptoms are referred to the eye, even though the vision appear to be normal, or to be properly corrected with glasses, the physician should put one drop of homatropin solution (2 grains to the fluidram—0.15 gram to 5 c.c.) into one eye every five minutes for an half hour. If the vision then falls to any great extent, the patient is ametropic; he is probably a simple hyperope, or is hyperopic and astigmatic. Persons who are simply myopic see nearly as well at a distance under a mydriatic as with the accommodation functional.

To determine the visual acuity of illiterate patients, a card containing characters like E ш m may be used. The patient is asked to tell which way the prongs of the E point—upward, downward, to the right or to the left. For very young children white ivory balls or marbles from ½ inch to 1½ inch in diameter may be used; if at from 15 to 20 feet distance (4 to 6 meters) the smallest ball is approached swiftly and promptly, vision is nearly normal.

.50 It is best to pay in your land a skillful gardener, or to buy good sense applied to gardening; in your sailor, good sense applied to navigation; in the house, good sense applied to cooking, sewing, serving; in your agent, good sense applied to accounts and affairs. So do you multiply your presence.

FIG. 167.—READING TEST-TYPE.

When the patient is young or is not compelled to use the eyes in his daily vocation and complains of persistent eye-pain or headache untraceable to other causes, the eyes should be put at rest under atropin for ten days and tested. This is accomplished by the instillation three times daily for two days of one drop of a suitable solution of atropin (1 grain to 2 fluidrams—0.06 gram to 8 c.c.) into each eye. If the vision falls under the mydriasis, or if the symptoms are relieved, the diagnosis of eye-strain is positive.

Testing Accommodation.—The small reading test-card is brought slowly up before each eye separately, the other being covered, and the patient is told to fix his gaze on the smaller reading type (Fig. 167). If he is younger than twenty-one, he should be able to read it easily at from 4 to 5 inches (say 10 to 13 centimeters) distance, otherwise he is considerably hyperopic or has some special disturbance of the ciliary muscle and his case is one for a specialist. If the patient is middle-aged and cannot see the fine type easily at 10 to 12 inches (say 25 to 30 centimeters), he is either presbyopic or hyperopic, and is in need of reading lenses. When there is a difference in the reading-power of the two eyes, the case is especially one for an oculist. If the patient has very poor distant vision, but can read the type easily at 5 inches (13 centimeters), he is myopic. If the patient is already wearing reading lenses and the type cannot be read easily with each eye at 10 to 12 inches (say 25 to 30 centimeters), his lenses are not strong enough. If he cannot read the 0.50 type with his lenses at a distance of at least 14 inches (35 centimeters), his glasses are too strong.

REFRACTION OF LIGHT

Prisms

When, as in a prism, the two sides of a refracting medium are not parallel, the refracted rays do not emerge in a direction parallel to the incident course. In the case of a prism they are bent toward its base, both at the incident and emergent surfaces. In figure 168 the ray *D M* falling on the prism *A B C* at the point *M*, instead of pursuing the direction of *M H*, is bent toward the base of the prism *B C*, and assumes the direction *M N*. It is again deflected toward the base at *N* and takes the direction *N E*, and an observer placed at *E* would receive the ray as if it came from *K*.

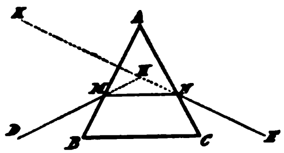


Fig. 168.

Lenses may be considered as a juxtaposition of prisms with different refracting angles (Fig. 169). Convex lenses are equivalent to prisms with their bases placed together, *A;* and concave lenses, to prisms with their apices placed together, *B.* Therefore, rays of light, always being deflected toward the base of a prism, will be rendered convergent by convex lenses, in which the prismatic bases are central; and divergent by concave lenses, in which the prismatic bases are peripheral.

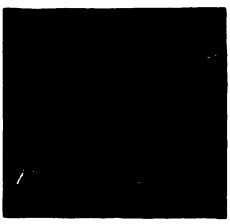


Fig. 169.—Diagram Showing Prismatic Values of Convex and Concave Lenses.

Spheric lenses are used in ophthalmology in six different forms (Fig. 170):

1. **Biconvex,** segments of two spheres having two convex surfaces.
2. **Planoconvex,** the segment of a sphere, having a plane surface on one side and a convex surface on the reverse side.
3. **Concavoconvex,** or converging meniscus.
4. **Biconcave,** having two concave surfaces.
5. **Planoconcave,** having on one side a plane surface and on the reverse side a concave surface.
6. **Convexoconcave,** or diverging meniscus.

A **cylindric lens** is a lens with a plane surface in one axis, and a convex or a concave surface in the axis at right angles to it. This form of lens is really a segment of a cylinder (Fig. 171). A cylinder refracts rays of light only in the meridian at right angles to its axis, while a spheric lens refracts rays of light in every meridian.

The **spherocylinder** is a combination of a sphere with a cylinder, and is used in cases of compound or mixed astigmatism in which there is a different refractive error in the two principal meridians of the eye.

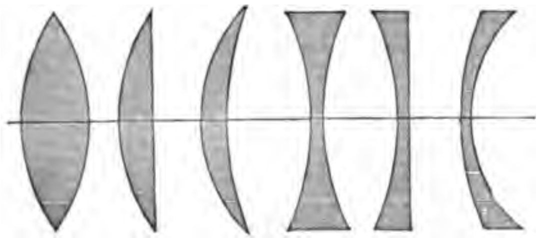


Fig. 170.—Different Forms of Spheric Lenses. 1. Biconvex lens. 2. Planoconvex lens. 3. Concavoconvex, or convergent meniscus. 4. Biconcave. 5. Planoconcave. 6. Convexoconcave, or divergent meniscus.

The **cross-cylinder** is a form of lens made up of two cylinders with their axes at right angles to each other. It is seldom prescribed, but is occasionally used in making tests.

Designation of Lenses.—Lenses are numbered according to their focal distance, the strength of a lens being inversely as its focal length. The metric or **dioptric** system of numbering lenses is now in general use. The unit is a lens having a focal distance of one meter, which is called a lens of one diopter (D.) strength—a comparatively weak lens. A two-diopter lens is one having half the focal length of the one-diopter lens, or 0.5 meter. Decimals are used in prescriptions, a lens of a focal length of four meters being a 0.25 D. lens, and so on.

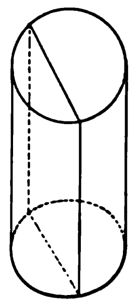


Fig. 171.—Cylindric Lens.

The right eye is designated by R., R. E., or O. D. (oculus dexter), and the left eye by L., L. E., or O. S. (oculus sinister). Both eyes are generally designated by B. E. or O^2. The convex spheric lenses are designated +S. or +Sph., and the concave spheric lenses, —S. or —Sph. A convex cylindric glass is designated +C. or +Cyl., and a concave cylindric glass, —C. or —Cyl. The combination sign $\supset\!\subset$ and the diopter (D.) are superfluous, as they are understood. Ax. indicates axis. The degree mark for the axis angle is not necessary in ordering cylinders. To illustrate the various forms of prescriptions, examples of each are given on page 373.

The **methods of determining the refraction of the eye** are by the test lenses, retinoscopy, ophthalmometry, and ophthalmoscopy. With intelligent patients, no method equals the use of the test lenses. For children and illiterate adults retinoscopy is of the greatest value.

ILLUSTRATIVE PRESCRIPTIONS FOR LENSES

Simple Hyperopia R., + S. 1.25	*Simple Hyperopic Astigmatism* R., + C. 1.50 ax. 90	*Compound Hyperopic Astigmatism* R., + S. 1.00 + C. 1.25 ax. 90
Simple Myopia L., — S. 1.25	*Simple Myopic Astigmatism* L., — C. 1.25 ax. 180	*Compound Myopic Astigmatism* L., — S. 1.00 — C. 1.25 ax. 180

Mixed Astigmatism
R., + S. 1.00 — C. 1.50 ax. 180

Fitting of Spectacles and Eye-glasses.—This is a most necessary adjunct to the art of ophthalmology. Spectacles should always have stout temple-pieces, to maintain their shape, and stay in proper position by their weight. To prevent jarring while walking or running, the side-pieces should fit closely to the face and temples; in fact, it is sometimes preferable that they should exert sufficient pressure to make a slight groove in the skin. By this means a definite and fixed support is given. Fourteen-karat gold is the best material. Next to gold, stout steel should be given preference. Although silver and aluminum do not rust, they cannot be made of sufficient rigidity. Delicate wires, either of gold or steel, should not be accepted, as they can only maintain their position by uncomfortable pressure behind the ears and on the nose. Hooks are preferable to straight temple-pieces when the lenses are to be worn constantly. Reading-glasses are sometimes more convenient with straight side-pieces, particularly for women, on account of the abundance of hair about the temples.

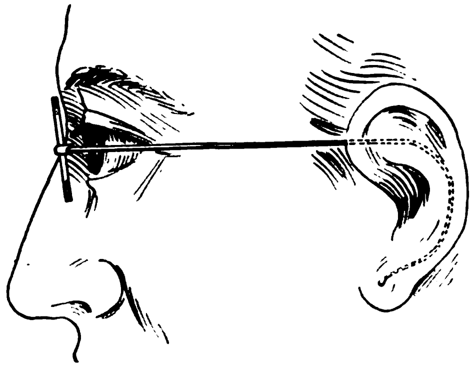


FIG. 172.—SPECTACLES PROPERLY ADJUSTED.

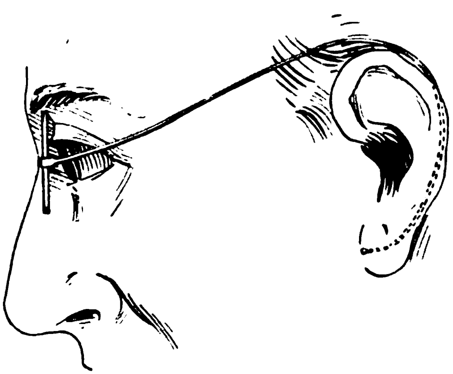


FIG. 173.—IMPROPERLY FITTED SPECTACLES.

For constant use lenses should be slightly inclined at an angle between the straight position and the inclination preferred for a reading-glass. However, the occupation of the patient must be taken into consideration in adjusting the lenses. The temple pieces or 'bows' should be carefully fitted about the ears to avoid pressure on any irregularity of the auricle. The curve at the top should be sharp, and the temple-pieces should extend straight backward (Fig. 172). Careless fitting of spectacles is shown in figure 173.

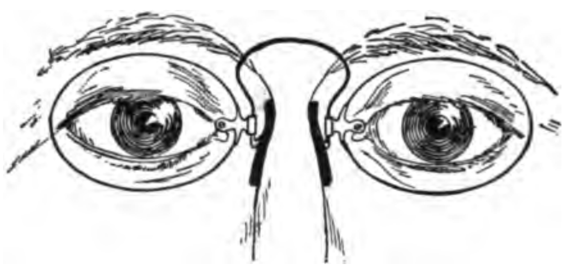


FIG. 174.—PROPERLY CENTERED LENSES.

All lenses should be of sufficient size to prevent the wearer from seeing over or under them. They must be accurately centered and equidistant from the eyes (Fig. 174). Lenses centered or applied improperly (Fig. 175) may produce prismatic and other effects so injurious as to offset their beneficial optic assistance. This is particularly true of strong lenses. In high defects the lenses should be fitted close to the eyes and, if necessary, the lashes should be trimmed from time to time. Convex lenses increase the refractive power as they are moved from the eye, while the reverse is true of concave lenses. Lenses should be worn constantly in high defects, in astigmatism, and in all cases in which there are asthenopic or reflex symptoms.

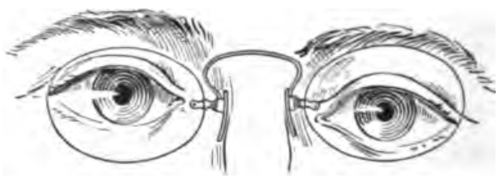


FIG. 175.—IMPROPERLY CENTERED LENSES.

Bifocal lenses are particularly valuable for a presbyope, or a high myope who is compelled to use a different lens for reading and for distance. The improved form (Fig. 176), with a reduced curved segment cemented on the distance lens, is far more satisfactory than the old straight Franklin bifocals. The lower segment should be about 2 cm. ($\frac{4}{5}$ inch) wide, and the upper edge more curved than the lower. The bifocal slip should be ground very thin, and, preferably, placed on the inner surface of the distance lens. If the occupation of the patient subjects him to high degrees of heat or steam, the lower segment should be inserted into a groove in the bottom of the distance lens instead of being cemented on its face. Although it takes some little time to become accustomed to bifocal lenses, they ultimately give far greater satisfaction and are more convenient than two different pairs. Constant improvements in manufacture are making bifocal lenses much more sightly and comfortable. In a recent form the smaller lens is inserted between two larger lenses, and is hardly noticeable.

Care of Frames and Lenses.—In removing spectacles the temple-pieces should not be pulled widely apart, or strained so as to wrench, bend, or loosen the attachments. In putting on spectacles the lenses should not be crushed against the eyelashes and soiled. The bridge should be placed one-third down the nose, the temple-pieces being held near the ear-curve between the thumb and first two fingers. The ear-curve should then be bent over the top of the ears without dragging the lenses any closer to the eyes; the frame should be pushed into position, and, lastly, the temple-pieces should be pressed down on the tops of the ears. Spectacles should be folded as little as possible so as to keep the hinges and attachments stiff. Lenses should never be set on their surface, but always on edge. If cleansed with unsuitable material or placed surface down, they are liable to become soiled or scratched. For cleansing an unstarched cotton or linen handkerchief may be used. Chamois, leather, tissue paper, silk or woolen material may scratch the surfaces.

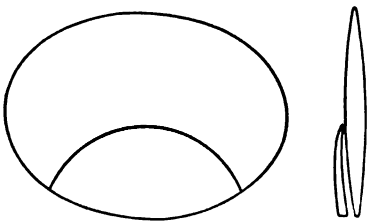


FIG. 176.—BIFOCAL LENS.

ANISOMETROPIA

Slight differences in the refraction of the two eyes are common; when great inequalities exist, the condition is termed **anisometropia.** In anisometropia there may be almost any combination of refractive disturbances. The eyes may be myopic, hyperopic, or astigmatic, in different degrees; or there may be emmetropia, myopia, hypertropia, or astigmatism in one eye and an entirely different defect in the other. Classifying according to the manner in which the visual act is performed, there are the following three varieties:

1. Cases in which there is **synchronous fixation** and, in the narrower sense of the term, binocular vision; for, even though the retinal images are not equal in distinctness and size, binocular vision is still possible.

In such cases it seems possible that satisfactory near-vision may be obtained by unequal accommodation for each eye.

2. Cases in which there is **alternation of fixation** in vision; for instance, the eye with the weaker refractive power may be used for distant objects, while the other, with the greater refractive power, is used for near objects. In this condition the patient has such satisfactory vision and so extensive a range of accommodation that he is often not aware of any defect. Alternating vision may easily be discovered by covering each eye successively and testing for near and distant objects. In this class the position of the eyes is usually correct.

3. Cases in which only one eye takes part in vision, the active eye being usually the one with the least refractive error; while the inactive eye, being excluded from vision, deviates, and there is a noticeable **squint.** Even in this condition the patient is very often unconscious of the fact that one eye has lost its visual acuity, and he usually discovers this defect by accident. Few of the laity are conscious of the fact that a squinting eye is usually more or less **amblyopic,** and that the refractive error is directly the cause of the squint, and indirectly the cause of the amblyopia. With this knowledge we see how important an early examination is in cases in which there is a tendency for one eye to deviate in either direction.

In cases of anisometropia the proper correcting lenses cause temporary discomfort of varying degree, on account of the rebellion of the established visual system to the innovation. The change in refraction and size of the retinal images, varying degrees of prismatic effect on ocular rotation, and muscle-deviation are the chief factors in producing the initial disturbances. There is great divergence in the rules suggested for the prescription of lenses in anisometropia; in fact, one of the most prominent foreign text-books advises that in these cases the same lens be ordered for each eye, or that the better eye only be corrected, a plane lens being placed before the other. In strong reaction to this *laisser faire* policy it is contended by most American ophthalmologists that almost invariably these patients will permit and respond to a proper and helpful optic correction in each eye. This correction may be inconvenient and even very uncomfortable at first. Often the initial discomfort is of very short duration; but, in any case, persistence and intelligent co-operation of the patient, in spite of subjective symptoms, is generally rewarded by a marked and progressive improvement.

AMBLYOPIA

In recent years there has been a strong tendency to attempt restoration of vision in eyes that have become amblyopic from the disuse coincident with marked ametropia, particularly anisometropia, strabismus, or defect in the ocular media, not sufficient to prevent useful vision. In restoring to function amblyopic eyes the desiderata are three: (1) The use of the proper lenses; (2) the reinstatement of proper muscle-balance; (3) visual exercises. The first two are considered elsewhere in this article. Naturally a certain visual exercise unconsciously occurs from the moment correcting lenses are applied, but special exercises are also employed.

Monocular exercise is effected by the use of an **occlusive bandage** or a **blinder** over one eye, while the other is used exclusively for a period varying according to the amount of discomfort or pain experienced. The blinder exercise may conveniently be employed at first for gross visual work, such as eating, and finally for reading, writing and near work generally. As soon as the vision is sufficiently restored, the amblyopic eye will participate in binocular vision and exercises may be discontinued. To hook over lenses a gutta-percha oval disc (Fig. 177) is most convenient, although care must be taken to prevent looking over, under or beyond the sides of the blinder. If there be any doubt as to this, the occlusive bandage should be employed. This should preferably be made of some light material, and so fitted that it covers the eye completely but does not exert pressure and necessitate closure of the lids of the blinded eye. In all monocular exercise both eyes should be kept open when possible. In young children the better eye may be tied up with a bandage, or it may be kept continuously under a **cycloplegic,** preferably atropin, for several weeks, being careful to avoid constitutional symptoms of poisoning.

FIG. 177.—BLINDER FOR MONOCULAR EXERCISE.

The best results are obtained in children and young adults; but even in older persons there is a strong response on the part of nature to measures of restoration faithfully pursued. To better demonstrate the mode of procedure, let us consider the hypothetic case of a child with a convergent squint in the left eye. Immediately, anisometropia is suspected; on examination there is found a slight refractive error in the right eye, but a high degree of compound hyperopic astigmatism in the left. It may be that the left eye is amblyopic to such an extent that vision is reduced to counting fingers at a few feet and refraction cannot be estimated satisfactorily with the test-lenses, so that resort must be made to some objective method, preferably the retinoscope. The oculist prescribes the proper correction for the right eye and slightly under-corrects the left eye. He then gives instruction that these lenses be worn constantly; and that for a short period each day, beginning with a few minutes and gradually increasing, a blinder be worn over the good eye —thus necessitating the use of the amblyopic eye. Repeated visual tests are made and the patient is encouraged in every way to persist. In young persons the speedy restoration of vision in an amblyopic eye thus treated is often surprising.

OCULOMOTOR ANOMALIES

Nomenclature

Adduction is the power of rotating the eyes inward—that is, of overcoming the diplopia produced by prisms, bases out.

Abduction is the power of rotating the eyes outward—that is, of overcoming the diplopia produced by prisms, bases in.

Sursumduction is the power of rotating the eyes in the horizontal meridian—that is, of overcoming the diplopia produced by prisms, bases up (infraduction) or bases down (supraduction).

Stevens, of New York, suggested a descriptive nomenclature for the functional anomalies of ocular muscles which has been universally adopted in this country. For normality and the different varieties of disturbance of muscular equilibrium, or **latent squint,** he suggests the use of the following terms:

Orthophoria, perfect binocular equilibrium.

Heterophoria, imperfect binocular equilibrium.

The *varieties of heterophoria* are:

Hyperphoria, a tendency of one eye to deviate upward.

Esophoria, a tendency of the eyes to deviate inward.

Exophoria, a tendency to deviate outward.

For cases in which there is absolute turning or deviation of the visual axis instead of only a tendency, and hence inability to effect perfect binocular fixation (**strabismus** or **squint**), the following terms are suggested:

Orthotropia, perfect binocular fixation.

Heterotropia, a decided deviation from parallelism (squint).

Of the different *varieties of heterotropia* we have:
Esotropia, a deviation inward (convergent squint).
Exotropia, a deviation outward (divergent squint).
Hypertropia, a deviation of one eye upward or the other downward.

Etiology

When the visual axes of the two eyes meet exactly at the point of observation, the ocular muscles are said to be balanced. This **muscular balance** is maintained by the perfect anatomic conformation of the muscles and equally distributed innervation to them. Any disturbance of these factors upsets the muscular equilibrium. If the insertion or structure of a muscle be faulty or if the innervation be anomalous **muscular imbalance** is produced. This, however, does not imply that binocular fixation becomes impossible. On the contrary, the visual axes may be rightly directed by increased innervation and single vision be maintained in ordinary work. In **true strabismus,** or permanent deviation, this is not possible and diplopia (double vision) is avoided only by the use of correcting prisms or by the exclusion of one eye from participation in the visual act. In other words, in true strabismus perfect binocular vision is impossible without optical assistance; while in ordinary muscular imbalance, or heterophoria, binocular vision is maintained by increased innervation. In the first, the anomaly is in some part organic; in the last, it is exclusively functional. The importance of the study of the **functional anomalies** of the ocular muscles lies in the fact that the extra expenditure of nervous energy in maintaining perfect binocular vision may cause asthenopic and reflex symptoms quite as annoying as those due to errors of refraction.

Formerly it was supposed that ocular muscle defects were always anatomic, that the muscles concerned were too short, too long, or anomalously inserted or attached, and that the only remedy was surgical intervention by means of tenotomy and advancement. It is now known that the most common cause is an error of refraction and that there is a complex disturbance of innervation. The involuntary or automatic movements of the eyes, such as the rotations in reading, are intimately associated with the act of accommodation. For instance, when a book or paper is brought close to the eye, there is an influx of nerve energy to the ciliary muscle, forcing it into action, thus changing the focus of the crystalline lens so that it will receive rays of light from the near object and place them exactly upon the macula of the retina. At the same time the two eyes must converge in order that their visual axes may meet exactly at the near object; otherwise there would result confusion of images or diplopia. In the same way the eyes must be rotated in or out, up or down, with a definite exactness, according as the object is held to the right, left, above or below the vertical and horizontal visual planes; otherwise the visual axes would not meet exactly at the point of observation. Whether congenital or due to long habit—the development of **automatism**—these movements of the eyeball are intimately associated, being probably controlled by one center, or contiguous centers, so far as participation in near work is concerned. Thus there is a constant relation maintained between the acts of accommodation and ocular movement. This is particularly so with convergence and the theory that squint is produced by excessive stimulation of the adduction (convergence) associated with excessive accommodation in hyperopic eyes has never been successfully controverted. The same is true of esophoria. Exophoria may be the result of weakened adduction by prolonged and excessive stimulation. Again, in uncorrected myopic eyes the eyeball is long and requires more force to rotate it, and the myope, working at a very close near-point, puts extra strain on the powers of convergence.

In addition to the foregoing, many other reasons have been advanced for the participation of ametropia in the causation of functional anomalies of the ocular muscles. No matter which explanation may seem the more rational, this fact is always before us—correction of ametropia generally remedies the muscle-defect. It is careful refraction and not ridiculously refined surgery that cures this class of cases. It is not the individual study of the external rectus, the superior oblique, the internal rectus, or the inferior oblique muscles that helps us in diagnosis and treatment; but it is careful observance of the powers of adduction, abduction, sursumduction and general rotation, that proves of value. No careful observer of to-day believes that convergence or adduction is performed by the internal recti alone, or abduction by the external recti alone. It is known that several muscles participate in these complex movements, and that they are controlled by a common center of innervation for the specific rotation in question.

HETEROPHORIA

As refractive troubles are the chief causes of ocular muscular anomalies, the refraction in every case should be examined under a mydriatic, and the ametropia correction ordered. In prescribing the correcting glasses the muscular condition should be considered. If the patient has exophoria and is hyperopic, it is wise to order at first a weak correction, in the hope of stimulating the adductors by allowing some accommodative strain. If the patient has esophoria and is hyperopic, a full correction is desirable in order to relieve all strain on the accommodation and hence on the associated convergence.

In the great majority of cases esophoria and exophoria disappear or are sufficiently modified by the simple correction of the ametropia to cause cessation of such reflex symptoms as headache, nausea, indigestion, vomiting, and various other nervous phenomena. Too much stress cannot be laid on the necessity of careful and complete correction of any existing astigmatism, incorporated in the lenses for the hyperopia or myopia. If the general vitality is impaired, the ocular musculature will not markedly improve even though the correcting lenses are applied, unless steps are taken to improve the systemic condition. Good food, abstinence from near work, outdoor exercise, and tonics are among the measures indicated. If the patient is very weak and debilitated, it may be necessary to allow the use of correcting prisms until the general condition has improved. However, in such cases only a partial prismatic correction should be worn, and this must be gradually reduced as soon as possible. Tenotomy should always be the last resort.

INSUFFICIENCY OF CONVERGENCE AND EXOPHORIA

One of the most frequent causes of muscular asthenopia is insufficiency of the convergence, with or without accompanying exophoria. As already stated, the prescription of proper glasses, temporary abstinence from near work, and general hygienic and tonic treatment will suffice in most cases to bring relief from the asthenopic symptoms. When, however, these measures do not afford relief, **ocular gymnastics** are indicated. For minor cases the '**thumb or finger exercise**' is of value. This consists in exercising the convergence by drawing the thumb or index-finger gradually toward the bridge of the nose, meanwhile trying to maintain a single image of the finger. The finger should be withdrawn immediately before diplopia results. This exercise should be repeated a dozen times, and should be used several times daily.

The more important method is that by **graduated rhythmic exercise in overcoming successively stronger prisms,** bases out. Formerly prisms of from 1° to 8° strength were employed. The following is the later method suggested by G. M. Gould for developing high adducting power by exercise with strong prisms: The amount of exophoria is noted, the abduction and adduction are then measured, followed by the measurement of the convergence-stimulus adduction. This is obtained by coaxing the patient to overcome as strong prisms as possible, with bases out, in the following manner: A pair of prisms together slightly stronger than the normal power of adduction are placed in the trial-frames; these will, of course, cause diplopia for the distance, but not, as a rule, at the near point. The patient is then requested to fix his gaze on a mark made on a card—a cross or a dot seven or eight millimeters in size—which is held at the reading distance or nearer. The card is then gradually withdrawn to a small gas-jet, the size of a candle-flame, about 6 meters (20 feet) from the patient's chair, the patient endeavoring and being encouraged to maintain a single image all the time. When this point is reached, the patient may transfer his gaze and fuse the double image of the flame instead of the mark on the card. This maneuver is then repeated with stronger pairs of prisms until the limit of adduction is reached. It will generally be found that a pair of 8° or 10° prisms is as much as can be overcome at first; but if the exophoria is not too great, it is seldom that, after a few trials, a patient cannot fuse the image of a candle-flame at 20 feet (6 meters) with this handicap.

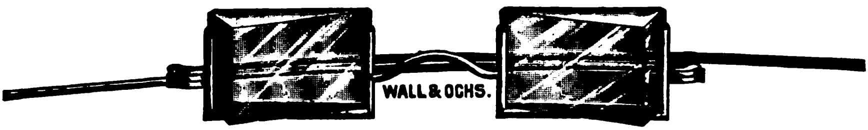


FIG. 178.—INTERCHANGEABLE PRISM-SPECTACLES FOR OCULAR GYMNASTICS.

The examiner should then prescribe a pair of prisms, bases out, suiting the strength to the indications, giving slightly less than the full amount of adduction power. It is of great importance to have the prism set in a well-adjusted interchangeable prism-frame (Fig. 178). The patient is instructed to place himself 20 feet (6 meters) from a flame, and endeavor to fuse the double image; if, as is usual, it is impossible for him to fuse at this distance, he must approach the flame until he gets the single image, then walk backward, keeping his gaze steadily fixed on the flame, until he reaches his starting-point. This is much more difficult for the patient than having some one withdraw the marked card from the near point to the flame; so that, whenever feasible, it is preferable to call in the assistance of a second person, particularly in the earlier days of the exercise. If the image is still single, the patient is told to hold it steadily so for about a quarter of a minute, then to raise the prisms and gaze at the flame with naked eyes for the same length of time, and repeat this ten or twenty times three times a day.

At the next visit the strength of the prisms is increased and the exercise continued at home, and at each succeeding visit an addition of about five degrees may be prescribed until the patient can, without the slightest trouble, overcome a pair of 25° or 30° prisms. Patients may be educated to overcome a combined prism-strength of over 100°, bases out. An arrangement may be effected with an optician to hire prisms and make the necessary changes for a very moderate charge, and the patient is saved the expense of buying a whole outfit of lenses that would be useless to him after a few weeks.

In moderate degrees of exophoria, or in cases in which there is no exophoria but a lack of power of convergence, the symptoms disappear after the second week; but this is no indication to stop treatment, for, unless the adduction is forced up to 50°, or 40° at least, the trouble is likely to return. When the patient can overcome a pair of 25° prisms, bases out, the cure is probably permanent. The higher the degree of insufficiency, the more necessary does it become to strengthen the power of convergence.

Insufficiency of adduction is not necessarily accompanied by exophoria; it is not usual, but still quite possible, to find a lack of converging power in cases of esophoria. It often happens in cases of mixed muscular defect that by correcting the ametropia and properly exercising the adduction with prisms, not only is the adducting insufficiency remedied, but general muscular balance is restored, and all the asthenopic symptoms are relieved.

ESOPHORIA

As we have no stimulus for bilateral divergence in the human being, prism-exercise is of little avail in esophoria. Besides, the attempt to strengthen to any marked degree the abductors, which have no such important functions as the adductors in the convergence for near work, would hardly be of use. The great trouble is generally with the adductors. They are on constant tension usually on account of uncontrolled hyperopia, causing ciliary strain. The rational treatment of esophoria is to suspend the ciliary spasm. As a rule, if taken early enough, the proper correction will afford relief. Sometimes it is necessary to keep the patient under atropin-cycloplegia for several weeks. Some oculists recommend over-correcting convex lenses for near work. Happily, extreme and intractable cases are rare. If such occur, partially correcting prisms, bases out, may be prescribed, and, as a last resort, advancement of the external recti or tenotomy of the internal recti.

HYPERPHORIA

Hyperphoria is usually relieved by the proper correction of ametropia and the general treatment prescribed in the cases of exophoria and esophoria. In the very rare refractory cases it may be treated by correcting prisms, bases up or bases down, ground in the ametropic correction. Tenotomy is the last resort.

STRABISMUS

As strabismus is often due to ametropia, or more commonly anisometropia, the first object should be to correct the refractive error in both eyes and to strive to bring the squinting eye into function by bandaging the second eye for a considerable time each day or by the **blinder-exercise,** in the manner described under the treatment of anisometropia. The amblyopia in strabismus is usually functional and acquired; only rarely is it congenital. The educative treatment should be begun early to prevent false fixation and suppression of retinal images and to maintain binocular vision. Even when one or more of the visual functions is lost, it may be restored by prompt treatment. Only when the educative methods absolutely fail should surgical intervention be used, and after operation these exercises are still necessary to complete the cure. Periodic squint is particularly amenable to this treatment.

Cycloplegics.—In young children in whom there is a tendency to strabismus, the constant use in the sound eye of a weak solution of atropin (from ½ grain to 2 grains in the fluidounce—0.03 to 0.12 gram in 4 c.c.) will often bring the other eye into function and correct the squint, or it may be necessary to paralyze the accommodative effort completely for some time by using the cycloplegic in both eyes. The drug may be instilled daily for one month and may be repeated after an interval of varying length. If any of the signs of atropin-poisoning, such as flushed face, dry throat, or hot skin, appear, the drug should be discontinued until they subside.

Bar-reading, the **lecture controlée** of Javal, is a popular method employed in strabismus. A small rod, pencil, or any similar small object is held vertically before the eyes while reading. If binocular vision is not operative, when the patient strikes the bar with the good eye there is a pause and a word or two will be skipped. If both eyes are being used the influence of the bar is not noticed. By practice with this method the patient may gradually be taught to use both eyes. Of course the obstructing bar cannot be used until the patient is old enough to read intelligently. A convenient instrument is a tin strip of metal bent in two places at a right angle, so that it may be held upon the book and moved on the page with the finger.

The Stereoscope.—For orthoptic exercises the stereoscope is one of the most valuable means. It was suggested in the treatment of strabismus by Dubois-Reymond, but was first put to practical use in ophthalmology by Javal. Improved instruments have been made by Derby, Holmes, Oliver, Landolt, and others. **Reflecting stereoscopes** have been suggested by Worth and by Wheatstone. The very ingenious instrument devised by Worth, sometimes called the **'amblyoscope'** is perhaps the best for training the fusion power. "The instrument, as devised by Mr. Worth, consists of two halves joined by a hinge (see Fig. 179). Each half consists of a short tube joined to a longer one at an angle of 120 degrees; at the junction of the tubes is an oval mirror. A translucent glass object slide is placed at the distal end of each tube. At the hinged ends

FIG. 179.—WORTH'S AMBLYOSCOPE.

FIG. 180.—ATTACHMENT FOR WORTH'S AMBLYOSCOPE.

are lenses whose focal length equals the distance of the reflected image of the object slide; in front of these lenses are grooves into which additional lenses of the trial case may be placed to correct the refractive error of the patient. The two halves of the instrument are united by an arc, having a long slot at one end and an adjusting screw at the other. The object slides can be brought together to suit a convergence of 60 degrees, or a divergence of the visual axes of 30 degrees. When the adjusting screw is used, an additional movement of 10 degrees is obtained."

Each tube is illuminated separately by a lighted candle placed in the direction of its axis at a distance of about a foot. The illumination before the amblyopic eye should be considerably greater than before the fixing eye; this may be accomplished by removing the light before the good eye to a distance and bringing the light for the amblyopic eye much nearer the end of the tube, or by means of the attachment (Fig. 180) consisting of two rotating discs containing smoked glasses of graduated shades, so that the diminished light effect may be secured without the operator leaving his chair.

An object-glass is placed at the free end of the longer tube. At the free end of the shorter tube is a lens, the focal length of which equals the distance of the reflected image of the object-glass at the end of the longer tube. "The two halves of the instrument can be brought together to suit a convergence of the visual axes up to 60 degrees, or separated to suit a divergence of as much as 30 degrees."

"The pairs of object-slides are drawn on translucent paper and stuck on glass slides. These are of three classes. The first class consists of pairs of devices, such as a bird and a cage, a mouse and a trap, etc. (Figs. 181 and 182). These require no blending of images, but only binocular vision. The second class consists of devices, part of which are on each slide (Fig. 184), so that a blending or fusing of the images must take place in order that the full picture may be seen. The third class consists of stereoscopic pictures, which when combined give an impression of perspective."

The instrument is used in the following manner: "The child with his correction on is held on the surgeon's knees and the amblyoscope roughly adapted to his degree of deviation; it is then held before the child's eyes and an electric lamp is put in the axis of each tube about four feet away. By a simple mechanical arrangement each lamp is easily brought nearer to, or put farther away from, the tube which it illuminates. A slide showing a cage, for instance, is put in the tube before the child's fixing eye, and a bird in that before the squinting eye, and the child is told what to look for. At first he sees only the cage. The lamp before the fixing eye is then taken farther away, and that before the squinting eye is brought nearer until the child sees the bird. By this time he has lost sight of the cage. The intensities of the illuminations are then adjusted until the child sees both the bird and the cage. The child is then allowed to grasp the instrument and, assisted by the hands of the surgeon, is taught to vary the angle of the instrument so as to make the bird go in and out of the cage. Many other similar pairs of slides are shown. The average child of three and a half or four years of age takes a very keen interest in the game which he imagines has been devised merely for his amusement. Slides which require a true blending of the images are then shown. After a time it is often found that the angle of the instrument may be altered to a very considerable extent, either in convergence or divergence, while the eyes follow the objects and maintain fusion of the pictures. One often gets a powerful 'desire' for binocular vision in these young subjects with surprising facility. The next step is to equalize the intensities of the lights.

FIG. 181.

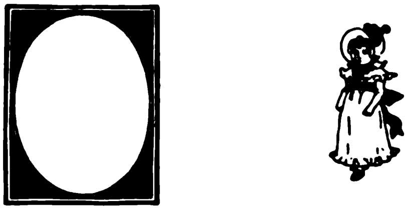


FIG. 182.

FIG. 183.

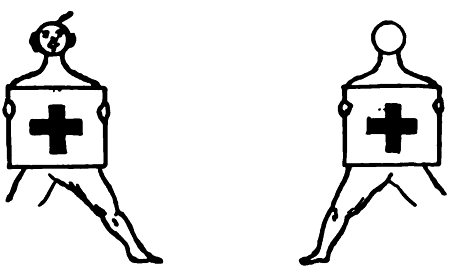


FIG. 184.

FIGS. 181–184.—PICTURES FOR STEREOSCOPIC EXERCISES.

This may usually be done at this stage without a return of suppression. In many cases one is able to deviate the two halves of the amblyoscope more and more at each visit until parallelism of the visual axes is obtained."

The **commercial stereoscope** with the ordinary lenticulo-prismatic combination in the eye-pieces may be used later to good advantage. Geometric figures, such as truncated pyramids, are valuable to give the idea of the perception of form in three dimensions. Stereoscopic pictures should first be looked at separately with each eye to be certain that the squinting eye will recognize its part. A set of incongruous pictures, such as a bird on one half and a cage on the other, are employed if there is only monocular vision. If the power of binocular vision is present, the exercise may be taken with congruous figures; that is, with the same outlines in duplicate. In Kroll's pictures there is one sliding picture (No. 21) so arranged that its component parts may be made to approach or recede from each other. In esophoria and convergent strabismus the pictures are made to approach each other until the eyes succeed in fusing the two images. The pictures are then slowly drawn apart, when the desire for binocular vision causes relaxation of the internal muscles and contraction of the external. In exophoria and divergent strabismus the reverse methods are used. When a moderate power of binocular vision has been established, the ordinary photographic stereoscopic pictures may be substituted. It is well to draw a vertical line through the center of one picture and a horizontal line through the center of its fellow. If the two eyes are in use, these lines will form a cross; when the cross is not seen binocular vision is not being exercised. For the same purpose, dissimilar or incongruous markings may be made on the pictures. The exercises may be kept up for from five to thirty minutes and repeated several times a day, according to the state of the muscles. Distinct fatigue or exhaustion should be avoided.

The **fusion tubes** of Priestley Smith consist of two hollow cylinders, each with two small openings in the ends, before each eye a 'white hole' and a 'colored hole' (red for one eye, green for the other). A person with normal vision looking through the tubes in a parallel position will see the two white 'holes' fused into one. Persons with convergent strabismus will see two white and two colored 'holes,' but by converging the tubes, may be able to fuse the two whites, while still seeing the red and green. If the patient has this potential faculty of fusion after adjusting the tubes for the abnormal position of the eyes, the tubes are separated and brought together many times in succession in order to develop the fusion habit The 'hole'-images are then made to overlap partly, and are fused. These exercises are practised daily at home.

PARALYSIS OF THE OCULAR MUSCLES

In addition to diaphoresis, the administration of alteratives, tonics and other constitutional measures, both the galvanic and faradic currents are sometimes of value (see vol. II, page 232). For the relief of the diplopia it may be necessary to exclude the unsound eye from the vision either by a bandage or an opaque disc. The simple patch is the least cumbersome occlusive bandage. In all cases we must remember that a long period of diplopia and its consequent distressing symptoms will elapse before a cure can be effected. If the paralysis continues in spite of all treatment, we may try to remedy the patient's discomfort by prisms, but these are rarely of value. However, **orthoptic exercises** may be of use. By rotating the head in the direction of the strabismus, or by the use of the correcting prisms, fusion of the two images may be effected. Then by gradually reducing the prismatic correction, or slightly turning the head in the direction opposite the strabismus, contraction of the paretic muscles is stimulated to maintain fusion. In cases beyond the possibility of cure in which strabismus has developed, tenotomy or advancement may be performed to relieve the disfigurement. Passive exercise by **massage** and **forcible stretching and contraction** of the paralyzed muscle is sometimes employed. In cases of secondary contracture an attempt may be made to oppose the development of the contracture by stretching the antagonist of the paralyzed muscle; for this purpose, seizing the overlying tissues with fixation forceps and strongly rotating the eye several times toward the paralyzed side.

OCULAR MASSAGE

Ocular massage consists in intermittent pressure of varying degrees, combined with rubbing, stroking, tapping, vibrating, and other movements. Gentle stroking in centripetal, centrifugal, and circulatory directions is ordinarily employed. Massage may be applied to the lids, directly to the anterior segment of the eyeball, or indirectly to the eyeball through the lids. It may be combined with local medication for anodyne, stimulating, or absorbent purposes.

Physiology.—By massage of the eyeball the capillaries and lymphatic vessels are **relieved of stasis,** the **movement of the ocular humors is stimulated,** and **absorption and elimination are promoted.** The more distant vessels may be affected similarly by varying degrees of pressure. Absorption or dislodgment of embolism and establishment of collateral circulation have been effected by ocular massage. In cases of glaucoma it is not improbable that intermittent and varying pressure may be of direct benefit to the percipient tissues (retina and optic nerves).

Uses.—Ocular massage is used in the treatment of blepharospasm, ciliary spasm, blepharitis, superficial corneal opacity, episcleritis, subacute and chronic conjunctivitis, subconjunctival extravasations, asthenopia, ciliary and supraorbital neuralgia, iridocyclitis, glaucoma, embolism of the central retinal artery, lenticular masses in the anterior chamber and incipient complicated cataract.

It is **counterindicated** in the acute inflammations of the conjunctiva, cornea, sclera, iris and ciliary body, and after accidents or purposive surgical wounds. The various mechanical devices are not without danger, and several cases of detachment of the retina from the use of apparatus to correct myopia, dissipate cataract, or other purpose are on record. There is practically no substantial evidence that ametropia has been noticeably and permanently corrected by instrumental means or by massage.

Technic.—Massage may be effected by the **fingers,** by **instruments** such as a corneal spoon, glass rod, douche, steam jet, and the like; or by **apparatus,** such as the electric vibrator of Maklakow, in which tapotement is effected by a small hammer striking on the eyeball with regular, equal, short vibrations as rapid as 9000 in a minute. There are also **oscillators** in which **rarefaction of air,** in appropriately shaped eye-cups attached to the pistons by tubes, causes a forward and backward movement of the eye. The degree of pressure and the duration of the séance must be adapted to the individual case. Massage should produce no more than passing discomfort—never distinct pain. The number of applications should vary from three a day to two a week, and the duration from one to five minutes. The tip of the second finger is conveniently employed, although the thumb and index-finger are also used. A drop of castor oil, cod-liver oil or other bland nonirritating lubricant may be used, but this is usually unnecessary. Ordinarily medicaments are applied in oleaginous mixtures.

Massage of the lids is used to promote absorption of extravasations, as in black-eye; to relieve blepharospasm, twitching, and neuralgic pain; and to remedy certain deformities. Massage of the lid-borders with weak yellow mercurial ointment is commonly employed in the treatment of blepharitis.

Massage of the conjunctiva has been suggested in many forms of subacute and chronic conjunctivitis. It is usually combined with the application of some stimulating medicament. **Traumatic massage** with a stiff brush and the use of the **roller forceps of Knapp** are mechanical measures in trachoma.

Indirect massage of the cornea and conjunctiva through the eyelids is the common means of treating superficial corneal opacities. It is generally used in conjunction with mild stimulating applications.

Direct massage of the cornea is employed chiefly in the treatment of superficial corneal opacities. The advantages of the sensitive finger are many, although the glass rod, spoon, and vibratory instruments may be used. A special **spoon** (Fig. 185) for direct massage of the cornea has been suggested by McMorton.* The manner in which he practises direct massage of the cornea is as follows: The cornea is rendered insensitive by a 10 per cent. solution of cocain, which, at the same time, by its action upon the corneal epithelium, facilitates the entrance of the drug used. The head of the patient rests upon the surgeon's knee, the eyelids are separated with the thumb and forefinger of the left hand, and the massage-spoon is held in the right. The cornea is gently rubbed alternately in a circular and radiating manner from one to three minutes, and this is repeated as often as may be indicated in the individual case. As the uvea, or region

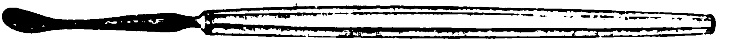


FIG. 185.—SPOON FOR CORNEAL MASSAGE.

just external to the corneal limbus, nourishes the cornea, the lens, and the vitreous, and is the great lymph-producer for the eye, particularly the anterior segment, these movements should not be confined to the area immediately adjacent to the opacity, but should be applied also in the ciliary zone upon the sclera. After massage has been practised, the globe is kneaded with the thumbs of both hands, carefully but thoroughly. By following out this plan the lymph-channels are thoroughly opened, and the activity of the lymph-currents increased. The spoon is so arranged that the cornea is thrown into very small furrows, and any ointment used is held between the forks, and may thus be worked into the cornea during the massage. This form of treatment has been of value in the deep forms of scleritis when used with the ointment of yellow mercurous oxid, and it has been used also in old interstitial keratitis.

Direct massage of the anterior segment of the eyeball is also effected by forcible douches, or irrigations of varying pressures, or a jet of steam. In these measures thermotherapy and hydrotherapy are combined with mechanotherapy. The use of the vibrator of Maklakow has not passed

* Medical News, Sept. 1, 1894.

the experimental stage, and all such appliances are not without danger, particularly in careless or inexperienced hands.

Massage in Glaucoma.—In view of the uncertain effects and great divergence of opinions relative to the value of iridectomy and other operative procedures in simple chronic glaucoma, non-surgical procedures, such as the correction of eye-strain, massage, the use of miotics, and observance of ocular and general hygiene, have been more generally employed in the last decade. Undoubtedly in the immediate prophylaxis of subacute and chronic attacks these measures are invaluable. It is not expected that ocular massage will remedy the effects of inflammatory and atrophic changes induced by high or long-continued excess of tension, and the permanency of reduced or normal tension gained by massage will, of course, depend upon the extent of damage done by the disease. Nevertheless, even in advanced cases, routine massage may keep the eye quiet and obviate the necessity of enucleation.

The **technic** of massage in glaucoma is simple, but requires delicacy of touch and intelligence. If the patient has these qualities, he may be instructed in the art; if not, a relative, friend, or professional nurse may be taught. The pulps of the fingers or thumbs are used, through the closed lids.

In the method advised by Gould, the massage is begun with **alternate palpation** by two fingers exactly as in estimating tension, but much more slowly. Pressure and all movements should begin and proceed to the extreme, very slowly and softly; the release or lessening of pressure may be a little rapid, but never sudden. The depth of the denting or the force exerted will depend on the hardness of the globe. In cases of high tension greater pressure is safe. When the tension under massage approaches the normal, the force exerted should be less than that which would produce distinct discomfort if one's own or the normal eye were pressed. The patient's judgment must be consulted and will not be far wrong—an added reason for making the patient the operator when the intelligence and self-control warrant such a course.

Palpation should be through the upper lid with the eyeball in the positions of extreme adduction, normal forward-looking, extreme abduction, and extreme depression. In extreme elevation the lower lid is used. Each position must be ordered systematically while massage is being carried on (the position of the other eye may be observed as a guide); in this way fully three-fourths of the globe is operated upon. The length of the sitting depends upon the time required to bring about normal tension, which is usually from three to five minutes. Sometimes normal tension will not follow so soon. Gould has yet to see any distinctly bad results, such as conjunctival hyperemia; although patients have sometimes alluded to the fact that there was some irritation or discomfort following long-continued or too rough manipulations. Palpation is alternated with shorter rolling or rubbing movements (effleurage), carrying the lid, so far as easily movable with and beneath the finger, around the equatorial regions of the globe. Gould also advises, in addition, massage of the eyebrows, forehead, nose, and cheek.

Deep massage of the eyeball is recommended in the early treatment of cases of **retinal embolism.** Casey A. Wood and H. V. Würdemann have recently reported cases with satisfactory results. Although the usual eliminative and alterative treatment was used in Würdemann's cases, the cure was attributed mainly to dislodgment of the embolus by mechanical procedures, as he has never had such success with the drug treatment alone. The method consists in placing the ball of the operator's thumb upon the upper lid of the closed eyes (Wood uses the second finger) and forcibly, with slow movement, exerting pressure upon the eyeball. It is important that massage be instituted as soon after the lodgment of the embolus as possible.

Massage of the crystalline lens was proposed several years ago by Förster, of Breslau, to hasten maturation of slowly progressing senile cataract. After performing an iridectomy, he rubs the cornea against the lens through the pupil, by means of a cataract spoon or other smooth instrument. The object is to bruise the lens, and break up its fibers without rupturing its capsule. Other surgeons prefer to bruise the lens directly with a small spatula passed through a corneal incision. This method is possibly attended with less risk than Förster's operation, but both are uncertain even in selected cases, and when necessary it is better to attempt extraction of the immature cataract than to resort to artificial ripening.

Massage of the anterior segment of the eyeball is sometimes employed to hasten the **absorption of lenticular debris** in the anterior chamber, after the operation of discission, or penetrating wound of the eyeball involving the lens.

Although ocular massage has been suggested in the treatment of **cataract,** there is not sufficient evidence that it modifies the course of development to warrant its employment. On the contrary, there seems to be some reason for believing that vigorous ocular massage, particularly by apparatus, may hasten the **complete maturation of an unripe cataract.**

Pressure bandages are used to check hemorrhage and prevent ecchymosis; to limit swelling; to support the eye after loss of the humors;

to maintain heat and support a deficient or ulcerated cornea; to prevent perforation and prolapse of the iris; to reduce exophthalmos, following hemorrhage, exudation, or emphysema in the orbit; to relieve pain by immobilization; and to prevent infection. The pressure bandage is also employed in the treatment of detachment of the retina. Bandages must not be employed when there is much discharge of any kind from the eye. The ordinary flannel or gauze roller bandage, two inches wide and six to eight yards long, is used to maintain securely in position and firmly press a cotton, woolen, or gauze pad against the eye. The pad is shaped to fill up the orbital depression in the face. The bandage should be applied firmly and evenly, and never so tightly as to distress the patient. The single tour and the figure eight (crossed) roller bandages are commonly used; although specially constructed tape bandages, such as that of Liebreich, are also employed.

INDEX

B

D

E

F

G

I

J

K

L

N

T

U

V