No. 5

BOOK REVIEW DEPT.

Pacific Coast Journal of Nursing

721 NEW CALL BLDG.

M____

Please review this book and return, if possible, on or

before______________________, and oblige,

M. Adelaide Waterman, R.N.,

Editor and Manager

SURGICAL AND GYNÆCOLOGICAL NURSING

BY

EDWARD MASON PARKER, M.D., F.A.C.S.
SURGEON TO PROVIDENCE HOSPITAL, WASHINGTON, D. C.

I.D., F.A.C.S.
N, D. C.

The price of this book is $2.50

T

Please state it in your review

PHILADELPHIA AND LONDON
J. B. LIPPINCOTT COMPANY

Printed by J. B. Lippincott Company
The Washington Square Press, Philadelphia, U. S. A.

"Life is short, Art is long, Opportunity fugitive, Experimenting dangerous, Reasoning difficult: It is necessary not only to do oneself what is Right but also to be seconded by the patient, by those who attend him, by external circumstances."

Hippocrates—*The Aphorisms.*

PREFACE

The task of preparing a text-book on surgical and gynæcological nursing has been approached with considerable hesitation and, it is believed, with a full appreciation of the difficulties to be encountered and the obstacles to be, if possible, surmounted. The responsibility of deciding as to the relative importance to the nurse of theory as opposed to practice and the proportion of such a book that should be devoted to each has proved no light one. Nor has the desire to present all theory from the viewpoint of its practical application seemed easy of fulfilment.

The effort, throughout the preparation of this volume, has been to present to the student and graduate nurse an essentially practical statement of those procedures in her professional work that fall within the realms of general surgery and gynæcology. While fully realizing the importance of a clear understanding of the theory governing the practice of these branches of nursing, it has not appeared either necessary or desirable to attempt the incorporation of the theories of the sister branches as presented to the student of medicine. As a consequence, such consideration as may be given to surgical bacteriology, pathology, symptomatology or treatment has been with the sole idea of emphasizing the importance of certain nursing duties—as the sterilization of instruments and dressings, the accurate noticing and recording of signs and symptoms, or the preparation of materials necessary for the proper surgical treatment of specified conditions.

The unusual amount of space (both textual and illustrative) given to the subject of surgical instruments was planned with the hope that it would give a chance to the nurse for preparation before she is thrown into the thick of the operating-room fray. Even a general idea of the names, appearances, and uses of the instruments she is to handle, together with some knowledge of their routine application and order of use, should spare the novice at least some part of the discouragement and confusion to which she is subject under the operating-room systems of many hospitals.

In addition to those portions of the book that are strictly surgical in their application, there has, necessarily, been some consideration of border-line subjects. Under this classification might come such chapters as the one on the use of fractional doses in hypodermic medication and the one upon weights, measures, solutions and formulæ. The excuse for the presence of these particular chapters must be based upon the existence of an apparent necessity for the consideration of these subjects—particularly in their connection with surgical nursing.

Throughout, the desire has been constant to prepare a textbook that would supply those needs that were most apparent to the lecturer and the operator, without neglecting that part of the field that had already been fully and successfully covered. It only remains to be hoped that the completed volume will, to some extent, fulfil this wish.

Many thanks are due to Captain Christie, Medical Corps, U. S. A., and to Sergeant Cahill, of the Army Hospital Corps, for assistance with the illustrations of instruments; to Lenz & Lossau for the loan of surgical instruments; to the Superintendent of Nurses at Providence Hospital for valuable suggestions and aid; to Mr. William Kearny Carr for the privilege of using some of his beautiful microphotographs of bacteria; and to Dr. R. M. Le Comte for the loan of a number of examples of the work of that past-master of microphotography, the late Dr. William M. Gray. Undoubtedly our greatest single obligation is to Miss Isabel M. Stewart, of Teachers' College, Columbia University, who has reviewed the entire manuscript, and whose criticisms and suggestions have pointed the way to a rather thorough revision both of the subject matter and arrangement of the book to its very great advantage. Our thanks are particularly due also to Dr. George W. Crile for his kindness in reading and criticising the chapter on anoci-association. Finally we desire to express our grateful appreciation to the J. B. Lippincott Company for their constant courtesy and forbearance throughout a somewhat tedious siege.

Edward M. Parker,
Scott D. Breckinridge.

Washington, D. C.,
December, 1915.

CONTENTS

PART I

INFECTION

PART II

THE FIELD OF SURGERY

PART III

MINOR TECHNIC IN SURGICAL NURSING

PART IV

THE PATIENT

PART VI

SUPPLEMENTARY CHAPTERS

ILLUSTRATIONS

PART I—INFECTION

SURGICAL AND GYNÆCOLOGICAL NURSING

CHAPTER I

THE CELLS OF THE BODY AND THE INVADING CELLS

MODERN surgery may be said to owe the whole of its wonderful advancement to the invention of a single instrument, the purpose and uses of which were so far removed from the obvious needs of the surgeon that not the wildest dreamer could have guessed its epoch-making importance in relation to surgical practice. The immensely widened field of vision which the microscope opened up to the students of living matter resulted finally, among many other benefits, in freeing surgery from the terrible handicap of wound infection under which it had labored for more than a score of centuries. Under this handicap surgical operations which are now considered trivial and practically devoid of risk, were attended with a huge mortality, and almost every form of operative interference involving the deeper parts of the body was absolutely prohibited by death in practically all the cases. All the great serous cavities of the body were thus placed beyond the possibility of surgical exploration. Abdominal surgery was an almost untouched field, surgical manipulation within the thoracic or cranial cavities undreamed of. Trephining the skull was a very ancient operation, it is true, but only the boldest surgeon ever ventured to cut through the lining membrane of the cranium which encloses the brain, and none dared repeat the venture often. John Hunter, greatest English surgeon of his time, declared that he never saw a case recover where the dura mater had been either wounded or incised at an operation. Even in the more external parts of the body wounds, whether operative or accidental, except the most trivial, resulted in a dreadful proportion of fatalities. The amputation of limbs, even in the most skilful hands, had a mortality of forty per cent. or more. Of compound fractures of the thigh treated during the Napoleonic wars over eighty per cent. were fatal. The menace of septic disease in wounds naturally increased in proportion as patients were brought together in large hospitals, so that the very circumstance which would otherwise have favored progress, by giving to the surgeon the advantage of an enlarged experience, became the means of retarding every effort at improvement in operative work by the almost prohibitive death rate which it imposed.

The emancipation of surgery from the bonds which had so long confined it began with the work of Joseph Lister, following the lead of the great Frenchman, Louis Pasteur. The time was peculiarly ripe for the triumph which Lister was destined to achieve. Anæsthesia by means of ether and chloroform had been discovered and had now been an established procedure in surgical practice for more than a decade. To make clear the full meaning of this innovation it is necessary to point out that its benefits were of two kinds. The "Death of Pain," inestimable boon though it was for the patient, was of far less importance from the larger outlook than the opportunity now given to the surgeon of doing his work with deliberate care. In pre-anæsthetic days surgical operations had to be done at the highest attainable speed. Two or three minutes, for example, was the record for an amputation which every surgeon strove to equal or surpass. With the introduction of anæsthesia all this was changed. Hours instead of minutes were now available if necessary. The dexterity of the juggler ceased to be the ideal for the work of an operating surgeon, and the painstaking skill of an expert handicraftsman took its place. As a consequence the temptation to try out improved methods and new operations was almost irresistible, and surgeons everywhere were pressing restlessly against the limitations which the huge mortalities from sepsis still imposed upon them. A quarter of a century earlier a great German anatomist had been the first to formulate clearly the theory of a living contagion; our own Dr. Oliver Wendell Holmes had pointed out the contagious nature of puerperal fever, and had suggested the employment of chemical disinfectants as a safeguard against it; in the obstetric wards of a great hospital in Vienna such measures had been put to the test of practical use with marked success; but because the time was unpropitious the voices of these pioneers had fallen on deaf ears, and to Joseph Lister was to belong the honor of leading the way in the greatest forward step that had been made since surgery began.

The early investigations of Pasteur had shown that the familiar phenomena of fermentation and putrefaction were in reality due to the action of minute living organisms which the microscope had made visible, and the character of the foul discharges from inflamed wounds, so like the putrefactive process, suggested to Lister the possibility of a similar causation. The case as regards fractures was particularly suggestive of this. It was a commonplace that simple fractures, *i.e.*, where the skin was unbroken, healed without inflammation, fever or any foul discharge, and practically all these cases recovered. In compound fractures, on the other hand, *i.e.*, where an open wound communicated with the broken bones, the putrefaction-like process of suppuration accompanied with inflammation and fever invariably occurred, and the majority of these patients died. In Lister's mind it was a clear inference that the difference in these two cases was due to the entrance into the wound of living germs from the air, and he acted on this idea. Carbolic acid was already known as an efficient preventive of putrefaction, and in August, 1865, Lister first applied a carbolic dressing to the wound of a compound fracture. The result was all that he had hoped. No suppuration occurred. A scab formed over the wound and the case progressed to recovery like a simple fracture. Other similar results followed, and he was encouraged to extend the application of what he called "the antiseptic principle in surgery" to other accidental wounds and also to operative wounds with equal success. Still possessed by the natural but mistaken idea that the air was the source from which the dangerous organisms came, he began to perform his operations under a cloud of spray impregnated with carbolic vapor formed by a steam nebulizer. Instruments were smeared with carbolic oil, hands, sponges, ligatures and dressings dipped into carbolic solution. These methods were crude in the light of later developments, but they sufficed.

The new principle in surgery thus inaugurated was naturally not accepted all at once or without controversy, but Lister's mind was of too fine a temper to be discouraged by opposition or embittered by hostile criticism. He pressed on, constantly improving his methods, and his results soon accumulated a weight of evidence that compelled recognition from his doubting colleagues. Even the most determined opponents of his theory unconsciously modified their own technic in accordance with the new idea, and in proportion as they did this were rewarded with improved results. Lister's investigations, however, were confined almost entirely to the practical side of the problem. He spoke vaguely of putrefaction in wounds resulting from the presence of living organisms, and the question as to the exact nature and life history of these organisms remained unanswered. His work, therefore, convincing as it was, lacked the completeness and precision of a scientific demonstration and it was reserved, as perhaps might have been expected, for the patient and exact methods so characteristic of German science to attain this goal.

A year after Lister's first experiment there was graduated from a Prussian university a young student in medicine who was destined to play a leading part in investigating the relation of microörganisms to infectious disease. Robert Koch began his studies of these organisms during the leisure moments that could be spared from a laborious country practice. The work which he did under these circumstances, judged in the light of its results, may be regarded as one of the most brilliant achievements of any scientific worker of modern times. The methods which he devised for manipulating, staining and cultivating bacteria, with the results of his investigations by means of these methods, brought him almost from the moment of their announcement a leading position among German scientists and made him virtually the founder of the science of bacteriology. The new science, attracting a host of eager workers, at once entered upon an amazingly rapid development, and in a few years the vague general ideas previously held had given place to a large fund of exact knowledge concerning the life history of many individual species of bacteria and their relation to communicable diseases, including the surgical infections. Koch himself, ten years after the publication of Lister's first paper, was able to give to the world a full account of some half-dozen species concerned in the traumatic infections in animals and man.

The methods of wound treatment and the technic at operations designed to prevent infection, which Lister's earlier experiments introduced, were crude indeed compared with those in use at the present time, but while nature holds us to strict account for disobedience to her laws she often rewards us generously, even lavishly, for only a partial understanding of her secrets. It was so now. As Lister's methods began to come into general use suppuration in wounds became less and less frequent. Large mortalities dropped to small and in some cases even to negligible figures. Healing "by first intention," so-called from the time of Hippocrates, *i.e.*, healing without inflammation or suppuration, ceased to be a surgical curiosity and began to be called normal healing. The awful scourge of hospital gangrene, so common up to Lister's time, vanished utterly.

The result of Lister's work for surgery may be likened to the setting free of a lifelong captive from a dark and narrow prison. The strong doors, barred and guarded for so many ages, were now, almost suddenly, thrown wide open. Surgeons, groping forward in an unaccustomed freedom, many of them hardly realizing what had happened, began to find that they could now do many things safely that had always been prohibited. Constant improvements in technic opened the way for new successes. The gradual recognition of the fact that the entrance of bacteria into wounds occurs practically always by contact with material things to which these organisms adhere (hands, instruments, ligatures, dressings), while infection through the air is negligible; the introduction, first in Koch's laboratory, of sterilization by high-pressure steam; and the use of rubber gloves for the hands of the surgeon and his assistants, first practised by Halsted at the Johns Hopkins Hospital, revolutionized the earlier methods of preventing infection in operative wounds, inaugurating the present or what is known as the "aseptic" era, in contradistinction to the "antiseptic" era of early Listerian practice, and enabled surgeons to perform the most extensive operations in all the formerly forbidden regions of the body with an almost mathematical certainty that no infection would follow and that normal healing would be secured. The way was thus opened for the immense development of operative surgery which in the past fifty years has been many times greater than in all the preceding centuries. There were many new difficulties to be overcome and dangers to be encountered, but the difference was that under the old conditions these problems could not be approached at all; now the path was clear.

Among the many changes which the new era, resulting from these discoveries, has brought about, not the least in importance is concerned with surgical nursing. The time has long passed when a surgical operation was the work of one man with the assistance of one or two unskilled helpers. Success under modern conditions requires the coördinated efforts of a highly trained and perfectly organized team of workers. The aseptic surgical technic, that elaborate system which has been gradually worked out, whose object is to prevent the occurrence of infection in wounds, demands not only the strict observance of proper methods at the operation itself, but also expert knowledge and conscientious exactness in all the details of preparation. This work of preparation calls for its own separate organization, with an elaborate equipment of technical apparatus requiring special skill in its use, and the responsibility for this rests almost wholly upon the shoulders of the surgical nurse. It is highly important that the carrying out of this part of the work should depend, not upon the blind observance of a set of rules, vaguely understood and often imperfectly remembered, but rather upon an intelligent application of clearly comprehended principles, based upon a correct knowledge of the conditions under which wound infection takes place. Before entering, therefore, upon the practical side of our presentation of the technical duties involved in surgical and gynæcological nursing, it is necessary to devote some space to a consideration of the infection problem, the life history and distribution of the living organisms concerned, and the relation of these organisms to infectious disease.

I. THE CELL

1. The Cell as the Unit of Living Matter.—To understand the meaning of infection we must begin with the study of the cell. When plant tissues were first examined under the microscope they appeared to be made up of an aggregation of tiny hollow chambers, which, because of their likeness to the structure of a honey-comb, were called cells. When on later study it became gradually clear that all living matter is made up of very small individual structural units, the name "cell" was retained for these units, although in most cases they bear no resemblance to a hollow chamber. Every living thing, whether plant or animal, is composed of cells. The bodies of all the higher animals, man included, are built up out of a vast number of cells of many kinds, and all the activities of their bodies, of growth, of nutrition, of secretion, of movement, or of reproduction, are really the activities of the cells which compose them.

2. Form and Structure of the Cell.—Cells exhibit immense variety in size, in form, in structural complexity, and particularly in functional activity. A few may be large enough to be visible to the naked eye, but most are far too small to be seen without the aid of magnifying lenses. In its essential features a cell (Fig. 1) consists of a minute globule of matter, the cell body, containing in its centre a smaller body called the nucleus. A more or less clearly defined membrane, the cell wall, may surround the body of the cell. When a cell is stained with aniline dyes the nucleus takes the stain more strongly than the cell

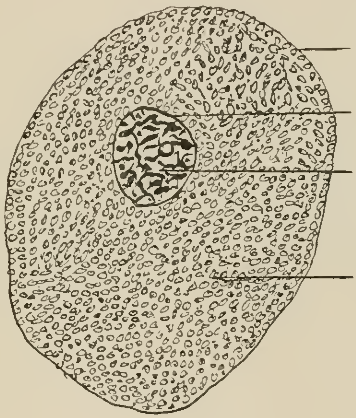


FIG. 1.—Diagram of a cell.

body and appears clearly and sharply defined, demonstrating its difference in chemical composition from the remaining cell substance. The nucleus is believed to be the most important element in the cell structure. It contains a special substance, peculiar to living matter, known as "chromatin" or "chromoplasm," which appears to play the most important rôle in the cell activities. The substance of the cell body is called "cytoplasm." It may be smooth or granular in appearance, and sometimes has the suggestion of an intracellular network. The consistence of the cell substance is probably that of a semifluid or thin jelly. The solid part of plants and animal bodies are not generally regarded as part of the living cell substance, but as inert material built up by the chemical activities of the cell. Many cells, particularly among the single-celled organisms, have special structural appendages to facilitate their motion or for other uses.

3. The Activities of the Cell: (1) *Movement.*—Many cells have the power of motion by virtue of a contraction of a portion of the cell substance in various ways. The movements of single-celled organisms and the muscular movements of the higher animals are alike due to the exercise of this power.

(2) *Reproduction.*—At some period in its life every cell has the power of reproduction by dividing itself, usually into two daughter cells (Fig. 2), sometimes into many new cells. Over this process the nucleus presides through a series of wonderfully

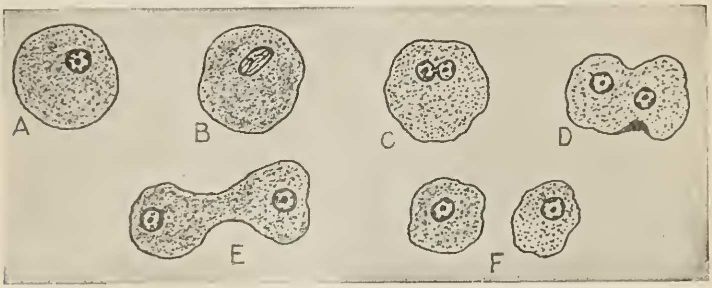


Fig. 2.—Multiplication by simple division in *Entamœba coli* (Craig). This is a single-celled organism which is the cause of certain forms of tropical dysentery in man.

complex changes. Every existing cell has arisen from another cell through the exercise of this reproductive power. Each cell reproduces only its own kind.

(3) *Chemical Activities.*—All cell activities are doubtless chemical in nature, but the mature cell does a vast amount of work in changing the chemical composition of substances taken into its own body and of the material surrounding it. These chemical activities appear in: (*a*) the absorption of suitable material from their surroundings to be utilized in their nutrition and growth; (*b*) in oxidation, or the burning up of material with the production of heat; (*c*) secretion, or the formation of new chemical compounds which are then extruded from the cell; (*d*) excretion, the casting off of waste material; and (*e*) what is perhaps akin to secretion, the building up of intercellular substances which form the solid parts of the structure of animals and plants.

4. The Vital Requirements of the Cell: (1) *Moisture.*—Every living cell must be surrounded with moisture in order to enable it to carry on its chemical activities. All the living cells of the human body are bathed in fluid. A scratch upon the surface shows how thin is the protecting covering of inert dried material by which the fluids are confined. Matter upon which the cell acts to produce chemical change must first be brought into a state of solution, and a fluid environment is therefore necessary to all cell life.

(2) *Food.*—Cells require suitable material in their surroundings to be utilized by them for their nutrition and growth and for the exercise of their other chemical activities. Some cells can go into a resting stage, during which they remain alive, although deprived for the time of food and of moisture. Later, under favorable conditions of moisture, food supply, and temperature, they may renew their active life.

(3) *Temperature.*—Active cell life is possible only within rather narrow limits of heat and cold. For each kind of cell there is an "optimum" temperature at which it thrives best. At a temperature a few degrees below this all cell activity will be checked or cease entirely. At a temperature somewhat higher the life of the cell will be destroyed. Some cells in a resting stage (such as the spores of certain bacteria) can survive extreme degrees of heat, considerably above the boiling point of water. Most cells bear exposure to cold rather well. Many of the cells of our own bodies can recover from a freezing temperature.

5. The Characteristics or Qualities of the Cell: (1) *Irritability.*—This means that the activity of a cell can be affected by influences from without. Any influence exerted upon a cell which causes a change in its activities is called a "stimulus." All the activities of a cell may be affected by a stimulus—its nutrition, its secretions, its motion, or its reproductive power; and the effect of the stimulus may be manifested in either of two ways, by increasing or by diminishing the activity of the cell, or, as we say, the effect may be to excite or to inhibit its activities. Any external changing condition may act as a stimulus—mechanical or chemical effects, light, heat, electricity, the influence which nerve fibres convey, and so on. Certain conditions within the body of the cell itself may also act as stimuli, such, for example, as its own physiological condition, particularly with regard to its supply of nourishment. Thus starvation or repletion will affect its activities in different ways. The excited activity may continue for a time after the stimulus has ceased to act. Repeated stimulation may bring about exhaustion and cessation of activity. Repeated stimulation, not of too high intensity or too continuous, may develop and increase the cell's power of action in some one direction. A high intensity may inhibit, while a lower intensity of the same stimulus may excite cell activity. When a cell's activity is affected by a stimulus it is said to respond or react to the stimulus. The lowest intensity of a stimulus which will cause a cell to react is called the "threshold" for that stimulus. Repeated stimulation may result in some cases in cessation of response on the part of the cell or a raising of the threshold, a higher intensity being required to excite action. The sum total of all the stimuli acting on a cell constitute its "environment."

(2) *Adaptability.*—That quality of the cell whereby it is enabled to respond differently to a stimulus because of previous stimulation is of far-reaching significance in the economy of nature. Because of this the cell is enabled to adapt itself within certain limits to changed conditions in its environment. The capacity of the cell to increase its power under stimulation is also a factor in the adaptation of the individual cell to changed conditions. Moreover, there are always slight differences among individual cells of the same kind in regard to their susceptibility to certain influences. Under changed conditions, then, some cells may perish while others survive, and these may transmit their resisting powers to their descendants, giving rise to a strain adapted to the new environment.

(3) *Specialization.*—In the single-celled organisms and in the cells which make up the tissues of animals and plants there is an infinite variety in the forms of activity which the cells exhibit. No cell is capable of all the forms of activity possible for a cell, but each kind of cell specializes in some particular form. Cells are specialized not only in their activities but also in being adapted to respond to particular kinds of stimuli. Thus, for example, certain cells in the retina of the eye are specially adapted to respond to light, other cells in the ear to respond to vibrations in the air. Any stimulus capable of exciting the special activity of a cell is called an adequate stimulus for that cell. A specialized cell responds with its own particular form of activity whatever the nature of the stimulus.

(4) *Constant Change.*—The chemical changes which go on within the living cell are exceedingly complex. It is a chemistry

of constant giving up and taking in, special substances capable of serving a purpose useful to the organism are formed, and other substances are thrown out because they have served their purpose and become waste matter. New matter is meanwhile being taken in to be built up into living substance in place of the material that has been thrown out. The cell is thus ceaselessly falling to pieces and rebuilding its own substance.

(5) *Continuity of Life.*—In the process of reproduction the cell does not die, but passes on its own substance and its living activities into two or more daughter cells. Thus cell life is continuous and not interrupted by any condition that can be called death. Many cells are destroyed, of course, by accident or otherwise; and many differentiated cells, having lost the power of reproduction, perish when their usefulness is ended, but there is a sense in which it may be said that death has no meaning as applied to the cell.

(6) *Stability.*—The evidences of life upon the earth in remote geologic ages, in all essentials like the forms of life now existing, give striking proof of the immense stability of the hereditary factors in the reproduction of the cell, while the traces of a wonderful evolutionary history throughout these ages testify with equal force to its powers of adaptation.

For the solution of all the problems in every department of science relating to living things we must seek the final answer in the study of these tiny units in the structure of all living things. Incessantly disintegrating, yet immortal; more stable than continents and oceans, yet infinitely plastic and adaptable; the cell, which is the ultimate unit of living matter, serves also as the most fitting symbol and expression of the mystery of life.

II. SINGLE-CELLED ORGANISMS

By the term organism is meant any individual animal or plant which lives a self-sufficient existence and in due course reproduces its own kind. Among the lower forms of life there are very many organisms which consist of only a single cell.

These single-celled or unicellular organisms behave in a primitive way much like the higher forms. Each cell lives an independent existence. They assimilate nourishment, grow, and reproduce their kind; and many of them are able to move about by means of active movements of portions of the cell body, or through special organs of locomotion, usually by a swimming process, for like all cells they require fluid surroundings for their active life.

Unicellular organisms are very abundantly distributed in nature. A vast number of different species of them exist, differing widely in structure, in their activities, and in the conditions under which they thrive. Swarming in countless numbers and variety wherever the conditions are favorable for them—in water, in soil, as parasites living upon higher organisms, and especially wherever there is dead organic matter—these silent, invisible living things play a rôle of incalculable magnitude and importance in the happenings of our world.

III. MANY-CELLED ORGANISMS

There are no two-, or three-, or few-celled organisms. We pass at once from the single-celled forms to those that are composed of many cells. These include many forms that are very low in the scale, and also, of course, all the higher species of plants and animals. In the multicellular organisms the cells do not live a separate and self-sufficient existence. They are dependent on each other for many of their needs, and their activities are often directed for the benefit of the organism as a whole rather than solely for their own individual requirements.

The most striking feature of the higher forms of life, considered as an aggregation of cells, is the amazingly perfect organization which they exhibit. This organization is manifest both in structure and in function. On the structural side we have the differentiation of cells into peculiar tissues and the aggregation of similar cells into special organs. In the animal body there are complex structures for locomotion, for the seizing of food material and for its digestion, and others for the purpose of keeping all the cells bathed in fluid and for conveying to them the nourishment that has been prepared for them. There are other organs (the special senses) for the reception of stimuli from outside the body, so that the behavior of the animal can be modified in ways appropriate to its environment. As regards organization in function we have a nearly perfect system of control whereby all the cell activities of the body are directed for the benefit of the whole organism.

It is the capacity of the cell to respond to a stimulus which makes it possible for the higher living organisms to exist, since because of it the cells composing the organism can be made to act in harmony. Our own bodies, for example, are made up of an innumerable host of cells whose activities are not haphazard or independent, but are obviously marshalled under orderly control and discipline. A wonderful division of labor exists among them. The muscle cells have given up all their other activities, save nutrition, to devote their whole energy to the exercise of their contractile power. Epithelial cells cover the body surfaces and line the tubes and ducts of the various secreting glands where they specialize in the production of different secretions which are useful to the organism as a whole. The connective tissue cells, through thickening of the cell wall and the formation of intercellular substances, build up the supporting framework of the body, its bones, ligaments, tendons, etc. The nerve-cells are organized into a wonderfully complex system for the regulation of all the bodily functions and activities. They specialize in the reception and coördination of stimuli received from sources external to the body, and in the conveying of appropriate stimuli to the cells of the various organs so that they may act in harmony for the best interests of the organism as a whole.

All the structural features of the body, its framework, its coverings of skin and mucous membranes, its complex tissues and organs, and all their manifold functional activities, are thus the result of the work of specialized cells under a marvellously complex system of control.

We do not know what the factors are that determine this organization. But it is quite certain that the amount or the intensity of the various activities of any cell is determined by the stimuli arising from its environment, and in the animal body, for example, a large part of this environment consists of conditions resulting from the activities of other cells, so that there is an amazingly intricate interplay of stimuli between the different cells of the organism. There are also adjustments for the rapid conveyance of stimuli arising from the activities of one set of cells to other cells at a distance, largely through the nervous system, but partly also by other means. Thus the responses of the cells to external stimuli, to stimuli arising from their own physiological condition, and to stimuli arising from the activities of other cells, bring about as a resultant an orderly balance and harmony in the activities of all the cells, and a condition of the body as a whole which we designate as normal or as a condition of health.

IV. HEALTH AND DISEASE

The word "normal" means conforming to a recognized standard; agreeing with an established type, but the standard is never very exact. Thus in any group of persons each one may be a normal individual although differing rather widely in many particulars from others in the group. The same is true of the normal working of a many-celled organism as represented by the harmonious activities of its cellular elements. The normal standard for these multitudinous activities is not rigid but extremely flexible. A deficiency, whether momentary or continued, of one part of the mechanism may be supplemented or compensated for in various ways by increased activity in other parts. Thus an adjustment of the working of the complex organism to changing conditions in its environment is continually going on. Different kinds or groups of cells are inevitably subjected from time to time to alien stimuli, often in themselves potentially harmful, and in such a case the organism must automatically find an answer to the problem of adjusting itself to that particular situation. This adjustment of the organism to its environment is called "adaptation." It is a commonplace that different living organisms are adapted to exist in very various surroundings; some, for example, to live under water, others on land. Moreover, each individual of a species has inherited the power of calling into play innumerable and often extremely dexterous ways of adjusting or adapting itself to harmful situations. When these adaptations are very perfect so that the organism is able to meet the situation with little or no disturbance of its functions we may consider the resulting adjustment as a normal condition. When, on the other hand, the adaptation is more or less imperfect, an abnormal or diseased condition will be brought about. For example, when any tissue of the human body has been subjected to a direct mechanical injury, *e.g.*, a wound, there results an adjustment of the cell activities which we call the healing process. This adjustment while not ideally perfect is in a very high degree efficient, and when not interfered with in any way proceeds to repair the defect with such smoothness, certainty, and speed and with so little disturbance of the organism as a whole that we are nearly or quite justified in calling it a normal process, although the cell activities involved are quite different from those exercised in ordinary times. Surgery is wholly dependent upon this nearly perfect adaptation, for without it surgery would be impossible, and the fundamental problems of practical surgery are concerned with the selection of methods for attaining the end desired which shall place the smallest possible obstacles in the path of the healing process. On the other hand, from what has already been said at the beginning of this chapter it is quite evident that when a wound is infected the healing process is very seriously interfered with. A new situation is developed to meet which the organism is very imperfectly adapted, and the condition which results cannot be called normal, but must be regarded as one of disease. There is thus no hard and fast line between the normal and the abnormal, *i.e.*, between health and disease. Disease may be said to be present when as the result of an imperfect adaptation to an injurious influence the normal balance of the activities of the body-cells is destroyed.

V. INFECTION

Now one of the most potent and also one of the most common causes of disease—that is to say, of such a disturbance of the disciplined harmony in the activities of the cells of the organism—consists in the entrance, among the cells of the body, of other cells which invade it from the outer world. When such alien and hostile cells, not subject to the discipline of its controlling system, obtain entrance into the body and find in any of its tissues a situation and surroundings suitable for their growth, they multiply there, and by their growth and the secretions which they produce they cause either a destruction of the body-cells or an interference with their normal working. This invasion of alien cells harmful to the body we speak of as an "infection," and the effects in the body of their harmful activities we call an infectious disease.

All of the large and familiar class of infectious diseases are caused by the entrance among the body-cells of unicellular organisms from without. It must not be supposed, however, that all the unicellular organisms can thus invade the body. On the contrary, the vast majority of these organisms, which exist in such countless numbers all about us, find in the tissues of the animal body conditions altogether unfavorable for them, and they can no more live there than a fish can live out of water or an air-breathing animal can live under the sea. Unfortunately for us, however, there are certain species of microörganisms which are specially adapted to live and multiply within the tissues of our bodies. Fortunately for us, on the other hand, these species are relatively few.

There are certain species of the hostile invaders which grow readily in any tissue of the body where an injury has taken place. An open wound offers an ideal portal of entrance for them and the injured tissues a favorable soil for their growth.

Infection through a wound with these particular species of alien cells we speak of as "septic" infection, and the resulting disease affecting the wound and the body as a whole is known as "sepsis," "septicæmia," or "septicopyæmia."

VI. THE SINGLE-CELLED ORGANISMS CONCERNED IN INFECTION

1. Bacteria.—Among the microörganisms which play the part of hostile invaders among the body-cells, the bacteria are the most numerous and important class. All the organisms concerned in wound infections belong to the bacteria. The bacterial cell is characterized by extremely minute size, great simplicity in form, and apparent simplicity in structure and manner of reproduction. On the other hand, the greatest variety and complexity is shown in the character of the cell activities, *i.e.*, in the chemical composition of the secretions which the cells produce and in the different conditions under which they thrive. An immense number of distinct species can be recognized mainly by these differences in vital activities, the form differences being relatively insignificant or even in some cases indistinguishable. The cell is many times smaller than the average size of the cells which make up the structure of animals and plants (Fig. 3). Bacteria are either rod-shaped or spherical in form. Straight rods are called bacilli (Fig. 4), rods with a slight curve are known as spirilla (Fig. 5). The rods vary considerably in length and thickness and may have rounded or blunt ends. Bacilli are either motile or non-motile, the former possessing whip-lash-like appendages, attached sometimes to the ends, sometimes to all sides, which by their rapid vibration propel the organism through the surrounding fluid (Fig. 6). The spherical forms, known as micrococci, differ only slightly in size, but characteristic differences in grouping appear, those which are seen in pairs being known as diplococci (Fig. 7), others which appear in chains, like a string of beads, are called streptococci (Fig. 8), while staphylococci

(Fig. 9) show an arrangement in irregular bunches. Reproduction takes place by simple division. A fissure appears in the centre of the bacillus or the micrococcus, which presently separates it into two equal parts. Each half grows to a full-sized organism and then again divides. This process can be observed,

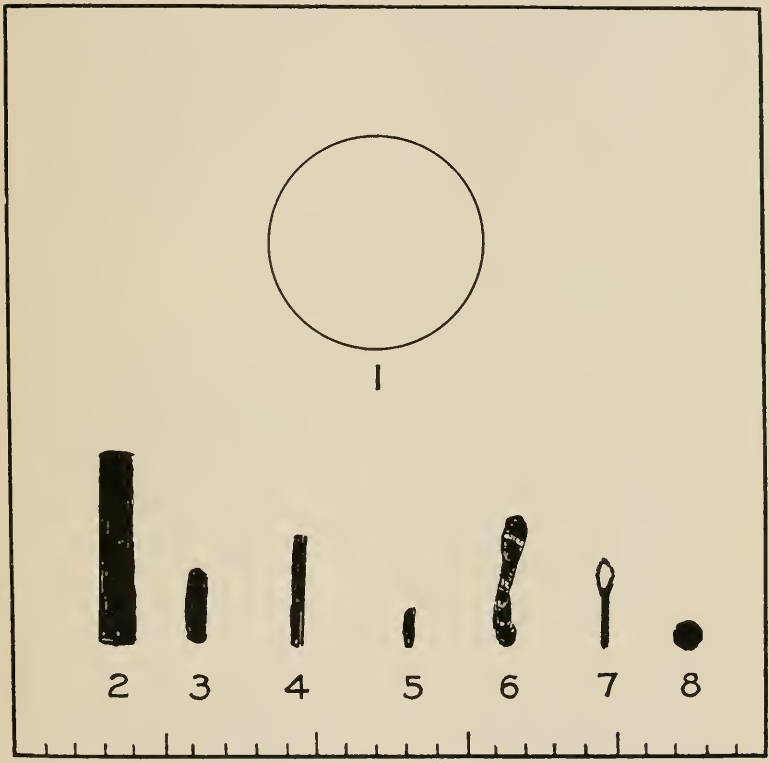


Fig. 3.—Each side of the square represents one-thousandth of an inch. The relative size is then shown of (1) a red blood-corpuscle, (2) the anthrax bacillus, (3) the typhoid bacillus, (4) the tubercle bacillus, (5) the influenza bacillus, (6) the diphtheria bacillus, (7) the tetanus bacillus, (8) a micrococcus.

and has been shown to take place under favorable conditions in about twenty minutes. The result is a rapidity of multiplication that is difficult to comprehend. A simple calculation will show that if this rate of increase continued uninterrupted for a period of twelve hours we should then have arising from a single organism a number equal to more than ten times the entire human population of the globe. Under natural conditions, of course, many influences check this process, but multiplication is nevertheless enormously rapid. Some species of bacilli produce spores, a method of reproduction somewhat analogous to seed formation in higher plants. The spore appears in the middle or end of the bacillus as a bright glistening body, the bacterial cell later melting away and leaving the spore free (Fig. 10). Each cell, except in rare instances, produces only a single spore, so that multiplication does not result from this process. The office of the spore appears to be to preserve the species from destruction under unfavorable conditions. In this "resting stage" the organism is highly resistant to heat and chemical disinfectants and may remain alive for years in the dried condition. When again placed under

Fig. 4.—Diphtheria bacilli. (Microphotograph by Carr.)

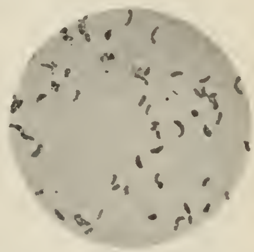


Fig. 5. — Spirilli of Asiatic cholera (Carr).

favorable conditions of moisture, temperature, food supply, etc., the spore germinates into a bacillus and the process of reproduction by fission recommences. Bacteria absorb nourishment through the external surface of the cell from the surrounding materials, these being acted on as a preparation for absorption by ferments secreted by the cell. Bacteria thus digest their food outside the cell body, a process which results in chemical changes in the matter surrounding them; changes made evident in the various processes of fermentation, putrefaction and decomposition of organic substances resulting from the action of "saphrophytic" bacteria, and in the case of the disease-producing or "pathogenic" species, in injury or destruction of the tissue cells of higher organisms invaded by them. Abundant moisture is essential for bacterial growth. The

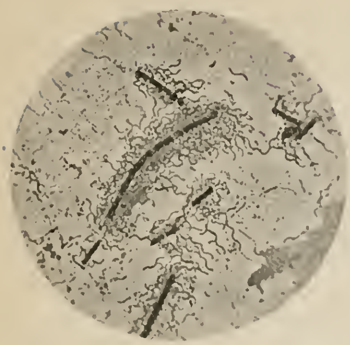


Fig. 6.—Bacillus subtilis showing flagellæ (Gray).

Fig. 7.—Diplococcus pneumoniæ. (Microphotograph by Carr.)

Fig. 8.—Streptococci. (Microphotograph by Gray.)

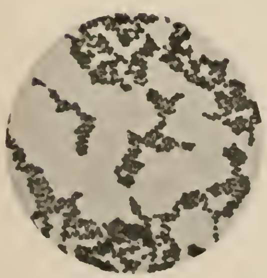


Fig. 9.—Staphylococci. (Microphotograph by Carr.)

Fig. 10.—Bacilli showing spores.

presence of air or free oxygen is essential for the growth of some and absolutely inhibits the growth of others. The former are called "aërobic," the latter "anaërobic"; others which grow equally well in both conditions are known as "facultative" species. As they are seen massed in "colonies" on the surface of culture media in the laboratory, most bacteria are grayish white in color, but many species produce pigments and the colonies of these may show brilliant coloring, orange yellow or red being most common, but blue-green and violet coloring may also occur. The limits of temperature within which bacteria grow are rather wide. For each species there is an upper and a lower limit above or below which growth will not take place; between these is an optimum temperature most favorable for growth; above the maximum temperature for growth is the thermal death point at which the organism is killed. All vegetative (not spore-bearing) forms are destroyed by a temperature considerably below the boiling point of water. Spores withstand a temperature much higher than this for a considerable time. Freezing does not kill bacteria with certainty, and some may withstand even the extreme low temperature of liquid air. Most vegetative forms are readily killed by drying, but some may survive for days or even weeks. Bacteria are destroyed by chemical agents such as carbolic acid, iodine, bichloride of mercury and a host of others, but in every known instance those chemical substances which kill bacteria are equally or even more destructive to the cells of the human body, so that we cannot combat bacterial infection by means of drugs administered in the hope of destroying the invading cells without poisoning the patient. The readiness with which bacteria are cultivated in the laboratory, upon simple and easily prepared media, by the methods introduced by Koch, has resulted in a great accumulation of knowledge concerning them which has been applied in many ways in the prevention, diagnosis and treatment of disease.

2. The Protozoa.—These are unicellular organisms which are classed as belonging to the animal kingdom, while the bacteria are regarded as vegetable in nature. The species of protozoa are very numerous and they are very widely distributed, being present everywhere in sea-water, in all stagnant fresh water, and in all moist soils. Active living forms are never present in the air, but many are able to pass into a resting stage in the form of spores or cysts, in which condition they may survive for some time in the dried state and be carried through the air. They are often parasitic in habit, and, while comparatively few species are the cause of disease in man, many others cause disease in domestic animals and plants which are useful to man. The protozoa are far more complex and varied in form than the bacteria, and many of the single cells show remarkable complex appendages and other variations of structure comparable to the specialized organs of the higher forms of life. Their modes of multiplication are also more complicated and varied than in the case of the bacteria. Bacteria, like plants, absorb their nourishment from substances in solution in the fluid surrounding them. The protozoa, like animals, derive their food from other organisms, chiefly bacteria. They do not multiply so rapidly as the bacteria. Except in a very few instances it has not been found possible to cultivate them in the laboratory.

3. Yeasts and Moulds.—Infections with single-celled organisms of this class do occur, but they are few and rare and need not be considered here.

4. The Filterable Viruses.—There is still another class of infections our knowledge of which stands in a very curious position. These diseases can be transmitted to a healthy animal by injecting into its tissues a very small quantity of the blood or of certain secretions from a diseased animal, and this can be done even after the blood or secretion has been passed through a porcelain filter, the pores of which are fine enough to stop the smallest known bacteria. These germs, whatever they are, must be from five to ten times smaller than the smallest of the bacteria. At least three human diseases belong to this class: yellow fever, the disease known as infantile paralysis or poliomyelitis, which especially affects children, and a tropical disease known as dengue or break-bone fever. Altogether some twenty diseases of this nature, affecting plants and animals, are known. No filterable organisms not related to disease have ever been demonstrated.

5. Unknown Invaders.—In spite of all the study that has been devoted to the infectious diseases, there are still a number in which the infectious agent—the invading cell—has not been found. Among these are such prevalent diseases as measles and scarlet fever. We know that they are infectious; we know, therefore, that they must be due to a living agent, an invading cell, but as to what the invaders may be like, we are up to the present time utterly in the dark.

Finally, there are a few diseases about which our knowledge is even less. They may possibly be infectious in origin, but we cannot prove either that this is true or that it is not true. In argument we may make a plausible case on either side, but there is no convincing evidence to decide the question. The malignant tumors perhaps are the most notable diseases in regard to which we are in this unfortunate position.

CHAPTER II

SOURCES AND MODES OF INFECTION

I. NUMBER OF SPECIES CONCERNED

We have defined infection as a disturbance of the normal activities of the cells of the body, due to an invasion of its tissues by alien cells from without. We have seen that the world about us is teeming with invisible life, consisting of countless species and varieties of single-celled organisms, infinitely small and insignificant individually, but irresistibly potent because of their prodigious numbers, and the almost inconceivable rapidity with which they multiply. In the great majority of instances the work they do is to dissolve and melt away dead organic matter wherever it may be found; a beneficent work, for the most part, in its relation to the welfare of mankind, since without it there would be no decay, the soil would soon become exhausted of its fertility, and the surface of the earth choked with its own dead.

A certain number of species, however, are parasitic in their habits; that is, their natural dwelling place is within, or on, the living bodies of some of the higher many-celled organisms. Some of these parasites do no harm to their hosts, but others cause serious and often fatal injury to the tissue cells of the higher organisms upon which they live, giving rise to many diseases in plants, in the lower animals, and in man. Only a very few species among the myriads are able to become hostile invaders in the human body, scarcely more than two score altogether, although, if we include all the occasional invaders and some which are quite incapable of doing serious harm, this number will be somewhat increased. On the other hand, if we include only those that are of special importance, because of their wide distribution and the high mortality for which they are responsible, we shall have a list that can almost be counted on the fingers. Our business here concerns only those which are of importance in relation to wound infection, including some half-dozen species of bacteria; but before we can begin the study of these understandingly we need to have clearly in mind certain facts about the sources and modes of infection.

II. DISTRIBUTION OF BACTERIA

1. In the Air.—If we expose to the air for ten minutes a thin layer of culture jelly contained in one of the small glass plates or "Petri dishes," and then replace the cover and put the plate in the incubator over night, we shall find next morning upon the surface of the medium a number of little round colonies of bacteria an eighth to a quarter of an inch in diameter, looking like little drops of paint. Each colony will have grown from a single germ that has fallen upon the surface of the plate while it was uncovered. There may be only five or six, or there may be twenty or thirty or more of the colonies, representing a variety of different species. There will certainly be some of a yellow color, some gray, and possibly some of a bright red. There will very likely be some of the fluffy growth that we recognize as mould. The number of colonies will vary; in a quiet room there will be few, in a dusty one many. Bacteria are sticky things and apt to adhere to particles of dust. There will be more in the city streets than in the country; more in the lowlands than in the mountains; comparatively few or none at sea, in desert regions, and particularly in polar regions. Among them micrococci and moulds will predominate. It will be rather unusual to find any of the pathogenic species upon our plate. Most of them come from the great reservoirs of saprophytic bacteria that are found in decomposing vegetation.

2. In Water.—In water we should find bacteria, for the most part, far more numerous than in the air. Here we must use a smaller measure for our standard. It is usual to estimate the number in a cubic centimetre, a quantity about equal to sixteen drops. In a mountain spring trickling from the rocks and in deep wells we may find the water almost sterile, that is, containing few bacteria or none. They have been filtered out in their passage through the deeper layers of the soil. In an ordinary stream the water will probably be found to contain from two or three hundred to five thousand or more bacteria per cubic centimetre. In a polluted stream the number may rise to enormous totals, a million up to fifty million or even more per cubic centimetre. Both bacilli and micrococci will be found here in abundance. But, except in specimens taken from sewage-polluted streams, disease-producing germs are not numerous.

A rapidly flowing stream tends quickly to purify itself, and a few miles below a point of contamination the number of bacteria contained will be found to be greatly diminished.

3. The Soil.—The superficial layers of the soil contain bacteria in great abundance. It is more difficult to determine the number in the soil than in water or air, and any estimate given as to an average would be useless and misleading. The variations are, of course, very great. In a moist soil contaminated by animal excreta or decaying vegetation the number is enormous. In a dry soil not subject to such contamination the number is relatively small. At about three feet below the surface the earth becomes practically sterile, no bacteria being ordinarily found below this level except in loose gravel, where they may be present at a somewhat greater depth. All the varieties of bacteria are included among those found in the soil, but it may be noted that the spore-bearing bacilli are relatively numerous here. Here, too, is the chief abode of moulds and other fungi, including yeasts, and very many species of single-celled animals are also present in great numbers. As regards the presence of pathogenic bacteria in the soil, perhaps the one species most to be dreaded is the deadly tetanus bacillus, which, as has been said, is found occasionally in garden earth and more commonly in stable-yards. It is a possible danger in the soil almost anywhere in thickly inhabited regions, and the same may be said of some other species of bacteria that are concerned in the production of disease, particularly those that thrive in the intestinal canals of men and domestic animals. Nevertheless, apart from areas liable to be contaminated with human or animal excreta, the bacteria of the soil are rarely pathogenic to man.

4. Food.—The presence of bacteria in various articles of food is constantly manifested by the evidence of decomposition. We may take milk as a typical example. What may be called the normal bacterial content of milk is surprisingly large. Milk containing no more than ten thousand bacteria to the cubic centimetre is considered the standard of attainable purity. The production in marketable quantities of milk in which the bacteria do not exceed this number is rarely attained. A milk that does not contain over one hundred thousand bacteria to the cubic centimetre is regarded as just passably clean by most of our health boards. A milk containing more than this is considered a dirty milk, and yet in all probability the majority of the milk now marketed contains, at the time it reaches the table of the consumer, vastly greater numbers of bacteria than this, often going up into the millions per cubic centimetre. It is true that the majority of these bacteria are not pathogenic, often not even unwholesome; nevertheless, dangerous and deadly disease germs are so often present in milk that the methods of its production and distribution are among the most important of the problems concerned with the prevention of infectious disease. Notable among the diseases that are not infrequently conveyed by milk are typhoid fever, streptococcus infections of the throat, dysentery and diarrhœal diseases and tuberculosis.

Bacteria, as has been said, readily adhere to any surface they come in contact with, and all the innumerable articles of use and ornament that surround us are more or less covered with them.

5. The Human Body.—The skin has its bacterial flora, distributed not only on the surface but in the ducts and crypts of its glandular organs. Here there are always micrococci capable of giving rise to the infection of wounds, and many other infectious germs may at times be found upon the skin, particularly of those who come in contact with disease. Bacteria are always present and even multiply abundantly in the mouth and throat. Here, also, certain species capable of invading the body may be practically always found in the healthy individual, and others are occasionally present. Many bacteria swallowed from the mouth and taken in with the food are destroyed in the stomach by the acid gastric juice, and that portion of the small intestine into which the food passes after leaving the stomach contains fewer bacteria than any other part of the intestinal canal. Lower down in the intestine, however, the bacteria multiply enormously until they actually form a considerable part of the bulk of the contents of the large intestine. From one-eighth to one-quarter by weight of the dried fæces consist of bacterial cells. The species present in the intestines are fairly constant and among those normally present are a number that are capable of invading the body tissues under certain conditions.

III. THE RELATION OF PARASITE TO HOST

When we think of the various ways in which infection may come to us it is natural to assume that the germs of disease always pass directly from the sick to the well and that the means of transmission is mainly through the agency of the air. This has probably been the generally accepted idea from the beginning of our knowledge of these diseases and still influences largely our practice in regard to preventive measures. But increasing knowledge is making it more and more evident that the problem of the sources of infection is far from being so simple a matter. An individual sick with an infectious disease is not by any means the only, and in many cases not the chief, source of infection to others, and transmission through the air is, with a few exceptions, an almost negligible factor. To understand this we must take into account certain facts about the relation of parasite to host. We have said that the presence of a parasitic organism is not necessarily harmful to the host, and we have also pointed out that certain individuals of a species may be apparently entirely insusceptible to an infectious disease to which other individuals of the same species readily succumb. That an invading organism will grow in the body of one individual and not in that of another is hard enough to explain, but we must also recognize the fact that the same organism may grow in the bodies of two individuals, producing symptoms of disease of the gravest character in one and no symptoms whatever in the other. It happens often that after an attack of disease the organisms which were the cause of the trouble may remain alive and continue to multiply in the body long after the patient has fully recovered; but it is also true that the germs of an infectious disease may be present in the body of an individual who has never had an attack of the disease. In the history of many of the infections there are found cases where the symptoms are so mild that they are scarcely recognizable, and it is but a step farther to find that there are cases of infection with no symptoms at all. How greatly these facts complicate the problem of determining and controlling the sources of infection will be readily seen, but even this is not the whole story.

When an organism acquires the parasitic habit, there is always a tendency for the parasite and host to become gradually adapted or, so to speak, used to each other, so that the mutual effects of a harmful nature are reduced to a minimum. It is obvious that, when the presence of the invader is rapidly fatal to the host, this fact works as much to its own disadvantage as to that of the species of animal invaded. The invaders die with their victim, and their chance of transmission to a new individual is diminished in proportion to the rapidity with which they kill. It is a curious fact that the most deadly among the infections are also the most rare; thus tetanus, anthrax and rabies are infections that almost invariably kill. In the case of the first two of these named, the organisms concerned have the immense advantage that they are spore producers and thus are able to survive indefinitely under the most unfavorable conditions. Yet the number of their victims is small in proportion to their deadliness.

Heredity plays an important part in gradually bringing about a mutual adaptation between parasite and host. The individuals having greater resistance to the invaders are the ones that survive, to transmit this quality to their descendants; on the other hand, the less deadly of the invading organisms are favored in their chances of survival.

Let us suppose now that a certain unicellular organism has acquired the parasitic habit, living in the body of a certain host, and that the two have become adapted to each other so that the host suffers little or no injury from the presence of the parasite. The host in this case we will suppose is one of the wild animals of the region, or perhaps one of the domestic animals. We will call this the habitual host. Suppose now that the same organism is also able to invade the tissues of some other animal, for example the human body, and in this new host its presence gives rise to grave disturbances. We shall have then an infectious disease of such a character that the main source of infection is not from the victims of the disease but comes rather from the inexhaustible reservoir found in the bodies of habitual hosts, who are unaffected by the presence of the organism. This is exactly the condition of affairs with regard to a number of infectious diseases of man and of the domestic animals, and it is quite possible that there are others of which the same is true, although the habitual host has not yet been discovered. The organism which is the cause of sleeping sickness, a disease invariably fatal to human beings, which prevails in certain regions of Africa, is transmitted by a biting fly from certain wild animals of the region who are its habitual hosts. The domestic goat is the habitual host of the micrococcus which is the cause of Malta fever, the infection being conveyed through the milk. There is evidence that septic streptococci may sometimes be present in the milk from apparently healthy cows, and it seems highly probable, though perhaps not proved, that milk from animals which show no outward sign of disease is one of the sources of infection with the tubercle bacillus.

IV. CARRIERS OF DISEASE ORGANISMS

When a healthy animal or human being is the bearer of an organism which is capable of becoming a disease-producing invader in the tissues of an animal of another species, or of another individual of its own species, we speak of it as a disease "carrier." Diseased individuals are of course also carriers of disease, but we use the word with reference particularly to healthy carriers. Among human beings we have chronic carriers, or those who, having had an attack of disease, retain the invading cells actively growing in their bodies for an indefinite time after they have been restored to perfect health. We have also healthy carriers, or those who have never had an attack of a certain infection and yet carry in their bodies the organism of that disease. Wild or domestic animals, and also insects, which are the habitual hosts of an infectious germ, are also spoken of as carriers. A certain number of those who have recovered from typhoid fever carry in the intestinal canal living and active typhoid bacilli for months or years, or even for the remainder of their lives. It is impossible to know how many of these there are, but there is evidence that they may amount to two or three per cent. of the population. Diphtheria bacilli are often present in the throat for weeks or months after recovery from the disease, and wherever there is an epidemic they are also to be found in the throats of a varying number of healthy individuals, sometimes in as many as ten or fifteen per cent. of those examined. With regard to the pneumococcus, which is the usual cause of pneumonia, and of a number of other diseased conditions in the human body, the case is a peculiar one. This organism is harmlessly present in the mouths of a large percentage of human beings, but is able to induce an attack of disease only under certain conditions which favor its invasion, probably because they lower the resisting power of the body. Thus prolonged exposure to cold and wet, particularly with exhausting labor, favors the development of pneumonia, as does also the presence of certain other infections, the administration of an anæsthetic, and so on.

The discovery of the typhoid carrier was felt to be almost revolutionary in its bearing upon our conception of the sources of infectious disease, and our sanitary authorities have been sorely puzzled as to the proper method of dealing with the problem. The difficulties of detecting these carriers, and also of dealing effectively with them after detection, are almost insuperable. Obviously a typhoid carrier whose occupation is concerned in any way with the preparation of food is a constant source of danger to others. Some few individual instances of this kind have been investigated, showing evidence that a large number of persons have been infected by a single carrier. There is something appalling in the thought of such an unfortunate individual going through life unconsciously leaving behind him a constantly lengthening trail of disease and death. And yet after all there was nothing really new or revolutionary in this discovery. The facts about pneumonia, which we have stated, had long been recognized, and for many years it had been known that, without exception, every surgeon, nurse, or other person who assists in surgical operative work, is a healthy carrier of the organisms concerned in wound infection.

V. MODES OF TRANSMISSION

The dissemination of infectious germs from the sick, the carriers, or the animal hosts depends on the method by which they are thrown out from the body. In some diseases, as for example in malaria, yellow fever, and sleeping sickness, the organisms cannot find exit from the body alive unless they are withdrawn directly with the blood. It is possible to transmit such diseases by means of a hypodermic syringe, but the ordinary method is by the bite of a mosquito or other insect. The principal avenues by which infecting cells leave the body are through the expectorated secretions from the mouth and throat, the discharges from the nasal passages, and with the urine and fæces. Other avenues of exit are the secretion of milk, discharges from abscesses and ulcerations, and even the secretion of the sweat glands. As a rule, probably ninety per cent. of the organisms so eliminated are dead at the time they leave the body, but the remaining fraction may represent prodigious numbers. The various possible modes of transmission are through the air, through the contamination of drinking water and food, through direct contact, and through contact with contaminated articles, such for example as the public drinking cup and all the innumerable things that may be soiled with infection-bearing secretions. Flies and other insects may transmit bacteria mechanically to articles of food or to an open wound, and finally the importance as bearers of infection of the busy human fingers, which are constantly touching everything within their reach, can hardly be overestimated.

There are two ways in which the germs of disease may be disseminated through the air. One is through the drying of infected secretions and excretions from the body, which are then carried about by air currents in the form of dust. Most of the organisms of disease do not live very long when dried, particularly if exposed at the same time to sunlight, yet some of them can survive under these conditions for several days at least, and certain diseases may undoubtedly be transmitted through inhaled particles of infected dust. The importance of this method of dissemination has quite certainly been greatly overestimated in the past, and it is probably not the usual mode of transmission in the case of any infectious disease and for the majority is a practically negligible factor. The other mode by which infectious organisms are carried through the air is of far more importance. It is the so-called droplet or mouth-spray method. In talking, coughing, or sneezing, and even in breathing through the open mouth, there is always driven out into the air a fine, often invisible, spray consisting of minute droplets of mucus, and in these droplets there are invariably present some of the bacteria of whatever kind that happen to be present in the mouth. The spray can be shown experimentally to extend for a considerable distance up to several yards, though ordinarily five or six feet is the limit of its reach. Any infection where the organism is present in the mouth, nose, or throat may be thus conveyed, the spray being directly inhaled or more often perhaps falling on the clothing or skin surfaces, particularly the hands, of persons standing near, to be later conveyed to the mouth. Diphtheria and influenza, for example, are doubtless often conveyed in this way. Both of these methods of conveyance through the air are of course more liable to occur in a closed space, like a room or street-car, than in the open.

CHAPTER III

INFECTION IN WOUNDS

I. DEFINITIONS

WHEN any of the tissues of the body are divided or separated by violence, as for example by a cutting or tearing or crushing injury, we have what is known as a wound. A wound may vary in extent from the slightest scratch up to any degree of severity. Accidental wounds are described under various terms which indicate their character, such as incised, lacerated, contused, and punctured wounds. A penetrating wound is one that enters any of the body cavities, such as the head, chest, or abdomen. A snake bite is an example of what is meant by a poisoned wound. A subcutaneous wound is one in which the deeper tissues have been torn without division of the skin. When the skin is involved we speak of an open wound. An infected wound is one into which living single-celled pathogenic (disease-producing) organisms have found entrance. A septic wound is one which is infected with certain species of bacteria to be presently described. A suppurating wound is one from which pus is being discharged, a condition always the result of septic infection. The word sepsis means the diseased condition of the body due to the invasion through a wound or otherwise of the particular species of bacteria concerned in septic infection. By an aseptic or clean wound we mean one which is entirely free from all microörganisms capable of giving rise to local or general injury within the body. The healing of a wound is the process of repair, due to the activities of the body-cells of the wounded part, whereby the divided tissues are reunited and restored more or less perfectly to their natural condition. Normal or primary healing is that which takes place in an aseptic wound.

II. OPERATIVE WOUNDS

The wounds which particularly claim our attention are those which have been deliberately made by the surgeon, with some definite purpose of a remedial character in view. Such wounds are called surgical or operative wounds. Any remedial measure carried out by the surgeon with his hands or with instruments is called an operation. A bloodless operation is one in which no open wound is made, as for example the "setting" of a fracture or the "reduction" of a dislocated joint. Any operation which requires the making of an incision through the skin or mucous membrane is known as an open operation. The object of an open operation may be either to remove something contained within the body, the continued presence of which is a menace to health and life, such as a foreign body, a diseased or injured organ or portion of tissue, or an abnormal accumulation of the products of disease; or else to correct some physical or mechanical defect. The special characteristics of these operative wounds should be clearly understood by the nurse in order that her work in the operating room and in the care of surgical cases after operation may be intelligently performed.

As a general rule every open surgical operation consists of three main steps or stages: (1) exposure of the part to be operated on is secured by cutting or separating the overlying tissues, so as to bring the diseased or injured area clearly into view and make it easily accessible; (2) the remedial measures required in the particular case are then carried out, a great variety of procedures being included under this head; (3) closure of the wound is accomplished by the use of stitches or "sutures," so as to restore the parts as nearly as possible to their normal relations.

The first step begins with the incision through the skin or mucous membrane. This varies in position, direction, and extent with the requirements of the case. It may be a single straight or curved incision, or there may be several incisions joining at different angles, so as to outline flaps of skin, which are separated from the underlying tissue and temporarily turned aside out of the way. The dissection proceeds with the division by knife or scissors of the superficial fascia or tissue lying immediately under the skin, with its layer of fat of varying thickness, then of the deep fascia covering the muscles, and finally with the separation and pulling aside of the muscles and other structures overlying the part to be operated upon. Large nerves are never divided in this procedure and large arteries or veins only when absolutely necessary. Many small blood-vessels are necessarily cut, and bleeding from these is at once checked by pinching with instruments known as clamps or hæmostatic (blood-checking) forceps, which temporarily compress the ends of the divided vessels. Permanent arrest of hemorrhage is later secured by tying the bleeding points with threads of silk, linen, or other material specially prepared for the purpose. These ties are known as ligatures and they remain permanently in the wound. Bleeding from the cut capillaries, too fine to be tied, is checked by pressure with pads of gauze called sponges, and these are also used to soak up the blood which at times obscures the field. Many operations require the opening of one of the large cavities of the body, as for example the abdomen, to secure access to the stomach, the intestines, the uterus and ovaries, and other abdominal organs. The other large cavities to which a way of entrance must be found are the head and the chest or thorax, and here, on account of the bony walls which enclose them, special means must be employed involving the cutting away of portions of ribs or of the skull; or else the formation of flaps containing bone as well as soft parts, which can be temporarily turned aside, exposing the underlying organs, and later replaced in their original position.

The second stage consists in carrying out the remedial measures to accomplish which the operation was undertaken, and may be called the operation proper. It includes, of course, a very great variety of procedures intended for the relief of the large number of injuries, abnormalities, and diseases that are amenable to surgical treatment. They are too numerous and varied to be briefly summarized here. One feature of operative work remains to be mentioned, namely, the use of drainage. All surgical operations fall into one of two classes: clean cases, where no alien invading cells are present, and infected cases. The latter include those where the operation is undertaken for the relief of conditions resulting from septic infection in some part of the body. In these, one of the principal objects to be attained is to provide for the escape of poisonous accumulations caused by the invading organisms. For this purpose rubber tubes or wicks of gauze are inserted through the wound, extending from the skin surface down to the infected area, so as to keep open a way for the escape of the toxic products of the infection. These drains, as they are called, remain in place for a variable time, sometimes for weeks. The deadly secretions of the alien cells are by this means continually discharged from the body instead of being retained and absorbed, thus giving the body-cells a great advantage in their struggle with the invaders. In very deep and extensive clean wounds temporary drains are sometimes inserted to prevent the retention of blood and serum in the wound. They are removed at the end of from twenty-four to forty-eight hours.

The third stage in a surgical operation consists in closing the wound by bringing the divided tissues together, restoring them to their normal positions and relation to each other, and fixing them when necessary by means of stitches, or "sutures," of silk or other material. The cut edges of the incisions in the skin are united with particular exactness and care. Finally the wound is covered by a protective "dressing." This usually consists of loosely woven absorbent gauze laid over the wound and held in place by straps of adhesive plaster, bandages, or a "binder."

Throughout all the steps of an open operation, from the first preparation to the placing of the dressing, the dominating idea in the minds of every one engaged in the work, never to be forgotten for an instant, must be to prevent the entrance into the wound of the bacteria of septic infection. The means that are used to attain this end have been purposely omitted here, since they form the principal theme of many subsequent chapters. In this place we are concerned rather with answering the questions as to what happens to such a wound when no infecting organisms have been allowed to enter it, and, on the other hand, what is the result when infection has occurred.

III. NORMAL HEALING

In every fresh wound there will occur a certain amount of oozing from the divided capillaries and lymphatic vessels, first of bright red blood, later of a clear fluid only slightly blood stained. In very extensive operative wounds this oozing will be of considerable amount and may last for several hours. Later, at the first dressing, the gauze covering the wound will be found deeply stained with this discharge. Pain in the wound may be present immediately after the operation, but it is rarely severe and ceases within a few hours. Pain is more often due to too tight bandaging or to pressure of skin stitches than to the wound itself. Pain resulting from movements of the body which call into play the muscles in the region of the wound will be present for several days. As a rule there is no elevation of the temperature of the body resulting from an operative wound in clean cases (Fig. 11), but in extensive wounds there may be a rise of from one to four degrees, beginning within twenty-four hours and lasting

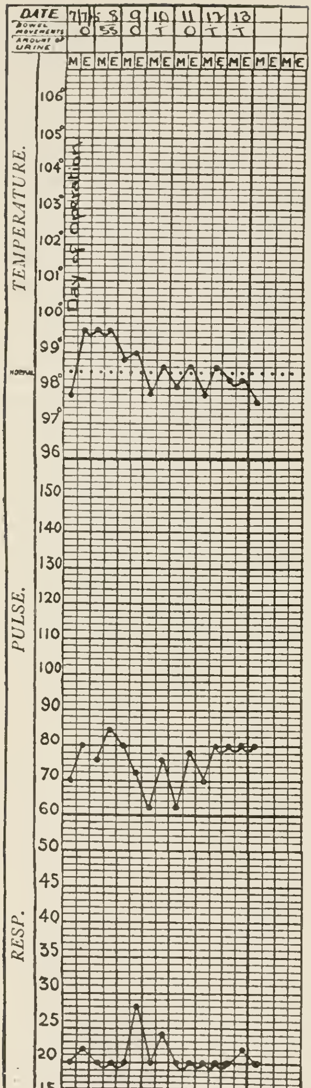


Fig. 11.—Chart showing normal temperature after operation (salpingectomy).

until the third or fourth day (Fig. 12). This is the so-called traumatic fever, resulting either from the absorption of the dead tissue cells or of blood that has collected in the wound, or else from increased oxidation due to the psychic and traumatic stimuli of the operation. This slight fever, occurring within the first three days, is quite harmless and calls for no interference with the wound. On the other hand, a sudden rise of temperature appearing from the third to the fifth day almost always means infection (Fig. 13), and if it persists for more than twenty-four hours calls for a change of the dressings and an examination of the wound. As a rule, the dressing of a clean wound is allowed to remain undisturbed for from five to ten days, the longer the better, for there is always some risk of infecting a wound at the first dressing if it is done too early. When such a clean wound is dressed and the skin stitches removed at any time from the fourth day onward, the edges of the skin incision will be found to be quite firmly united, there will be no discharge from the wound, the dressings being free from moisture although deeply stained with dried blood. The skin about the incision will be normal in appearance. There will be no redness or swelling and scarcely any soreness on pressure. Even very extensive wounds will thus appear to be quite perfectly healed by the fourth or fifth day

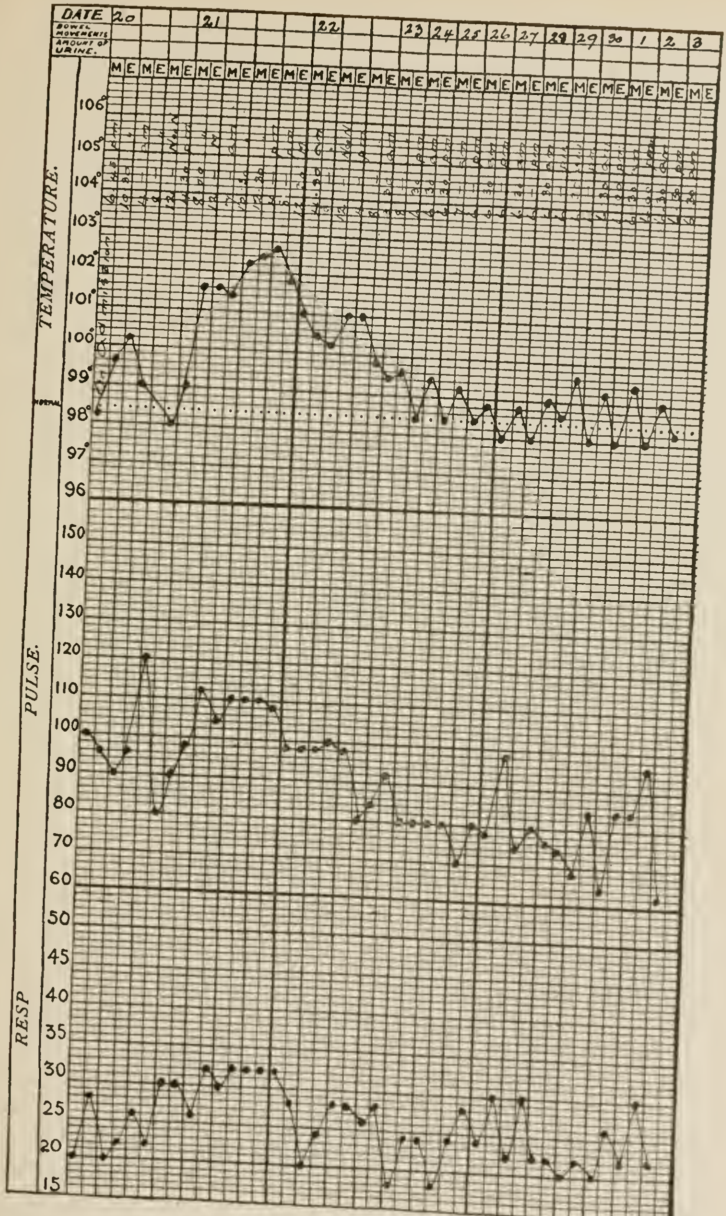


FIG. 12.—Chart showing temperature rise due to trauma and not to infection. Amputation for crush of foot. (Chart by Miss Kathleen Carroll.)

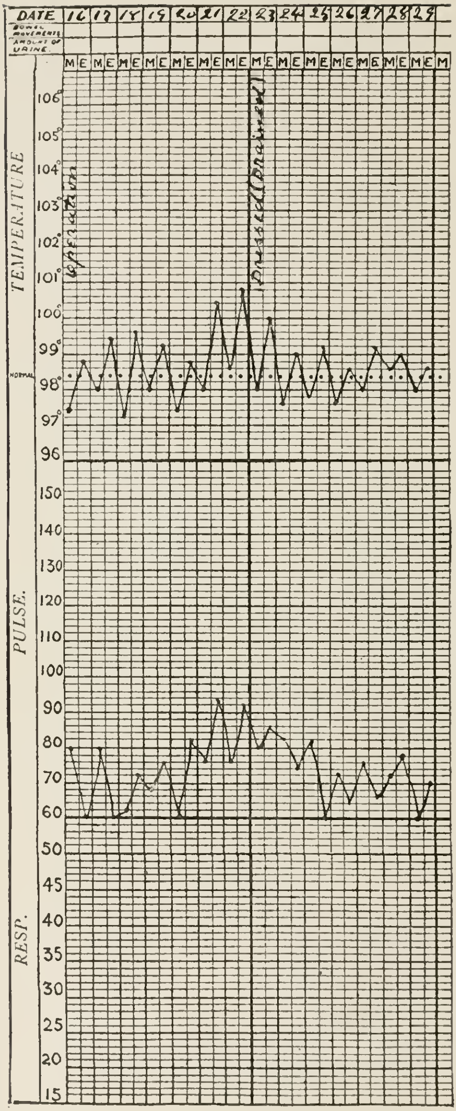


Fig. 13.—Chart showing septic infection after operation. (Excision of cystic tumor of breast, local abscess.) (Chart by Miss Virginia Ryan.)

in all but one particular. The new-formed tissue resulting from the healing process is still soft and easily torn. What we may call the solidification of the new tissue is not complete until two or three weeks have passed. The final visible result is a scar, a bond of new-formed fibrous or connective tissue solidly uniting the wound surfaces, and appearing as a narrow line along the site of the incision. At first the scar is of a red or purple color, owing to the presence of numerous capillary blood-vessels, but this color gradually fades away, until after some weeks the scar appears much whiter than the surrounding skin.

IV. INFECTED WOUNDS

There are many varieties of single-celled organisms capable of giving rise to disease, which can make use of an open wound as a portal of entry into the body, but when we speak of infection in wounds we ordinarily mean septic infection; that is, an invasion by certain species of bacteria which cause, when growing in the tissues, a local diseased condition, known as sepsis, characterized by inflammation, delayed healing and the formation of pus, together with constitutional disturbance or general illness, the most prominent symptoms of which are high fever, chills, profuse sweating, and digestive disturbances.

When an operative wound has been infected with the bacteria of sepsis, the course of events will be somewhat as follows. For the first two or three days there will be no disturbance, the condition of the patient being the same as in normal healing. On the third or perhaps the fourth or fifth day there will be a sudden rise of temperature, of probably from three to five degrees, making its appearance usually in the afternoon. There will be an increase in the pulse rate. There may be a sharp chill or slight chilly sensations, known as rigors, followed by more or less profuse sweating. Pain in the wound will be present, and may have been complained of before the fever appeared. On the following morning the temperature will be found to be nearly or quite normal, but in the afternoon it will again rise to a higher level than before, and the other constitutional symptoms that have been referred to, together with digestive disturbances and restlessness, will be increasingly manifest. This type of fever with a sharp rise in the afternoon and a drop to nearly normal in the morning is quite characteristic of septic infection, although in many cases the fever is more continuous in character and often irregular (Fig. 14). When the dressings are removed and the wound is exposed to view, a characteristic appearance will present itself. The tissues in the neighborhood of the wound may be markedly swollen, rendering the skin stitches quite tense. The skin about the incision will be of a bright red color unless the infection has begun in the deeper part of the wound and has not yet extended to the surface, in which case there may be little change in the color of the skin. To the touch the tissues about the wound will be distinctly warmer than other parts of the body and the wound itself will be exquisitely tender. These symptoms, swelling, redness of the skin, heat and pain, are the so-called cardinal signs of inflammation, which is usually defined as a condition entered into by the tissues as a result of irritation, in this case from the presence of septic bacteria. When the stitches have been cut the edges of the wound will readily separate, allowing the escape of a more or less abundant discharge of a pale yellow fluid material, of a creamy consistency and a pasty odor, known as pus. When a wound discharges pus it is said to be suppurating. The color and consistency of pus are due to the presence of enormous numbers of leucocytes, which have found their way into the wounded tissues through the walls of the blood-vessels. They seem to be attracted to the locality by the presence of the invading organisms, and moreover the number of leucocytes in the blood increases in cases of septic infection sometimes to as much as five or six times the normal number. When the exudate in an infected wound has the character of pus it is said to be purulent. The character of the exudate varies considerably in different cases. If very few leucocytes are present, it may be thin and watery and it is then described as a serous or, if blood stained, as a serosanguineous exudate. If coagulated fibrin is present in considerable quantity it is spoken of as a fibrinous exudate.

The growth of septic bacteria within the body often results in the death of many tissue cells and a breaking down and liquefaction of tissue in the infected area so that a cavity is formed which becomes more of less rapidly distended with an exudate, usually of a purulent character; that is, one containing an enormous number of leucocytes. Such a cavity containing pus is called an abscess.

There are thus to be found both local and general symptoms and signs in septic disease due to wound infection. The local disturbances known as inflammation and suppuration are due

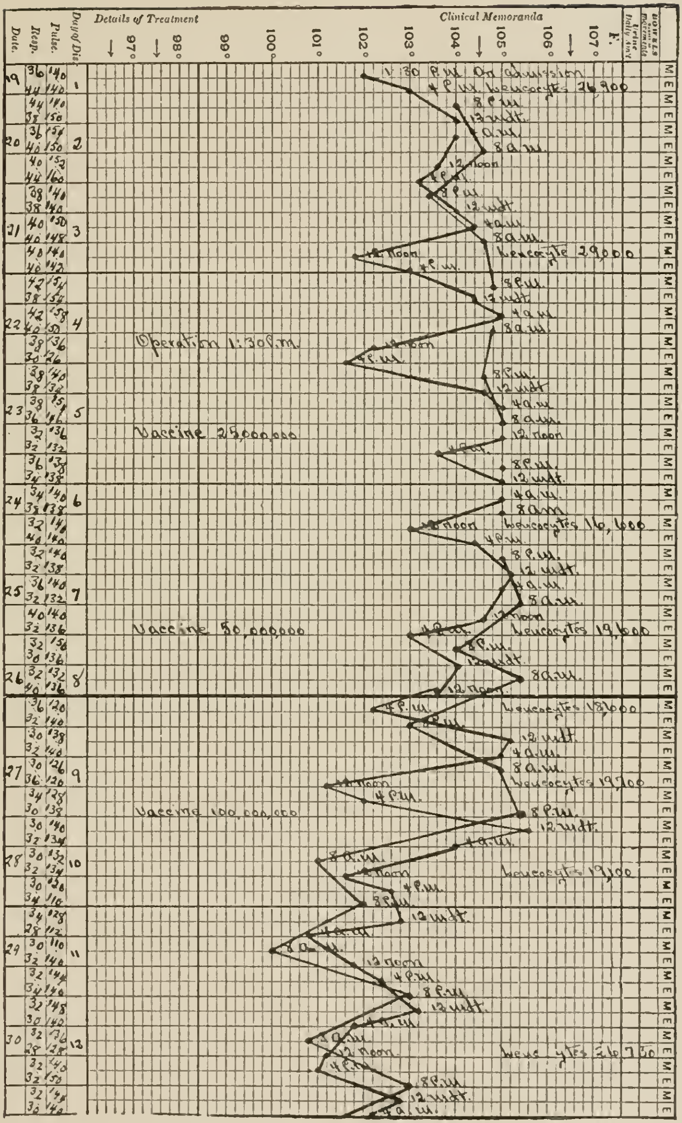


FIG. 14.—Chart showing septic infection, continued type. Infection of ankle and both hip-joints, multiple abscesses. (Chart by Miss Emily Warren.)

to the direct irritation of the tissues by the invading bacteria and their toxic secretions. The general or constitutional symptoms of fever, chills, sweating, digestive disturbances, and so on, are caused by the absorption into the blood stream of poisonous chemical products derived from the infecting organisms and from the dead tissue cells in the infected area. When provision is made for free escape of the exudate containing these products the poison is no longer absorbed into the blood and the symptoms due to its presence are promptly relieved. When, for example, an abscess either ruptures spontaneously or is laid open by an incision with the knife, the escape of the pus which has been confined within it is followed by almost instant fall of the temperature to normal and the disappearance of other symptoms which accompany the fever. The treatment of septic infection therefore is drainage, and when this can be satisfactorily accomplished the chances of recovery are greatly increased.

V. HEALING IN INFECTED WOUNDS

The healing of an infected wound appears to follow a very different course from that which has been described for a clean or aseptic wound, although in reality the processes involved are essentially the same. The time required is much longer, for not only does the presence of the invading cells effectually retard the process, but the necessity for drainage of the wound frequently requires that all the stitches shall be removed and the wound allowed to gape widely open, so that a very much larger amount of new tissue has to be formed to fill it up. This new-formed tissue is known as granulation tissue, a name which is derived from the characteristic surface appearance of the growth. The color of this granulation tissue is a bright red, and the surface is not smooth but granular, showing many small elevations of uniform size, each elevation representing a capillary loop. The tissue consists of young connective-tissue cells and newly formed capillary vessels, the same in character as those which form to unite the edges of a clean wound which is undergoing normal healing with the cut surfaces in contact. A gaping open wound heals by filling up from the bottom with granulations until they are level with the surface, after which the new-formed epithelial cells growing in from the edges gradually cover the wound. Granulations are soft and easily torn, bleeding readily on the slightest touch, but the unbroken surface offers an almost impervious barrier against the entrance of infecting organisms, and slight injuries are rapidly repaired, so that a granulating wound is comparatively safe from infection.

The severity of septic infection in a wound may vary in every degree from a superficial and insignificant " stitch abscess " to a rapidly fatal general infection. By the latter term we mean that the bacteria have found their way into the general circulation and are growing everywhere in the body instead of being confined to one locality. Several terms commonly used in relation to septic infection may now be defined. Septicæmia means that the blood contains poisonous products of bacterial growth absorbed from some local infection. Pyæmia is the older term used to indicate the presence of septic bacteria in the blood. Since, when bacteria are to be found in the circulation their poisonous products must be present also, the word septicopyæmia is the more modern term used in describing this condition.

VI. THE SOURCES AND MODES OF SEPTIC WOUND INFECTION

In the early days of antiseptic surgery it was assumed that the air was the source from which the germs of sepsis came. Later it was recognized that septic infection of operative wounds rarely came from the air, but almost invariably from contact, the bacteria being carried in by anything that touched the wounded surface. The conception then was that all material objects, our own bodies included, of course, were resting places for septic bacteria, which gradually accumulated upon them from the air, although the air itself contained comparatively few at any one time. This conception revolutionized our operative technic, bringing in the era of so-called aseptic surgery. It was nearly enough true to enable us to develop our technic to a high degree of efficiency. But to understand the real situation it is necessary to go one step farther. It is a fact that all material objects in daily use about us are, as a rule, the bearers of living bacteria of the kind that cause septic disease, but why? The reason is that *we* have handled them, breathed upon them, sprinkled them with mouth spray, silted them with dust rubbed from the surface of our bodies or derived from its dried secretions. The human body, healthy or not, is the reservoir from which comes the ever-present supply of septic organisms. Material objects are contaminated in proportion as we handle them. In the great world of out of doors, the air, the water, the soil, and vegetation, living or decaying, are comparatively free from the germs of sepsis. *Every human being is a chronic carrier of the organisms of septic disease.* Operative wounds are infected by human contact, direct or indirect, and the same is true of accidental wounds. In many of these, infection takes place not at the time of injury, as we are accustomed to suppose, but by careless handling afterward. The same rigid precautions should be exercised in dealing with them as in the case of operative wounds.

VII. THE BACTERIA CONCERNED IN WOUND INFECTION

The vast majority of cases of septic infection in wounds are due to the action of only three or four distinct species of bacteria. There are a number of other occasional invaders, but they are so rare that they need not be mentioned here.

1. *Staphylococcus Pyogenes* (Fig. 15).—This organism is the most common cause of septic infection, being found in probably eighty per cent. of the cases. The individual cells are minute globular bodies (cocci), and they appear under the microscope in irregular masses, suggesting a bunch of grapes to their first observers, who named them in accordance with this characteristic. "*Pyogenes*," meaning pus-producing, was added to the name to distinguish the species from other staphylococci which do not cause disease. A third name is added to indicate one of several varieties or allied species, and this is usually suggested by the color of the growth on artificial culture media. *Aureus* (golden yellow) and *albus* (white) are the most common forms. These bacteria grow abundantly on all our culture media, either in the presence or absence of air. They retain their vitality in the dried condition for a considerable time, and are rather resistant to chemical disinfectants and to heat. Boiling water kills them within a few minutes. Abundant formation of pus is characteristic of the infections with which they are concerned. The *Staphylococcus pyogenes aureus* is the variety usually found in the more severe infections, and the *albus* in milder cases. This organism is very often present on the skin, in the mouth, and in the intestines of healthy individuals, one variety of the *Staphylococcus albus* being a quite constant inhabitant of the human skin.

2. *Streptococcus Pyogenes* (Fig. 16).—This organism holds the second place in point of frequency among the bacteria of sepsis. From another standpoint it might be regarded as of first importance, since on account of its extreme virulence in some cases it is more to be dreaded than the staphylococcus as a

cause of wound infection. The most rapidly fatal forms of infection are due to this cause. The streptococcus appears under the microscope in the form of short chains, which look like strings of beads. It is this peculiarity of arrangement that enables us to distinguish it readily from the staphylococcus, since the individual cells of each species look almost exactly alike, appearing to the eye under the microscope as very small spherical bodies. It is easily cultivated on our culture media, growing best at about the body temperature and in the presence of air. It is a rather more delicate organism than the staphylococcus, dying out rapidly under conditions that are unfavorable to it. The character of the inflammation which it produces in the tissues differs from that caused by the staphylococcus. There is less tendency to the formation of pus and the production of abscess

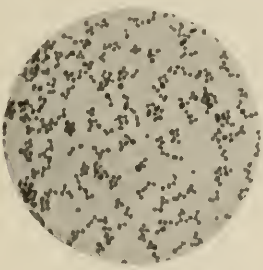


Fig. 15. —Staphylococcus pyogenes (Carr).

Fig. 16—Streptococcus pyogenes.

cavities. The exudate is more serous or watery in character, and tends to infiltrate the tissues and to extend rapidly. This organism is also the cause of erysipelas, and is found in the majority of cases of puerperal fever. It is frequently present in the mouth and intestinal canal in both man and lower animals. Great variation in virulence is one of its marked characteristics. It is for this reason perhaps that in spite of its wide distribution infection with the streptococcus is fortunately less common than infection with the staphylococcus. When it does occur it is regarded as the most serious of all the forms of septic infection, and in some cases its virulence probably surpasses that of any other organism known. In every case of erysipelas or other form of streptococcus infection occurring in a hospital the most extreme precautions must be taken lest these deadly germs be conveyed to healthy wounds either at an operation or at a redressing.

3. *Bacillus Coli Communis* (Fig. 17).—A number of closely allied species or varieties are included under the name of colon bacilli. These organisms are normal inhabitants of the large intestine, and form the largest part of the bacterial content of fecal matter. They appear as short, thick rods with rounded ends. Some varieties possess motility and some do not. None form spores. They grow readily on culture media either with or without the presence of air or oxygen. They withstand drying well, but are not highly resistant to heat or chemical disinfectants. They are pus producers and are the most common organism found in cases of peritonitis due to perforation of the intestine

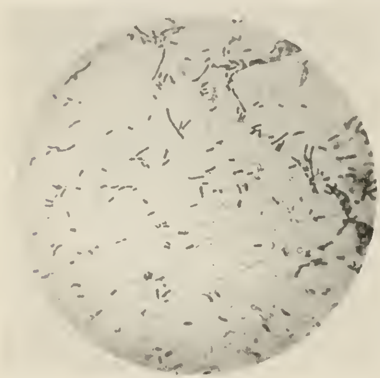


Fig. 17.—Bacillus coli communis, showing flagellæ (Gray).

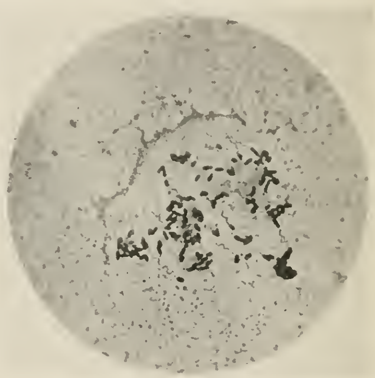


Fig. 18.—Bacillus pyocyaneus, showing flagellæ (Gray).

with escape of its contents into the abdominal cavity, although probably always associated in these cases with pyogenic cocci. In operative wounds, the colon bacillus is sometimes the cause of infections, which are, however, not usually of a very severe grade.

4. *Bacillus Pyocyaneus* (Fig. 18).—The bacillus of green pus is an occasional invader in operative wounds and is usually associated with the staphylococcus. When it is present, the pus discharged from the wound assumes a peculiar bluish-green color, for which the organism is named. It is a small, rod-shaped organism (bacillus), provided with flagellæ at each end, and is very actively motile. It grows readily on culture media, where it produces its characteristic pigment. It is often present on the skin and in the intestines of healthy human beings. It does not form spores.

VIII. OTHER INFECTIONS OF IMPORTANCE IN SURGERY

The bacteria already described include those which are commonly found as the cause of septic infection in operative wounds. It is not a complete list, but others, being of less frequency and importance, need not be enumerated here. There are a number of other organisms which are able to use a wound anywhere in the skin or mucous membrane as an avenue of entrance to the body, and which give rise to a variety of diseases which are not properly classed as septic. Two of these must be enumerated

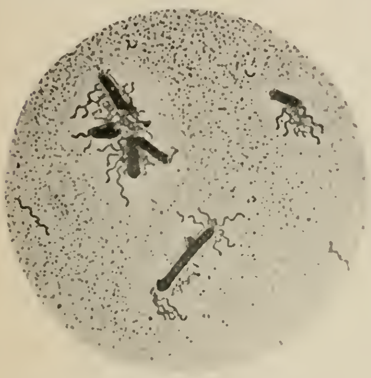


Fig. 19.—Bacillus tetani, showing flagellæ (Gray).

Fig. 20.—Bacillus tetani, showing spores (Carr).

on account of the deadly character of the diseases caused by them, although both are fortunately rare invaders in operative wounds.

1. *Bacillus Tetani* (Figs. 19 and 20).—The tetanus bacillus, the cause of the disease commonly known as lockjaw, is a small, slender bacillus, actively motile by virtue of numerous flagellæ which it possesses. Each bacillus produces a spore at the end of the rod, giving it a characteristic appearance resembling a drumstick. It is a strict anaërobe, growing on culture media only when every particle of oxygen is rigidly excluded. The spores of this organism are exceedingly resistant to heat and chemical disinfectants. Boiling for an hour or more in water is barely sufficient to kill them, and they survive immersion in powerful disinfecting solutions for many hours. They are found in the soil, particularly about horse stables, being a frequent inhabitant of the intestines in horses, cattle, and sheep, and even in man. This organism produces a powerful toxin which has a selective action upon certain groups of cells of the nerve centres. Tetanus

infection results in death in the great majority of cases. It occurs most frequently in accidental wounds contaminated from the soil.

2. *Bacillus Aërogenes Capsulatus* (Fig. 21).—The gas bacillus, as it is commonly called, is a large bacillus surrounded by a capsule. It is not motile, and is strictly anaërobic, the smallest amount of oxygen or air preventing its growth entirely. It forms spores and is therefore highly resistant to drying and heat. In its growth it produces a large amount of gas, and in the tissues of the body when infected by it this is manifested by great distention, causing a tight stretching of the skin over the part, and by a crackling sensation felt and heard when the finger presses on the skin, due to the presence of gas in the intercellular spaces.

Fig. 21.—The gas bacillus.

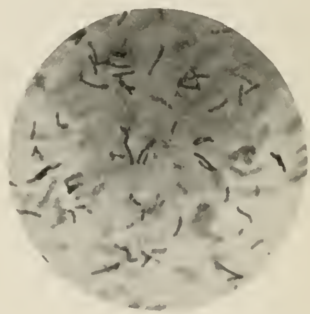


Fig. 22.—Tubercle bacilli (Carr).

It is a widely distributed organism, being a common inhabitant of the digestive tract, and is frequently found in water, soil, and dust, but fortunately it is rarely a successful invader of the human body. It is, on the other hand, an exceedingly fatal infecting agent when once it has become established.

Finally, brief reference must be made to three forms of infection which call for special attention, not so much as possible invaders in operative wounds as because of their wide prevalence and great surgical importance.

3. The tubercle bacillus (Fig. 22) (*Bacillus tuberculosis*) is a slender, non-motile organism which does not produce spores. It is cultivated with difficulty in artificial media, growing in the presence of air but very slowly and only under special conditions. Special staining methods are also required to make it visible for microscopic study. Its invasion of the body gives rise to a great variety of diseased conditions, involving nearly every tissue and

organ. The forms of tubercular disease which are amenable to surgical treatment are mainly those which affect the bones, joints, and lymphatic glands. Many cases of undoubted infection with this organism through operative wounds have been noted, but this mode of infection is so easily under control that it can only occur as the result of gross ignorance or carelessness. The usual mode of infection is either through the respiratory or alimentary tract. With the exception of the two diseases to be mentioned in the following paragraphs, tuberculosis is probably the most prevalent disease to which man is subject. The sources

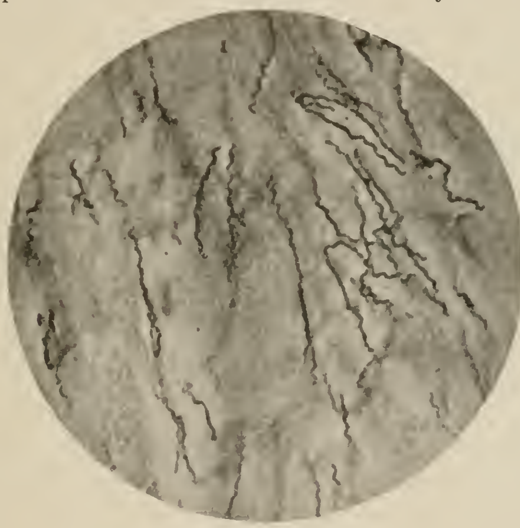


FIG. 23.—Trepomena pallidum (Gray).

and modes of its invasion are not yet thoroughly understood, and the question of its control is one of the great problems of preventive medicine.

4. The organism which is the cause of syphilis (*Treponema pallidum*) (Fig. 23) is a slender, corkscrew-shaped rod, actively motile and possessing flagellæ, but it probably belongs to the class of protozoa, or single-celled animals, rather than to the bacteria. It finds its portal of entrance into the body almost always through slight surface wounds of the skin or mucous membrane. Like the tubercle bacillus it is not a serious menace to the work of the operative surgeon, and for the same reason. The diseased conditions caused by syphilis, like those of tuberculosis, are of great variety and may involve any tissue or organ.

The most prominent manifestations are ulcerations of the skin and mucous membranes, and the destruction of tissue cells in extensive local areas in different internal organs. Cases of this disease are always to be found in the wards of a hospital, often associated with other surgical conditions. A thorough knowledge of its infectious character is essential for the nurse on account of its wide prevalence and the grave character of the disease itself. The organism is, in the vast majority of cases, conveyed through direct contact with an infected person, though infection by indirect contact may occur, as for example by means of a public drinking cup, or any contaminated utensil handled by an infected person. The organism, however, does not long survive outside the body and is readily killed by the ordinary means of disinfection. The secretions from the ulcerative lesions are particularly infectious.

Fig. 24.—Micrococcus gonorrhœæ (F. C. Wood, M.D.).

5. The organism of Neisser (*gonococcus*) (Fig. 24) is a diplococcus, appearing under the microscope as two incomplete spheres with flattened surfaces in contact. It is a pus-producing organism and therefore belongs in the class of septic bacteria, but it is considered here apart from the others in order to emphasize its rôle as a cause of disease requiring surgical treatment rather than its insignificant importance as an infecting agent in operative wounds. This organism has a special affinity for the mucous membranes, particularly of the genito-urinary tract and of the eye. The serous membranes are also susceptible to it. Many cases of pelvic disease in women are caused by extension of this form of inflammation through the uterus and Fallopian tubes. It has been estimated that this organism is responsible for eighty per cent. of deaths from inflammatory diseases peculiar to women, and for sixty per cent. of all the work done by gynæcologists. The serous membranes lining the joints may be infected (gonorrhœal rheumatism), the diplococci being carried to them by the blood stream. The eyes of infants born of infected mothers are frequently involved, resulting in blindness in neglected cases (*conjunctivitis neonatorum*). In adults also destructive inflammation of the eyes may occur from this form of infection. This organism is very delicate, dying out in a few hours outside the body and being easily killed by disinfectants and by a comparatively low degree of heat.

PART II—THE FIELD OF SURGERY

CHAPTER IV

SURGICAL PATHOLOGY

I. DEFINITIONS

1. Affection.—Any structural change or abnormality in a tissue or organ or part of the body with a resulting alteration in the functional activity of the part involved is an affection. An affection may or may not be the result of disease, and it may or may not be the cause of disease. For example, an alteration in the convexity of the crystalline lens with resulting disturbance of vision is an affection of the eyes and not a disease. The affection in this case is not produced by disease and does not give rise to any diseased condition, except perhaps through the effect of eye-strain upon the nervous system. A shrivelled valve in the heart, with resulting obstruction to the onward flow of the blood, or regurgitation from imperfect closure of the valve, is an affection of the heart and not a disease. In this case, however, the affection is the result of disease, namely, an endocarditis occurring, for example, in the course of an attack of rheumatism. It also is likely to become sooner or later a cause of disease in distant organs, particularly the kidney, by reason of the disturbance it produces in the circulation of the blood. An affection which is caused by a disease may be transient, passing away with recovery from the disease, or it may persist for a certain time after recovery, or it even may be permanent.

2. Disease is an active process depending essentially on altered activities of some of the cells of the body due to the presence of abnormal stimuli. The cells are thus impelled, not to do new things, but to do too much or too little of the things they normally do, and the harmonious interplay of their activities is interfered with. All the cell faculties may be affected, nutrition, oxidation, secretion, and reproduction. The death of some cells, the active reproduction of others, and profound nutritional changes in still others give rise to visible tissue alterations, which we know as organic changes, and these in turn may become the basis of an affection.

When disease gives rise to structural change in any tissue of the body, we speak of it as an organic disease. When altered cell activities are present without recognizable tissue changes, we speak of the disease as functional.

An acute disease is one of sudden onset and short duration, measured by days or weeks. A chronic disease is one of long duration, measured by months or years. A chronic disease may have an acute onset. There is, of course, no exact time limit, and subacute or subchronic are used as intermediate terms. A disease may be local or topical, or it may be general or constitutional, according as the disturbance involves a part only or the whole body. A complication is a disturbance occurring during the course of a disease, arising from a cause wholly or in part different from that of the disease itself. Sequelæ are the late and remote effects following an attack of disease. Specific disease is a term which, though susceptible of a wider meaning, is commonly used as a synonym for syphilis or lues.

3. **Etiology** means the study of the causes of disease. An important distinction is made between a predisposing cause, or one which renders an individual more susceptible to an attack of disease without actually producing it, and an immediate or exciting cause. Exposure to cold is a predisposing cause of pneumonia; the exciting cause is the invasion of the pneumococcus. The exciting causes of disease are those agents which give rise to the abnormal stimuli acting on the body-cells. They may be mechanical, chemical, physical, or living agencies inimical to the cell, or disease may be caused by the absence or the presence in excess of substances normally used by the cell. The interaction of stimuli between the groups of cells, which make up the glands and other organs, plays a rôle of great importance in the complex manifestations of disease.

4. **A lesion** is any organic tissue change. Various types of lesions are given special names. Hypertrophy is overgrowth or increase in bulk of a cell or tissue. Atrophy is shrinking or wasting. Necrosis is the death of the cells of a part of the body. Degeneration is a term used to describe many forms of nutritional changes in the cells resulting in partial or complete loss of their normal activities. Regeneration is the rebuilding or renewal of normal tissue cells. Cicatrization is the filling of a defect with fibrous or scar tissue, such as occurs in the healing of wounds. Infiltration is the distention of the spaces between the cells with fluid or with other cells, such as the leucocytes. Metaplasia or

heteroplasia are different forms of a rare condition, namely, the growth of normal tissue in the wrong place, as the growth of bone in tendon, cartilage, or muscle. Neoplasia is the formation of new-growths or " tumors " (neoplasms).

Local functional disturbances occur without alteration of tissue structure. Hyperæmia is an increased flow of blood to a part. Passive congestion is a damming back of the blood in a part. Stasis is a checking of the blood flow. Local anæmia is a diminution of the normal amount of blood in a part. Anæsthesia of the skin is a loss of sensation in a local area. Hyperæsthesia is an increased sensitiveness to touch and pain.

5. Symptom.—A symptom is any recognizable manifestation of disease, or of altered function resulting from an affection. When a symptom is manifest only in the consciousness of the patient, it is called a subjective symptom; when it is manifest in any manner to the observer as well as to the patient, it is an objective symptom. Thus nausea is a subjective symptom; vomiting is an objective symptom; pain is a subjective symptom; the observable manifestations of pain, the cry, the facial expression, the shrinking from pressure on the painful area, are objective symptoms.

A pathognomonic symptom is one which is known to indicate one particular disease condition and one only. A premonitory or precursory or prodromal symptom is one which tells us beforehand what is going to happen. They are, in other words, the earliest manifestations of disease which appear before the disease condition has developed sufficiently to be recognizable. Local or topical symptoms are those which occur in a particular part or organ of the body. General or constitutional symptoms are those which cannot be referred to one locality, such, for example, as fever, restlessness, or insomnia. Symptoms may be classified according to the part of the body in which they are present, as, for example, abdominal symptoms, gastric, renal, or pulmonary symptoms. Or, they may be classified according to the physiological system involved, as respiratory, circulatory, digestive, sensory, or motor symptoms. A localizing or focal symptom is one which indicates the exact locality of a lesion, particularly in the brain or spinal cord. A consistent group of symptoms characteristic of a particular disease condition is spoken of as a symptom-complex or syndrome.

6. Physical signs are the recognizable manifestations of structural or organic change, that is of an affection. They are always objective in character and in many cases can be recognized only by a skilled and practised observer.

Physical signs are recognized by the senses of sight, touch, and hearing. By inspection we note the general condition of the patient as regards nutrition, the presence of altered contours of the body, local swellings, changes in the color or texture of the skin and mucous membranes, motor disturbances, the facial expression, and so on. By palpation we learn through the sense of touch whether any part is harder or softer than normal, the size, shape and mobility of tumors, the presence of fluctuation indicating fluid, and of areas that are painful on pressure. By manipulation we detect limitation of motion in joints, abnormal points of motion such as occur in fractures, and so on. In mensuration we use the tape line to obtain exact measurements, usually comparing the two sides of the body. The sense of hearing is used in auscultation to determine the character of sounds within the body, principally in examination of the heart and lungs. In percussion the ear detects differences in the resonance or sounds produced by a blow with the fingers upon the surface of the body. This is used almost exclusively in examination of the chest and abdomen.

7. Signs.—The word sign is used to describe certain single symptoms or physical signs, usually elicited by some special manipulation or procedure, and supposed to be pathognomonic of some particular disease or affection. Many of these signs have not proved to be susceptible of any rational explanation, but have been observed to be present more or less constantly in cases of the disease in question. Very many such special signs have been described, of varying value and importance, and they are usually known by the name of the discoverer. For example, Kernig's sign in spinal meningitis consists in the fact that the knee cannot be fully straightened when the thigh is placed at right angles to the trunk. Graefe's sign in exophthalmic goitre is the failure of the upper lid to move with the eyeball in glancing downward.

Evidence of the greatest value as to the character of disease is also to be obtained by both chemical and microscopical examinations in the laboratory of the blood and the various excretions, particularly the urine, sputum, and fæces.

8. Diagnosis and Prognosis.—Diagnosis is the act of determining the character of a disease and of the lesions and affections produced by it. Described in the crudest form, it is the act of distinguishing one disease from another. Prognosis is the estimation of the probable course, duration, and outcome of a disease. Diagnosis in many cases is a complex and difficult problem, for the manifestations of disease are very variable, the physical signs often obscure, and many symptoms or even groups of symptoms may arise from widely different causes. Clinical diagnosis is that based on the symptoms of the disease, physical diagnosis is based on the physical signs. Pathological diagnosis is that based on an examination of the tissues and organs after death. Differential diagnosis is made by contrasting the symptoms and physical signs of two diseases that are liable to be mistaken for each other. A presumptive diagnosis is one based on a few prominent symptoms. A provisional diagnosis is one made with a mental reservation, to be changed if further evidence presents itself.

9. **Treatment** is the application of any measure designed to assist in bringing about the cure of disease, or relief of its symptoms, or to correct a disturbance of function arising from an affection. Therapeutics or therapy is the general term for all forms of the treatment of disease. Empirical treatment is any form which we have learned by experience to be efficacious without knowing the reason why. Rational treatment is that based upon reasoning from the known facts about the disease or its causation. Treatment is spoken of as radical when it is directed to the removal of the cause of the disease, symptomatic when its object is the relief of the symptoms only without any attempt to remove the cause, palliative when it is not expected to cure the disease but only to hold it in check, supporting when it is mainly directed to sustaining the strength of the patient. Specific treatment is the use of a single remedy which has a definite curative action upon a certain disease; for example, quinine in malaria, mercury and salvarsan in syphilis, diphtheria antitoxin in diphtheria. In the treatment of disease it is quite as important to know when to let nature alone as when to try to aid her, and this attitude is expressed by the term "expectant treatment." Active treatment, on the other hand, consists in the vigorous use of strong remedies.

10. **Pathology** is the science which treats of the changes that take place in the body as the result of disease. It deals both with

alterations of appearance and structure in the tissues and organs, and with disturbances of function in various parts of the body mechanism. The causes of disease also come within its scope in finding an explanation of the manner in which different harmful influences act upon the body. Gross pathology, or pathological anatomy, treats of changes in the tissues that are visible to the naked eye. Pathological histology, or cellular pathology, is concerned with changes in the individual cells as seen under the microscope. Changes in the body functions resulting from disease constitute a very important part of pathological study and this department is described by the rather awkward term "pathological physiology." Surgical pathology is the pathology of surgical conditions; *i.e.*, of those diseases and affections which are amenable to surgical treatment. This latter is obviously a very artificial subdivision. Pathological processes are not capable of separate classification according to the methods of treatment that happen to be applicable to them, but the term is convenient as designating a limited part of the field when discussed in surgical treatises.

II. THE MEANING OF PATHOLOGICAL CHANGE

Every pathological change is the result of changes in the activities of some of the cells of the body, brought about by various forces which act as stimuli upon the cells. The normal body is of course the seat of incessant change, and very many pathological processes can be paralleled by changes which occur normally in the body. It is impossible to frame a concise definition of so complicated a subject that is not open to criticism, but a helpful point of view in understanding the meaning of pathological changes may be obtained if we say that the difference between health and disease consists largely at least in the fact that in the normal condition a certain balance is maintained in the activities of the cells, whereas in diseased conditions this balance is destroyed. Such a disturbance of balance manifests itself in a variety of ways. For example, the needs of the organism as a whole continually require that one or another group of cells shall be called upon temporarily for extra work. The organism is so constituted that in such a case influences automatically arise which urge these cells on to work. When the extra work is done or is no longer needed other influences come into play which restrain the cells. Thus the organism (*e.g.*, the human body) is able to carry on its functions normally in spite of changing environment, by what may be called a properly balanced adjustment of its cell activities. If either the urging influences (exciting stimuli), or the restraining influences (inhibiting stimuli), are increased or suppressed from any cause, then the cells either fail to do the work needed, or they continue in riotous and undisciplined activity. Examples of such disturbance in the equilibrium of cell activities are innumerable in disease. In fevers the rise of temperature and the rapid heart action are manifestations of abnormal increase in cell activity, and the depressed secreting activity of other cells is seen in the dryness of the skin and mucous membranes. But a disturbed balance may be shown to be the cause not only of functional changes but of visible physical changes as well. Thus in the healthy body fluid is constantly leaking through the walls of the capillary blood-vessels into the spaces between the cells in the tissues. This fluid bathes the individual cells, furnishes them with nutriment, and carries off their waste products. Normally the fluid is carried off exactly as fast as it comes in, passing along the lymphatic channels, from which it eventually returns to the blood stream, while a part is thrown off in the form of excretions from the skin, kidneys, etc.; if, however, less is carried off than comes in, this fluid accumulates in the tissue interspaces; they become soggy with watery fluid, and we have a pathological condition known as œdema. Physical changes in individual cells are also due in many cases at least to a similar disturbance in balance. Thus every cell in performing work gives out energy, and in doing this it must use up some of its own substance in chemical change. This used substance must be replaced by an equal amount of substance taken into the cell from the material surrounding it. The work of the cell may be done quietly and almost continuously, or it may be done with a sudden explosive exercise of energy, as in a violent muscular exertion. In the latter case a period of rest must follow for the cell to restore the substance that has been used up. In either case an exact balance must, in the long run, be maintained between what is used up and what is taken in, if the cell is to maintain its normal life. If more is used up than is taken in the cell will waste away. If more is taken in than is used the cell will increase in size. In many chronic diseases particularly, alterations in the nutrition of cells give rise to a variety of transformations in cell substance which are known as degenerative changes. We know so little about the complex chemistry of these processes that no general statement can properly be made in regard to them, but if these degenerative changes are due, as is possible, to an excess or insufficiency in some one link in a chain of chemical reactions normal to the cell, then we should have here also an example of altered balance as a cause of pathological change.

III. THE CAUSES OF DISEASE

All the causes of disease may be classified as either mechanical, physical or chemical in nature; *i.e.*, every change in cell environment must in the last analysis fall under one of these divisions. It is far from being true, however, that we are able to place all the facts known about disease causation in so simple a classification. Consider, for example, such problems as inherited abnormalities, irregularities in nutrition, overwork and disuse, predisposition and susceptibility, the influence of sex, life period, occupation, etc.: these and many other factors in causation are so exceedingly complex in character that any simple systematic classification of them is quite impossible. We can consider here only some of the more obvious causes which give rise to conditions of disease.

1. Mechanical Causes.—Trauma, or direct mechanical injury, is of course one of the most common causes of abnormal conditions of the body calling for surgical treatment. Wounds, fractures, dislocations, sprains, bruises, and a variety of internal injuries are produced by direct external violence. In all of these there is destruction of tissue cells, rending of anatomical structures, always including blood-vessels, with an escape of blood externally or into the tissue spaces. The reaction of the tissue cells to such a local injury constitutes one of the most important parts of surgical pathology, and will be considered in a later paragraph. Mechanical pressure is a potent cause of harm, having many manifestations. The first effect of pressure upon a tissue is to squeeze out the fluid contained in it; the cells, being dependent upon the continuous flow of this fluid about them for their nourishment, die if it is withheld even for a few hours, and the result is therefore death of tissue in the compressed area: a condition called in this case sloughing or gangrene. Thus, if in putting up a fracture a splint is allowed to press too tightly upon the skin, particularly over a point where a bone lies near the surface, the result will be a sloughing of the skin and underlying tissue. Long-continued pressure not severe enough to shut off the circulation entirely has a different effect. The cells of the part undergo what is known as atrophy; *i.e.*, they waste away. Even a solid tissue like bone will thus melt away by pressure atrophy from the presence of a growing tumor or an aneurism. On the other hand, pressure applied to a part not continuously but at intervals may stimulate cell growth and cause a thickening on the part, as in corns and bunions on the calloused hands of the workingman. Many surgical conditions can be attributed to mechanical disarrangements within the body which are not due to external violence. For example, a strangulated hernia is due to a purely mechanical cause. A loop of intestine is pinched in the narrow neck of the hernial sac so that its circulation is cut off, with a resulting gangrene unless relieved by operation. All the forms of intestinal obstruction, whether by adhesion bands, kinks, volvulus (twisting), intussusception (telescoping), impaction or the growth of a tumor, come under this head; so also do cases of obstruction in other tubular organs, such for example as the plugging of the outlet ducts of glands giving rise to retention cysts, or the shutting off of the flow of urine from the kidney to the bladder due to a stone lodged in the ureter. Displacements of abdominal organs due to relaxation of their supporting tissues (splanchnoptosis) give rise to a peculiar group of symptoms (Glénard's disease), including dyspepsia, constipation and neurasthenia.

2. **Physical Causes.**—These include the effects of temperature (heat and cold), light, electricity, X-rays, radium rays. The human organism is almost perfectly adapted to light of any intensity to which it can be subjected, and to a very wide range of temperature. The other forces mentioned rarely act as causes of disease. We need consider here only the effects of extreme degrees of heat and cold. Burns are classified as to severity in four degrees. In the first degree there is simple redness of the skin; in the second degree there is a separation of the superficial layers of the skin by effusion of serous exudate from the blood with the formation of blisters. In the third degree the deeper layers of the skin are destroyed, and in the fourth degree the whole thickness of the skin and part of the underlying tissue are charred. A second-degree burn of half the surface of the body or a third-degree burn of a much smaller area is always fatal. Healing of extensive burns of the third degree often gives rise to serious

deformities due to the contraction of the scar. The thermal death point of tissue cells is less than 130° F., so that water bottles which do not feel very hot to the hand may cause deep burns if left in contact with the skin of an unconscious patient for even a short time.

Tissue cells are much less susceptible to destruction by cold than by heat. Local tissues, as of the hands or feet for example, may even recover after being frozen, provided that the thawing process is very gradual and that the brittle frozen tissues are not injured by manipulation. Frost gangrene occurs as a result of mechanical injury to the frozen tissue, and of too rapid thawing leading to paralytic stasis of the circulation. On the other hand, the changes of temperature which the organism as a whole can survive are comparatively narrow. The reason is that any marked variation from the normal (or optimum) temperature inhibits cell activity, and if the action of certain cells, such as those which control respiration and the heart action, becomes suppressed death ensues. Thus a fall of the body temperature of even four or five degrees below the normal is apt to be associated with alarming symptoms of collapse, and a fall to ordinary room temperature (70° F.) is always fatal. In fever a rise of temperature to 106° F. is of grave omen: a rise to 109° F. is practically always fatal, though a few anomalous cases of higher temperature have been recorded.

3. Chemical Causes.—Since the activities of living cells are so largely chemical, it is obvious that they are likely to be profoundly affected by any marked change in the character of the chemical substances which surround them. The word "poison" presents a familiar idea of the harmful effect of a chemical substance upon a living organism. A change in the chemical environment of a cell, like any other change, is spoken of, with reference to its effect upon cell activity, as a stimulus, which must, as has been pointed out, influence a cell in one of two ways only, *i.e.*, by exciting or inhibiting activity, although there may be first an increase and later a suppression of activity. Different kinds of cells are of course differently affected by any one chemical substance, some being more susceptible to it than others. This fact is taken advantage of in medicine by the administration of various drugs with the purpose of increasing or diminishing one or another form of cell activity. Thus we relieve pain with morphine, suppress consciousness with ether, increase the secretions in the intestinal canal with cathartics, etc. Poison is therefore a relative term, since the harmful effect of a substance depends on the dosage and sometimes on other factors. Even distilled water is a deadly poison when introduced in quantity directly into a vein, whereas water containing from six- to nine-tenths of one per cent. of common salt (the so-called "normal" salt solution so much used in surgery) has no ill effect.

The poisonous substances which give rise to disease arise from various sources. They may be introduced from without, as with the food or drink or with the inspired air. They may be produced in the digestive canal by the fermentative action of saprophytic bacteria. Other poisons are produced within the tissues of the body by the secretions of invading pathogenic microörganisms. The disintegration of dead tissue cells, such as result from burns or other injuries or from disease, gives rise to poisonous substances. Finally the body may be poisoned by its own secretions, either by the reabsorption of retained excretions or by excessive activity of certain glands, or by the failure of the cells of some organ to do their part in the complex chemical changes which normally go on within the body.

IV. CHANGES IN CELL ACTIVITIES

The many kinds of cells which make up the various tissues and organs of the body are so interrelated in their activities that it rarely if ever happens that one set of cells can be deranged in their action without effecting changes in other groups throughout the body. The normal body is continually adjusting itself to changes in its environment, and the altered activities of cells which occur in disease are very often of the same kind as those which occur normally; *i.e.*, the organism is attempting to adjust or adapt itself to the abnormal situation, but in the case of a diseased condition with only partial success. Changes such as these may be called adaptive changes in the activities of the body-cells.

On the other hand, certain groups of cells may be directly stimulated to an abnormal activity which has no adaptive quality. These we may call perverted changes in cell activity. It is, however, by no means always possible to distinguish in diseased conditions between adaptive and perverted changes.

1. Adaptive Changes.—These are very numerous in pathological conditions, and it is of the greatest importance to be able to understand as far as possible their significance.

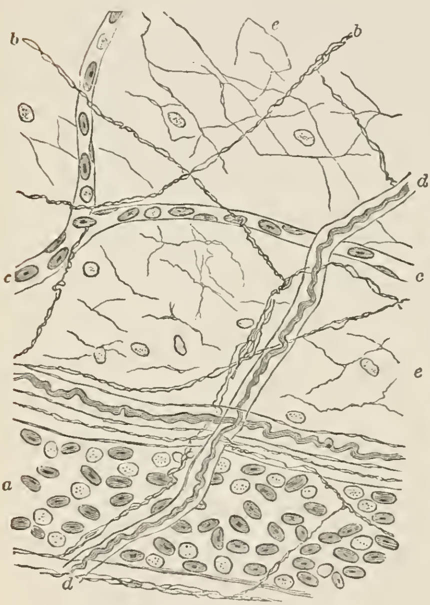
Examples of Adaptive Changes.—There is no sharp line between the adaptive changes which occur in health and in disease. For example, the flushed face, the gasping breath and the quickened pulse which are manifest after a hard run or other muscular effort are adaptive changes which are seen also in scarcely altered form in such a disease as pneumonia and in other pathological conditions. The phenomena which accompany an attack of acute peritonitis furnish a remarkable example of the organism adapting itself to an abnormal situation. Infectious material introduced from without or escaping from the intestinal tract at one locality within the abdomen would be rapidly spread throughout the peritoneal cavity by the movements of the intestinal coils which occur normally in the process of digestion, and by the action of the abdominal muscles. It is for the greatest advantage to the organism that such scattering of the infectious material should be prevented and that it should be confined as far as possible to one locality. All the phenomena which appear therefore are such as will contribute to this end. The muscular walls of the intestines are paralyzed and motion of the coils ceases. Distention with gas increases the fixation of the intestinal coils. The abdominal muscles also are held with a board-like rigidity. Local pain and tenderness make a constant and imperative demand upon the attention to insure voluntary effort to keep this region quiet. If food is taken vomiting ensues to prevent its passage into the intestinal tract. Locally in the infected region inflammation is inaugurated, itself a notable example of adaptive change whereby the surrounding coils of intestine become adherent and the infected area is rapidly walled off from the surrounding parts.

Compensatory changes are those whereby (*a*) one group of cells take up and perform the work of other cells (of the same or even of a different kind) which have been destroyed or whose function has been impaired; or (*b*) where certain cells increase their activity in response to a special need. Thus if one kidney is removed the other does double work and may increase in size. If the spleen is removed other organs, perhaps the lymph-nodes, take up its work and the animal continues in health. One lung can readily do the work of two. Hypertrophy of the heart muscle is an example of the second type of compensatory change, being adapted to overcome increased resistance at some point in the circulation. If a blood-vessel is obstructed other smaller vessels in the neighborhood dilate till they are able to carry the full volume of blood, forming what is known as the collateral circulation.

Primary adaptive changes occur in an accidental or operative wound. When living tissues are divided by a wound a large number of blood-vessels (arteries, veins and capillaries) are severed, and this condition calls for the immediate inauguration of adaptive changes, which to be effective must serve two ends: first, to check the escape of blood, and, second, to preserve un impaired the flow of blood to the tissues which the severed vessels originally supplied. The first end is accomplished by changes in the blood resulting in what is known as clotting, whereby the fluid blood becomes changed into a firm jelly which plugs the vessels and checks the escape of fluid blood. This chemical change in the blood is a very complex one due to the giving off, from cells in the blood and from tissue cells, of certain substances which then unite with another substance dissolved in the circulating blood to form the fibrin that constitutes the clot. The second end is attained by the compensatory action already referred to, *i.e.*, the dilatation of the adjacent vessels to carry on the blood stream into the area to which its flow has been interrupted. These two adaptive changes are essential conditions for the success of operative surgery. Without the first every wound would result in fatal hemorrhage. In practice it is necessary to assist nature by the temporary closing of the larger vessels by means of clamp and ligature until the clot has formed. This means of checking hemorrhage, however, is by itself of no avail when, as happens in certain individuals (bleeders), the clotting adaptation fails. Without the second adaptation large areas of sloughing tissue would result from every extensive wound. Such sloughing of tissue, more or less extensive, does in fact occur at times as the result of injudicious or unavoidable interference with the circulation by a surgical operation.

Inflammation is defined as "the condition into which tissues enter as a reaction to irritation" or injury. It is an adaptive reaction of the greatest interest and importance which can only be briefly outlined here. The process can be actually seen at work in the classical experiment of placing the web of a frog's foot, or a portion of the mesentery drawn out of the abdomen, under the lens of the microscope, and irritating the surface of the tissue by a slight scratch (Figs. 25 and 26). Through the thin transparent membrane the arteries, veins, and capillaries can be clearly seen with the blood stream flowing through them. The pulsating stream through the arteries is distinguishable, and the continuous flow through veins and capillaries. In the capillaries the individual blood-cells or corpuscles can be seen as they pass in single file, but in the larger vessels these are seen only as a swiftly moving mass. The first change observed as the result

Fig. 25.



Frog's mesentery, normal.

Fig. 26.

Frog's mesentery, inflamed.

Figs. 25 and 26.—*a*, small vein; *bb*, *dd*, nerve-fibres; *c*, capillary; *ee*, connective tissue (in Fig. 12 filled with migrating leucocytes). (Agnew.)

of the irritation is a dilatation of the vessels with a more rapid flow of the blood stream; later the rapidity of the flow is diminished and in places it becomes actually stagnant, with an occasional backward and forward motion of the mass of free blood-cells. Through the thin walls of the capillaries there is an escape of the fluid part of the blood which distends the spaces in the tissues between the blood-vessels. The cells of the blood, red and white, particularly the leucocytes, also make their way through the capillary walls and wander free in the tissue interspaces (Fig. 27). Later (this, however, is not readily visible in the living tissue) the local connective-tissue cells have their reproductive power stimulated, new ceils are produced and new capillary blood-vessels are formed.

These changes seen in the frog's mesentery under the microscope readily explain the familiar phenomena of inflammation, with its cardinal signs of heat, redness, swelling and pain, as seen on the surface of our own bodies, for example in a boil. The redness of the skin and the local heat are due to the dilatation of the vessels and the consequent increased flow of blood to the part, while the swelling and pain are due to the great distention of the tissue interspaces with the inflammatory exudate. When

Fig. 27.—Emigration of leucocytes. The arrow shows direction of blood-current. (F. C. Wood, M.D.)

mechanical injury alone is present, uncomplicated by bacterial invasion, the inflammatory reaction is relatively slight and under these conditions identical with the first stages of the healing process, to be presently described, whereby repair of the injured tissue is effected. When, however, septic bacteria have found lodgement in the injured tissues the reaction becomes greatly intensified; the amount of the exudate, both fluid and cellular, is largely increased, constitutional symptoms, including fever and other disturbances, appear, and the rôle of these adaptive changes becomes extended beyond the mere repair of the injury to an active defence against the action of the invading bacteria.

The Healing Process.—The reaction by which injured tissues are repaired and the loss of tissue restored is an adaptation of vital importance to the organism and one that is almost constantly going on in some part of the body, as in the familiar rapid healing of superficial cuts and abrasions on the surface of the skin. It may therefore be considered a normal process when uncomplicated by conditions which retard it, such as infection. It is a highly efficient process within certain limits, but these limits are rather sharply defined. In general it may be said that only the simpler tissues are capable of restoration by the healing process. Highly differentiated cells of complex function, such as those of the central nervous system and the muscles, are incapable of

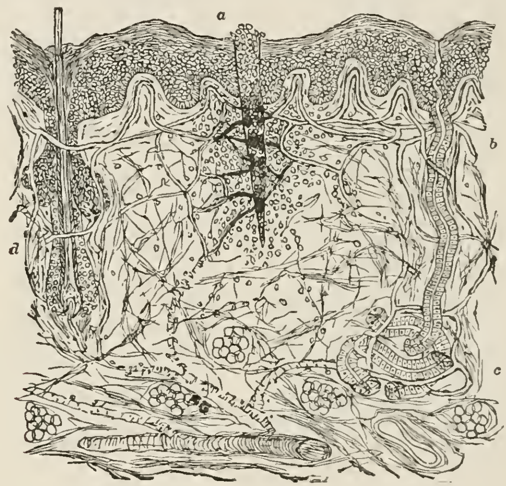


Fig. 28.—Section through skin of guinea-pig eight hours after a wound: *a*, the wound, filled with clot, the capillaries thrombosed on both sides; round-cell infiltration; *bc*, sweat-gland; *d*, hair-follicle. (Shakespeare.)

restoration. When such cells which are incapable of restoration have been destroyed the gap is filled by new connective tissue, forming what is known as a scar. Healing is more rapid in the young than in the old, and in individuals with impaired health the process may be more or less retarded. We will consider briefly what takes place in the healing of a wound.

The earlier steps of the process are those which have been described under inflammation.

Whenever any tissue of the body has been wounded, the injury acts as a stimulus upon the cells of the part, calling into activity certain of their faculties, principally those of reproduction and of motion. Several varieties of cells are thus set to work in the reparative process. The most active part appears to be taken by the connective-tissue cells, whose function it is to build up everywhere the solid framework of the body. The cells which form the capillary blood-vessels and the epithelial cells of the skin participate in the process, as do also in another way the free-moving white cells of the blood, or leucocytes.

The first thing that happens is a temporary cementing or gluing together of the wound surfaces by the coagulated fibrin formed by the blood which oozes from the divided capillaries (Fig. 28). The connective-tissue cells on each side multiply

Fig. 29.—The same at a later stage. The clots on the capillaries almost removed, new vessels forming towards the gap, new connective-tissue spindle-cells replacing the round cells. The epithelium has united on the surface. (Shakespeare.)

by division, closing in the space between the wound surfaces with an interlacing mass of new cells. The cells which form the walls of the capillary blood-vessels increase in number, and loops of new-formed capillaries push across the gap to unite with similar loops from the opposite side (Fig. 29). The epithelial cells of the skin also have their reproductive powers awakened, though somewhat more slowly, new cells being formed which bridge the incision at the surface (Fig. 30). Meantime, beginning almost from the moment of the injury, the leucocytes are stimulated to more active motion and are attracted in large numbers to the wounded area. By virtue of their so-called power of amœboid movement they force their way through the walls of the smaller blood-vessels and into the tissue spaces (Fig. 27) in the vicinity of the injury, where they exercise their "phagocytic" power to eat up and carry away fragments of dead tissue cells and other débris, including the fibrin which provisionally cemented the wound surfaces and even bacteria or other alien cells, if any have found their way into the wound. The secretions of the leucocytes also digest and liquefy the dead matter in the wound, and the absorption of fluid material passing into and carried away by the blood stream aids in the process of cleaning

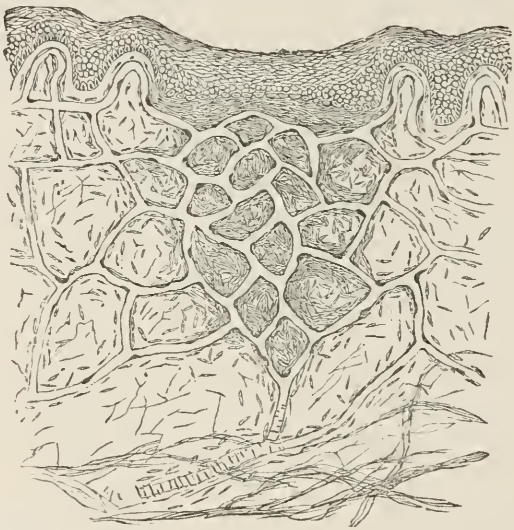


Fig. 30.—The same later. The gap filled with new connective tissue and young blood-vessels (Shakespeare).

up. By the end of the third to the fifth day the divided tissues are practically reunited and there remains only to be accomplished the slower process of the formation of intercellular substances by the connective-tissue cells to consolidate the scar (Fig. 31).

Healing by granulation so called occurs where an open wound with widely separated edges is filled up with new-formed tissue (Fig. 32). The process is essentially the same only with a more extensive formation of new tissue and a much slower accomplishment.

Defences of the Body Against Infection.—When an infection occurs a series of reactions within the body is inaugurated varying with the character of the infection itself and also with other factors, such as the locality of the invasion and the powers of resistance of the individual. These reactions are partly adaptive, tending to protect the body from harm and to aid in its restoration to a normal condition, and partly also due to altered cell activities which have no adaptive quality. The weapons of attack of the invading cells are chemical in nature. It is by the poisonous products of the invaders that the tissue cells are injured. These harmful chemical products produced by the invading cells are

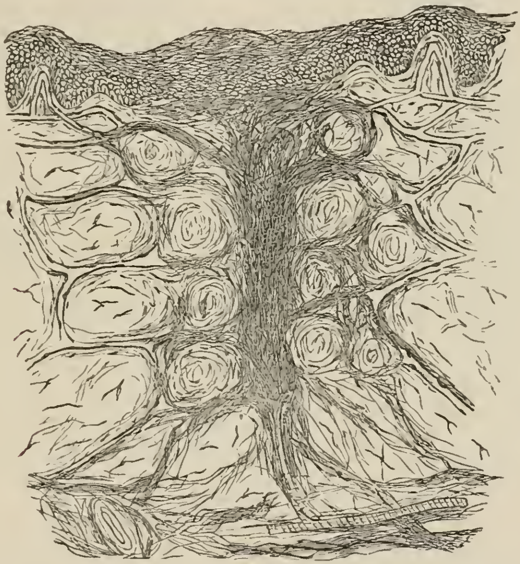


FIG. 31.—Cicatrix formed in the wound, the young blood-vessels having disappeared (Shakespeare).

of several kinds; for example: (1) poisonous secretions extruded by the infecting cells known as toxins; (2) ferments or enzymes which have the power of disintegrating and dissolving living and dead tissue cells; (3) poisonous products resulting from the disintegration of dead tissue cells or dead cells of the infecting organism.

The symptoms or manifestations of infectious disease, the high fever, the chills, the digestive and nervous disturbances, the weakness and rapid emaciation, and sometimes the local signs of inflammation indicate a very profound derangement of the normal functions of the body. Even to the most superficial observation there is a suggestion of a struggle between the disease and the forces that tend toward health, or, to speak more definitely, between the cells of the body and the invading cells. The very fact that recovery ever takes place at all is in itself conclusive evidence of such a struggle. What, then, are the means of defence which the cells of the body are able to employ against the invaders?

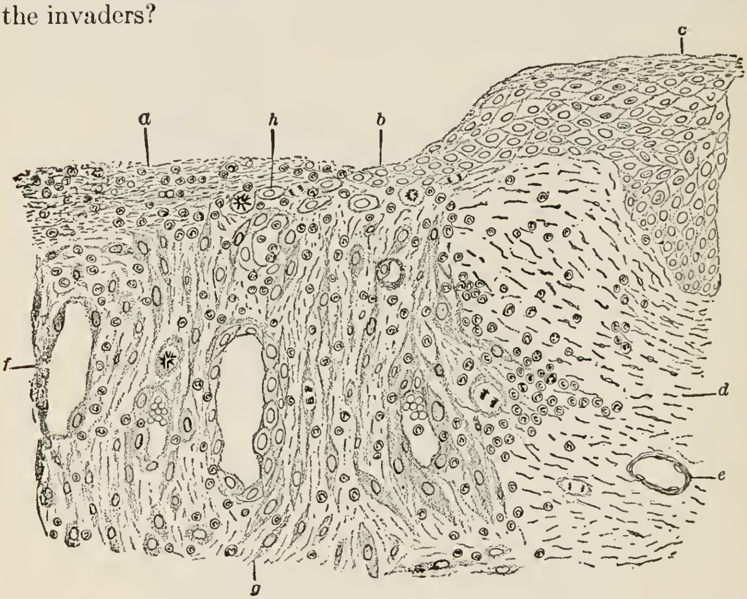


FIG. 32.—Healing of a wound by granulation: *a*, layer of fibrin, leucocytes, and detritus over surface of granulations; *b*, advancing edge of epidermal cells from skin; *c*, skin at edge of wound; *d*, corium with some inflammatory infiltration; *e*, blood-vessel in normal tissue differing in its structure from those in the granulation tissue; *f*, blood-vessel in latter with a leucocyte emigrating through its walls; *g*, new connective-tissue cells, called fibroblasts; *h*, points to an epithelial cell, and on the other side of *h* are two cells in process of division, showing their rapid growth. (F. C. Wood, M.D.)

These appear to be of two kinds: (1) those by which the alien cells are destroyed or their growth is checked, and (2) those by which the poisonous products of the infecting organisms are neutralized and rendered harmless. Thus the body-cells possess both offensive and defensive weapons in their battle with the invading enemies. There are two ways in which the infecting cells may be destroyed after they have entered the body. One is through the presence in the blood of substances which are poisonous to them. Such substances are normally present in the blood; they are the result of chemical activities of the body-cells, and there is evidence that they are produced in increased amount as a result of the presence of the infection.

The invading cells may also be killed by the direct attack upon them of certain of the cells of the body, which literally

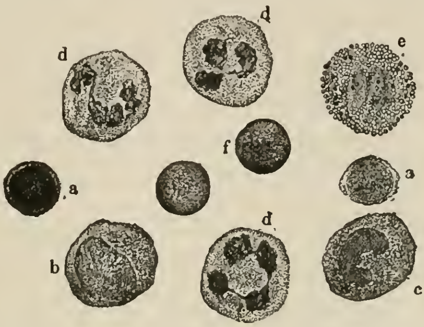


FIG. 33.—Varieties of colorless blood-cells seen in normal human blood: *a*, small lymphocytes; *b*, large lymphocyte or mononuclear leucocyte; *c*, transitional leucocyte; *d*, polymorphonuclear leucocytes; *e*, eosinophile; *f*, red cells. × 900.

seize and devour them. Beside the highly specialized fixed cells which make up the various tissues and organs of the body, there are other cells which are not fixed, but detached and free, and

FIG. 34.—Amœba coli (Entamœba dysenteriæ), common form. × 400.

are carried about in the ceaselessly flowing blood stream. These cells are of two kinds which exhibit a remarkable contrast in the character of their activities (Fig. 33). The red corpuscles of the blood are perhaps the most highly specialized of all the cells of the body. They can do one thing only, take up oxygen from the air and carry it to the tissue cells. They have lost all the other powers of the cell and even the most essential part of the cell structure, the nucleus. On the other hand, the white cells of the blood, or "leucocytes," appear to be the least differentiated and specialized of any of the cells. They retain all the activities that single-celled organisms possess. In their appearance and behavior they strikingly resemble certain forms of unicellular organisms known as amœbæ (Fig. 34) which are found in stagnant water. These organisms have a peculiar method of movement, by a process of thrusting out a portion of the protoplasm of the cell body and of enclosing particles of food material which then become digested and dissolved. The cell folds itself about a solid particle of food material, much as one may wrap a piece of putty about a pea. Around the food particle within the cell body there then forms a small cavity or vacuole, into which there is apparently secreted from the cell protoplasm digestive juices which dissolve the food and prepare it to be assimilated. With reference to this faculty such cells are designated by a name which signifies "cells that eat." They are called "phagocytes" (Fig. 35). The leucocytes possess this same power of amœba-like or amœboid movement; and it is a part of their normal activities to take up and dispose of dead and waste and foreign material in the blood stream and tissue interspaces, and when infection takes place they exercise this phagocytic power upon the invading cells. They thus take up and destroy both dead and living bacteria and other organisms. This form of activity of the leucocytes, known as phagocytosis, is in many cases heightened during infection as a result of stimuli brought to bear upon them, directly or indirectly, through the presence of the alien cells. There is a close relation between these two offensive means which the body-cells employ against infection, and together they play a most important part in the struggle.

Another of the defensive activities of the body-cells is the formation of antitoxins, which, as we have indicated, do no harm to the infecting organisms, but render them harmless by neutralizing their poisonous secretions or toxins. The formation of antitoxin is also an example of the use of certain normal activities of the body-cell as a means of defence against infection. A beautiful explanation of this is furnished by the celebrated side-chain theory of Ehrlich. In the process of nutrition the cell must first seize upon the ultimate particles or molecules of food substances and fix them to the cell, later incorporating them into the cell substance through chemical changes. It must be remembered that we are here dealing with the ultimate chemical structure of cell substance, which is infinitely below the limits of visibility. The actual manner of fixation, therefore, we cannot know, but must picture it to our minds in a somewhat crude mechanical form.

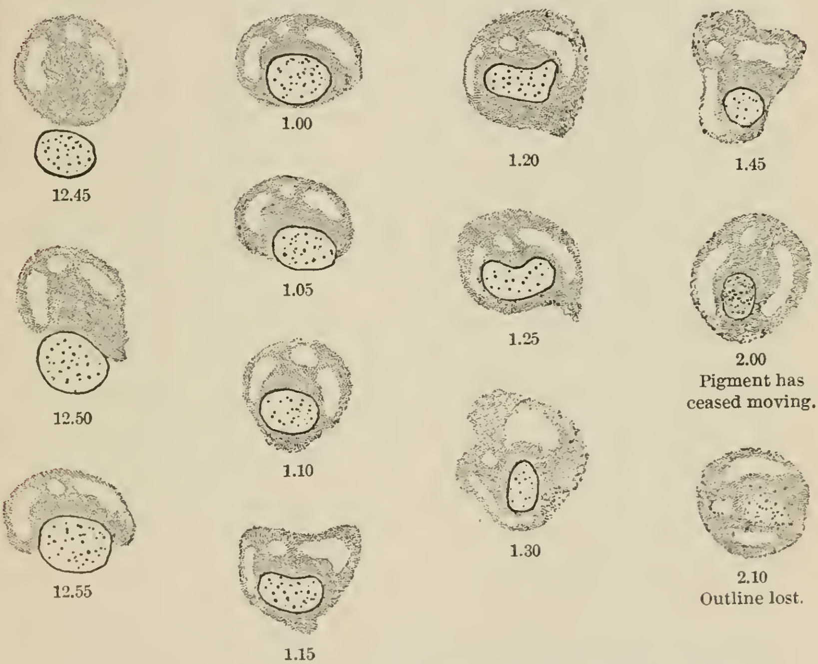


FIG. 35.—Phagocytosis. Destruction of a plasmodium malariæ by a leucocyte in human blood. The figures indicate the time of observation, the whole process lasting 1 hour and 25 minutes. (F. C. Wood, M.D.)

We may thus think of the molecules which make up the cell protoplasm as possessing little rods or chains projecting from their sides, each furnished at the end with a locking device of a certain shape exactly fitting a corresponding locking device attached to the molecule of food substance. To use a homely illustration, it is as if the two were supplied with a set of hooks and eyes of a special pattern. These side chains of the cell molecule are called receptors, or, to indicate their function of fixing nutritious substances to the cell, nutrireceptors. Now the toxin molecule is peculiar, in that it has a locking device of exactly the same shape as that of some variety of food molecule; its eye fits the nutrireceptor's hook, but the rest of its structure is wholly different from that of the food molecule. It is not only unavailable as food, but it is a deadly poison to the cell. When a toxin molecule has once become fixed to a receptor they cannot be separated, but the cell has one way left of getting rid of its dangerous incumbrances. It breaks off and sets free the receptors to which toxin molecules are attached. New receptors are then formed to take the place of those lost, and, by a well-known law of nature's bounty, they are formed in great excess over those lost. Many of the over-abundant, new-formed receptors are crowded off and become free in the blood stream. Here they encounter and fix the free toxin molecules before they have had time to reach the cells, thus rendering them harmless. These free and detached receptors in the blood form what we know as antitoxin.

In all that we know about its powers of resistance against disease, there is nothing to suggest that the body is supplied with a special defensive mechanism designed or adapted for that purpose alone. What happens is that the cells are stimulated by the invaders to increase (or sometimes to decrease) certain activities that they are constantly exercising in the condition of health, activities of motion, of reproduction, or of chemical change, such as are normally concerned with the nutrition of the cell or with its oxidating or secreting power.

Perverted Activities of Cells.—These are those which are due to the direct effect of abnormal stimuli exciting the cells to activity which has no adaptive uses. Notable examples are the convulsive seizures in tetanus and poisoning by strychnia. The thyroid gland is excited to over-activity (hypersecretion) in exophthalmic goitre (Graves's disease). In other cases its activity is depressed (hyposecretion), as in myxœdema. The formative or reproductive activities of cells are apparently perverted in the case of rapidly growing tumors, particularly of the malignant type, and the same is true in certain infectious diseases, notably syphilis and tuberculosis, where there occurs a rapid proliferation of cells (hyperplasia) associated with degenerative changes.

V. TISSUE CHANGES

Activities of cells are of three kinds: (1) functional, (2) nutritive, (3) formative or reproductive. Increase or diminution of formative activities gives rise to tissue changes varying from microscopical lesions to gross anatomical alterations.

1. Constructive Tissue Changes.—We have already considered the constructive changes involved in the process of healing or repair. Other examples of constructive change are seen in hypertrophy and in the formation of tumors.

Hypertrophy.—Simple hypertrophy is an increase in the size of individual cells. Numerical hypertrophy is an increase in the number of cells of a part (hyperplasia). Examples of normal or physiological hypertrophy are seen in the uterus in pregnancy, in the breasts in laceration, and in the growth of muscles by exercise; adaptive hypertrophy in the increase of the heart muscle when called upon for continuous extra work from any cause, such as imperfection in the valves of the heart. When a part of the intestine is constricted for a long time, as by a tumor, the muscular coats of the intestine above the constriction hypertrophy. Compensatory hypertrophy is seen, for example, when one kidney enlarges following the destruction by disease or the surgical removal of the other kidney. It has already been indicated that intermittent pressure may cause hypertrophy, as in "corns" and calluses. Irritation by abnormal chemical substances circulating in the blood may give rise to overgrowth of cells, particularly in some of the infections.

Tumors, or new-growths, are among the most important conditions in the human body which are amenable to surgical treatment.

The formation of a tumor is due to the increased growth of some of the cells in that part of the body where the tumor originates, under the action of stimuli the character and origin of which are unknown. Two of the cell faculties are concerned, their reproductive power and their power to form those intercellular substances of which all the solid parts of the body are composed. We divide all tumors into two classes, known as benign and malignant. In the case of the benign tumors something like the normal balance between the reproduction of cells and the formation of intercellular substance is preserved; in other words, the cells behave like the normal mature cells of the part. The result is that the new-growth resembles normal tissue to some extent, the tumor increases slowly in size, the formation of intercellular substances fixes the cells in the part so that there is no tendency for them to infiltrate the surrounding tissues or for loose cells to be carried away through the lymphatics or blood stream to start new tumors in other parts of the body (metastases). Such tumors usually have sharply defined borders. They do not tend to recur after removal, and their presence does little harm.

In the case of the malignant tumors, on the other hand, all the energies of the cells are devoted to the exercise of their reproductive power; the new cells show little or no tendency to the formation of intercellular substances or to grow to the mature form of the normal cells. These tumors therefore do not resemble any normal tissue. The cells are not fixed, and tend to infiltrate the surrounding tissues and to be carried to distant parts of the body, to start new tumors there. They invariably cause the death of the patient, usually within a time varying from a few months to two or three years. There are two types of malignant tumors —one (sarcoma) in which the connective-tissue cells are the ones concerned, and one (carcinoma or cancer) in which the epithelial cells, such as form the skin and secreting glands, are involved. The only hope of cure lies in early and complete removal.

2. Destructive Tissue Changes.—*Atrophy* is the opposite of hypertrophy, a wasting away of cells or tissues. Atrophy occurs as a normal adaptive change in involution of the uterus following parturition. Just as cells increase in size as a result of active exercise of their functions, so as a result of disuse they shrink away. A limb fixed in a plaster cast rapidly diminishes in size from wasting of the muscles, and the same is true of muscles paralyzed by section of a motor nerve. Atrophy resulting from pressure has been mentioned. A diminished supply of nourishment is a cause of atrophy, both local and general, as seen in starvation, and so also is malnutrition due to the inability to utilize food material properly, as in many wasting diseases.

Necrosis means the death of cells. In the normal body many cells are constantly perishing when their usefulness is ended, this being particularly true of the cells of the blood, red and white, and of the epithelial cells which clothe the body surface. All of these are as constantly replaced by new cells. The causes of pathological cell death are either toxic or nutritional, *i.e.*, by the action of poisons or by the deprivation of nourishment.

Trauma, extreme degrees of heat and cold, and active chemicals such as strong acids and alkalies are direct causes of cell death. The toxins of infectious diseases, such as typhoid and diphtheria, circulating in the blood, cause necrosis of small groups of cells here and there in the liver and other organs; this being known as focal necrosis. It is found also in severe cases of septic disease. In local areas of septic infection more or less extensive necrosis of cells always occurs, large sloughs sometimes forming as in carbuncles. Depriving the tissues of the circulating fluids which normally bathe them is followed by death of the local cells within a few hours. The effect of continued pressure has been referred to as a cause of sloughing, a fact which should be borne in mind in applying bandages and splints. Gangrene is the death of large areas or whole parts of the body, such as the extremities, and is due either to cutting off entirely the arterial supply of blood or to obstructing the return of the blood through the veins, as by a tight bandage about a limb. Certain constitutional diseases, such as diabetes, and also the cutting off of the normal nerve supply to the part predispose to gangrene.

3. Cell Degenerations.—Perverted nutrition of cells gives rise to changes known as degenerations. Albuminous materials (proteids); carbohydrates (starches and sugars); fats; certain salts and water are the materials entering into cell nutrition. The degenerative changes connected with each of these can only be briefly mentioned here. Many of them are named from a fancied resemblance to familiar substances. Thus among the degenerations concerned with the proteid elements of nutrition we have waxy or amyloid (starch-like) degenerations; hyaline (glass-like); mucoid (mucus-like); caseous (cheese-like); and colloid (gum-like) degenerations. Fatty degeneration, with deposit of minute fat globules in the cell body, occurs associated with damaged cell activity in many conditions. Carbohydrates taken with the food are stored in the body, for use in the production of energy, in the form of glycogen, called animal starch, and degenerative changes in certain cells are associated with loss of balance in the utilization of this material. Excessive deposits of lime and other salts in cell bodies and intercellular substances constitute what is known as calcareous degeneration. Akin to this perhaps is the deposit of the same materials in ducts and passages of the body, forming so-called calculi or stones in various organs, the urinary bladder, the gall-bladder, and the kidney.

VI. DISTURBANCES OF GENERAL FUNCTION

As a result of these pathological changes in the functional, nutritional and formative activities of the body-cells there necessarily follow far-reaching changes in the general function of the body as a whole. All the great systemic divisions of the body are involved in varying degrees, the digestive, vascular, respiratory, glandular, muscular and nervous systems. These disturbances, arranging themselves into various groups or complexes, according to the nature of their origin, constitute the symptoms of disease, and the study of these together with the local changes which accompany them is what is known as clinical (bedside) medicine and surgery.

CHAPTER V

SURGICAL AND GYNÆCOLOGICAL NOMENCLATURE

It is probable that no branch of her studies offers more constant and troublesome confusion to the student nurse than do the accumulation and proper comprehension of her professional vocabulary. And, the medical nomenclature being derived from single and combined Greek and Latin words, this statement is particularly applicable to those who have not included a groundwork in the "dead languages" as part of their preliminary education.

It will be the effort, in this chapter, to present the methods of derivation and construction in such a light that the student will quickly comprehend their application; will readily assimilate the more usual forms; and will (it is hoped) be so stimulated in her interest in this line of work that she will feel as lost without her dictionary as without her thermometer or hypodermic syringe. In other words, the object will be not to supplant the dictionary, but to so supplement it that its use will be a matter of pleasant investigation rather than of tedious memorizing.

It would, of course, be far beyond the possibilities of a single chapter to even approximately supply the vocabulary contained in even the smallest of medical dictionaries. When, however, once a comparatively small list of root-words, prefixes and suffixes has been mastered, their methods of combination understood, and the resulting words (broad in meaning, but simple and regular in construction) observed, the nurse will be in a position to build up most of the routine words for herself—or at least to "*unbuild*" those with which she comes in contact into their easily recognizable component parts.

General Derivation.—It may be generally accepted that all strictly medical words are either Latin, Greek, or a combination of the two. The facts that the earliest traditions of medicine, as a science, are founded in Greece and that, at a later day, Latin was the universal language of educated and scientific people, easily explain this great preponderance of terms from the "dead languages."

Method of Construction.—The entire medical vocabulary may, broadly speaking, be considered as composed of root-words—either alone or in combination with prefixes or suffixes, or both. The root-word may generally be considered as describing some definite object, as (perhaps) one of the organs of the body. The prefix usually describes some variation from the normal or defines the relation of the root-word to its environment or of another object to the root-word. The suffix generally describes some condition of, or act performed upon, the root-word.

Root-words.—The medical vocabulary being, as already indicated, derived from both Greek and Latin, it is not surprising that we frequently find two (and even three) words meaning the same thing. In such cases, we may have the common name, the Greek scientific name and the Latin scientific name, all in frequent, though not necessarily interchangeable, use. In these cases it will, generally, be found that either the English or the Latin word is used in speaking directly, by name, of the object and the Greek root-word in those compound words that are so common throughout the medical vocabulary. For instance, we have the English word, womb, the Latin word, uterus, and the Greek words, hystera and metra, referring to the same organ. The English word is the one in common, or vernacular, usage; the Latin is the one in regular, unmodified medical usage; and one or other of the Greek roots is regularly found in the compound forms. Occasionally but one root-word is in use; in other cases, they are both present, but identical; and, less frequently, they are present, different and used interchangeably. In the last case, however, it is generally true that the Greek root would be preferably and more correctly used. In the present listing of those root-words, a classification by systems will be made and, where both Latin and Greek roots are used, in the forming of compound words, both will be given.

Respiratory System:		
Nose	L. naso-	G. rhino-
Tonsil	L. tonsillo-	G. amygdalo-
Larynx		G. laryngo-
Trachea		G. tracheo-
Bronchus		G. broncho-
Lung	L. pulmo	G. pneumo-
Digestive System:		
Mouth		G. stomato-
Pharynx		G. pharyngo-
Œsophagus		G. esophago-
Stomach		G. gastro-
Liver		G. hepato-

Gall-bladder		G. cholecysto-
Bile-duct		G. choledocho-
Pancreas		G. pancreato-
Intestines		G. entero-
Duodenum	L. duodeno-	
Jejunum	L. jejuno-	
Ileum	L. ileo-	
Cæcum	L. cæco-	G. typhlo-
Appendix	L. appendico-	
Colon		G. colo-
Rectum	L. recto-	
Anus	L. ano-	G. procto-
Urinary System:		
Urethra		G. urethro-
Bladder		G. cysto-
Ureter		G. uretero-
Kidney	L. reni or reno-	G. nephro-
Pelvis of kidney		G. pyelo-
Female Genital System:		
Vulva	L. vulvo-	
Perineum		G. perineo-
Labium	L. labio-	
Vagina	L. vagino-	G. colpo-
Cervix	L. cervico-	G. trachelo-
Womb	L. utero-	G. { hystero- / metro-
Fallopian tube	L. tubo-	G. salpingo-
Ovary	L. ovario-	G. oöphoro-
Regions of Body:		
Head		G. cephalo-
Neck	L. cervico	G. trachelo-
Chest		G. thoraco-
Abdomen	L. abdomino-	G. celio-
Tissues:		
Skin		G. dermato-
Fat		G. lipo-
Muscle	L. musculo-	G. myo-
Bone		G. osteo-
Marrow		G. myelo-
Cartilage		G. chondro-

In the preceding list, the actual word has not been given, but the root form (as found under altered conditions in our compound words) is presented. Such a list is, necessarily, full of omissions, but should (taken in connection with those following) give a fairly comprehensive working idea of those names used in the diagnoses of surgical diseases and the operations for their relief.

Prefixes.—As has already been stated, the prefix usually describes some variation from the normal or defines the relation of the root-word to its environment, or of another object to the root-word. The succeeding list gives some of the prefixes in most common use—and, at the end of the suffixes, will be found some examples of the utilization of prefixes, root-words and suffixes in the formation of compound words. It will be noticed that these prefixes are taken from both Greek and Latin.

A- or An-.......................means *without* or *not*.
Ab-.............................means *from*.
Ad-.............................means *to*.
Ante-...........................means *before*.
Anti-...........................means *against*.
Circum-.........................means *around*.
Con-............................means *together*.
Contra-.........................means *against*.
De-.............................means *down* or *from* or *away*.
Dia-............................means *through*.
Dis-............................means *apart*.
Dys-............................means *difficult* or *painful*.
E-..............................means *without*.
Ec-.............................means *out*.
Ecto-...........................means *without* or *on the outside of*.
En-.............................means *in*.
Endo-...........................means *within*.
Epi-............................means *upon*.
Eu-.............................means *well*.
Ex-.............................means *out* or *away from*.
Exo-............................means *outside*.
Extra-..........................means *outside of* or *beyond*.
Hyper-..........................means *above* or *beyond*.
Hypo-...........................means *deficiency of* or *under*.
In-.............................means *in*, *into* or *not*.
Inter-..........................means *between*.
Infra-..........................means *beneath*.
Intra-..........................means *within*.
Para-...........................means *beside*.
Peri-...........................means *around*.
Poly-...........................means *many*.
Post-...........................means *after* or *behind*.
Pre-............................means *before*.
Re-.............................means *again*.
Retro-..........................means *backward*.
Sub-............................means *below* or *under*.
Super-..........................means *above*.
Supra-..........................means *above*.

In the list above, there are necessarily a number of prefixes which are less common than the others. In the succeeding list of suffixes, however, it is fairly safe to say that the very large majority (if not all) will be constantly encountered in terms used in the wards and in the operating-room, particularly the latter. Many medical and the greater part of surgical diagnoses and nearly all surgical operations, when described in medical terms, will include one or another of these suffixes.

Suffixes:

-algia	means *pain in.*
-cele	means *hernia of.*
-cleisis	means *closure of.*
-dynia	means *pain in.*
-ectasis	means *dilatation of.*
-ectomy	means *excision of.*
-ectopy	means *displacement of.*
-itis	means *inflammation of.*
-lith	means *stone.*
-oma	means *tumor.*
-osis	means *disease.*
-pathy	means *disease.*
-pexy	means *fixation of.*
-ptosis	means *falling of.*
-rrhaphy	means *sewing of.*
-rrhagia	means *bursting out from.*
-rrhea	means *flowing.*
-rrhexis	means *rupture of.*
-scopy	means *viewing of.*
-stomy	means *making a mouth in or between.*
-spasm	means *spasm of.*
-tomy	means *cutting of.*
-trismus	means *spasm of.*

Having attempted to give sufficiently full lists of root-words, prefixes and suffixes to at least give the nurse a fair groundwork in building up a surgical vocabulary—a number of examples of these built-up words will be taken and separated into their component parts, to give an idea of the application of this sort of learning in practical work.

First, let us take that best known of all surgical complaints—appendicitis. We have here a combination of the root-word "appendico" and the suffix "-itis." Reference to the lists will show that this combination means "inflammation of the appendix."

As a second example, let us take another of the more common of the disease conditions (this time gynæcological), "endometritis." Here we find prefix, root-word, and suffix. Reference to the lists gives us the meanings: "endo-," within; "metro-" the womb; "-itis," inflammation of. Hence, we have "endometritis," or an inflammation of the lining of the womb.

Similarly, we have those compound words that represent operative procedures. *Gastrostomy* means making a mouth (or opening) in the stomach. *Perineorrhaphy* means sewing of the perineum. *Cystoscopy* means viewing of the bladder.

Abbreviations.—A discussion of the subject of medical and surgical nomenclature should not entirely omit brief reference to those abbreviations commonly used in hospital work and private practice, when writing orders for the nurse's direction. Accordingly, a short list of the more common of these abbreviations, with their meanings, is appended.

āā............from *ana*, meaning *of each.*
A.c...........from *ante cibum*, meaning *before meals.*
Ad lib.........from *ad libitum*, meaning *as desired.*
Aq............from *aqua*, meaning *water.*
B.i.d..........from *bis in die*, meaning *twice daily.*
c.............from *cum*, meaning *with.*
c.c. or c.cm.....from *cubic centimetre.* a unit of volume.
cm............from *centimetre*, a linear unit.
G. or Gm......from *gramme* or *gram*, a unit of weight.
gtt............from *gutta*, meaning *a drop.*
H............from *hora*, meaning hour.
P.c...........from *post cibum*, meaning *after meals.*
P.r.n..........from *pro re nata*, meaning *according to circumstances.*
Q.............from *quaque*, meaning *every.*
Q.S...........from *quantum sufficit*, meaning a *sufficient quantity.*
S.o.s..........from *si opus sit*, meaning *if necessary.*
ss.............from *semis*, meaning *half.*
T.i.d..........from *ter in die*, meaning *thrice daily*

CHAPTER VI

THE SURGICAL FIELD

The distinction between medicine and surgery rests entirely upon the methods of treatment employed. The word surgeon is derived from two Greek words meaning hand and work. A surgeon, therefore, is one who works with his hands, and surgery is that branch of the science of medicine in which the remedial measures that are required consist of manual or operative procedures. The diseases and affections with which the surgeon has to deal constitute the field of surgery and may be briefly summarized as follows:

I. OUTLINE OF THE SURGICAL FIELD

1. Affections Which Are not Caused by Disease.—(1) *Anatomical Defects.*—These may be congenital, as in the case of hare-lip and cleft palate, or acquired after birth, as in the case of certain forms of hernia, and the results of burns or other injuries. The operative means employed in their treatment are spoken of as plastic or reparative operations.

(2) *Mechanical Derangements.*—Conspicuous examples of these are the forms of intestinal obstruction produced by torsion (volvulus) or telescoping (intussusception) of the intestinal tube, conditions which become rapidly fatal if not given prompt relief. Displacement of various abdominal organs (floating kidney, enteroptosis) gives rise to many distressing chronic symptoms. Mechanical distention of veins occurs in various parts of the body (varicocele, varicose veins of the leg). Affections which mechanically interfere with the various functions of the body may be the result of injury and also sometimes of disease.

(3) *Foreign Bodies.*—Various articles held in the mouth and accidentally swallowed may become lodged in the œsophagus, stomach, or air-passages. Foreign bodies, such as bullets embedded in the tissues, frequently require removal.

(4) *Trauma.*—This means any injury of the tissues of the body produced by violence. In this class are included wounds, open or subcutaneous, contusions and crushing injuries, burns,

fractures of bones, dislocations of joints, and any "internal" injuries resulting from violent means. Surgical treatment is called for in cases suffering from trauma always at the time of injury and sometimes later, after the injury has healed. Thus accidental wounds, like surgical wounds, must be properly "closed," so as to bring divided nerves, muscles, skin, and other tissues into normal position with relation to each other; fractures must be "set" and retained in place by splints or other means; dislocations must be "reduced"; bleeding from divided arteries or veins must be controlled; appropriate steps must be taken to prevent infection of the injured tissues; and special methods of treatment appropriate to certain injuries too numerous to be mentioned here must be employed. After an injury has healed, structural defects or other conditions resulting from it may bring the patient under the hands of the surgeon for operative treatment. In the field of gynæcology the conditions resulting from trauma are for the most part those which are incident to child-birth, such as lacerations of the cervix and perineum, vesicovaginal fistula, and so on. These conditions frequently call for operative repair at a later period. The emergency measures which the nurse may be called upon to employ in the immediate treatment of injuries will be considered in a separate chapter.

2. Diseases and Affections Arising from Disease.—(1) *The Infections.*—The greater number of diseased conditions caused by the entrance of single-celled organisms into the body come under the care of the physician. The principal organisms concerned in what may be called the surgical infections have already been described. The bacteria of sepsis, which have been enumerated in speaking of the infection of wounds, are often encountered as disease-producing invaders in the body when no visible wound is present, having found a portal of entrance through some minute break in the surface either of the skin or of the mucous membrane. When septic bacteria are growing in a number of small areas scattered throughout the body, or when the locality of their attack cannot be determined, surgical treatment is not available and the disease must be considered as belonging to the province of the physician. Cases of septic infection become surgical when the disease is localized in some definite area in the body, since in that case the proper treatment consists in the establishment of drainage; that is, the opening up by operative means of a way of escape from the body for the poisonous products produced by the growing bacteria. In many cases also portions of tissue or even entire organs too extensively diseased to be capable of recovery have to be removed. Septic infections of this character are very common and of great variety. They include superficial lesions, such as boils, and carbuncles, and ulcers, abscesses in almost every part of the body, infections of the serous membranes lining the great body cavities, such as the pleura and peritoneum. The joints and even the solid bones may be the seats of septic infection. The organism of Neisser (gonococcus) plays the leading rôle in the pelvic infections in women which are responsible for a large proportion of the operative work that the gynæcologist is called upon to perform. Infective lesions beginning in the mucous membrane of the intestine, and resulting in perforation of the intestinal wall, allow the escape of highly infective material into the peritoneal cavity, and give rise to general or localized peritonitis, requiring prompt operative interference for its relief. The vermiform appendix is by far the most common seat of such perforative lesions. The infection here is necessarily of a mixed character, owing to the varied bacterial content of the material poured out from the intestine. The colon bacillus, the staphylococcus, and the streptococcus are the organisms almost invariably found.

The tubercle bacillus is the cause of a great variety of conditions requiring surgical treatment. This organism attacks almost every tissue and organ in the body. Tuberculosis of the lymphatic glands, of the bones and joints, and of the kidney and bladder are the most common forms of this disease which come under the care of the surgeon.

(2) *New-growths.*—Nearly every tissue in the body may become the seat of an abnormal enlargement known as a tumor, consisting of an excessive growth of tissue more or less resembling the normal, usually with well-defined boundaries, but tending to progressive increase in size and sometimes to the formation of similar tumors in other parts of the body at a distance, through the proliferation of cells carried from the original tumor through the blood or the lymphatic circulation. Very little is known about the causation of these new-growths. The only successful treatment of them consists in their removal by operative means.

(3) *Other organic diseases* and affections arising from them are amenable to surgical treatment in numerous instances too varied to be briefly summarized. A few examples must suffice. The

harmful effects of an overactive or perverted gland secretion may call for the partial removal of the offending organ, as in the case of exophthalmic goitre. Obliteration of smaller arteries from chronic disease (arteriosclerosis, diabetes) may lead to gangrene of the extremities, requiring amputation. Evacuation of fluid accumulated in various body cavities as a result of disease is a surgical measure often called for. Concretions and calculi are formed by the deposit of calcareous salts in various ducts and passages of the body. Gall-stones and stones in the bladder, ureter or kidney are the most common examples of this class. Such bodies frequently require operative removal.

(4) *Functional Diseases.*—Examples of purely functional disease, either medical or surgical, are very few. Neuralgia is the name of a condition in which there is usually only a single symptom present, namely pain, and often no discoverable organic tissue change. Surgical treatment is sometimes resorted to when other means of relief have failed.

II. SURGICAL SPECIALISM

The field of surgical knowledge is so wide that it is impossible for a single mind to master the innumerable details necessary to be known in order to do efficient work in the diagnosis and treatment of surgical conditions in all parts of the body. The result is a division of the surgical field into a number of departments or specialties, so that by confining his attention exclusively to one of these a surgeon may attain a higher degree of efficiency in his work. It is the difficulties of diagnosis rather than of treatment that make specialism necessary. A large experience, that is, the opportunity to observe and study many cases, and a wide scientific knowledge are indispensable in making a correct diagnosis in many cases. Skill in the use of the many and often highly complex instruments of diagnosis that have been devised for use in the various special fields can be acquired only by constant practice. Contrary to the popular idea, operative skill is the least important and most easily acquired part of the equipment of a competent surgeon. The recognized surgical specialties we may take to be those which are usually assigned to separate departments in hospital work.

1. Ophthalmology.—Treatment of diseases of the eye is largely surgical. It is a wide field in itself, giving scope for the highest ability and skill.

2. **Otology,** or surgery of the ear, is a narrower field frequently combined with surgery of the throat and nose or of the eye.

3. **Surgery of the throat and nose** (laryngology, rhinology) is an important specialty in which many practitioners are engaged on account of the great frequency of diseases and affections in this region.

4. **Gynæcology** deals with the diseases and affections of the female genito-urinary organs. It is a separate department in most hospital organizations, and is a specialty of the greatest interest and importance for the surgical nurse.

5. **Genito-urinary surgery** is the name applied to that specialty which deals with the diseases and affections of the kidney, bladder, and genital organs in the male. The setting aside of this portion of the surgical field as a special department is made particularly necessary by the high degree of skill required in the use of a wonderful instrument of diagnosis, the cystoscope, by means of which the interior of the bladder can be inspected and surgical conditions of the kidney directly demonstrated.

6. **Orthopædic surgery** deals with the treatment and the prevention of deformities, particularly in children, either congenital or acquired, the latter most commonly as the result of trauma, tuberculous disease of the bones and joints, or infantile paralysis. The treatment of these conditions, while partly operative, consists largely in the fitting of proper braces and supports, and also in the training of particular groups of muscles by special exercises—forms of treatment which must be carried out over long periods of time and which require a high degree of patience, knowledge, and skill in their application.

7. **Surgery of the Nervous System.**—The brain and spinal cord are subject to all the forms of surgical disease and affection that have been enumerated, especially perhaps to trauma and to affections resulting from pressure due to the presence of tumors or new-growths. A few practitioners, exceptionally well qualified by reason of experience and ability, usually resident in large centres of population, have specialized in this department. It is perhaps the most difficult of all fields, but the cases are not numerous enough to support many specialists, and in areas where these are not available such conditions come under the care of the general surgeon.

8. **General surgery** includes all that remains of the wide domain of surgery outside of the narrower fields included in the

special departments. There are, of course, many border-line cases. A case may, because of the nature of the disease or affection or of its complications, come within the province of more than one special department. In operations within the abdomen the work of the general surgeon and that of the gynæcologist frequently overlap. Both general surgeons and orthopædists treat fractures and infections involving bones and joints; and there are a number of other classes of operations which the general surgeon has not yet wholly resigned to the special department to which a strict classification might assign them.

III. OPERATIVE SURGERY

1. Nomenclature.—A major operation is one that is extensive, involving the deeper parts of the body. A minor operation is one that involves only the skin or mucous membrane and the superficial tissues. An operation is spoken of as capital when it involves danger to life; radical or complete when it is intended to cure a disease or affection; palliative when it is done to relieve some distressing symptom without expectation of cure. An exploratory operation is one in which an incision is made to bring into view some deeper part of the body, most frequently the abdomen, for purposes of diagnosis. A plastic operation is one where flaps of skin or mucous membrane are moved to a new position to cover a defect. Incision is a simple cut. Excision is cutting out, to remove a tumor or portion of tissue or organ. Resection is cutting from between, as the removal of a joint, or a portion of a long bone, or of a nerve, or of the intestinal tube. Anastomosis is the establishment of a communication between portions of a hollow organ. The term is applied to operations of this character on the stomach and intestines and on arteries and veins. Many special operations are known by the name of the surgeon who first performed them. The meanings of many compound words, including names of operations, have been explained in the chapter on nomenclature. A two-stage operation is one in which at a certain point the operation is stopped, the wound closed and the patient sent back to the ward. The operation is then completed at another time some days later. There may be two reasons for doing this. One is that completion of the operation at a single stage would add materially to the operative risk. The other is that in certain cases it is desirable for the healing process to have time to make a certain amount of progress between the first steps and the later steps of the operation. This intervention of the healing process between two stages of an operation may be required, for example, to close off the pleural or the peritoneal cavity before opening an abscess or a loop of intestine which has been drawn out to form an artificial anus. It may also be an advantage or a necessity in certain plastic operations.

2. Operative Hazards.—Operative surgery has one distinguishing characteristic, of the greatest gravity and importance, which it shares with no other method employed in the treatment of disease. It is attended in many cases with danger to the life of the patient. In the treatment of medical cases an overdose of a drug may kill, or an error in treatment may hasten the inevitable end or permit a fatal issue that could have been avoided; but almost without exception every properly used therapeutic measure, other than surgical, is free from direct hazard to life or health. This feature of the work of the surgeon has undergone a great and wonderful change for the better within the last fifty years. Before the days of antiseptic and aseptic surgery, the operative risks were appalling. Operations that are now done daily with scarcely a thought of danger were then attended with a death rate of thirty to fifty per cent. or more. Many operations now regarded as very moderate risks could not be undertaken at all. The elimination of septic infection in surgical wounds, which began with the work of Lister, has thus wrought a truly revolutionary change with respect to operative hazards, and other important advances have contributed largely to the same end. The time will never come when all surgical operations will be free from danger, but under modern conditions, in the hands of competent surgeons and properly trained nurses, we may roughly group all operations into three classes with respect to operative risks: (1) the largest class includes all minor and many major operations, numbering possibly three-fifths of all cases, in which the danger is negligible, being scarcely more than that from the ordinary accidents of daily life; (2) a smaller but numerous group of cases in which there is a risk varying from very moderate to moderately grave; (3) a small group of cases involving very grave risk.

The three primary operative risks are shock, hemorrhage, and infection, including sepsis and pneumonia. All of these are preventable in most cases with a very high degree of certainty. There are a number of other operative dangers that are under less perfect control and also very much less frequent, and one or two, fortunately rare, against which we have as yet practically no safeguards. The character of the various dangers and the methods of forestalling and combating them will be considered in a later chapter. As regards time, the critical period following an operation may be said to last from three to five days, after which, if all has gone well, the patient may usually be considered out of danger.

3. **Mortality** (as applied to operative surgery) means the death rate expressed in percentage; that is, the number of deaths in every hundred operations (of the particular kind in question) that have been recorded. Mortality is usually estimated for each particular operation without regard to other factors which influence it, since these are very variable and difficult to determine accurately. The direct causes of death are numerous, including the immediate effect of the operation itself and all the complications that may arise afterward. The predisposing causes are the factors which chiefly affect mortality, and these may be grouped under four heads: (1) The extent and severity of the operation. For example, the mortality of amputations at the hip-joint is much greater than that of amputations at the knee. (2) The character of the operation without regard to its severity. For example, the mortality of ligation of the common carotid artery, a comparatively simple operation in itself, is very high because of the shutting off of the blood supply from the brain. (3) The resisting power of the patient, a factor which must always be carefully estimated beforehand by the surgeon. (4) The thoroughness and conscientiousness with which the details of asepsis and other parts of the technic are carried out.

4. **Morbidity** (in relation to operative cases) means the period of illness following an operation. It is ordinarily measured by its duration. There is an unavoidable morbidity following every operation. A patient operated upon, often with unimpaired general health beforehand, then passes through what may be regarded as an acute illness, and for practical purposes this may be said to last as long as he is disabled from his ordinary occupation. For uncomplicated abdominal operations the minimum duration of morbidity may be set at about two weeks, for slighter operations it will be considerably less, and in the severer cases may extend to a month or more. When complications arise morbidity may be prolonged to an indefinite extent. Morbidity

is, of course, subject to variation in severity or intensity as well as in duration.

5. The Surgical Obligation.—The operative hazard imposes upon the surgeon and upon the surgical nurse a unique and peculiarly binding obligation. In no other occupation is a serious risk of life involved to the recipient of a personal service. The patient, therefore, is compelled to repose a great trust in those into whose hands he commits himself, and the possibility of failing him in any avoidable way is not a matter to be lightly regarded. For a patient, in good general health and undergoing an operation of slight or moderately grave danger, to die as a direct result of the operation is a disaster of such magnitude that no labor or painstaking care is too great to be exacted of those responsible for the work. In the graver cases the result may turn on small things. A failure to estimate properly some factor in the patient's condition, a slip in the technic, a failure through carelessness to notice in time premonitory symptoms of a coming complication, delayed or perfunctory carrying out of an important remedial measure, may determine a fatal issue. In the majority of operations the risks are small, but they are increased in proportion whenever any failure occurs in applying all available means for safeguarding the patient. The responsibility for this rests principally and primarily upon the surgeon, but the surgical nurse shares it with him in large measure in certain aspects of the work, particularly in the operating-room technic and in the care of the patient after operation.

PART III—MINOR TECHNIC IN SURGICAL NURSING

CHAPTER VII

POSTURES

In the various procedures of surgery and gynæcology, whether for purposes of examination, treatment or operation, there are numerous variations of the posture of the patient that are resorted to for the purpose of simplifying the anticipated procedure. The greater part of these postures are really variations of the horizontal recumbent position, and will be considered as such in their regular order as decided by the degree of variation from the original position.

1. Horizontal Recumbent Position (Fig. 36).—This position, as the name would imply, is that normally taken by the patient when reclining flat upon the back. The legs are together and the arms may be in any of three positions, depending upon the object in view and, partly, upon the preference of the physician. For purposes of abdominal operation upon the lower abdomen or of abdominal examination, the arms may be placed either alongside the body, across the chest, or above the head. If the operation is to be upon the upper abdomen, the position of the arms across the chest would, naturally, be undesirable, as they might interfere with the operator. In this case, either of the other arrangements would be equally satisfactory.

2. Trendelenburg Position (Fig. 37).—This position is identical with the horizontal recumbent so far as the immediate relation of the patient to the top of the table is concerned. The difference in the two positions is based upon the changing of the level of the table top. By a mechanical adjustment upon the table, the patient's head is lowered so that the top of the table takes an angle of anywhere from 10 degrees to 45 degrees with the horizon. The object of this position is the gravitation of the intestines out of the pelvis into the upper abdomen. For the proper use of this position, it is necessary to have a table with shoulder supports and a sectional arrangement by which the lower end may be depressed so that the legs are flexed on the thighs. This combination gives proper support to the patient so as to prevent slipping off the table in the higher elevations. The position is generally taken just after the abdomen is opened.

3. The Reversed Trendelenburg Position.—As the name would signify, this position is identical with the last mentioned, except for the reversal of the patient's position. Here the feet, instead of the head, are lowered. Its application is not a very

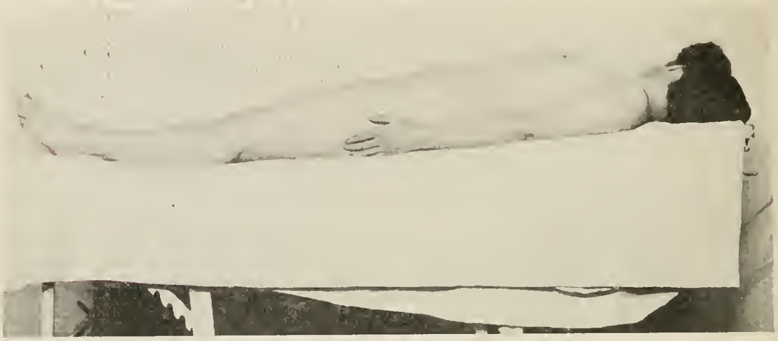


Fig. 36.—Horizontal recumbent position.

wide one,—resort being had to it only in those infectious cases where it is vital to take every precaution to prevent already existent pus from gravitating into the upper abdomen. Where

Fig. 37.—Trendelenburg position.

used, this position is arranged at the very outset,—the patient being put on the table in this position. The patient is generally retained in position by adhesive plaster strapping, by towels or straps passed around the thighs and fastened to the table, and by brought by the surgeon and more full description of those procedures by which the nurse may be required to overcome the natural difficulties of the situation as it bears upon that branch of the subject under discussion.

1. The Trendelenburg Position.—In abdominal gynæcological operations in private houses, it is the duty of the surgeon to provide the necessary apparatus for obtaining the Trendelenburg position (Fig. 37), should he desire to use it. There are frames specially designed for this purpose and made by the instrument makers in a portable form. A rough substitute may, however, be made by reversing a straight-backed chair so that it rests upon the front edge of the seat and the top of the back.

2. The Lithotomy Position.—This is a position that is used in most of the gynæcological operations performed in private houses, as it is generally minor operations that are done in these surroundings. Evidently, the kitchen table has no lithotomy posts or foot holders, nor attachments for their adjustment. Assuming that the surgeon has not brought his own table with the necessary appliances, how is the difficulty to be met? If properly supplied, the surgeon may meet the emergency by bringing adjustable lithotomy posts and foot holders or one of the lithotomy slings with which the market is deluged. If not, the nurse must meet the requirements as best she may with the supplies at hand. The lack is usually supplied by a large bed sheet, so folded and applied as to maintain the patient in the desired position. There are two methods in general use, either of which is likely to give satisfaction. In the first, a large sheet is folded diagonally and placed on the table with the long, folded edge under the patient's shoulders and the apex hanging over the lower end of the table. The patient is then placed in the lithotomy position and the long ends of the sheet that hang down the sides of the table are brought under the thighs, between the legs and up the body, being tied under the patient's neck by carrying one under the neck and tying to the other. A sheet properly adjusted in this manner will hold the patient in a very satisfactory lithotomy position. The second method consists in folding a sheet in several thicknesses lengthwise until it is only from eight to twelve inches wide. The sheet is then passed under the table and the ends brought out up over the body of the patient. The patient is put in the lithotomy position and the two ends of the sheet carried between the thighs, outward over them with sufficient force to hold the thighs well flexed in position and fastened securely to the part coming up over the table,—several safety pins serving very well for this purpose.

3. The Knee-Chest Position.—The knee-chest position under an anæsthetic. It is quite true that this position is neither generally nor, indeed, very frequently used in conjunction with general anæsthesia. But, at the same time, it is true that, when the occasion does arise, the confusion is all the greater for the very infrequency of its use. There are two solutions of the difficulty, a plenitude of assistants to hold the patient in position or lithotomy posts and slings. The sling, in this case, should be a broad and well-padded one, as the weight of the patient must be sustained by resting her thighs in these. The patient is put in the knee-chest position, after being completely under the influence of the anæsthetic, and the slings placed around her thighs and fastened to the posts, in such a manner as to support her weight and maintain her in the proper position.

CHAPTER VIII

BANDAGING

I. PRINCIPLES OF BANDAGING

It is impossible, in a brief chapter, to describe in detail all the numerous and often complex ways of applying a bandage that have been devised, and it is also unnecessary, since the nurse will rarely if ever be called upon to apply any but the more simple forms. As a matter of fact, the surgeon rarely adheres strictly to the rules laid down, but varies his methods to suit the individual case. There are, however, certain fundamental principles in bandaging that are of the greatest importance, and these should be as clearly understood by the nurse as by the surgeon. A badly applied bandage may be a source of great discomfort and even of serious danger to the patient. A bandage, although properly applied at the time it was put on, may later become ineffective, or possibly injurious, because of a change in the condition of the part bandaged, for example, through increased or diminished swelling, or because of a change in the position of the part, or a disarrangement of the bandage itself, due to accident or other cause. When such a condition arises the nurse will usually have the first opportunity to recognize the fact, and she should be able to understand what is wrong so as to call the attention of the surgeon to it, either immediately or at his next visit, according to the circumstances of the case. When a surgeon has occasion to examine a bandage that has been applied by an inexperienced student, interne or nurse, he will not observe or criticise the character of the " turns " selected (spiral, reverse or figure-of-eight), or whether these are put on in the exact order or manner described and pictured in the text-books. What he will note particularly, on the other hand, will be the character, amount and distribution of the dressing or padding material under the bandage; the area included, whether too scanty or too extensive; whether the bandage is applied so as to have the proper grasp of the limb or other part of the body to which it is applied, so that it will not tend to slip; the amount of tension, particularly at the edges and over bony points; and finally (and also of least importance), the smoothness and neatness of the overlying folds. A bandage that is the perfection of neatness may be hopelessly bad in the essential particulars, and some of the most skilful surgeons, although the bandages which they apply are models of efficiency, pay little or no attention to their external appearance. We may now give a brief summary of the general principles of bandaging and these will be included under two headings, first those which refer to the efficiency of the bandage, its proper application with reference to the purpose for which it is employed. These are of the first importance and should always be kept uppermost in mind. Under the second head will be given those points, of minor importance relatively, which refer to the neat appearance of the bandage.

Principles which concern the efficiency of a bandage:

1. An arm or leg, when a bandage includes one or more of its joints, should always be bandaged in the position it is to remain in afterwards.

2. With a few exceptions a bandage should never be applied next the skin, an elastic padding usually of cotton being placed between the skin and the bandage. The exceptions are (*a*) when a bandage of flannel or elastic fabric is applied for pressure, (*b*) the Unna's paste bandage, (*c*) the bandage for a Buck's extension; here the padding is placed only over bony points and edges.

3. Skin surfaces should never lie in contact. At the fold of the groin, at the bend of the elbow and knee, between the fingers or between the arm and the side, padding should be placed to keep skin surfaces apart.

4. A bandage should exert even pressure everywhere. There should be no tight bands.

5. When a bandage of an arm or leg is required to be put on with firm pressure for any reason it should extend from the base of the fingers or toes up, otherwise constriction of the limb will result with swelling below the bandage.

6. To secure a proper grasp of the limb a bandage on an arm or leg should cover all the space between two joints or include the joint above or below in the turns of the bandage.

Points which concern the neat appearance of the bandage:

1. The turns of a bandage should lie flat, not with one edge tight and the other wrinkled.

2. Each turn should overlie two-thirds of the preceding turn.

3. The edges should lie in parallel lines.

4. The points where the edges cross should lie in a straight line.

These points are well illustrated in Figs. 61 and 62.

II. FORMS AND USES OF BANDAGES

When we speak of bandages we ordinarily mean the roller bandage which is so extensively used in surgery; but there are a number of other forms which are in constant use, some of which will be described later in the chapter on the operating-room outfit. Thus we have the triangular bandage (Fig. 42), used as a sling for the arm and sometimes for other purposes; the T-bandage (Fig. 43); the four-tailed bandage (Fig. 44); the

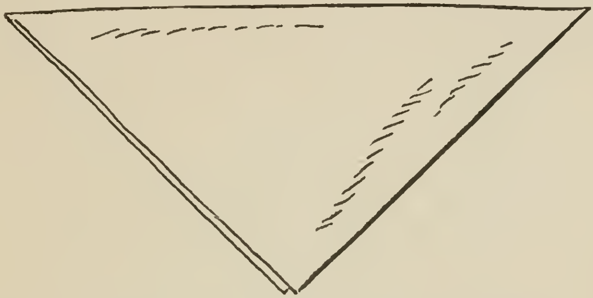


Fig. 42.—Triangular bandage. (Eliason's Practical Bandaging.)

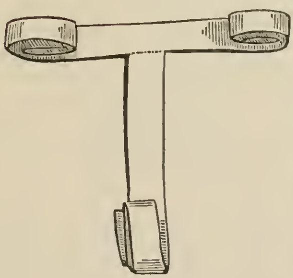


Fig. 43.—Single T-bandage.

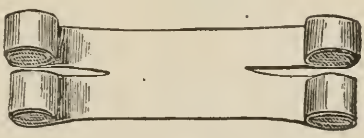


Fig. 44.—Four-tailed bandage.

plain abdominal binder; the many-tailed bandage; the Scultetus (Fig. 45); and some special forms of bandages, such, for example, as those used for supporting the female breast.

In the employment of all these forms of bandages there are three principal purposes that are aimed at, either singly or in combination. These are (1) the retention of dressing materials over a wound, (2) fixation of the part with the aid of splints or of some stiffening material impregnating the bandage itself, (3) the application of pressure.

III. MATERIALS AND PREPARATION

The materials of which roller bandages are made are gauze, usually of much finer mesh than the gauze used for surgical dressings, unbleached muslin, crinoline, flannel, and sheet rubber. Each material has its own special use according to the object to be attained.

The gauze bandage is now almost universally used for the retention of surgical dressings. These bandages are furnished ready made in all sizes by the manufacturers, and are for sale at all drug stores, often at rather fancy prices. When purchased in

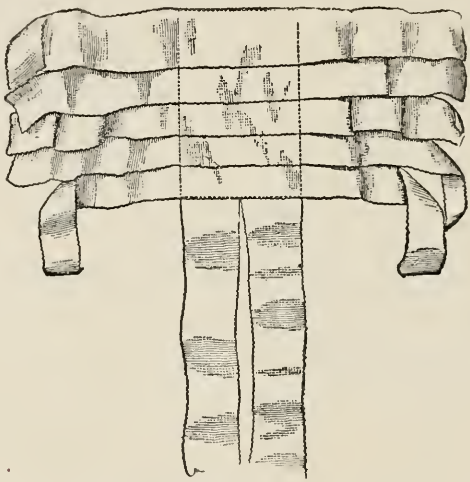


FIG. 45.—Modified bandage of Scultetus.

quantity, however, they are cheap enough, so that most hospitals no longer find it an economy to make their own gauze bandages. The most common sizes are ¾ inch (for the fingers), 2½ inches, 4 inches, and 6 inches in width, and from 2 to 10 yards long.

The muslin bandage, formerly the most common form, is now generally restricted in its use to cases where it is desirable to exert a considerable amount of pressure on the part to which it is applied, and to the retention of splints and the treatment of fractures. Only two sizes are ordinarily used, 2 inches and 4 inches in width and 5 yards long.

Crinoline bandages, because of the starch with which the material is impregnated, are used to make a stiff covering over the gauze bandages put on to retain a surgical dressing, the object being to make the bandage more secure and give it a certain amount of rigidity. Two-and-one-half and four-inch widths are the usual sizes. The bandages are soaked in water and wrung out before being applied. It will add much to the surgeon's good temper if the nurse will remember to pull off all the ravellings from the edges of the wet crinoline bandages before handing them to him. Crinoline is also used as the material from which plaster-of-Paris bandages are made.

Flannel bandages are used solely to exert pressure, being particularly adapted for this purpose on account of their elasticity. This bandage is applied next to the skin without any intervening padding. Four inches is the usual width.

Fig. 46.—Rolling bandage by hand.

The bandage made of sheet rubber, known as the Esmarch or Martin bandage, is used at the time of operation to expel blood from a limb and to compress the vessels so as to prevent hemorrhage. They are made three inches wide.

Triangular bandages, binders, slings and tailed bandages are made of unbleached muslin or of Canton flannel. The triangular bandage is made from a thirty-inch square of muslin folded or cut diagonally. Its principal use is as a sling for the arm. The four-tailed bandage is either a square of muslin, of suitable size for the purpose intended, with tapes at the corners, or is made from a strip of muslin bandage, split from each end with the scissors, leaving an uncut portion in the middle. Their principal use is for dressings applied to the chin, the eye or the ear. The forms and sizes of plain and many-tailed binders will be described in a later chapter.

In making roller bandages muslin may be torn into strips of the desired width, but gauze, crinoline and flannel must be cut with the scissors. Gauze and crinoline are cut in line with the threads in the length of the goods. Flannel bandages are cut diagonally across the goods, the short pieces being then stitched together to make the requisite length. The object of this is to make them elastic.

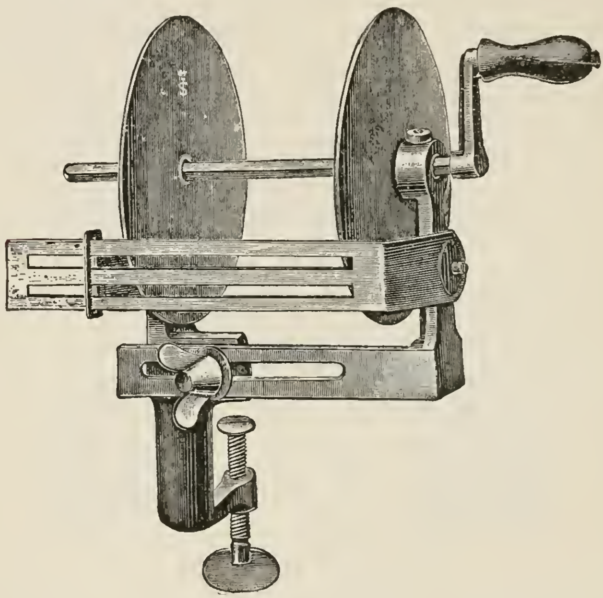


Fig. 47.—Bandage roller.

Bandages may be rolled by hand (Fig. 46) or by means of one of the simple machines provided for the purpose (Fig. 47). Muslin and gauze bandages should be rolled as tightly as possible. Crinoline and flannel bandages should be loosely rolled. All loose threads and ravellings should be carefully removed.

IV. APPLICATION OF THE ROLLER BANDAGE. BANDAGING FOR THE RETENTION OF DRESSINGS

The first consideration in bandaging for the retention of a surgical dressing is the character and distribution of the dressing material. From every fresh clean wound there will be for some hours an abundant discharge of watery fluid which oozes from the divided capillaries and is derived from the serum of the blood. In infected wounds there is a free discharge of pus or other form of inflammatory exudate. The dressing material must be of such a character as readily to absorb these fluid discharges and at the same time exert an elastic, non-rigid pressure in the neighborhood of the wound. To meet these indications there is nothing equal to the absorbent surgical gauze manufactured expressly for the purpose. The gauze is cut and prepared in various forms and sterilized in packages wrapped in muslin, or in metal drums (see page 275, Fig. 88), and must be handled, of course, only with sterile gloves or instruments. The manner of applying the gauze dressings varies according to the amount of discharge from the wound. For the primary dressing of all operative and accidental wounds, and for all dressings of suppurating wounds the gauze used should not be in the form of pads, like a folded handkerchief, but in the form of fluffs, like a handkerchief shaken out and lightly crushed in the hand. The dressings should cover a rather wide area on all sides of the wound, six to eight inches at least, except, of course, in the case of very small wounds. The fluffs should be piled up to a thickness of from two to four inches or even more in the case of large wounds, and should be massed rather more heavily about the circumference of the wound and rather more lightly directly over the wound itself. When the wound is on an arm or leg a part of the gauze dressing should encircle the entire limb, which is best done by means of fluffs applied to the wound and over them a gauze roll wound about the limb. This applies also to dressing wounds of the neck. Wherever skin contact occurs, as in binding an arm to the side, abundant padding should be placed between the skin surfaces. When the gauze dressing has been applied it is well in some cases to secure it from slipping by means of strips of adhesive plaster which pass across the dressing and adhere to the skin on either side. Over all a gauze bandage of suitable width is now applied. In the case of abdominal wounds a binder takes the place of the bandage. The bandage should cover the entire dressing and extend a short distance beyond it on every side. It should be so applied as to have the proper grasp of the limb or other part, in order that it may not slip. This point will be referred to again in the discussion of regional bandaging. A dressing bandage should never be very tight, just sufficient tension being used to make it firm and secure. It should be, as a rule, about as tight as a comfortably fitting glove. Occasionally very much stronger pressure must be temporarily applied, principally for the purpose of controlling hemorrhage. Finally, the end of the bandage is twisted into a cord and fastened with a safety pin, preferably at a point directly over the wound itself, thus indicating its location. A small square of adhesive plaster also answers well for the purpose of fixing the end of the bandage.

In cases where a certain amount of rigidity is desirable a wet crinoline bandage is put on over the gauze bandage. This, when dry, will give a moderately stiff superficial covering. For additional support, in certain cases, strips of thin, pliable wooden splints may be incorporated in the bandage.

When the formation of pus is very abundant, or where there is a discharge of fæces, urine, or bile through the wound, the dressings must be changed very frequently and the means of holding them in place should be arranged so that the changes can be easily made. The use of short strips of adhesive plaster, two inches wide, attached to the skin on either side of the wound, with tapes fastened to them to tie across the dressings, will make it easy to remove the saturated gauze and replace it with a fresh supply. A binder pinned over this dressing gives additional security. In many cases when wet dressings are applied to a limb these must be changed every three hours or even oftener, and the roller bandage is too cumbersome a means for holding them in place. The wet gauze should be loosely folded about the limb, not wound around it with many turns; it should be covered with a piece of oiled silk and held in place by means of a towel wrapped about the limb and fastened with safety pins or by three or four turns of a gauze roller.

In the case of aseptic operative or accidental wounds there will be no discharge after the first few hours. For the second dressing of such wounds the requirements are, therefore, quite different from those called for at the first, since no provision need be made for the absorption of fluid material. Flat gauze pads may now be used, and these need not be so thickly piled or so widely distributed as at the primary dressing.

V. BANDAGING FOR FIXATION

In cases of fracture, of dislocation, and of disease involving a joint, the injured or diseased part must be kept at rest and in a fixed position for a considerable time. Fixation of a limb may be accomplished by means of padded splints held in place by strips of adhesive plaster and a gauze or muslin roller bandage or by means of bandages impregnated with some substance like plaster-of-Paris which will form a rigid covering for the injured part. The nurse may be called upon to apply some form of fixation apparatus as a first-aid measure, and it is very desirable that she should understand the principles governing their use, since a fixation bandage may be capable of doing serious harm when improperly applied.

All splints or other fixation appliances should be well padded, especially over bony points. They should be put on tightly enough to ensure immobility but not enough to produce constriction. The position of a limb should not be changed after a fixation bandage has been put on, since this may cause undue constriction at the point where the joint is flexed. The usual and normal position of the various joints in fixation is as follows: ankle, flexed at right angle; knee, straight; hip, straight; wrist, straight or slightly flexed; elbow, flexed at right angle; shoulder, in normal position at side. There are some exceptions to these rules; for example, the elbow must, for one fracture particularly, be put up in the straight position, and in many cases of fracture at the elbow-joint the best position is with the arm flexed at an acute angle; but these points are for the decision of the surgeon. In fractures of the shaft of a long bone the bone itself and the joint of either side must be included in the fixation. Some exceptions to this rule occur in the case of fractures close to a joint and in fractures of only one of the two bones in the forearm or leg. Fingers and toes, particularly the former, should always be left free in applying fixation to a limb, unless, of course, these are themselves the injured members. It is the most inexcusable kind of bad surgery to include the fingers in a splint for a broken arm. They will inevitably become stiff and their restoration to their normal suppleness will be an extremely difficult matter. When the hand or foot below a fixation bandage becomes markedly swollen or cold and blue, the whole bandage, everything down to the skin, must be at once cut with the scissors, even, if necessary, without waiting for orders from the surgeon. After doing this, however, the fixation appliance need not be removed, a very loose bandage being put on over it until the surgeon has an opportunity to readjust it.

VI. BANDAGING FOR PRESSURE

Bandaging for the application of pressure may be required to control hemorrhage, or to give support and prevent swelling, as for example in ankle sprains and varicose veins of the leg. A pressure bandage must always extend from the toes or fingers up, leaving these free, otherwise swelling will occur below the bandage. Pressure must be elastic, not rigid, and therefore when either gauze or muslin bandages are used for pressure, padding must be applied between the bandage and the skin. Hospital wadding (sheet cotton glazed on both sides) is the best material for this purpose. The diagonally cut flannel

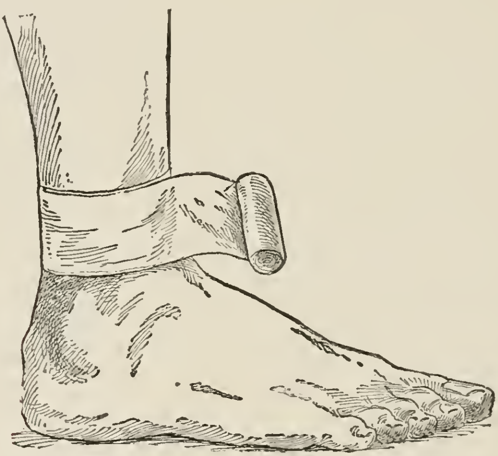


Fig. 48.—Circular turns of a bandage. (Eliason's Practical Bandaging.)

bandage is sufficiently elastic so that it may be used as a pressure bandage without any padding under it. The tension exerted by the pressure bandage must never be sufficient to interfere seriously with the circulation of the limb. Badly injured tissues, or those the subject of long-standing chronic disease, and the tissues of the very young or very old bear pressure badly.

VII. THE "TURNS" USED IN BANDAGING

In order to make the folds of the roller bandage lie smoothly and with equal tension it is necessary to vary the manner of placing them in a number of ways as the bandage is wound in successive layers about the limb or other part. These various turns are very simple in character, but it is difficult to describe them clearly, and they must be learned from pictures and by practical demonstration. They are six in number and are known as the "circular," the "spiral," the "oblique," the "reverse," the "figure-of-eight," and the "recurrent" turns. A bandage may be applied using one of these turns exclusively, or two or more in combination, or even changing from one to another at each successive encircling of the part with the bandage, unconsciously selecting each time the particular turn that is best adapted to the case in hand, and forgetting all the rules laid down in the text-books on the subject. This latter method is the usual practice with those who do much bandaging and gives the best results as regards efficiency, although not always the most finished appearance.

The circular turn is one which simply encircles the part overlying the preceding turn. It is used principally to fix the free end of the bandage at the start (Fig. 48).

The spiral turn is what its name indicates, each turn overlapping the preceding turn with parallel edges (Fig. 49). It is applicable where the diameter of the part does not vary.

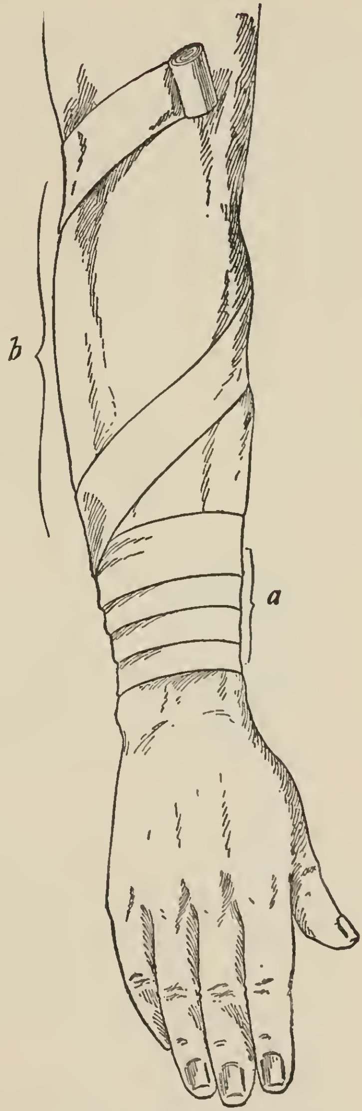


Fig. 49.—Spiral and oblique turns. (Eliason's Practical Bandaging.)

In making the oblique turn the bandage is allowed to fall in any direction across the limb where it will lie smoothly, no attention being paid to uniform overlapping of the preceding turns.

The reverse turn (Fig. 50) is made when it is found that the bandage, in order to lie flat, must be made to take a very oblique direction across the limb and the next turn will carry it beyond the area to be included in the bandage. The bandage is then "reversed," that is, turned over, making a diagonal fold across its width, so that what was the outer surface, away from the

FIG. 50.—Making reverses.

skin, now becomes the inner surface, towards the skin, and the course of the bandage takes a new direction. This turn is used where there is variation in the diameter of the part to be bandaged.

The "figure-of-eight" (Fig. 51) really consists of two turns which cross each other at an angle on the front or back of the limb. A figure-of-eight bandage passing from the thigh to the trunk or from the arm to the shoulder is called a "spica" bandage (Fig. 52).

Recurrent turns (Fig. 53) are made by folding the bandage back and forth upon itself, the bends of the folds being then caught by a circular turn. It is used in bandaging the head,

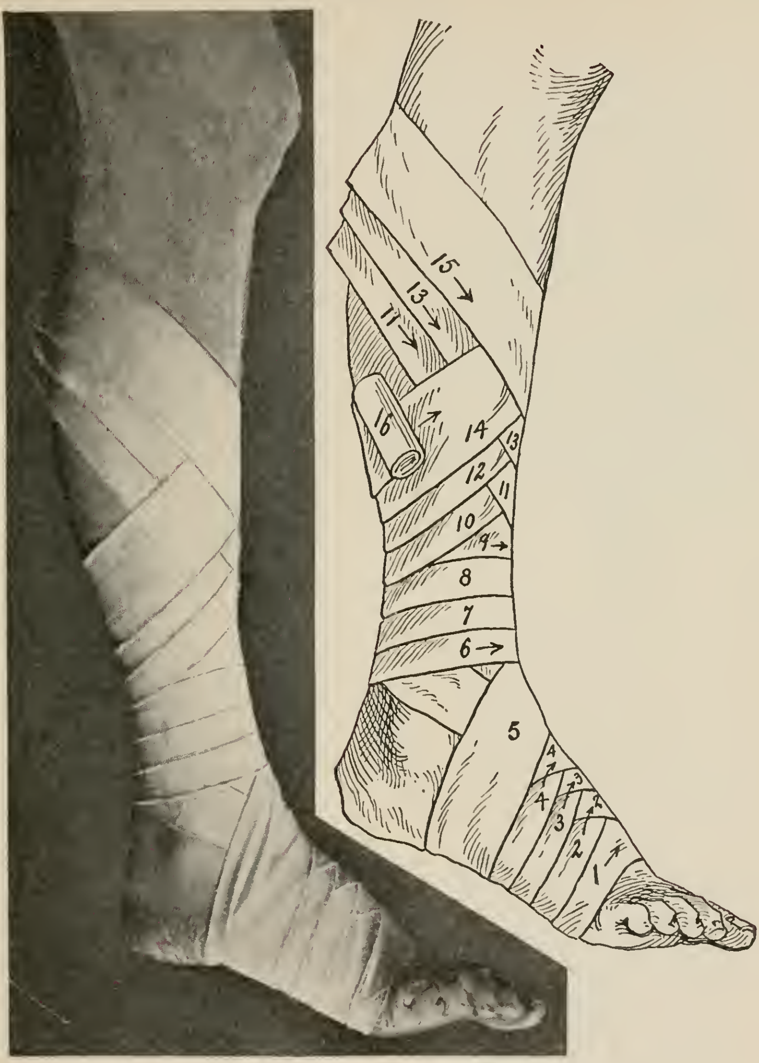


Fig. 51.—Figure-of-eight turns. (Eliason's Practical Bandaging.)

covering in the ends of the fingers or an amputation stump (Fig. 54), making a suspender over the shoulder for a breast bandage, and so on.

VIII. REGIONAL BANDAGING

1. The Head.—Bandages of the head for the retention of dressings may include (1) only the scalp region, with the forehead; or (2) the scalp region and the neck; or (3) in addition to these the chin may be included by turns which pass from the

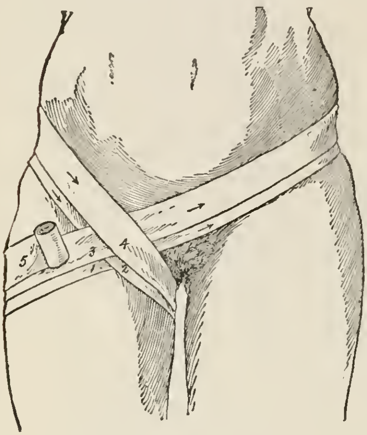


Fig. 52.—Spica of the hip.

Fig. 53.—Recurrent of the scalp (first step). (Eliason's Practical Bandaging.)

top of the head in front of the ear and under the chin, thus covering everything but the face. In the first case circular turns pass under the occiput (Fig. 55) as low down as the hair line at the back of the neck and around the forehead, these holding recurrent turns which pass over the top of the head; or the scalp may be

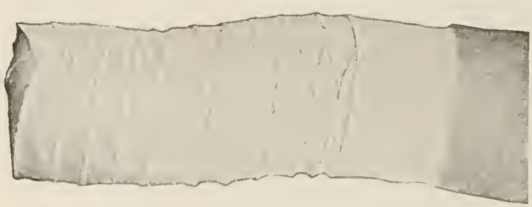


Fig. 54.—Recurrent bandage of the stump.

covered by oblique and reverse turns caught under the circular turns. The ears should be left out, or, if included, padding should be placed behind and over each ear to protect it from pressure. When the neck is included, or the neck and chin, figure-of-eight turns are used crossing at the back of the neck

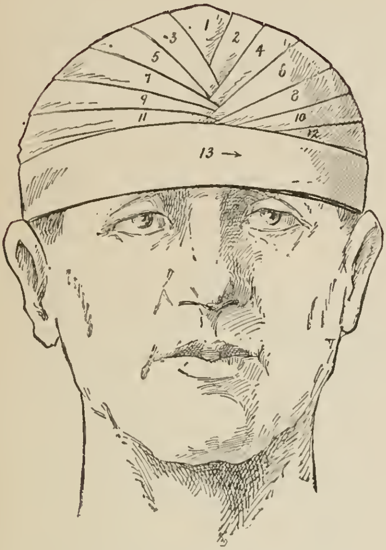


Fig. 55.—Recurrent turns. (Eliason's Practical Bandaging.)

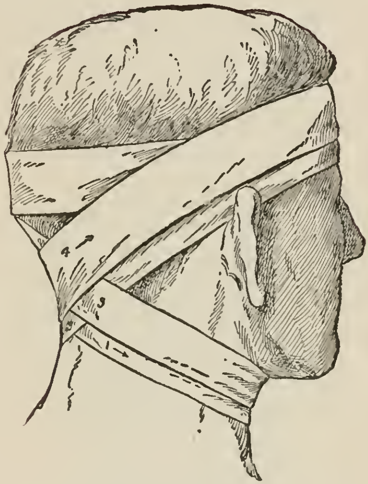


Fig. 56.—Figure-of-eight of the head and neck (Eliason's Practical Bandaging.)

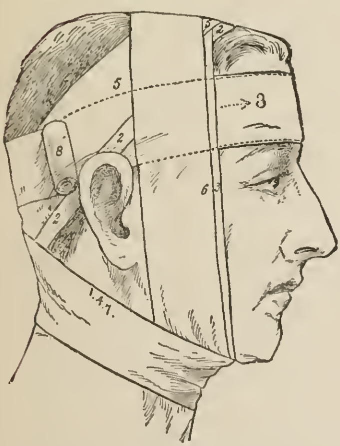


Fig. 57.—Double oblique of the jaw. (Eliason's Practical Bandaging.)

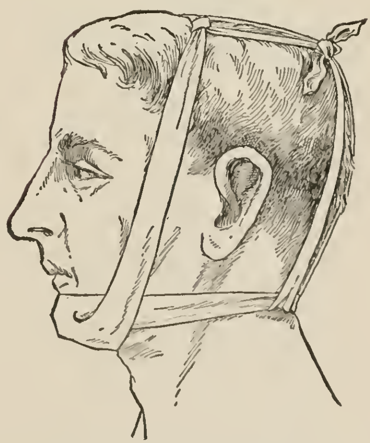


Fig. 58.—Four-tailed bandage of the chin. (Eliason's Practical Bandaging.)

(Fig. 56) or under the chin, or at both these points (Fig. 57). Fracture and dislocation of the lower jaw are the only conditions calling for fixation bandages applied to the head. A four-tailed bandage over the point of the chin with the tails tied behind the neck and at the top of the head is the simplest appliance for this condition (Fig. 58). When the roller is used a sort of triple figure-of-eight with crossing points at the chin, at the top of the head, and at the occiput (Barton's bandage) (Fig. 59), or one with the crossing point at the chin, with turns to the back

Fig. 59.—Barton's bandage.

Fig. 60.—Gibson bandage. (Eliason's Practical Bandaging.)

of the neck, to the top of the head, and circular turns about forehead and occiput (Gibson's bandage), give good fixation and security (Fig. 60).

2. The Neck.—Bandages for the retention of dressings including the neck alone are never used except for very slight and insignificant wounds, for which a few circular or oblique turns are all that is necessary. For wounds of any extent in the neck the bandage must include a number of turns about the head sufficient to secure the upper border of the neck bandage. Wounds of the lower part of the neck, and particularly those of the throat in front, will also require figure-of-eight turns passing down under both arms. Abundant dressings must be used here and the bandage must never be tight. Fixation appliances for the neck, required occasionally for disease or injury of the spine, must possess a firm grasp upon the whole trunk, neck, chin and head.

3. The Thorax.—Extensive dressings are often needed here, particularly for operations on the female breast. Circular, spiral or oblique turns about the body with oblique turns from under the arm over the opposite shoulder and recurrent over the shoulder will be required. Wide gauze bandages should be used and care should be exercised that the turns about the chest are not too tight and that they do not extend too high under the arms. In extensive wounds (*e.g.*, complete operation for cancer of the breast) the whole arm on the wounded side should be included in the bandage and fastened to the chest wall. Abundance of safety pins should be used to secure the folds of the bandage. Fixation for fracture of one or more ribs is often called for, and may be accomplished by means of a wide muslin roller, a tight binder, or wide strips of adhesive plaster.

4. The Abdomen.—Dressings of wounds in this region are usually secured by adhesive straps and a binder, the roller bandage being rarely used, but bandages for the groin or thigh always include the lower abdomen to give them the proper grasp, and for wounds of the back in the lumbar region a wide gauze roller may be employed. Fixation appliances covering this region are always for injury or disease of the hip or of the spine.

5. The Extremities.—In bandaging for the retention of dressings as applied to either the arm or leg, the figure-of-eight, spiral and oblique turns are the ones to be selected as a rule. The reverse will rarely be called for. Where simply the retention of a dressing, without pressure, is required, the figure-of-eight turn is to be preferred, since it will be found applicable to almost all situations, gives great security and at the same time the most finished appearance to the bandage. Circular and spiral turns will be resorted to where firm pressure is required, as for the control of hemorrhage, and recurrent turns in special situations, as for covering an amputation stump or the ends of the fingers. An occasional oblique or even a reverse turn may be called for, and a few circular turns to finish the edge of the bandage or to secure the recurrent turns. The use of the reverse turn will be mostly confined to the application of fixation appliances where the bandage must follow up a tapering limb (Fig. 61) covered with an even thickness of padding, as, for example, in bandaging over the adhesive straps in putting on a Buck's extension, and in

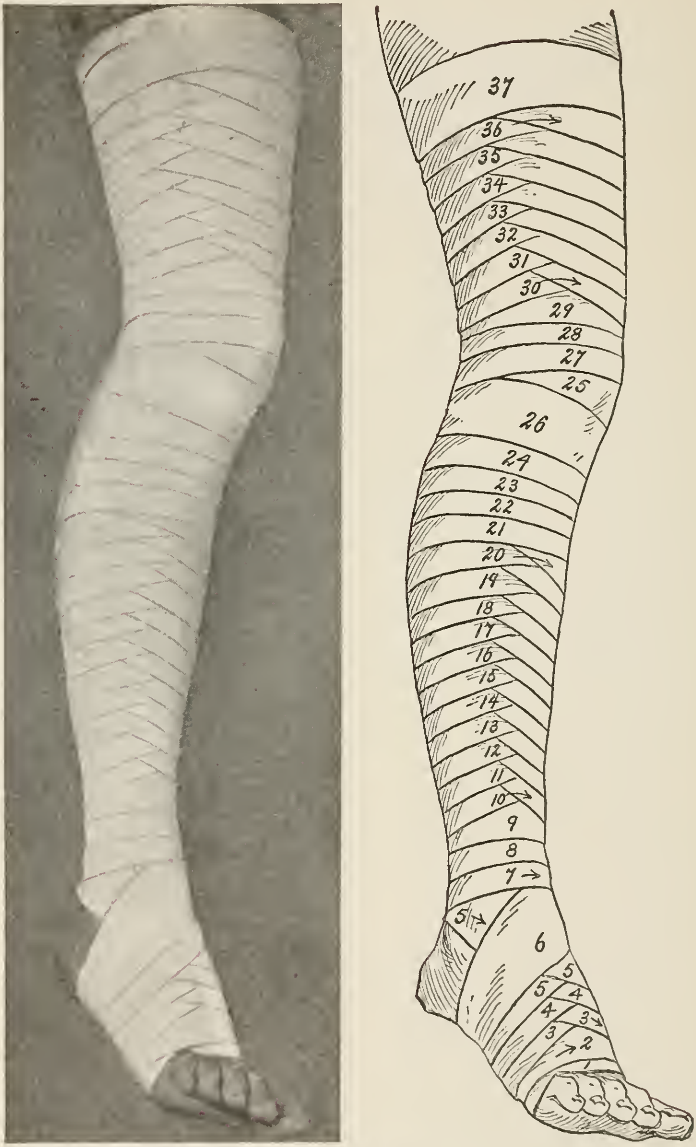


FIG. 61.—Spiral reverse of lower extremity. (Eliason's Practical Bandaging.)

applying a plaster-of-Paris cast for fixation of a fracture. The flannel bandage is used almost exclusively on the foot and leg (sometimes the wrist and arm) to give supporting pressure in cases of sprain or other conditions, such as varicose veins of the leg. It is to be applied from the toes up with figure-of-eight turns for the foot and spiral turns only for the leg, since this bandage stretches so readily that a reverse is never needed.

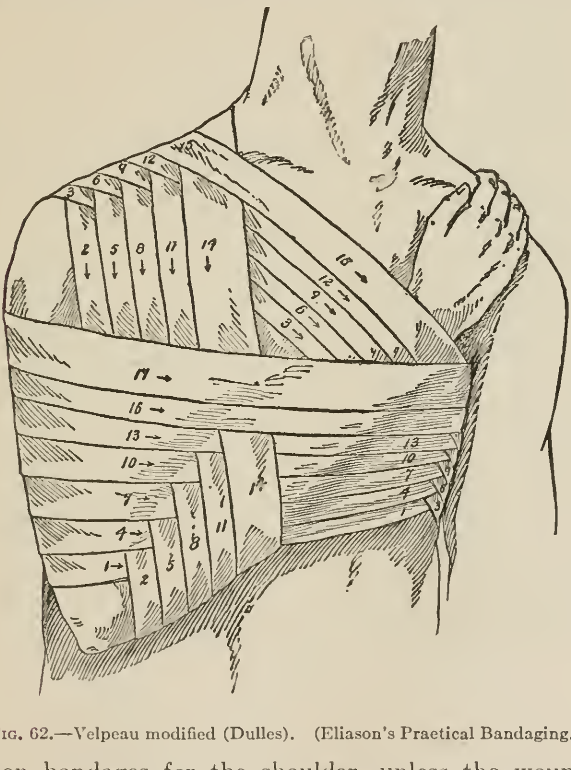


Fig. 62.—Velpeau modified (Dulles). (Eliason's Practical Bandaging.)

Retention bandages for the shoulder, unless the wound is an insignificant one, should fix the arm to the side, with plenty of padding between the skin surfaces. There are two classical forms of bandage for securing the arm to the side, known as the "Velpeau" (Fig. 62) and the "Desault" bandages. In the former the whole arm is included, in the latter only the upper arm is fixed, the forearm being left uncovered and with some freedom of motion. The position of the arm for the Velpeau bandage is with the hand resting on the front of the opposite shoulder. The bandage consists of spiral turns about the body including the arm and forearm, with alternate turns passing over the shoulder on the injured side, from behind forwards, and passing down under the arm and forearm. Desault's bandage is applied with the arm lying straight across the body at the level

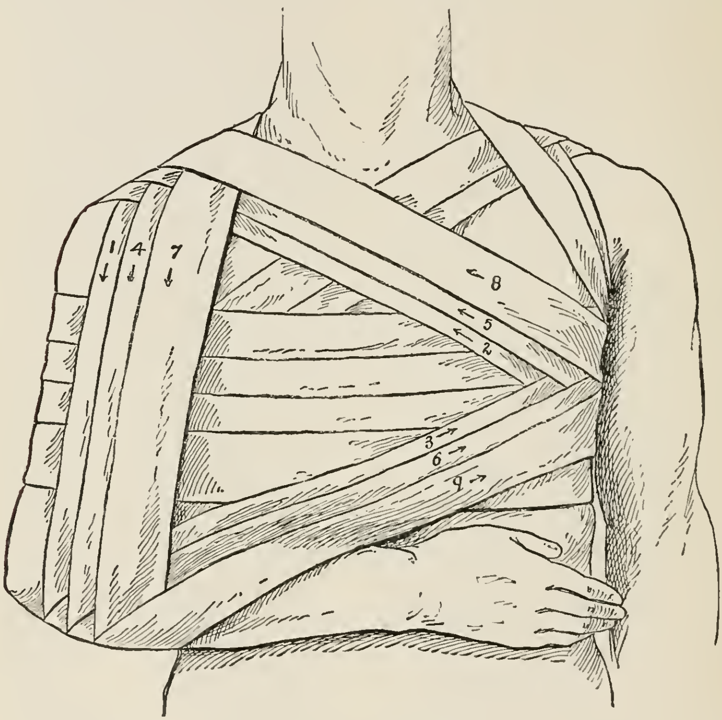


FIG. 63.—Desault bandage. (Eliason's Practical Bandaging.)

of the lower ribs. The bandage consists of circular and spiral turns about the arm and body, with a final roller applied as a compound figure-of-eight, having three points where the folds cross (Fig. 63), over the shoulder on the injured side, under the elbow and under the opposite axilla. In the classical description a first roller fixes a pad in the axilla on the injured side, but this step need not usually be considered by the nurse in cases where she may be called upon to apply the bandage. It must always be remembered, however, that plenty of padding is to be used to prevent contact of skin surfaces. Particular care must be exercised to avoid pressure over the point of the elbow.

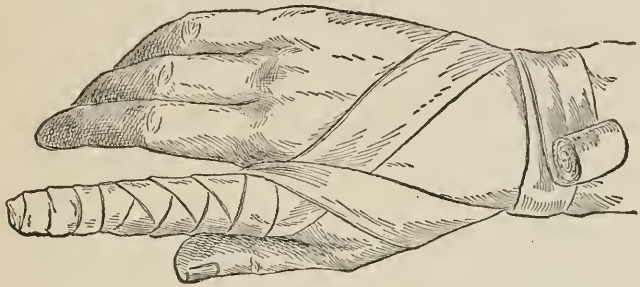


Fig. 64.—Finger bandage.

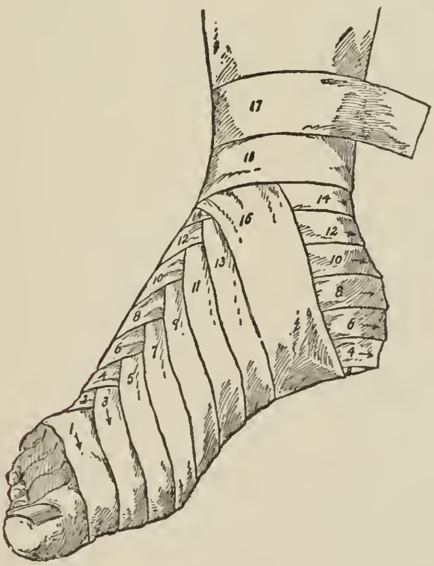


Fig. 65.—Spica of the foot. (Eliason's Practical Bandaging.)

The fingers are bandaged singly or two or more together, a three-quarter inch gauze roller being used with figure-of-eight and recurrent turns (Fig. 64). For the foot and ankle a simple application of the figure-of-eight is most suitable (Fig. 65).

In applying retention bandages to any part of the arm or leg, an ample area beyond the seat of injury should be covered and the bandage should be so adjusted as to have a proper grasp upon the limb so that it will not slip. To this end the bandage should always extend to or over one of the adjacent joints. A bandage of the upper arm should, as a rule, include a spica of the shoulder, the turns of which cross above the shoulder and pass under the opposite arm. A bandage of the thigh will require a spica of the hip to make it secure, the turns passing about the lower abdomen. Strips of adhesive plaster may at times be used to advantage to make a bandage secure, and the free use of safety pins at points where the folds are apt to slip is to be recommended. Retention bandages for the wrist and lower forearm should include the hand but leave out the fingers and thumb. The elbow should be bandaged in the position in which it is to remain, usually flexed. It should never be bandaged in the straight position, and flexed afterwards. Even a slight additional flexion of the elbow after a bandage has been applied may cause dangerous constriction. In bandaging the feet, the heel where it rests upon the bed should be protected by a ring pad.

IX. PLASTER-OF-PARIS BANDAGES AND CASTS

The Plaster-of-Paris Bandage.—The materials for these bandages will consist of a good quality of dental plaster and a rather wide meshed gauze or preferably crinoline cut into strips of the requisite width, usually 2½ to 4 inches. The plaster should be very finely ground, should feel very smooth to the fingers and absolutely free from grit. It should " set " within ten or fifteen minutes. The best material for the bandages consists of white crinoline such as is used by dressmakers, with a mesh of about 28 threads to the inch. If a cheap quality of crinoline is used containing an excess of dextrine in the starch the bandages will not set.

Plaster bandages must be rolled by hand for the reason that they must be so loosely rolled that when immersed in water they will become rapidly and completely saturated. A machine-rolled plaster bandage will always be too tight. The core of the bandage should be an open cylinder the size of the finger. To prepare them properly the crinoline is cut on a thread to the requisite width and rolled, in ten-yard lengths. On a flat table or board a quantity of dry plaster and a spatula are placed.

Fig. 66.—Method of squeezing water from bandage. (Eliason's Practical Bandaging.)

Fig. 67.—Making plaster bandages. (Eliason's Practical Bandaging.)

Fig. 68.—Instruments for removal of plaster casts. *A*, Henry's knife; *B*, Bergman's saw; *C*, Reed's cutter; *D*, bandage scissors; *E*, Hopkin's shears; *F*, Sentin's shears; *G*, Gigli saw. (Eliason's Practical Bandaging.)

The crinoline bandage is placed on the table and unrolled for a distance of about a quarter of a yard, with the free end toward the operator. Into this length of crinoline lying flat upon the table a sufficient quantity of plaster is rubbed with the spatula to fill all the meshes evenly. The free end is now turned into a cylinder about one inch in diameter, and is rolled across the table nearly as far as the plaster filling extends; it is then drawn back toward the operator and another length unrolled. This is in turn impregnated with plaster and the same process continued until the whole bandage is completed. Before beginning to roll each successive length the nurse should slide the impregnated roll one inch forward on the length of crinoline lying flat upon the table, thus insuring loose rolling. If this is not done the bandage will be too tight. A time-saving method consists in impregnating and rolling the entire width of the crinoline at one operation, the long roll being afterwards cut into suitable lengths (Fig. 66). The completed bandages should be secured with pins, wrapped in thin paper and stored in a tin pail containing a small quantity of loose plaster and fitted with an air-tight cover.

When the bandages are to be used they are placed on end, one after another as required, in a basin of water till air bubbles cease to appear. Each bandage as needed is lifted out, wrung fairly dry (Fig. 67), all ravellings removed, the free end separated from the roll and the bandage handed to the surgeon. Not more than one or two bandages at the most should be in the water at the same time. The water should be warm and deep enough to immerse the bandages completely. Care must be taken that no water is accidentally sprinkled into the container in which the unused dry bandages are stored. The removal of a plaster cast after it has set and dried is a somewhat tedious task at best. Various instruments have been devised for this purpose (Fig. 68). The best means is a heavy-bladed knife. The operation is much easier if the line along the plaster cast where it is to be cut is softened with vinegar or other diluted acid.

CHAPTER IX

PREPARATION FOR THE TREATMENT OF FRACTURES

1. The treatment of fractures consists essentially in the fixation of the broken bones in proper position long enough for bony union to occur at the seat of fracture. The usual period during which fixation is maintained is six weeks when the patient is an adult, a shorter time (three to five weeks) sufficing for children, whose bones heal much more rapidly. Two forms of external appliances are employed for the fixation of fractures: (1) the plaster-of-Paris cast, and (2) properly fitted and padded splints held in place by straps or bandages. In certain cases weights and pulleys are required in addition to overcome muscular contraction, which tends to pull the fragments out of position. We may mention in passing (3) what is known as the open treatment of fractures, where an open operation is performed, an incision being made down to the seat of fracture and the fragments fixed in position by means of bone grafts or by wires passed through holes drilled in the bone or by steel plates fastened to the bone with screws or bolts. Cases of fracture where the patient is allowed to be up and walk about during the fixation period are spoken of as ambulatory cases. As a rule, fractures of the thigh and leg are the only ones among those enumerated which need confine the patient to his bed, and even some of these may be treated with advantage, by means of special apparatus, as ambulatory cases. The materials required for splinting a fracture may include (1) the fracture bed, (2) splints, (3) padding, (4) means of fixation (including straps, adhesive strips, bandages, swathes and binders), and sometimes (5) pulleys and weights.

2. The Fracture Bed.—The first requisite for the treatment of a fracture of the hip, thigh or leg is a rigid flat surface for the patient to lie on. No such fracture can be treated properly on a bed that sags. A fracture bed consists simply of a rigid frame to support the mattress. In the case of the usual form of hospital bed the purpose may be well served by the use of four boards, one inch thick, twelve inches wide and as long as the bed is wide. These are placed across the bed frame under the wire springs, cleats being nailed to the ends to prevent slipping. Where a box spring is in use it must be discarded and a rigid wooden frame covered with a mattress substituted. The fracture bed is to be put in place before the patient is put to bed in all cases of fractures of the lower extremity.

3. **Splints.**—A variety of materials are employed for these. Wood, metal, felt and binder's board are the most common. Flexible wooden splints, of the thinness of veneer, are used by surgeons for many purposes. They can be broken or cut with scissors to any convenient shape and used singly or in several thicknesses as desired. Rigid wooden splints, from 3/16 to 1/2 inch thick, may be cut with a knife or saw to fit any particular case, and separate pieces may be fitted together, when necessary, with nails, screws or brackets. Metal splints may be of wire or sheet metal. Many forms are manufactured moulded into various shapes ready for use. Felt used for splints is impregnated with gum or shellac to give it stiffness. It comes in sheets and may be cut to fit, softened by heat and moulded to any shape desired. On cooling it becomes rigid in the moulded form. Binder's board, or pasteboard, is used as a makeshift for the temporary fixation of fractures, and sometimes as an additional support in certain cases.

The nurse should be familiar with the names of several common forms of splints. The right-angle elbow splint is commonly inaptly called the "internal angular" splint. It is really an anterior right-angle splint, fitting over the front of the arm and forearm and bend of the elbow. It is usually made of three pieces of tin soldered together, two pieces slightly rounded to fit the arm and forearm, with a "gusset" set in at the elbow. The internal angular splint, properly so-called, has the angle "on the flat" like a carpenter's square, and fits the inner side of the arm and palmar surface of the forearm. It has a round hole at the angle to avoid pressure on the internal condyle of the humerus. When dorsal and palmar splints for the forearm are called for, two pieces of splint wood, long enough to reach from the elbow to the base of the fingers and a little wider than the arm, should be provided. The surgeon will trim them to the proper dimensions and shape. A posterior leg and foot splint fits the back of the leg and has a piece at right angles to this which rests against the sole of the foot. It may extend to the knee or to the middle of the thigh. It may consist of a wire frame wound with bandage (Cabot's), or it may be made of woven wire or wood. A wooden splint of this form, fitted with grooves on the under side to slide on a flat board or frame resting on the bed, is known as Volkmann's sliding rest, and is used when extension is applied to fractures of the thigh.

A posterior knee or ham splint is a splint fitting the leg and thigh back of the knee with the object of immobilizing that joint. It may be made of a straight piece of wood about twenty inches long and four inches wide, well padded, or it may (better) be of wood or metal shaped to fit the curves of the leg. The axillary or long side T-splint is a long wooden splint applied to the side of the body extending from the foot to the axilla, used in cases of fracture of the thigh and hip. It usually has a short cross-piece nailed to the posterior edge of the lower end to keep it from turning. For an adult it will be about four feet ten inches long, four inches wide and ¾ of an inch thick. Coaptation splints are short, narrow wooden splints which are laid close together about the circumference of a limb and held by straps in order to exert equal pressure from all sides. They are applicable only to the upper arm and thigh, where but a single bone exists, never to the forearm and leg. The shoulder cap is used by some surgeons as an adjunct in the treatment of fractures of the humerus near the shoulder-joint. It is not a true splint, its purpose being simply to guard the shoulder and to distribute evenly the pressure of the bandage which holds the arm to the side. It is made from a piece of binder's board 10 by 16 inches. It is first bent into the form of a half cylinder. One straight central cut, and two curved slanting cuts at the top enable this portion to be folded over in the form of a dome covering the shoulder, the overlapping pieces being fixed by some means, such as needle and thread, safety pins or paper fasteners. The lower six inches in front are cut away where the cap fits over the bend of the elbow.

4. Padding Splints.—The materials for padding are cotton wadding (preferably that sold by the trade under the name of hospital wadding, which has a double glazed surface), felt, folded towels and sheets, with adhesive plaster and bandages to fix the pad. Felt is the best material to pad splints, but also the most expensive. Toweling is used for certain special pads and sometimes to pad temporary splints in emergency. For a straight wooden splint six or more thicknesses of hospital wadding are cut or folded to make a pad large enough to project a half inch over the edge of the splint. The pad is fixed to the splint with three narrow strips of adhesive plaster and the whole covered neatly with a gauze roller bandage or, better, with a single piece of cotton cloth stretched smoothly over the padded splint and neatly stitched in place. A ham splint must have extra padding, 2 inches thick, under the knee. All the flat wooden splints should be padded to fit the limb; that is, the padding should be made thicker where needed to fit the hollows. It is better, when possible, to do the fitting on the sound side in order to avoid unnecessary handling of the fractured limb. In padding splints the body prominences, such as those at the wrist, elbow, ankle and heel, must be particularly looked after. Pressure on these points, even if continued only for a few hours, may result in sloughing of the skin. The splints must be cut away over these points or the padding adjusted to guard them. The heel is particularly susceptible where it rests on the bed, carrying part of the weight of the foot and leg. For protection of the heel the ring or "doughnut" pad must be used with every form of splint or plaster cast applied to this region. This pad is made of cotton wound with a narrow gauze bandage. It is exactly the size and shape of the common doughnut.

Fractures of the upper arm are treated by means of coaptation splints and with the arm bandaged to the side. A pad must be placed between the arm and side, and this is known as an axillary pad. It extends from the axilla to the elbow, and in some cases may be wedge-shaped. A strip of bandage passing over the opposite shoulder, or adhesive plaster, prevents it from slipping down. The axillary pad may be made of cotton, but is better made of folded towels. A folded towel is also the best pad for coaptation splints. When it is used the splints themselves are not padded, but a smooth towel is folded in four to eight thicknesses and wrapped smoothly about the limb. The coaptation splints, narrow pieces of thin wood one inch wide, are then laid over the towel and strapped in place.

5. Materials for Fastening Splints.—Straps of webbing, one inch wide, with a buckle sewed to one end, or strips of adhesive plaster one to two inches wide, and long enough to encircle the limb and splints one and a half times, are used for this purpose. A roller bandage of gauze or muslin is usually applied over the whole for additional security and protection. There is sometimes a little difficulty in passing the strip of sticky adhesive plaster under and about the limb without becoming twisted and kinked before it has been properly adjusted. This minor annoyance can be easily prevented by a very simple expedient. A piece is cut from a roller bandage twice the length of the adhesive strip, folded end-to-end and laid on the adhesive side of the strip. The whole is next passed under and about the limb and adjusted to the proper position. The bandage is then removed by pulling on the free end. The end of the adhesive strip should be folded on itself for a quarter of an inch to facilitate removal.

6. Apparatus for Extension.—This is used almost exclusively in cases of fracture of the thigh. It is commonly called Buck's extension. A strip of adhesive plaster is applied to each side of the leg, extending from the middle of the thigh to the ankle, these strips being held in place by means of other strips of adhesive passed spirally about the leg and a roller bandage. The lower ends of the strips are attached to a weight by means of a cord passing over a grooved pulley at the foot of the bed. A wooden cross-piece or " spreader " is placed an inch or two below the sole of the foot to prevent the straps from pressing on the ankle bones. The foot of the bed is elevated about six inches to counteract the tendency of the patient to slide down. The extension straps with the spreader require some little time to prepare and should therefore be kept in stock ready for use. To make a set of suitable size for an adult two strips of adhesive plaster two inches wide and twenty-six inches long are cut, the gauze facing on the adhesive side being, of course, left in place until the strips are used. One end of each strip is folded to pass through the shank of a one-inch buckle to which it is securely sewed. A strap of webbing one inch wide and fourteen inches long is next provided. The spreader is fastened to the middle of this strap. A simple and convenient way for making the spreader consists in cutting two pieces of splint wood, 1½ by 3½ inches in dimensions, the middle of the strap being placed between these and fastened by winding them with adhesive plaster. At the exact centre of the spreader (that is, where lines joining the opposite corners cross) a ¼-inch hole is bored. One end of a four-foot piece of window cord is passed through this hole and knotted. The pulley wheel will be attached to an iron rod which is provided with a clamp to fix it to the foot of the bed frame and allow it to be adjusted to any desired position. Weights up to twenty pounds should be available (Figs. 69–70).

The ward should be provided with the means of setting up an overhead frame which will be needed in a number of conditions where overhead suspension of a limb is desirable. The frame consists of an upright piece $5\frac{1}{2}$ feet long securely fixed at the head of the bed and another, somewhat shorter, at the foot, the tops being joined by a third piece securely fastened to them.

Fig. 69.—Buck's extension. (Eliason's Practical Bandaging.)

The frame may be of wood or iron and must be sufficiently rigid to support any ordinary weight. The Bradford frame will be needed as an aid in the treatment of fractures occurring in young children, as well as in orthopædic cases. It consists of an oblong,

Fig. 70.—Dressing for fracture of the shaft of the femur.

stretcher-like frame a little longer and wider than the child's body. It is made of gas pipe and covered with canvas.

7. Temporary Fixation of Fractures.—It is often desirable for a number of reasons to postpone for from one to several days the attempts at reduction and the permanent dressing of a fracture. There is often excessive swelling of the soft parts about a fracture, lasting for some days. An anæsthetic must frequently be administered when reduction is attempted, and for this it is desirable that the usual preparation should be given. Time is needed for the taking and proper study of X-ray pictures. Since the patient's interests are not jeopardized, nor the final union postponed by a reasonable amount of delay, it is entirely proper to wait for a suitable and convenient time, provided that in the meantime the limb is kept at rest by some suitable means. A full description of these temporary appliances will be given in the chapter on emergencies.

8. Permanent Fixation of Fractures.—The materials that are to be assembled by the nurse for the permanent dressing of the principal varieties of fractures are here briefly summarized. Warm water, soap, alcohol and talcum powder will be needed for the preliminary cleansing in all cases. When a plaster-of-Paris cast is the means selected a rubber sheet to protect the bed or table on which the patient is lying will be needed. An apron and a pair of rubber gloves should be provided for the surgeon, or, if he prefers to use his bare hands, some hand lotion, containing glycerine or dilute acid (vinegar), for removing the plaster from his hands. A number of rolls of hospital or sheet wadding, a ring pad for the heel, when the foot is to be included; some thick harness maker's felt; gauze bandages (2-, 3- and 4- inch sizes); an abundance of plaster bandages of at least two sizes; some common salt; and a basin of water deep enough to allow the largest plaster bandage to be immersed when standing in the upright position will be required. When the fracture is to be immobilized by means of splints the surgeon will indicate the particular forms he desires to employ. Abundant material for padding, adhesive strapping, gauze and muslin bandages should be at hand. For putting up a fractured thigh in Buck's extension the following articles should be assembled: the ready prepared extension set, consisting of adhesive straps with buckles, webbing strap and spreader; four feet of window cord; the pulley wheel, with its attachments; from eight to twenty pounds of weights, according to the age or size of the patient; blocks or bricks to elevate the foot of the bed; Volkmann's sliding rest; axillary long side T-splint; coaptation splints for the thigh; six webbing straps with buckles sewed to one end long enough to extend once and a half about the thigh; adhesive plaster; a sheet (for the long splint), towels and cotton wadding for padding; a ring pad for the heel; several yards of muslin or Shaker flannel to make swathes to hold the long splint to the body and thigh; and plenty of safety pins. If the Volkmann rest is not used a properly padded ham splint, a rubber sheet to lay over the bed under the splint, and four sand bags, 20 inches long by four inches wide, must be provided. For a fractured clavicle in an adult, three strips of adhesive plaster, four inches wide and long enough to extend once and a half about the body; three towels; rolls of sheet cotton wadding; four inch gauze bandage; three-inch muslin bandages; and four-inch crinoline bandages will be needed.

For fractured ribs, a four- to six-inch muslin roller or four strips of adhesive plaster, four inches wide, and equal in length to three-fourths of the circumference of the chest, should be provided.

9. Observation After Dressing of Fractures.—All fracture cases must be closely watched for at least the first twelve hours after a fixation dressing is applied. Continued pain at the seat of fracture or over a bony prominence calls for serious attention from the surgeon. Blueness and coldness of the extremities below the bandage (fingers and toes), with or without swelling, calls for instant relief of pressure, even to the extent of cutting through the whole bandage down to the skin.

CHAPTER X

REMEDIAL MEASURES

I. MEASURES REQUIRING SIMPLE CLEANLINESS

In the preparatory, post-operative and routine treatment of gynæcological patients, there are a number of measures for the relief, cure or comfort of the patient that do not require the strictest technic,—and it seems fitting that these should receive consideration in a separate group, so that, by no chance, could they be extended to include those of a stricter order.

1. The enema has already been referred to upon several occasions in its connection with preparatory and after-treatment. While the average enema does not require adherence to the most careful technic in its administration, it must be realized that this leeway does not admit of careless or unclean methods. The enema can, tube and tip should be cleansed by mechanical methods after each use. The tip should be sterilized as well as mechanically cleansed before putting away. This is particularly true in hospital work, where a large series of patients must necessarily include some from whom dangerous infections might be transferred to innocent persons if these precautions were not taken. In performing the manipulations necessary for the administration of an enema, it should not be forgotten that there is as much a right and wrong way of doing this as of any other treatment. There seems to exist in some minds the impression that giving an enema means taking a can with the usual accessories; filling with the prescribed solution; inserting the tip; lifting the can to the extreme limit of the tube or of the nurse's arm; removing the tip; and going off and leaving the patient upon a bed-pan until it is convenient to remove the same. Strange as it may seem, there are several fallacies in these conclusions. There are a number of elements that enter into the use and administration of enemata that should be considered before the subject is referred to the limbo as one of no difficulty and little importance. In the first place, there are at least three positions in which enemata may be administered, according to the result desired and the preference of the attendant: the dorsal, the left lateral and the knee-chest. No matter what the position, the general details followed in each case are very much the same. The enema formula is prepared in the can. The patient is placed in the desired position and the tip inserted with the aid of a little vaseline or other lubricant. The passage of the rectal or colon tube, while of apparent simplicity, may be done in such a way as to add much to the discomfort of the patient and the difficulty of the procedure. The general outline and direction of the anal and rectal canals (Fig. 71) should be borne in mind and the tip

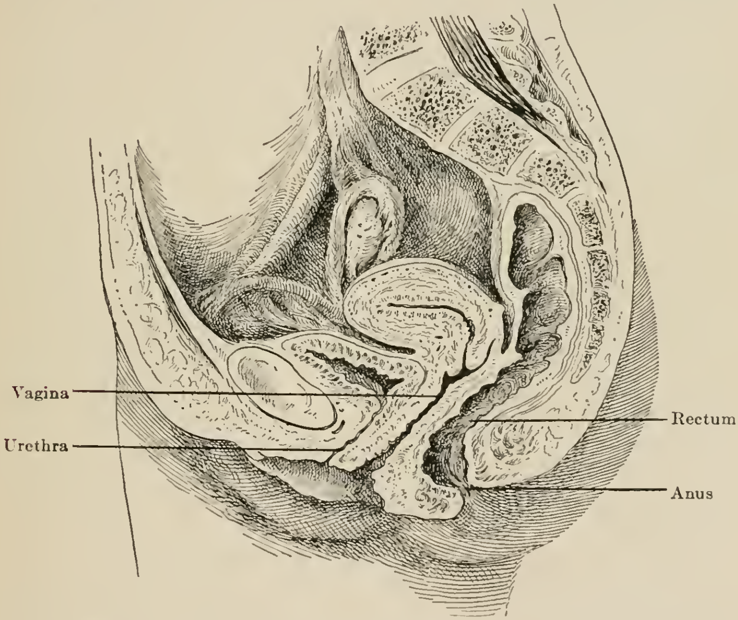


FIG. 71.—Median section of female pelvis. The difference in direction of anus and rectum should be noted.

directed thus along the line of least resistance, instead of forced in a straight line. This means that the tip must be inserted first in an anterior direction until it has passed the sphincter and is in the rectum. The direction is then changed, the tip being pointed backward and passed in such a manner as to somewhat follow the curves of the sacrum. The passing of the colon tube beyond this point frequently requires considerable patience and ingenuity of manipulation. The sigmoid leaving the rectum at an angle towards the left, the tube, being long and soft, must be permitted to follow the course of the bowel. Kinking and doubling of the tube in the rectum will generally cause complaint of pain by the patient and, should this not be the case, is sure to interfere with the flow of the solution. The colon tube is best introduced with the patient in the left lateral position. The enema generally does not exceed one quart in quantity,—and frequently falls short of that amount. The fluid should not be run into the rectum with speed and the highest possible hydrostatic pressure, but should be allowed to run in slowly with the can elevated only from 12 to 18 inches above the patient. Furthermore, when there is any possibility of intestinal obstruction existing, which means after every abdominal section, the patient should not be left until the enema is expelled,—as it is very important that the passage of gas be noted should it occur. As this may happen even when the enema returns clear, its importance should be manifest to every one.

Enemata are divided into several classes, according to the use for which they are intended: cleansing, stimulating, purgative and nutrient being the generally accepted descriptive names applied.

The cleansing enema partakes more of the character of a washing, or irrigation, of the lower bowel, consisting of hot water, salt solution or soapsuds. It is usually given in preparation for abdominal, perineal or rectal operation to clear the rectum of such food detritus as remains after the usual catharsis, or before nutrient enemata in order to clear the lower bowel for the reception and absorption of the food material introduced by this route.

The stimulating enema is generally composed of salt solution, together with general stimulants. One of the most common consists of one pint each of hot normal salt solution and strong, black coffee. Another consists of ammonium carbonate, brandy and salt solution.

The purgative enemata are given when a prompt and thorough evacuation of the bowels is sought and the simple enema proves inefficacious. A list of the ingredients utilized in the preparation of this particular class of enemata would very nearly resemble a transcription of the pharmacopœia, but a few of the more commonly employed are magnesium sulphate, glycerine, turpentine, alum and asafœtida. A small and usually very efficient enema is made up of one ounce of a saturated solution of magnesium sulphate, two ounces of glycerine and three ounces of water or soapsuds. This is commonly called a " one, two, three " enema. Another well-known routine purgative enema is composed of the same ingredients in larger quantities and named accordingly. This is the " two, four, eight " enema, consisting of two ounces of a saturated solution of magnesium sulphate, four ounces of glycerine and eight ounces of water or soapsuds. Turpentine may be added to either of these enemata, in varying quantities—as much as half an ounce being added to the larger.

Nutrient enemata are given when, for any reason, mouth feeding must be temporarily abandoned and the condition of the patient necessitates the continued ingestion of supporting food. On account of rapidly developing irritability of the larger bowel, this treatment is, at best, not feasible for extended periods. On account of the limited digestive capacity of the large bowel, the range of nutriment to be employed is necessarily curtailed. Nutrient enemata must, therefore, be, so far as possible, of the most readily assimilable and the most slightly irritating possible ingredients. The most common ingredients are milk (plain or peptonized), eggs, sugar (grape or cane), red wine and salt,—varying in proportion to make a maximum total quantity of eight or nine ounces. One of the simplest is the sugar and milk enema, consisting of:

Grape sugar	60 gm.
Peptonized milk	250 c.c.

A more complicated one is that of Boas, consisting of:

Milk	250 c.c.
Yolks of two eggs	
Pinch of salt	
Red wine	15 c.c.
Starch or flour	15 gm.

2. Rectal Irrigation.—There is very little to be said of rectal irrigation that has not already been referred to under the discussion of enemata. The preparation of rectal irrigation is the same as that for the enema, except for the substitution of a glass or enamel-ware funnel for the enema can. The funnel is then filled with the solution that is to be used and the solution run into the rectum by elevating the funnel to the necessary height. This proceeding is repeated several times, until the rectum has been somewhat distended by the solution, when the funnel is lowered and permitted to fill with the solution running back from the rectum. The contents from the funnel are then poured into a receptacle provided for the purpose and the process repeated, time and again, until the rectum has been emptied. This treatment is continued until the rectum has been cleansed, if that is the object of the irrigation, or until the application has been sufficient for the purpose in view, whatever it may be. In addition to the above apparatus and method, mention might be made of the double-channel rectal or colon tube, that permits of the return of the fluid by one channel as fast as it enters by the other.

3. Continuous Proctoclysis (Murphy Method for Rectal Salt Solution).—The application of the principles of this method of treatment is so varied with different physicians and in different hospitals that it would take a small book to go into the details of each different apparatus and the method of using it. But the end to be attained is in each case the same, so that a general description of the principles involved appears proper in this place.

The object is the introduction into the rectum of a physiological salt solution at the temperature and rate at which it will be most rapidly absorbed. The method is of the greatest value, and it is extremely important for both nurses and internes to know how to give it properly. It is a frequent experience of surgeons when ordering this treatment to have it reported that the patient is unable to retain the saline solution, and this is due in the great majority of instances to faulty methods of administration. The requisites are (1) that the fluid should be warmed, (2) that it should flow drop by drop, about one-half pint entering the rectum each hour, (3) that there should be a free return so that when the rectum contracts the gas and fluid which are present may flow easily back through the tube and not be expelled. The form of apparatus first suggested by Dr. Wroth (Fig. 72) is the simplest and best and can be readily improvised anywhere. A glass or metal funnel is connected by about four feet of rubber tubing and a glass connection tube with a small or medium-sized catheter. The catheter is introduced into the rectum and fixed to the inner side of the thigh by a strip of adhesive plaster. The funnel is suspended by the side of the bed at a height of about 6 to 14 inches above the level of the buttocks. The irrigator containing the saline solution is suspended above the funnel and is furnished with a short rubber tube terminating in a stop-cock so adjusted that the fluid can be allowed to flow drop by drop into the funnel. The fluid is warmed just before it enters the rectum by placing a coil of the tube which joins the funnel and the catheter between two hot-water bags lying on a table beside

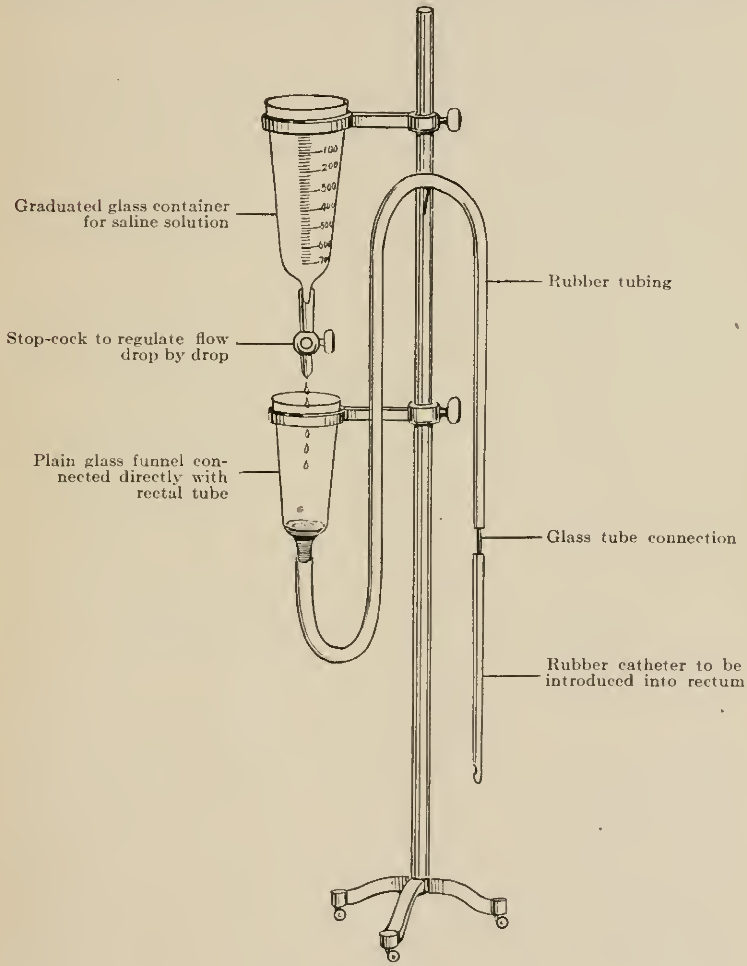


FIG. 72.—Apparatus for proctoclysis.

the bed. About 60 to 80 drops per minute is the proper rate of flow. It is sometimes difficult to regulate the flow exactly. To facilitate this a shallow notch should be filed at the edge of the opening through which the water flows in that part of the stop-cock which is turned by the finger and thumb (Fig. 73). In an improvised outfit the tube from the irrigator may be compressed by means of two flat sticks and rubber bands, the sticks being wedged apart to regulate the flow.

4. Active and Passive Congestion.—Several methods designed to influence the flow of blood to a part are frequently resorted to in the treatment of surgical cases. These include the use of moist and dry heat, constriction of arms or legs by rubber bands to induce passive congestion by obstructing the return flow of blood through the veins, and the use of cups of various

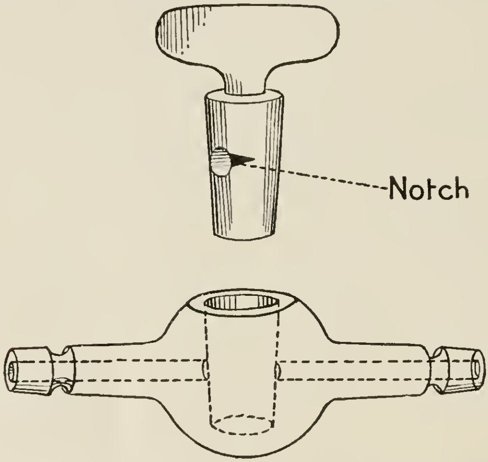


Fig. 73.—Showing notch filed in stop-cock to facilitate regulation of rate of dropping.

forms in connection with a small suction pump by means of which passive congestion may be induced in parts of the body surface where constriction is not available. The application of heat in either moist or dry form causes what is known as active congestion; that is, it induces a dilatation of the small arteries and produces an increased flow of blood to the part. Moist heat is applied by means of hot fomentations. Dry heat is applied by means of hot air. The arm or leg, for example, is wrapped in blankets and placed in a double-walled chamber or oven (supported so that the limb does not come in contact with the walls of the chamber) in which the air is heated by means of a gas jet up to 250° or 300° F. Passive congestion, on the other hand, consists not in increasing the flow of blood to the part, but in allowing blood to accumulate in the part by partly obstructing the return flow, and the methods of doing this by means of constricting bands and cups are known as Bier's hyperæmic treatment, employed in acute and chronic (tuberculous) infection. The apparatus for constricting a limb consists of an Esmarch bandage or rubber tube tourniquet applied over a smooth folded towel wrapped about the limb. The treatment is intermittent, the constriction being maintained for from one to several hours, the bandage being then removed for a time and later reapplied. As the nurse may at times be entrusted with its application and must in any case observe the condition of the limb during the period of constriction, it is important for her to bear in mind the following points. The band should be applied over healthy tissue well above the seat of the disease; it should moderately constrict the veins of the part, so as to diminish but not stop the return flow and without affecting the volume of the pulse; the skin below the constriction should be of a slightly bluish-red color and warmer to the touch than normal; there should be no pain. If there is much swelling, and the skin is blue and cold, or if there is pain, then the constriction is too tight and must be loosened or removed for a time. It is better to change the location of the constriction at each application. A great variety of cups are manufactured for the production of local hyperæmia at different areas of the body surface, for the treatment particularly of local infections, such as furuncles, carbuncles, abscesses, etc. At least two or three sizes of some of the simpler forms of this apparatus should be available; for the application of this method the proper cup attached with rubber tubing to a rubber bulb or small hand pump to produce suction, and some sterile vaseline to make the edge of the cup air-tight, will be needed. In this case the hyperæmia is continued for short intervals only (five minutes) at a time, with five to ten reapplications at each treatment. If there is a wound the cup must be sterilized before and after use.

5. Continuous Irrigation.—Long, deep basins of special form are made for the purpose of immersing the hand or foot in water or a weak antiseptic solution for the treatment of infections of severe type by means of the continuous bath. Where special apparatus of this kind is not available an ordinary foot-tub may be pressed into service. The treatment may be applied to the whole body by means of the ordinary bath-tub or special tubs which are now made for this purpose. The water should be at a temperature of 105° to 110° F. In other cases continuous irrigation by the drop method may be used. A Kelly pad, draining into a basin, an irrigator with irrigating stand, and rubber tubing, and a pinch cock or other means to regulate the flow will be required.

6. The Fowler Position.—After certain abdominal operations, particularly suppurating appendix cases, it is at present the almost universal custom to place the patient in bed in the so-called Fowler position, that is, in a semi-sitting posture; and to do this some special apparatus must be provided. One of the best is known as the Gatch bed, an iron frame placed under the mattress and capable of lifting it at the patient's back and under his knees into the form of a reclining chair. An apparatus may be improvised by the use of a back rest, a bolster made from a pillow tightly rolled in a sheet placed under the buttocks, with the ends of the sheet tied to the bed frame to prevent the patient from slipping down in the bed, a rolled pillow as a brace for the feet, and supporting pillows under the knees.

7. Special Forms of Dressings.—" Wet dressings " are used in the treatment of accidental and infected wounds. The gauze is wrung out of an antiseptic solution. Usually 1–10000 bichloride or boracic acid solution is employed. The dressing may be covered with oiled silk to prevent evaporation.

The " hot pack " takes the place of the old-fashioned poultice. The dressings are wrung out of hot sterile water or salt solution and are changed frequently before the water has become cold. This is a very efficient way of treating acute suppurative processes.

Bismuth paste which is used for the injection of sinuses is a mixture of subnitrate of bismuth and vaseline. It is semisolid at ordinary temperatures, and must be liquefied when it is to be used, by warming over a water bath. A glass or metal syringe of suitable size, alcohol, small sterile pads of gauze and adhesive plaster will be required.

Unna's paste is used in the treatment of leg ulcers. The basis of the paste is gelatine mixed with oxide of zinc. It is solid at room temperature, but melts at a low heat. When in the liquid form it looks like white paint. A quart or more of the paste, melted over a water bath, a medium-sized paint brush, alcohol, sponges and a number of two-inch gauze bandages will be required.

In the dry treatment of burns no dressing whatever is applied over the burned surface, which is fully exposed to the air. Burns so treated heal more rapidly and with less scar formation than when wrapped in an occlusive dressing. The pain of frequent change of dressings, often very severe, is also avoided. For a burned arm or leg there will be needed: a pillow covered with rubber sheet and sterile towels and a cradle or wire frame over which is thrown a single layer of gauze which does not touch the burned surface but merely acts as a fly screen. Cleansing is done as needed with dry sponges.

II. ROUTINE MEASURES REQUIRING ASEPTIC TECHNIC

In addition to those measures executed by the nurse that have already been enumerated as of a kind requiring mechanical cleanliness alone, there are several that demand as strict an aseptic technic as any of the procedures of major surgery. These are generally, if not always, performed by the nurse, and she should constantly bear in mind her responsibility to patient and physician for the proper care and precautions in every such case.

1. Hypodermic Medication.—We have already made some passing reference to the generally accepted inexcusability of abscess following hypodermic medication. While admitting without hesitation that such abscesses will occur when, apparently, every possible precaution has been taken, yet the fact remains that suspicion of the care and technic of the administrator invariably follows the appearance of this unfortunate complication. The technic of administration, while exacting, is of the simplest,—whence, possibly, the carelessness that makes the occasional infection a possibility. The steps are four: (*a*) preparation of the syringe; (*b*) preparation of the solution; (*c*) preparation of the patient; and (*d*) administration of the injection of the medicament. The division of such a simple performance into parts may seem like the making of a mountain out of a mole-hill, but it remains true in nursing as it has of all admirable branches of the world's work that what is worth doing is worth doing well.

(*a*) The best type of syringe for general use is the all-glass instrument that will permit of the instrument being repeatedly sterilized by boiling and permit the contents to be seen. It is best to boil the entire instrument before using, but, if this be not feasible, the needle should be boiled, a wire being kept run through the lumen to prevent clogging by rust.

(*b*) A small amount of water is then sterilized by boiling over a flame in a teaspoon or other convenient receptacle. The syringe is then drawn full of the sterile water and the remainder thrown away. The contents of the syringe are then once more discharged into the spoon and a hypodermic tablet containing the prescribed dosage of the medicament is dissolved in the water and the solution drawn into the syringe.

(*c*) The patient's arm is then scrubbed with a sterile gauze sponge and 95 per cent. alcohol, over the area of injection, a point on the upper arm in the region of the humeral insertion of the deltoid muscle being the usual point of election.

(*d*) A small bit of skin is then pinched up between the thumb and index finger of the left hand and the hypodermic needle quickly inserted. The needle is withdrawn about ⅛ of an inch and the solution slowly injected. The needle is then slowly withdrawn, the point of injection being covered and then lightly rubbed with the alcohol-saturated sponge.

2. Catheterization of Patient.—The importance and responsibility of this procedure have already been touched upon in our remarks upon post-operative treatment. We shall, therefore, confine ourselves, at this time, chiefly to a discussion of the ideal technic and the variations thereof that are commonly resorted to for the purpose of lessening the time and tedium where numerous catheterizations are necessary.

The outfit for catheterization should consist of: (*a*) a sterile glass or rubber catheter; (*b*) sterile sponges; (*c*) a basin of sterile water; (*d*) a basin of 1–1000 bichloride solution; (*e*) a receptacle for the urine; and (*f*) a pair of rubber gloves or four finger cots for the nurse. All materials should be perfectly sterile. A small jar of sterile glycerine, or other lubricant, is sometimes added to the above outfit. The preparation of the patient consists in the careful cleansing of the vulva and the area around the urinary meatus, first with sterile water and then with bichloride solution. The preparation of the nurse consists in careful scrubbing of the hands, as for operative work, and the additional use of sterile rubber gloves or of sterile rubber finger cots upon the thumb and index finger of each hand. After the careful preparation of patient and nurse, the labia are well separated with the thumb and forefinger of the left hand and the catheter introduced with the corresponding fingers of the other hand. After the withdrawal of the catheter, the parts should again be sponged off with bichloride.

The variations that are resorted to for the purposes of rendering this proceeding less exacting are generally with respect to the preparation of the nurse, the preparation of the patient remaining the same. In such cases, the scrub is sometimes omitted,—confidence being placed in the protective power of the gloves. In others, finger cots are used, without the scrub. In others, pieces of sterile or bichloride soaked gauze are substituted for either gloves or cots, and the scrub is, of course, again omitted. Yet another evasion of the most careful technic is the use of a sterilized forceps to grasp and insert the catheter, this instrument taking the place of both scrub and gloves. These methods are mentioned because they are frequently observed in hospitals where the authorities would feel insulted if any question were raised regarding the perfection of their aseptic technic, and with the view of condemning, not condoning. It is true that our methods are more or less dependent upon our supplies and surroundings, but the duty is ours to see that our methods are either the best that we know or the best that we can attain under existing conditions. Unless we attain this requirement of every conscientious physician or nurse, we must consider ourselves directly responsible for any unsavory results of our work.

3. Bladder Irrigation.—Bladder irrigation, by the nurse, is for the purpose of removing infectious and cast-off material from the bladder and for applying remedial agents to its lining membrane. The apparatus for its proper performance consists of a sterile glass funnel with tube attached; a rubber catheter and glass joint for connecting it with the tube and funnel; a receptacle for receiving the return flow from the irrigation, and a pitcher of the chosen solution. The solution used may be of any one of a number, ranging from sterile water, through physiological salt solution and boracic acid solution, up to the stronger antiseptics,—as potassium permanganate, silver nitrate and protargol. The solution should be warm, but not hot,—a temperature of between 100° and 105° F. being about the best. The technic of irrigation starts with the preparation of the patient, the nurse and the apparatus. The entire vulva should be carefully cleansed,—first with soap and water, and then with a solution of bichloride of mercury. The nurse's hands should be scrubbed and then immersed in a solution of bichloride. The funnel, tube, joint and catheter, as well as the pitcher containing the solution, should be sterilized by boiling and the solution prepared from sterile water. The catheter is then inserted and such urine as may be in the bladder drawn off. The joint between the tube and catheter is now connected, care being taken to see that the tube is filled with solution so as to prevent the introduction of air into the bladder. The funnel is filled with solution (being held at or below level of bladder) and the solution run into the bladder by raising the funnel to a height of several inches or a foot above the bladder. This process is repeated several times, until the patient complains of a sensation of fulness, when the process is reversed,—the funnel being lowered until it is filled by the return flow, which is emptied into the provided receptacle, and the process repeated until there is but one funnel-ful left in the bladder. The object of leaving some of the solution in the bladder is to prevent the already inflamed and tender bladder walls from collapsing and coming in contact with the catheter. This precaution requires the nurse to keep accurate count of the amount of solution that has been introduced,—an easy matter if the number of times that the funnel is filled be remembered. This filling and emptying of the bladder is repeated a number of times,—the number depending upon the condition present and the result desired.

4. Vaginal Douche.—The vaginal treatments with which the nurse is most immediately concerned are the various solutions used for medicated douches. The effects of vaginal douches are remedial in three ways: by the action of heat and cold; by their mere mechanical cleansing effect; and by the application of curative solutions to the parts. Two or more of these objects may be combined by the giving of a warm douche of some antiseptic solution for the multiple purpose of obtaining the combined benefits of heat, cleansing and antisepsis.

Technic.—The necessary articles are a glass or enamel douche can or rubber douche bag, a rubber tube and a glass vaginal douche nozzle for the administration of the douche. In addition, there should be the douche pan for the patient and the solutions and sponges for cleansing the external genitalia. The can, tube and tip should be sterilized by boiling. The solution should be prepared from sterile water. The preparation of the external genitalia should be as that for catheterization. And the preparation of the nurse should be the same as for any other aseptic procedure. It is true that, in some cases, the strictest technic may seem somewhat out of place, but the habitual slighting of the proper technic in some of the less important cases will invariably lead up to a corresponding carelessness in the occasional case where the error will involve vital responsibility. The douche tip having been introduced under aseptic precautions, the can is raised until there is a free flow without excessive speed or force. The object of the douche is never to run a stream of solution as rapidly and forcefully as possible over the mucous surface of the vagina, but to bathe with a cleansing or curative application—and this fact should never be lost sight of in the demands of hospital work upon the time and efforts.

5. Changing of Perineal Dressings After Vaginal or Perineal Operation.—The duty of keeping the perineal dressings fresh after a minor operation is generally, and indeed necessarily, left to the nurse. As it is necessary for the nurse to remove these dressings every time that the patient desires to urinate or to have an evacuation of the bowels, and to carefully cleanse the parts with an antiseptic solution before reapplying the dressings, it is only natural that the entire responsibility of caring for these dressings should be assigned to her. She should see, as above indicated, that the parts are carefully cleansed after passage of urinary or fecal matter. She should also see that the dressings are maintained in a fresh condition at all times and that they be not permitted to become so disarranged that the operative wound is exposed to infection or the patient's bedclothing to soiling with the discharges. The dressings are usually of the simplest character, consisting of specially constructed vulvar pads, sterile gauze fluffs, or any of the other usual forms of sterile dressings, kept in position by a T-binder.

III. ASEPTIC WARD MEASURES, IN WHICH THE NURSE PREPARES AND ASSISTS

In taking up this branch of gynæcological nursing, we shall endeavor to give the nurse an idea of just what will be required of her in the preparation for some of the more usual and important of the ward measures in which she participates as the assistant of the attending or resident physician. It is, of course, impossible to say in positive terms that there are certain things and none other that will be expected of her, as the custom must vary in different institutions and under different surgeons. The endeavor, therefore, will be to give a general outline that will enable the nurse to see what will be expected of her in the ordinary course of events and the instruments that are always necessary and generally sufficient for the end in view.

1. The Dressing Room.—A separate room for the dressing of wounds is a desirable but not essential adjunct to the ward. There may be a separate room for each ward, or one well-equipped room or suite of rooms may serve for several or even for all of the wards of the hospital. In the latter case a number of nurses will be assigned to special duty in the dressing room during certain hours of the day, usually in the morning. The dressing rooms should not be connected with the operating suite, since many of the cases to be dressed are suppurating and the presence of pus where aseptic operations are being done is to be avoided as far as possible. Clean cases are better dressed apart from septic ones, although with proper precautions the danger of a wound's becoming infected at a dressing is small.

The equipment of the dressing room will be much like that of the operating room, but on a smaller scale. The fixtures will include basins with running water for hand scrubbing, apparatus for hot and cold sterile water and an instrument sterilizer. Sterile towels, gauze dressing materials and sponges in sterile packages will be supplied for the use of the wards from the operating room. The furniture, all of enamelled iron and glass, will include an operating table of simple pattern, one or two tables, a cabinet with shelves and drawers, two or three stools and chairs, an irrigating stand, a number of basins and trays of different sizes, and wheel stretchers for conveying patients. A folding screen like those used in the wards will be needed in some cases. The instrumental outfit required is very simple, but a sufficient number of each kind of instrument should be provided so that there may be no delay where several dressings are being done at the same time. Bandage scissors and at times a plaster knife or plaster shears will be needed. The standard sterile dressing set of instruments consists of two dressing forceps, one thumb forceps, one scissors, one probe. An additional pair of scissors of a special pattern (Littauer's) designed for removing sutures is convenient. For minor gynæcological cases a vaginal speculum, uterine dressing forceps, and a volsella should be added. The instrument cabinet may also contain space for all the instruments of the ward outfit which are described in other sections of this chapter. Rubber goods that may be required have already been enumerated. An abundant supply of sterile dressing materials in packages, bandages, binders, and adhesive plaster should be at hand. Standard solutions or tablets for making antiseptic solutions of any desired strength, alcohol, benzine, collodion, ether, hydrogen peroxide, balsam of Peru, bismuth paste, oxide of zinc ointment and such special formulæ of dusting powders, ointments and other local applications as the practice in the institution calls for should be provided.

2. The Dressing Cart.—There are always cases in the open wards that cannot be safely or conveniently moved to the dressing room, and private patients are usually dressed in their own rooms. For these cases some kind of a vehicle on wheels must be used to convey the instruments and materials required for a wound dressing to the bedside.

Many forms of ward dressing carriages or carts are supplied by the manufacturers. There is little choice between them. The carriage should be on large rubber-tired wheels and should have plenty of shelf room for the materials to be conveyed. An irrigating stand attached to the carriage is not a specially desirable addition. The carriage may be equipped either for a single dressing or for a number of dressings to be done in succession, and the arrangement of supplies will be somewhat different for these two purposes. Where several dressings are to be done one or two drums filled with dressing materials and sponges in sterile packages sufficient for all the cases will be provided, and enough dressing instruments to supply a fresh set for each individual case may be sterilized in bulk. An empty tray for soiled instruments, and basins or, better, paper bags for the soiled dressings will be needed, together with an abundant supply of bandages, adhesive straps and binders. A number of prepared wick drains, iodoform gauze in strips, and also uterine and vaginal gauze should be included in the equipment. Adhesive straps with tapes attached may be occasionally called for and several sets should be provided (Fig. 74). Where a single case is to be dressed only one set of instruments and dressings will be required. Certain stock supplies should be always on the carriage. These include protective (gutta-percha) tissue in strips, two by eight inches, immersed in bichloride solution in a wide-mouthed jar; benzine for loosening adhesive plaster; alcohol; tincture of iodine with alcohol (equal parts); a flask of sterile normal salt solution; peroxide of hydrogen; balsam of Peru; sterile vaseline; oxide of zinc ointment; boric acid ointment; pencils of fused silver nitrate (lunar caustic) and nitrate of silver in solution; scarlet red; talcum powder and special formulæ of dusting powders; and one or two basins containing bichloride (1 to 3000) or other antiseptic solution. The last item may perhaps be regarded as a survival of the antiseptic era. In some of the best clinics all wounds are now dressed with dry sponges without the use of any antiseptic solutions whatever. Sponging the neighborhood of the wound with alcohol adds to the patient's comfort, and may be done for that reason. Hand disinfection and rubber gloves are unnecessary in the routine dressing of even clean wounds, the surgeon handling everything with sterile instruments. When, for any reason, it is desirable to touch the wound with the hands, rubber gloves will be worn whether the wound is clean or suppurating, in the

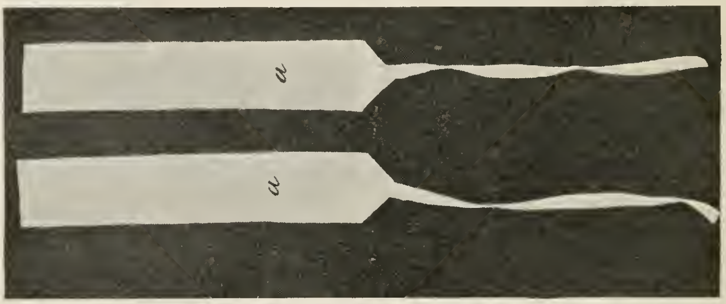


Fig. 74.—Taped adhesive strips.

former case to avoid wound infection and in the latter to protect the surgeon's hands from contamination with septic material.

The various kinds of surgical cases that require more or less frequent change of dressings may be classified as follows: (1) Clean operative wounds in which the dressing put on at the time of the operation is allowed to remain undisturbed for from four days to two weeks, usually about ten days. In these only one or two redressings are usually necessary. (2) Accidental wounds which heal aseptically like operative wounds. (3) Suppurating wounds: these may be operative wounds, intended to be clean, which have become infected almost always through some failure in carrying out the aseptic technic, or they may be cases in which the operation was originally done for a septic condition, such, for example, as a gangrenous appendix or an empyema, or they may be accidental wounds, infected either at the time of the accident or through careless handling later. In these drains will have been inserted and fresh drains may be required from time to time. (4) Suppurating sinuses resulting from infected operative or accidental wounds or from septic diseases in cases that have not been operated on. In some of these suppurating wounds and lesions the discharge of pus may be very great, necessitating daily dressings. (5) Fistulous openings communicating with the intestines or bladder: these are sometimes accidental and sometimes deliberately made by the surgeon. The fæces or the urine, as the case may be, will be constantly discharged through the wound and the dressings will have to be changed very frequently, sometimes several times in the day. (6) Ulcers, such as varicose ulcers of the leg, bed-sores, etc. (7) Burns and scalds, which may be superficial or deep, and always in the more severe cases require frequent attention.

3. Dressing of Abdominal Wound.—As the first step in the dressing of an abdominal wound is the removal of the old dressing, and as the old dressing is generally held in place by adhesive straps, the first necessity is something for the removal of the adhesive plaster. Therefore, the first accompaniment of the dressing tray (or carriage) is a small bottle of benzine. This should be accompanied by sponges for its application. The next article is a pus basin, or other receptacle, for the old dressings and the sponges to be used in the present dressing. Next in order come the sterile instruments for the proper performance of the dressing and the removal of stitches. These are: a basin with bichloride solution; sterile sponges; two dressing forceps; one thumb forceps; one scissors. This list completes the instruments necessary for the ordinary dressings, but these are usually supplemented by the addition of a probe. As a large part of the importance of the dressing should be the welfare and comfort of the patient, the next step should consist in carefully going over the entire area that has been covered by the old dressing, with alcohol. A bottle of this medicament should, therefore, be found on every dressing carriage. Finally should come the sterile dressings and the adhesive plaster for fastening them in place. If an abdominal binder is used, a fresh one should be at hand for use at the completion of the dressing. As supplements, in the occasional case where slight infection or granulation is found at the first dressing, it is well to add a small bottle of balsam of Peru and a stick of silver nitrate to each dressing tray.

4. Hypodermoclysis.—For the subcutaneous injection of physiological salt solution, the materials required are those for cleansing the field of injection, for performing the operation and for dressing the wound. The hypodermoclysis tray should, therefore, contain alcohol, bichloride solution and sterile sponges for cleansing the skin; sterile apparatus consisting of can, tube, needles and thermometer; hot and cold sterile physiological salt solution, so that it may be prepared at a temperature of about 115° F. at the time of injection; and a small sterile gauze dressing with adhesive plaster for fastening it in place over the needle wound. It is desirable, although not necessary, that the salt solution container be graduated in ounces or cubic centimetres so that the exact amount of the solution used may be recorded.

5. Intravenous Infusion of Physiological Salt Solution.—The tray should contain the same articles as for hypodermoclysis, with certain differences and additions. All articles are the same with the exception of the needles, a special blunt-pointed needle being used for intravenous infusion. In addition to these articles, there should be a sterile hypodermic syringe and needle and cocaine solution for local anæsthesia. There should also be included a dissecting set consisting of knife, dissecting forceps, scissors, two sterile hæmostatic forceps, some sterile No. 2 catgut and two small cutting needles—or fine silk and straight round needles for skin suture.

6. Uterine or Vaginal Packing.—The first step in packing either the vagina or the uterus consists in properly cleansing the vulva. For this purpose bichloride solution and sponges are needed. As it may be desirable to give a hot douche, either for cleansing purposes or as a preliminary to the packing, a sterile douche outfit should be at hand. The packing outfit proper should contain: one bivalve vaginal speculum; one volsellum forceps; one uterine dressing forceps; one scissors; and sterile packing gauze, five to ten yards. In case the vagina alone is packed, the volsellum will not be necessary. In addition to the articles already enumerated, one pair of sterile rubber gloves should be prepared for the physician, in case he wants to use them.

CHAPTER XI

FRACTIONAL DOSES IN HYPODERMIC MEDICATION

The problem of hypodermic medication seems, at times, to present a serious stumbling block to the nurse who, while perfectly familiar with the technic of administration, is unused to dealing with those irregular doses that are not supplied in stock tablets, or, if so supplied, are not at hand. But the same person would probably feel affronted if asked if she had studied arithmetic through common fractions. Yet it is there that the solution lies, and the method of partition is such an essentially simple one that there is no shadow of an excuse for the splitting of hypodermic tablets with a pin, a pen-knife, or a thumb nail. And, ridiculous as it may seem, no one of these latter procedures is uncommon.

What, then, is the accurate and scientific method of obtaining the proper fractional dose of a stock tablet? We must follow it back to the process of obtaining the lowest common denominator of two simple common fractions and then apply this knowledge to the division of a known quantity of solution.

For example, suppose that we have a tablet containing $\frac{1}{12}$ of a grain of heroin hydrochloride and that a dose containing $\frac{1}{16}$ of a grain is ordered. The fractions here are $\frac{1}{12}$ and $\frac{1}{16}$. The lowest common denominator of the fractions is the least common multiple of their denominators. What is it in this case? The least common multiple of 12 and 16 is 48. Therefore, the lowest common denominator of $\frac{1}{12}$ and $\frac{1}{16}$ is 48. Reducing, now, to fractions of a common denominator, $\frac{1}{12}$ equals $\frac{4}{48}$ and $\frac{1}{16}$ equals $\frac{3}{48}$. Therefore, $\frac{1}{16}$ is $\frac{3}{4}$ of $\frac{1}{12}$. The further application is quite as simple as what has gone before. The average hypodermic syringe has a capacity of 25 minims. The tablet containing $\frac{1}{12}$ of a grain is dissolved in this amount of sterile water and drawn into the syringe. We now have a 25-minim solution containing $\frac{1}{12}$ of a grain of heroin hydrochloride. But, the dose ordered being only $\frac{3}{4}$ of this amount or $\frac{1}{16}$ of a grain, $\frac{1}{4}$ of 25 minims or $6\frac{1}{4}$ minims is expelled from the syringe and the remaining $\frac{3}{4}$ or $18\frac{3}{4}$ minims injected hypodermically. It is immediately clear that the division of one minim into quarters and the expulsion of one-quarter is not feasible. We have, therefore, evidently chosen an inconvenient quantity for making the solution. How, then, is this to be avoided? We will take a number of minims which is an exact multiple of the denominator of the fraction representing the part of the total solution that is to be given. In this case the fraction is three-fourths. The denominator is 4. The highest number of minims in a total capacity of 25 that is exactly divisible by 4 is 24. We, therefore, use 24 minims. The result is now simplified. One-fourth of 24 is 6. We, therefore, eject 6 minims of the solution from the syringe and give the remaining 18.

This is the general application of the method, the only variation being in the total quantity of water used in the making up of the solution. If, for instance, a dose of $\frac{1}{6}$ of a grain of morphine sulphate is ordered and the stock tablet at hand contains $\frac{1}{4}$ of a grain, by the same process of lowest common multiples we find $\frac{2}{3}$ of the stock tablet is to be given. We again use but 24 minims in making the solution and expel 8 minims, this being for convenience, as there would be some difficulty in expelling an exact $\frac{1}{3}$ of 25 minims.

In the following table an effort has been made to give a list of the more common stock tablets, together with the fractional doses that may be ordered. The arrangement in such a table gives immediately the fraction of the stock tablet that must be taken to give the desired dose. This leaves only the amount of water in which it must be dissolved for determination by the nurse and may, consequently, be some saving in time and effort, particularly for the more difficult and unusual doses.

In arranging the table, the vertical column of quantities represents the size of the stock tablet and the horizontal row of quantities the size of the dose ordered. To use the table in any given case, it is only necessary to select that quantity in the vertical column that corresponds with the size of the stock tablet at hand and follow it across the table in a horizontal line until the division corresponding to the size of the dose ordered is reached. The fraction found in this place will represent the part of the stock tablet to be used. If the dose ordered is larger than the stock tablet, the space will indicate the number of stock tablets to be used in making the solution and the fraction of this quantity that is to be used.

	gr. $\frac{1}{4}$	gr. $\frac{1}{6}$	gr. $\frac{1}{8}$	gr. $\frac{1}{12}$	gr. $\frac{1}{16}$	gr. $\frac{1}{24}$	gr. $\frac{1}{30}$	gr. $\frac{1}{40}$	gr. $\frac{1}{60}$	gr. $\frac{1}{100}$	gr. $\frac{1}{150}$
gr. $\frac{1}{4}$	1	$\frac{2}{3}$	$\frac{1}{2}$	$\frac{1}{3}$	$\frac{1}{4}$	$\frac{1}{6}$	$\frac{2}{15}$	$\frac{1}{10}$	$\frac{1}{7}$	$\frac{1}{25}$	$\frac{2}{75}$
gr. $\frac{1}{6}$	$\frac{3}{4}$ of 2	1	$\frac{3}{4}$	$\frac{1}{2}$	$\frac{3}{8}$	$\frac{1}{4}$	$\frac{1}{5}$	$\frac{3}{20}$	$\frac{1}{10}$	$\frac{3}{50}$	$\frac{1}{25}$
gr. $\frac{1}{8}$	2	$\frac{2}{3}$ of 2	1	$\frac{2}{3}$	$\frac{1}{2}$	$\frac{1}{3}$	$\frac{4}{15}$	$\frac{1}{5}$	$\frac{2}{15}$	$\frac{2}{25}$	$\frac{4}{75}$
gr. $\frac{1}{12}$	3	2	$\frac{3}{4}$ of 2	1	$\frac{3}{4}$	$\frac{1}{2}$	$\frac{2}{5}$	$\frac{3}{10}$	$\frac{1}{5}$	$\frac{3}{25}$	$\frac{2}{25}$
gr. $\frac{1}{16}$	4	$\frac{8}{9}$ of 3	2	$\frac{2}{3}$ of 2	1	$\frac{2}{3}$	$\frac{8}{15}$	$\frac{2}{5}$	$\frac{4}{15}$	$\frac{4}{25}$	$\frac{8}{75}$
gr. $\frac{1}{24}$		4	3	2	$\frac{3}{1}$ of 2	1	$\frac{4}{5}$	$\frac{3}{5}$	$\frac{2}{5}$	$\frac{6}{25}$	$\frac{4}{25}$
gr. $\frac{1}{30}$			$\frac{15}{16}$ of 4	$\frac{5}{6}$ of 3	$\frac{15}{16}$ of 2	$\frac{5}{8}$ of 2	1	$\frac{3}{4}$	$\frac{1}{2}$	$\frac{3}{10}$	$\frac{1}{5}$
gr. $\frac{1}{40}$				$\frac{5}{6}$ of 4	$\frac{5}{6}$ of 3	$\frac{5}{6}$ of 2	$\frac{2}{3}$ of 2	1	$\frac{2}{3}$	$\frac{2}{5}$	$\frac{4}{15}$
gr. $\frac{1}{60}$					$\frac{15}{16}$ of 4	$\frac{5}{6}$ of 3	2	$\frac{3}{4}$ of 2	1	$\frac{3}{5}$	$\frac{2}{5}$
gr. $\frac{1}{100}$							$\frac{5}{6}$ of 4	$\frac{5}{6}$ of 3	$\frac{5}{6}$ of 2	1	$\frac{2}{3}$
gr. $\frac{1}{150}$							5	$\frac{15}{16}$ of 4	$\frac{5}{6}$ of 3	$\frac{3}{4}$ of 2	1

In using the table, it is evident that another problem arises after the necessary fraction is obtained, in those doses that involve a very small proportion of the stock tablet to be used. Of course, these doses are quite unusual, being resorted to in those cases where an opiate is to be given to a child. It must be granted that, in the well-equipped hospital, it will seldom be necessary to resort to these fractional or multiple doses, but it is equally true that the simpler forms will not be unusual in private nursing, where the nurse has but one size of each tablet in her hypodermic case and this size may not correspond to the dose ordered. Applying the use of our table to the original problem of administering a dose of $\frac{1}{16}$ of a grain when the stock tablet contains $\frac{1}{12}$ of a grain, we find the process a very simple one. Taking the horizontal column representing the stock tablet of $\frac{1}{12}$ of a grain and proceeding across to the vertical column representing $\frac{1}{16}$ of a grain, we obtain the required fraction of $\frac{3}{4}$. The stock tablet is then dissolved in 24 minims of sterile water, 6 minims expelled and the remaining 18 minims injected. This, as we have said, is one of the simplest applications. But, taking one of the more unusual multiple doses, let us assume that the stock tablet contains $\frac{1}{30}$ of a grain and that the dose ordered is $\frac{1}{12}$ of a grain. Here, taking the $\frac{1}{30}$ of a grain horizontal column and carrying it across to the $\frac{1}{12}$ of a grain vertical column, we find the required dose to be $\frac{5}{6}$ of 3 tablets. As $\frac{5}{6}$ of 25 minims would be rather difficult to measure, we must first decide upon the quantity of sterile water to take into the syringe. We decide upon 24 minims because it is the largest quantity that can be contained in the syringe and of which $\frac{5}{6}$ can be easily obtained, $\frac{5}{6}$ equalling $\frac{20}{24}$. Three stock tablets are then dissolved in 24 minims of sterile water and drawn into the syringe. Four minims are expelled and the remaining 20 minims injected. This proceeding, while somewhat more complicated than the first, is still quite simple. The third example taken will be one of the most difficult forms, and, at the same time (fortunately), one of the most infrequent. We shall assume that a dose of $\frac{1}{150}$ of a grain of morphine sulphate has been ordered for a child and that the only available tablet contains $\frac{1}{4}$ of a grain. Reference to the table gives us the required fraction as $\frac{2}{75}$. It is immediately evident that it will be very difficult to accurately determine $\frac{2}{75}$ of 25 minims in such a way as to be of any practical value in administering a hypodermic injection, the resulting fraction being $\frac{2}{3}$ of a minim. What, then, are we to do? We must dissolve the tablet in a quantity of water that will enable us to easily obtain $\frac{2}{75}$ of its total volume and of which $\frac{2}{75}$ will make a quantity practicable for hypodermic injection. Here we are once more confronted with the problem of common multiples. We are to obtain the least common multiple of 25 and 75. This is 75. But the use of 75 minims would still leave our dose 2 minims, which is much too small for hypodermic administration. We must, therefore, so increase the size of the remaining dose that its administration is feasible. Eight minims could be readily administered. 8 is 4 times 2. Therefore, an original total quantity of 4 times 75 (or 300) would give us an ultimate dose of practical size. So we take 300 minims of water, which is ʒv, and dissolve in this quantity the $\frac{1}{4}$-grain tablet. $\frac{2}{75}$ of 300 equals 8. We, therefore, inject 8 minims of the total solution, thus giving the required dose of $\frac{1}{150}$ of a grain. A hypodermic injection of 8 minims is quite practicable, but the quantity might have been three or four minims, an impracticable dose. In such a case, the difficulty may be overcome in either of two ways:

(1) the small dose may be taken and increased by the addition of sufficient sterile water to make up a suitable quantity; or (2) the original quantity of water represented in minims by the size of the least common multiple may be doubled or tripled before the solution is made and the quantity of the final solution to be administered thus increased.

It will be noted that some twenty doses have been omitted at the lower left-hand corner of the table. This has been done with the idea of keeping the multiple doses, so far as possible, within practical limits. The omitted doses all deal with quantities of five tablets or more, some being more than twenty-five. As it can scarcely be conceived that any dose will be ordered that would require the dissolving of so many tablets or that such a number would be at hand should the dose be ordered, it has seemed as well to omit the doses of this kind from tabulation.

General Rules.—1. Reduce the fractions representing the size of the dose and the size of the stock tablet, at hand, to fractions with a common denominator. A new fraction, whose numerator is the numerator of the fraction representing the dose and whose denominator is the numerator of the fraction representing the tablet, gives the fraction of the stock tablet to be taken. The stock tablet is dissolved in the greatest number of minims of water containable in the syringe and evenly divisible by the denominator of the new fraction. This solution is drawn into the syringe and that part of it, equal to the new fraction, administered to the patient, the remainder being first ejected from the syringe.

2. Where the new fraction (obtained as above) is greater than one (as $3/2$), a number of stock tablets is taken, equal to the whole number next larger than the new fraction (in this case 2 tablets). A second fraction, obtained by multiplying the denominator of the new fraction by the number of tablets used, gives the part of the total solution to be used (here $3/4$).

3. Where the new fraction (obtained as in the general rule 1) is so small as to leave an amount impractical for administration, the amount used for making the solution must be increased as many times over the number of minims divisible by the denominator of the new fraction as the part of that sum represented by the new fraction must be increased to give a dose of practical size.

Example.—Suppose the new fraction to be $1/25$. This would make the dose to be administered only one minim, if a single syringeful (25 minims) were used in making the solution. Suppose that we decide upon 10 minims as the size of the minimum practical hypodermic dose. Then, according to the rule given above, instead of using one syringeful to make the solution, we use ten, and, instead of giving one drop of this solution, we give ten drops.

Stock Tablets.—As an indication of the forms in which some of the more common drugs used in surgery and gynæcology by the hypodermic method may be found, we shall enumerate the sizes of some of the more common stock tablets and the drugs occurring in doses of these sizes.

Morphine sulphate: gr. 1/4; gr. 1/6; gr. 1/8.
Heroin hydrochloride: gr. 1/12; gr. 1/16; gr. 1/24.
Strychnine sulphate: gr. 1/30; gr. 1/60.
Physostigmine (eserine) salicylate: gr. 1/10.
Nitroglycerin: gr. 1/100.
Atropine sulphate: gr. 1/100; gr. 1/150.

Examples.—1. To give a dose of 1/6 of a grain when the stock tablet is 1/4 of a grain.

$$\begin{array}{r|l} 2 & 6,\ 4 \\ \hline & 3,\ 2 \end{array} \qquad 2\times3\times2=12$$

Therefore, 12 is the least common multiple of 4 and 6, and the lowest common denominator of 1/6 and 1/4.

$$1/6=2/12 \qquad 1/4=3/12$$

Therefore, 1/6 of a grain is 2/3 of 1/4 of a grain.

The highest number of minims in 25 (the maximum contents of the syringe), equally divisible by 3 (the denominator of the new fraction, 2/3), is 24. We, therefore, dissolve the tablet containing 1/4 of a grain in 24 minims of sterile water and draw into the syringe. But, as only 2/3 of this quantity is to be administered, we first eject 1/3 (8 minims) and administer the remainder (16 minims).

2. To give a dose of 1/8 of a grain, when the stock tablet is 1/4 of a grain. We proceed, as before, to obtain the lowest common denominator of 1/8 and 1/4.

$$\begin{array}{r|l} 2 & 8,\ 4 \\ \hline 2 & 4,\ 2 \\ \hline & 2,\ 1 \end{array} \qquad 2\times2\times2\times1=8$$

$$1/8=1/8 \qquad 1/4=2/8$$

Therefore, 1/8 of a grain is 1/2 of 1/4 of a grain.

The highest number of minims in 25, exactly divisible by 2, is 24. We, therefore, dissolve the tablet containing 1/4 of a grain in 24 minims of water and draw this into the syringe. But, as only $\frac{1}{2}$ of this is to be administered, we first eject $\frac{1}{2}$ (12 minims) and administer the remainder (12 minims).

3. To give a dose of $\frac{1}{8}$ of a grain, when the stock tablet is $\frac{1}{6}$ of a grain. Finding the least common denominator of $\frac{1}{6}$ and $\frac{1}{8}$:

$$\begin{array}{r|l} 2 & 6,\ 8 \\ \hline & 3,\ 4 \end{array} \qquad 2 \times 3 \times 4 = 24$$

$$\tfrac{1}{6} = \tfrac{4}{24} \qquad \tfrac{1}{8} = \tfrac{3}{24}$$

Therefore, $\frac{1}{8}$ is $\frac{3}{4}$ of $\frac{1}{6}$.

The highest number of minims in 25, exactly divisible by 4, is 24. We, therefore, dissolve the tablet containing $\frac{1}{6}$ of a grain in 24 minims of sterile water. As only $\frac{3}{4}$ of this is to be administered, we eject $\frac{1}{4}$ (6 minims) from the syringe and administer the remaining $\frac{3}{4}$ (18 minims).

4. To give $\frac{1}{12}$ of a grain, when the stock tablet contains $\frac{1}{8}$ of a grain. Finding the least common denominator of $\frac{1}{12}$ and $\frac{1}{8}$:

$$\begin{array}{r|l} 2 & 12,\ 8 \\ \hline 2 & 6,\ 4 \\ \hline & 3,\ 2 \end{array} \qquad 2 \times 2 \times 3 \times 2 = 24$$

$$\tfrac{1}{12} = \tfrac{2}{24} \qquad \tfrac{1}{8} = \tfrac{3}{24}$$

Therefore, $\frac{1}{12}$ is $\frac{2}{3}$ of $\frac{1}{8}$.

Twenty-four minims being the largest sum exactly divisible by 24, we dissolve the tablet of $\frac{1}{8}$ of a grain in 24 minims, eject $\frac{1}{3}$ (8 minims) and give the remaining $\frac{2}{3}$ (16 minims).

To show the application of the general rules, we shall take example 1:

The least common denominator has been found to be 12 and the fractions transposed, $\frac{1}{6}$ equalling $\frac{2}{12}$ and $\frac{1}{4}$ equalling $\frac{3}{12}$. By rule 1, the new fraction is obtained by taking the numerator of the dose as a new numerator and the numerator of the tablet as a new denominator. The dose is $\frac{2}{12}$ and $\frac{3}{12}$ the tablet. Therefore, 2 is the numerator and 3 is the denominator, the new fraction being $\frac{2}{3}$. This is the new fraction of the tablet to be given. This tablet is dissolved in 24 minims of water. The solution is drawn into the syringe and that part of it equal to the new fraction administered.

5. To give a dose of $\frac{1}{6}$ of a grain when the stock tablet is $\frac{1}{8}$ of a grain. Finding the least common denominator of $\frac{1}{6}$ and $\frac{1}{8}$:

$$\begin{array}{r|l} 2 & 6,\ 8 \\ \hline & 3,\ 4 \end{array} \qquad 2 \times 3 \times 4 = 24$$

Reducing:

$$\tfrac{1}{6} = \tfrac{4}{24} \qquad \tfrac{1}{8} = \tfrac{3}{24}$$

Therefore, $\frac{1}{6}$ is $\frac{4}{3}$ of $\frac{1}{8}$.

Hence, as $\frac{4}{3}$ is greater than one tablet and less than two tablets, we must use two tablets in our solution. Two tablets of $\frac{1}{8}$ of a grain equals $\frac{2}{8}$ of a grain, or $\frac{6}{24}$ of a grain.

If $\frac{1}{6}=\frac{4}{24}$ and $\frac{2}{8}=\frac{6}{24}$, then $\frac{1}{6}$ is $\frac{4}{6}$ (or $\frac{2}{3}$) of $\frac{2}{8}$. We, then, dissolve the two tablets containing each $\frac{1}{8}$ of a grain in 24 minims of sterile water (the greatest part of 25 minims exactly divisible by 3) and, after ejecting $\frac{1}{3}$ or 8 minims, administer the remaining 16 minims.

Applying general rule 2 in the above, we multiply the denominator of the new fraction ($\frac{4}{3}$) by the number of tablets used (2) and get a second fraction, $\frac{4}{6}$. This corresponds with the result obtained above.

6. To give a dose of $\frac{1}{60}$ of a grain, when the stock tablet is $\frac{1}{12}$ of a grain. Finding the least common denominator of $\frac{1}{60}$ and $\frac{1}{12}$:

$$\begin{array}{r|l} 2 & 60,\ 12 \\ 2 & 30,\ \ 6 \\ 3 & 15,\ \ 3 \\ & \ \ 5,\ \ 1 \end{array} \qquad 2\times2\times3\times5\times1=60$$

Reducing: $\frac{1}{60}=\frac{1}{60}$ $\qquad \frac{1}{12}=\frac{5}{60}$

Therefore, $\frac{1}{60}$ is $\frac{1}{5}$ of $\frac{1}{12}$. 25 is exactly divisible by 5, therefore 25 minims is the quantity taken for the solution. $\frac{1}{5}$ of this is to be administered. $\frac{1}{5}$ of 25 is 5, a quantity rather small for hypodermic administration. But 15 minims is readily administered. This amount is three times 5. Therefore, 75 minims (or 3 syringefuls, or 3 times 25 minims) is taken to make the solution and 15 minims of this drawn into the syringe and administered.

6. To give a dose of $\frac{1}{150}$ of a grain, when the stock tablet is $\frac{1}{4}$ of a grain. Finding the least common denominator of $\frac{1}{150}$ and $\frac{1}{4}$:

$$\begin{array}{r|l} 2 & 150,\ 4 \\ & \ \ 75,\ 2 \end{array} \qquad 2\times75\times2=300$$

Reducing: $\frac{1}{150}=\frac{2}{300}$ $\qquad \frac{1}{4}=\frac{75}{300}$

Therefore, $\frac{1}{150}$ is $\frac{2}{75}$ of $\frac{1}{4}$. 25 minims (the maximum contents of the syringe) is not equally divisible by 75, the denominator of the new fraction, but 75 (or three times this amount) is just divisible. Therefore, if the solution is made in three syringefuls (or 75 minims) of water, two minims of this solution would be the desired dose. But a hypodermic dose of two minims is not practical. Twelve minims is, however, practical; 12 is 6 times 2, the original dose. Therefore, a quantity of water equal to 6 times 75 (450 minims, or 7½ drachms) is used in making the solution and 12 minims of this drawn into the syringe and administered.

CHAPTER XII

WEIGHTS, MEASURES, SOLUTIONS AND FORMULÆ

1. WEIGHTS AND MEASURES

ALTHOUGH it may be presupposed that the nurses who are studying the surgical and gynæcological part of their course have already mastered the subject of weights and measures, in its various applications, yet it appears wise to reconsider it in this place, particularly in connection with its application to the preparation of solutions.

There are two systems now in common use for the measuring of distance, weight and volume. These are the English and the metric systems. The former is a fairly independent and unrelated series of tables, each with its distinct unit, which is increased by arbitrary multiples to obtain the next higher unit. In the metric system, however, the linear unit is the basis, not alone for the measure of distance, but also of weight and volume, and the graduation of succeeding greater units is based upon the decimal system, each being ten times greater than the next smaller. Such a system is obviously more scientific and, indeed, more simple than the English system, but long usage has made the latter so much a part of our customs that it is difficult to have it discarded, even for a better.

A. Linear Measure.—The English system of linear measure is, of course, familiar to all and is given here merely for the purpose of comparison with the metric linear measure.

12 inches	equal 1 foot
3 feet	equal 1 yard
$5\frac{1}{2}$ yards	equal 1 rod (or perch)
40 rods	equal 1 furlong
8 furlongs	equal 1 mile

The entire metric system, as already stated, is based upon the linear unit (the metre), which is equal to one ten-millionth of a quarter meridian of the earth, or about 39.37 English inches. This linear unit being assumed, those of successive higher order are obtained in multiples of ten (represented by Greek prefixes) and those of successive lower order by decimal fractions (represented by Latin prefixes). Thus (where, in the English system, we obtain the successive units of feet, yards, rods, furlongs and miles by multiplying successively by twelve, three, five and a half, forty and, finally, eight) we have the metric system, in the ascending scale, as follows:

10 metres...equal	1 decametre (Dm.)		
100 metres...equal	10 decametres...equal	1 hectometre (Hm.)	
1000 metres...equal	100 decametres...equal	10 hectometres...equal	1 kilometre (Km.)

To obtain smaller units than the metre (which, being somewhat greater than the English yard, is too large a unit for fine measurements), we have recourse to the descending scale of decimals, with the Latin instead of the Greek prefixes, as follows:

.1 metre (M.)..equals	1 decimetre (dm.)		
.01 metre.......equals	.1 decimetre..equals	1 centimetre (cm.)	
.001 metre.......equals	.01 decimetre..equals	.1 centimetre..equals	1 millimetre (mm.)

To somewhat reverse the above process, we have:

1000 millimetres.....equal 100 centimetres.....equal 10 decimetres.....equal 1 metre

As the centimetre is the metric unit of linear measure most commonly used in hospital work and, at the same time, the one upon which the units of weight and volume are based, it is advisable to obtain an idea of its value in the English system. As we have already seen, the metre equals about 39.37 inches. One centimetre, being one one-hundredth of a metre, equals one one-hundredth of 39.37 inches, *i.e.*, 0.3937 inch. This is approximately four-tenths of an inch.

B. Measure of Volume.—In the English system (apothecaries') the unit of volume is the minim (indicated ♏), and the names of the successive higher units are equally arbitrary and unrelated, as are the multiples by which they are obtained. Thus, we have:

60 minims (♏lx)...........................	equal 1 fluidrachm (f ʒ i)
8 fluidrachms (f ʒ viii).....................	equal 1 fluidounce (f ℥ i)
16 fluidounces (f ℥ xvi)......................	equal 1 pint (Oi)

It is customary, in writing these terms, to employ the method parenthetically indicated above; that is, to use the symbol instead of writing out the word and to use the Roman instead of the Arabic numeral, the number following instead of preceding the symbol.

In the metric system, the unit of volume is based upon the linear unit. It is termed a litre and is equal to a cubic decimetre. A decimetre is one-tenth of a metre (*i.e.*, ten centimetres). A litre, therefore, equals one thousand cubic centimetres. The larger units of volume are obtained identically as in the linear system, by the use of Greek prefixes to denote successive multiples of ten of the standard unit and the smaller units by the use of Latin prefixes to denote successive decimal fractions. Thus:

10 litres......equal 1 decalitre
100 litres......equal 10 decalitres..... equal 1 hectolitre (Hl.)
1000 litres......equal 100 decalitres.....equal 10 hectolitres.....equal 1 kilolitre (Kl.)

On a descending scale, we have:

1 litre (L.)..equals 10 decilitres (dl.)..equal 100 centilitres (cl.)..equal 1000 millilitres (ml.)

To this brief summary may be added that the cubic centimetre, with its multiples and decimal fractions, is usually employed as the unit of volume in medical work and is equivalent to a trifle over ♏xvi. The litre measures somewhat over a quart (about 1.05 quarts).

C. Measures of Weight.—In the English system, the unit of weight is the grain (abbreviated gr.) and we have the following table:

20 grains (gr. xx)..............................equal 1 scruple (℈i)
3 scruples (℈iii)..............................equal 1 drachm (ʒi)
8 drachms (ʒviii)..............................equal 1 ounce (℥i)
12 ounces (℥xii)..............................equal 1 pound (℔i)

The unit of weight in the metric system is the gramme, which represents the weight of one cubic centimetre of pure water—thus, again, going back to the linear system for its unit. And, again, we have the identical system of construction for the table. Thus:

10 grammes equal 1 decagramme (Dg.)
100 grammes equal 10 decagrammes equal 1 hectogramme (Hg.)
1000 grammes equal 100 decagrammes equal 10 hectogrammes equal 1 kilogramme (Kg.)

and, further,

1 gramme (Gm.)...equals 10 decigrammes (dg.)...equal 100 centigrammes (cg.)...equal 1000 milligrammes (mg.)

The gramme is equal to about gr. xv in the apothecaries' system.

Although, from what has here been said, we may gather some idea of the greater simplicity of the metric over the English system of weights and measures, yet no true appreciation of the enormous difference can exist until we consider that only one of the English tables of weight and one of the tables of volume have been considered (the apothecaries' in each case). When we realize that there are, in addition to these, the avoirdupois and troy systems for weights and the imperial, cubic and dry measures for volume, then alone can the great advantage accruing from the general adoption of such a system as the metric be appreciated.

Transposition of Tables.—After the somewhat extended attention given to prefatory considerations, we shall endeavor to even further simplify their application. The tables of linear measure will be disregarded as of no particular interest to the nurse, and the measures of volume and weight will be considered as possessed of only one unit each,—the cubic centimetre and the gramme. We have already stated that the cubic centimetre equals about 16 minims and the gramme about 15 grains. We have, further, stated that practically all prescriptions employing the metric system are written in decimal multiples or fractions of these units. The system of writing, therefore, is identical to that employed in our monetary system,—the unit being the cubic centimetre or the gramme instead of the dollar. Thus, it should be quite as simple to read Gm. 3.25 as $3.25,—one representing three and twenty-five one-hundredths dollars and the other three and twenty-five one-hundredths grammes.

The transposition from one system to the other should be equally simple. Taking the above example, suppose that we wish to transpose Gm. 3.25 to its equivalent in the apothecaries' system of weights.

We know that	Gm. 1 equals gr. xv
Therefore	Gm. 3.25 equals 15 × 3.25 equals 48.75 grains
Thus,	Gm. 3.25 equal gr. 48¾

The reverse process is equally simple. Suppose, for instance, that we wish to transpose f℥iiss (2½) from the apothecaries' to the metric system.

(1) There are 480 minims in an ounce.
(2) Therefore 2½ ounces equal 2.5 × 480 or 1200 minims.
(3) 16 minims equal 1 cubic centimetre.
(4) Therefore 1200 divided by 16 (*i.e.*, 75) equals the number of cubic centimetres in f℥iiss
(5) Thus, f℥iiss = 75 c.c.

From these two examples, we promptly realize the simplicity of the application of the following general rule: To change quantities from the metric to the apothecaries' system, multiply (if liquid and expressed in cubic centimetres) by 16, to reduce to minims, and (if solid and expressed in grammes) by 15 to reduce to grains. To change from the apothecaries' to the metric, first reduce to grains (or minims) and then divide by 15 (if solid) to transpose to grammes, or by 16 (if liquid) to transpose to cubic centimetres.

II. SOLUTIONS

Since such a large part of the surgical nurse's work consists in the preparation of solutions of drugs, it seems advisable that something more than passing notice should be devoted to this subject. The nurse is required to prepare physiological salt solution for dressings, or for subcutaneous, intravenous or rectal administration; various antiseptic solutions for use as a part of the aseptic technic or for wound dressings; solutions for enemata; solutions for vaginal douches; and other solutions for any one, or all, of the various fields covered by surgical nursing. In some instances, the amounts of the various constituents will be given. In others only the percentage strength of the solution will be specified, and, possibly, the total quantity of the solution to be used. It is in the latter class of cases, particularly, that the nurse must be familiar with the preparation of percentage solutions.

The method of preparation of these solutions naturally divides itself into two parts, dependent upon which system of weights and measures is employed,—the metric or the apothecaries'. The natural tendency, in approaching this subject, is to mention the apothecaries' system only to condemn its use. However, the realization that custom has made the apothecaries' system the routine in many hospitals makes it necessary that we should give it due consideration.

To make an aqueous solution (and this is the form generally prepared by the nurse) of any drug, it is first necessary to decide how much of the drug must be used, in order to make the desired percentage in the total quantity. The simplest method of accomplishing this is by resolving the volume representing the total solution into its smallest units, which will be susceptible of treatment by the percentage system. For example, suppose that we are required to make up two gallons of a one-half per cent. solution of lysol. This looks like a rather imposing task. But, by reducing to its simplest form, we have

2 gallons equal 8 quarts equal 16 pints equal 256 ounces equal 122,880 minims
1 per cent. of 122,880 is 1228.80
½ of this is 614.40

We, therefore, to 614 minims of lysol add enough water to make 2 gallons. If it is inconvenient to measure 614 minims, we may first transpose it to higher units by the process of division, remembering that 60 minims equal 1 drachm and that 8 drachms equal 1 ounce, or that 480 minims equal one ounce. Thus, dividing 614 minims by 60, we find the equivalent quantity of ʒx ♏xiv, and, further transposing ʒx, we find the equivalent quantity of ℥i ʒii. Therefore, 614 minims equal 1 ounce, two drachms, 14 minims.

This example, which shows the method employed to find the amount of a liquid drug that must be used to make up a specified quantity of a certain percentage, is identical with that used for solids, the latter being measured in grains instead of minims.

In the use of the metric system, practically all of this work is unnecessary. Suppose that we take the same example. In the first place, it is necessary to transpose the 2 gallons to the metric system. The quantity being so large, absolute exactness may be to some extent disregarded. We know that one quart equals approximately one litre. Therefore, 2 gallons, equalling 8 quarts, also equal 8 litres. We, now, have the problem of making 8 litres of a ½ per cent. lysol solution.

1 litre equals 1000 cubic centimetres
8 litres equal 8000 cubic centimetres
1 per cent. (or one one-hundredth) of 8000 is 80.00
½ of 80.00 is 40.00

We, therefore, add to 40 cubic centimetres of lysol sufficient water to make 8 litres. The only inaccuracy in this solution is that, by transposing to the metric system, we have made up slightly more than the required quantity of the solution, but of exactly the required percentage.

III. FORMULÆ

In every hospital there are in general use a number of stock solutions or preparations for various purposes. These may be in the form of tablets of a given strength, from which the diluted solutions are prepared, or they may be in the form of solutions of varying degrees of concentration, which are used either as prepared or after considerable dilution. While it would, of course, be quite out of the question to give even an approximately full list of these preparations in this place, yet a few of the more common and, possibly, more important will be tabulated. In addition, there will be included some formulæ which may not be kept prepared but which appear of sufficient importance to warrant their presence in such an abbreviated list.

Formulæ for local anæsthesia:

1. Cocaine and adrenalin (A):

Cocaine hydrochloride	0.03 gm.
Adrenalin chloride	0.003 gm.
Sodium chloride	0.18 gm.
Distilled water	30.00 c.c.

This makes a solution of cocaine (1–1000) and adrenalin (1–10,000) in physiological salt solution.

2. Cocaine and adrenalin (B):

Cocaine hydrochloride	0.3 gm.
Adrenalin chloride	0.03 gm.
Sodium chloride	0.18 gm.
Distilled water	30.00 c.c.

This makes a solution of cocaine (1–100) and adrenalin (1–1000) in physiological salt solution.

A simpler method of making these solutions is to use tablets already prepared in suitable strength, dissolving one in the proper quantity of physiological salt solution.

3. Novocaine 1–400:

Fill flasks with distilled water and add salt to make normal saline. Boil twenty minutes. Add novocaine crystals and boil two successive days, ten minutes each.

4. Quinine and urea hydrochloride 1–200:

Fill flask with distilled water and boil twenty minutes. When cool, add sterile quinine and urea hydrochloride tablets. Boil ten minutes. Quinine and urea do not stand boiling as well as novocaine.

The above formulæ (3 and 4) are those used by Dr. Crile in his anoci-association work.

Formulæ for antiseptic solutions:

1. Bichloride of mercury:

Bichloride of mercury	1.00 gm.
Water	1000.00 c.c.

This makes a 1–1000 solution and may be used for preparing the surgeon's hands, the field of operation, etc.

2. Harrington's solution:

Commercial alcohol (94 per cent.)	640.00 c.c.
Hydrochloric acid	60.00 c.c.
Water	300.00 c.c.
Bichloride of mercury	0.80 gm.

Used for surgeon's hands, field of operation, etc.

3. Iodine and alcohol:

Tincture of iodine	50.00 c.c.
Alcohol	50.00 c.c.

Formulæ for enemata:

1. 1–2–3 enema:

Magnesium sulphate	℥i
Glycerine	℥ii
Water	℥iii

2. 2–4–8 enema:

Magnesium sulphate	℥ii
Glycerine	℥iv
Water	℥viii

3. Oil and glycerine enema:

Glycerine	30.00 c.c.
Olive oil	90.00 c.c.
Soapsuds	120.00 c.c.

4. Oxgall and glycerine enema:

Oxgall	8.00 c.c.
Glycerine	120.00 c.c.
Warm water	500.00 c.c.

Formulæ for saline solutions:

1. Physiological salt solution:

Sodium chloride	9.00 gm.
Distilled water to	1000.00 c.c.

2. Ringer's solution:

Sodium chloride	9.00 gm.
Potassium chloride	0.20 gm.
Sodium bicarbonate	0.20 gm.
Distilled water to	1000.00 c.c.

3. Locke's solution:

Calcium chloride	0.24 gm.
Potassium chloride	0.25 gm.
Sodium bicarbonate	0.20 gm.
Sodium chloride	9.00 gm.
Glucose	1.00 gm.
Distilled water to	1000.00 c.c.

4. Adler's solution:

Sodium chloride	0.5900 gm.
Potassium chloride	0.0400 gm.
Calcium chloride	0.0400 gm.
Magnesium chloride	0.0250 gm.
Sodium phosphate	0.0126 gm.
Sodium bicarbonate	0.3510 gm.
Glucose	0.1500 gm.
Distilled water	98.7914 c.c.

These four formulæ represent solutions used by hypodermoclysis or intravenous infusion. The first is the usual solution and the other three are examples of attempts to more closely approximate the true blood-serum.

Formulæ for ointments and pastes:

1. Zinc oxide ointment:

Zinc oxide	20.00 gm.
Benzoinated lard	80.00 gm.

2. Unna's paste:

Gelatine	4 parts
Water	10 parts
Glycerine	10 parts
Zinc oxide	4 parts

3. Boracic acid ointment:

Boracic acid	10.00 gm.
Paraffin	10.00 gm.
White vaseline	80.00 gm.

4. Bismuth paste:

Bismuth subnitrate	30.00 gm.
White wax	5.00 gm.
Soft paraffin	5.00 gm.
Yellow vaseline	60.00 gm.

5. Stearin paste:

Melted stearin	50.00 c.c.
Ammonia water	2000.00 c.c.
Water	2000.00 c.c.

6. Wax paste:

Melted yellow wax	100.00 c.c.
Ammonia water	300.00 c.c.
Water	300.00 c.c.

7. Marble dust (Schleich's) soap:

Cut resin soap	750.00 gm.
Warm water	1500.00 c.c.

Melt and boil 1½ hours. Add

Wax paste	150.00 gm.
Stearin paste	150.00 gm.
Marble dust	7000.00 gm. (15 lb.)

Stir while boiling.

Formulæ for vaginal douches:

1. Lysol	10.00 c.c.
Water to make	2000.00 c.c.
2. Alum acetate	8.00 gm.
Water	2000.00 c.c.
3. Bichloride of mercury	1.00 gm.
Water	2000.00 c.c.
4. Potassium permanganate	2.00 gm.
Water	2000.00 c.c.

Formula for Boudet's depilatory powder:

Fresh unslaked lime	10.00 gm.
Sodium sulphide crystals	3.00 gm.
Powdered starch	10.00 gm.

Rub into thick paste with water and apply about ¼ inch thick. Wash off after five minutes.

The formulæ and solutions already considered deal entirely with the handling of the actual medicament in its full strength. But another problem presents itself when, instead of the pure drug, a more or less concentrated solution thereof is the preparation to be used. As examples of these concentrated solutions, we have the 10 per cent. aqueous solution of bichloride of mercury and the 10 per cent. aqueous solution of sodium chloride which are the stock strengths in many operating rooms from which weaker solutions of these drugs are prepared. And, naturally, the use of such a solution somewhat complicates the problem of finding the amount to be finally used. If a 1–3000 solution of bichloride of mercury is to be prepared from the pure drug, it is very easy to see that there must be one part of the drug to every 3000 parts of the final solution, or one gramme of the drug in every 3000 c.c. of the solution. But, with a 10 per cent. solution as a starting point, the problem does not end at this point. We have only found how much of a 100 per cent. concentration of the drug must be used. But we do know that 10 per cent. is only $\frac{1}{10}$ of 100 per cent. Therefore, ten times as much of a 10 per cent. solution must be used as of the pure drug. In other words, instead of 1 part in each 3000, we must use 10 parts in each 3000. That is, we use 10 c.c. of the 10 per cent. solution in each 3000 c.c. of the 1–3000 solution. In approaching the salt solution problem of preparing a $\frac{9}{10}$ per cent. solution from a 10 per cent., we employ the same method. If the preparation were 100 per cent. strength, we should have to use 9 parts of the preparation in each 1000 parts of the solution (as $\frac{9}{10}$ per cent. equals $\frac{9}{10}$ of $\frac{1}{100}$, or $\frac{9}{1000}$). But a 10 per cent. solution is only $\frac{1}{10}$ as strong as a 100 per cent. preparation and, therefore, 10 times as much must be used. Therefore, 90 parts of the 10 per cent. strength must be used in each 1000 parts of the solution. But 90 parts to the 1000 equals 9 parts to the 100. Therefore, 9 c.c. of the 10 per cent. strength must be used in each 100 c.c. of the solution.

The preparation of solutions of carbolic acid from the stock strength of 5 per cent. is, of course, identical in principle with the preceding examples. Suppose that a 3 per cent. solution of carbolic acid is required. Using the pure drug, this would require 3 parts of the pure drug in each 100 parts of the solution. But a 5 per cent. solution is only $\frac{5}{100}$ as strong as the pure drug. So we must use $\frac{100}{5}$ (*i.e.*, 20) times as much of the 5 per cent. solution as of the pure drug. That is to say, we must use 60 parts of the 5 per cent. strength to each 100 parts of the solution.

A study of these three examples gives us the three steps followed in preparing solutions from other solutions of greater strength. (1) Find what part of the required solution the pure drug would represent. (2) Multiply this by the denominator of the fraction that represents the strength of the stock solution. (3) Divide this result by the numerator of the same fraction. The last step will be unnecessary when the numerator is 1. The amount thus obtained is then measured and to it is added enough of the solvent (usually water) to give the total quantity of solution required.

CHAPTER XIII

CHARTS AND RECORDS

I. THE CHART

The proper keeping of the chart giving full details of the patient's condition, of what has been done and is being done for her, and the entire history of the patient from the beginning of her illness is one of the most exacting of the duties that fall to the share of the nurse,—either in hospital work or in private practice. The hospital chart is generally much fuller than that used in private nursing,—and, as a result, requires more attention. A full chart consists of a number of sheets for different purposes, mounted on a board with a clip for holding the sheets in place. These sheets are arranged according to a definite system in different hospitals, and may, indeed, be different in character and requirements. As a basis for description, a full chart that covers the entire field of diagnosis, treatment and daily progress will be considered at this time. While some of the sheets mentioned will be such as to be omitted in some charts, yet the entire number will be necessary in every case of operative character in which a full history has been taken and a thorough examination, both physical and pathological, made. The arrangement of the sheets for reference will be used, as this is the form of practical importance to the nurse rather than the order in which they are filed away among the hospital records.

1. Cover Sheet.—This is generally a blank piece of white paper, upon which the name of the patient, date of admittance, ward and name of attending physician are to be written. It is used merely as a cover for the remainder of the chart, with the double purpose of protecting the next page and preventing any one from seeing the other data without taking the chart for examination.

2. Temperature Sheet.—This sheet has a space at the top or side for the patient's name and the date and is so divided off into spaces that a record of the patient's temperature, pulse and respiration may be kept upon it, as well as a summary as to the condition of her bowels and kidneys. The temperature, as recorded on this sheet in the average case, is generally merely the morning and evening record (Fig. 75). It may, however, be divided into spaces with red ink lines so as to be used for every four-hour recording (Fig. 76). This sheet gives to the physician, at one glance, a picture of the patient's temperature and pulse record from the time of her admittance to the hospital.

3. Record Sheet.—This sheet has at its top space for the name of the patient and the date. Its contents are more comprehensive and minute than those of the temperature sheet. It is divided vertically into a number of columns, each with a heading to indicate the kind of information that is to be recorded in that particular place (Fig. 77). Through each 24 hours, as nourishment is given, or medicine administered; as the bowels or bladder act; as the temperature rises or falls, the time and all other details are recorded in the proper columns on this sheet. The temperature, pulse and respiration are generally taken every four hours when using this sheet, although, in very serious cases, a two-hour temperature record may be kept. As will be readily understood, a sheet of this kind has much data that would not be required in the simplest cases. It is, therefore, used only in opera-

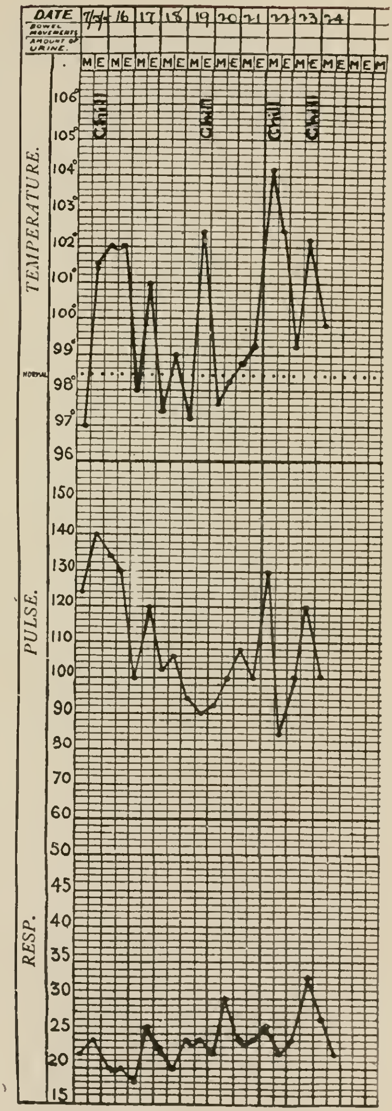


Fig. 75.—Chart showing morning and evening temperature. (Septic peritonitis.)

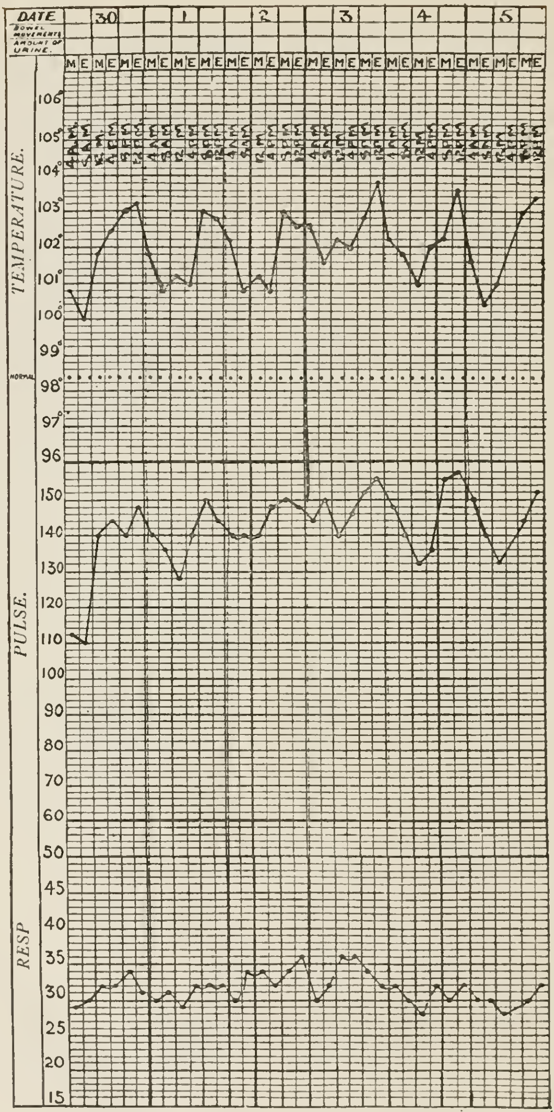


Fig. 76.—Four-hour chart. (Septicopyæmia.)

tive cases and those where there is an elevation of temperature that requires watching. At the end of 24 hours, the material gathered on the record sheet is totaled so as to give in a brief summary those facts of importance during the time covered.

It is well that we should remark at this time upon one or two points of special interest and importance in the recording of data. The two points upon which particular emphasis will be placed are the recording of bowel and bladder evacuations. The first of these is particularly important in those cases where there seems the possibility of intestinal obstruction, and the patient

Date..............................Sheet No...........

Name..

Date	Hour	Nourishment	Medication	Remarks	Def.	Urine
7/7/15.	8.30		Morphine sulph. gr. 1/6 Atropine sulph. gr. 1/150	On leaving for operating room		
	10.30			Returned from O. R. Pulse good.		
	11.20			Fully reacted.		
	1.00	Water ℥i.		Retained.		
	8.00			Voided.		℥viii
	8.00			Complains of slight pain in region of incision.		
	10.00	Crushed ice.		Voided.		℥iv
	12.00			Sleeping.		
7/8/15.	2.00			Voided.		℥ix
	4.00	Water *ad lib.*		Turned p. r. n.		
	6.00			Comfortable night.		
		Twenty-four-hour summary.				
		Water *ad lib.* Crushed ice.	Morphine sulph. gr. 1/6 Atropine sulph. gr. 1/150	On leaving for operating room Voided. Turned p. r. n. Comfortable night.		℥xxi

FIG. 77.—Type of record sheet. The more usual form has column for recording temperature, pulse, and respiration.

should be carefully watched during such times to decide whether or not gas is passed. Of course, this caution applies particularly after the administration of an enema, as there is very little likelihood of a patient with suspected obstruction passing gas at any other time. In regard to the bladder function, attention must be called to the occasional error of recording the fact that the patient has voided involuntarily and not giving the amount (or approximate amount) voided. This may seem an impossibility when the urination is involuntary, but it is simple enough to tell whether or not the amount passed was a mere dribble or a large quantity. The importance of accuracy in this matter lies in the possibility of the patient, instead of having incontinence of urine in the accepted meaning of this term, being the victim of retention with overflow. In cases of this sort, the dribble that is forced out may give the impression of incontinence, while the patient has, in fact, a bladder distended with forty or fifty ounces of urine.

4. Medicine and Treatment Sheet.—This sheet (Fig. 78), as the other, has a place at the top for the name of the patient. It should be divided into five vertical columns for the recording of the following data: date ordered; time ordered; medicament, frequency and manner of administration; and date when discontinued. This gives at a glance just what the patient is receiving in the line of medicine and treatments, and whether or not any of them have been discontinued.

In addition to the four sheets already mentioned and described, there are four that are for the use of the house staff of the hospital. These are: (1) the history blank, for the brief outlining of the salient points of the history of the disease from which the patient suffers, with additional spaces for a brief record of the treatment of an operative sort; (2) the history sheet for the full and careful recording of the past and present history of the patient's condition; (3) the urinalysis sheet for the recording of the results of the examination of such specimens of urine as may be sent to the laboratory; and (4) the pathological sheet for the recording of the results of the examination of such pathological specimens as may have been sent up for diagnosis. The specimens under the latter head may be blood, fæces, sputum, stomach contents, or any removed tissues. The four last mentioned sheets should be placed on the chart at the back, when it is first made up for use. If it chances that they are not used, they may be later removed.

In some hospitals there is another special sheet employed during that period which an operative case spends in the recovery room. The regular ward order book is not here convenient for the writing of orders for the patient, and the stay is frequently very abbreviated before transference to the ward. A supplementary sheet, ruled so as to have columns for date, hour and order, is supplied and kept on the chart. All orders, prior to patient's removal to ward, are written on this sheet and, thus, Date..........................No..........

Name.................................... Sheet No........

6/23/15.	Send specimen of urine to laboratory.
	Ol. ricini ℥i at 9 A.M. to-morrow.
	Liquid diet.
	B.
6/24/15.	Prepare for operation at 9 A.M.
	S. S. enema in A. M.
	Morphine sulphate gr. $\frac{1}{6}$; atropine sulphate gr. $\frac{1}{150}$ by hypo., before leaving for operating room.
	B.
6/25/15.	Hot water *ad lib.*
	Catheterize in 8 hours if necessary.
	Morphine sulphate gr. $\frac{1}{6}$ by hypo. now, and repeat if necessary.
	B.
6/26/15.	Liquid diet, without milk.
	B.
2.15 P. M.	S. S. enema now.
	G.
9.00 P. M.	Morphine sulphate gr. $\frac{1}{6}$ by hypo.
	B.
6/27/15.	Catheterize p. r. n.
	E. E. M.
	1–2–3–enema in A.M.
	G.
6/28/15.	Soft diet.
	S. D. B.
	Urotropin gr. xv t. i. d.
	B.
7/3/15.	Pil. A. B. & S. No. ii q., P.M.
	Specimen of urine to laboratory in A.M.
	G.
7/6/15.	Light diet. Irrigate bladder b. i. d. with 2 per cent. boracic acid solution, until clear return. At completion of irrigation, instil and leave argyrol (15 per cent.) ℥ss.
	S. D. B.

FIG. 78.—Medicine and treatment sheet.

return to the ward with the chart and such orders as have not been discontinued are conveniently recorded for continued execution.

A careful study of the illustrated sheets will give a good idea of how the various records appear in practical work.

A full chart, on any serious case, would thus consist, at the beginning, of eight sheets. As the condition progresses, successive additions are made as the record increases, and, after operation, the necessary recovery ward sheet is added.

PART IV—THE PATIENT

CHAPTER XIV

OBSERVATION

I. THE NURSE AS AN OBSERVER

A VERY important part of the work of the nurse consists in the observation of the symptoms and condition of the patient during the absence of the physician or surgeon. The doctor sees the patient once or at most twice in the twenty-four hours, and then only for a few minutes. For a knowledge of what happens in the intervals he is dependent on the nurse, and while he is absent many things may occur of the greatest importance in relation to the diagnosis, prognosis, and treatment of the case. It may be noted in the first place that the object of the observations made by the nurse is quite different from that of those made by the surgeon. His primary purpose is the diagnosis of the condition, and his chief attention is given to the facts which have a bearing upon that problem. The nurse is not directly concerned with the diagnosis, that is not her business, although her observations may often help materially to that end. The primary object of the nurse's observations is the discovery of premonitory symptoms, which foretell a change in the course of the disease or the coming of a complication. In surgery the work of the nurse as an observer is of supreme importance in the period of morbidity and of hazard following an operation. The character and meaning of the symptoms to be noted by the nurse in connection with post-operative complications will be considered in a separate chapter. In this place we shall discuss the meaning and the methods of observation itself and a brief outline of the field of observation within the province of the surgical nurse.

II. THE MEANING OF OBSERVATION

Observation means the act of noting intelligently some fact or occurrence that is pertinent to the subject matter under consideration or to the work in hand. In practice the observer, whether in scientific investigation or in technical work of any kind, is required to do three things: (1) to observe, (2) to measure, (3) to record. To observe properly requires, in the first place, knowledge. Simply to see or hear or touch a thing is not to observe it. Observing implies, not indeed full knowledge of what the thing seen means, but at least a recognition of the fact that it has a probable meaning pertinent to the matter in hand. The greater the ignorance of the observer, the greater is the certainty that he will overlook important facts and occurrences. The wider his knowledge, the more certain it is that he will note all the facts that have a bearing on the case. The second requisite for a good observer is attention, for this means clearness of the impression received from seeing, hearing or feeling the thing observed, and the third is interest, for without interest continued attention is difficult if not impossible. Finally, the observer must possess an attribute which is perhaps the most important of all and at the same time the most difficult to attain. It is that attitude of mind which permits its possessor to be satisfied with nothing else than the exact truth, without regard to its agreement with preconceived ideas or personal wishes. It is so easy to deceive ourselves into the belief that we see something that we wish to see, or that we strongly expect to see. An observation that is inaccurate is worse than useless, because it is misleading. The need for accuracy also makes it imperative that the phenomena observed should be measured whenever possible, and that the result of the observation should be set down in writing at the time it is made, for memory unaided is an untrustworthy repository for facts.

III. METHOD IN OBSERVATION

System and a regular plan of procedure are essential to thoroughness and completeness in any undertaking. If the observations of the nurse are made only when some symptom or change in the patient's condition forces itself upon her attention, many important facts will quite certainly be overlooked or discovered too late to save the patient, it may be, from unpleasant consequences. For this reason the nurse should learn to follow as far as possible a definite plan in her observations of the patient's condition. This means that she should direct her attention successively and at suitable intervals of time to different aspects of the case, so that all the ground may be covered thoroughly, and no important new development escape her notice. Thus the temperature is taken and the pulse and respiration counted at regular hours, varying with the gravity of the condition. The character and amount of the excretions are regularly noted.

Known danger signals that are likely to appear should be borne in mind, and the attention deliberately directed to determine their presence or absence often enough to ensure their prompt discovery. Different regions of the body should be inspected regularly according to the circumstances of the case, as the abdomen for distention, the back for bed-sores, the bandages for staining with blood or other discharges, etc. Symptoms that tend to gradual increase should be noted at stated intervals, and those that tend to recur at certain periods should be looked for at the proper time. Attention should be directed from time to time to detect disturbances of the circulatory, respiratory, digestive, genito-urinary, and nervous systems. When a symptom is obscure or its presence doubtful, repeated observations should be made from time to time, to verify or correct the first impression, with intervals between the observations during which the attention is directed to other matters. Observations should be systematically entered on the records, and these should be kept fully up to date.

IV. THE SIGNIFICANCE OF SYMPTOMS

The inexperienced nurse will often be at a loss to determine whether a symptom has any significance at all, or in other cases whether it is of such importance that the surgeon should be informed at once. Facts that have no bearing on the case should not be recorded. Their presence in the record is not only useless but confusing. To enter an observation that is not pertinent to the case, or to summon the doctor unnecessarily, is a humiliating confession of inexperience. To omit the record of an important symptom, or to fail to send for the doctor at the earliest appearance of a danger signal, is not only a confession of inexperience but a grave dereliction of duty. There are occasions when the experienced nurse, or, for that matter, the experienced surgeon, may be puzzled to determine offhand whether a certain symptom has any significance, and the first rule of conduct is, " When in doubt act always on the safe side." There are, however, certain considerations which will assist the nurse in deciding as to the importance of a symptom.

1. Severity.—Every severe symptom is of importance, whether its relation to the case is apparent or not.

2. Duration.—A slight or moderate symptom that is transient may mean little or nothing, but if it persists it should receive serious consideration. Hiccough as a transient symptom is of no moment, but persistent hiccough in some cases of disease is a symptom of the gravest import.

3. **Tendency to Recur.**—A symptom that tends to recur persistently may be regarded as having significance.

4. **Progressive Development.**—A symptom that increases in severity from hour to hour is always important.

5. **Known Character as a Danger Signal.**—For example, a sudden abdominal pain, whether severe or not, occurring in the third week of typhoid is very likely to mean a perforation, and the physician should be called at once.

6. **Relation to affected region,** or to the physiological system involved in the disease. For example, all digestive or abdominal symptoms are important after a laparotomy.

7. **Association with Other Symptoms.**—A symptom that would be of no importance by itself may, when associated with other symptoms in a group that is known to have a definite meaning, become of the utmost significance. A sigh, even if often repeated, is not a symptom of importance by itself, but sighing respiration associated with great restlessness, anxious expression of the face, progressive pallor, etc., means that a dangerous hemorrhage is going on.

8. **Disposition of the Patient.**—In estimating subjective symptoms the tendency of the patient to exaggerate or minimize his sensations must be taken into account. Physical evidences outweigh his statements if they contradict them, but at the same time the patient's sincere complaints should never be too lightly regarded.

V. THE CONDITIONS WHICH REQUIRE THAT THE SURGEON SHOULD BE CALLED

These cannot be defined with exactness. They may be briefly summarized as follows:

1. When the presence of any danger signal, or premonitory symptom of a serious complication, is recognized.

2. When a progressive change for the worse is taking place in the patient's condition.

3. When a severe symptom arises not provided for in the orders already received.

4. When the nurse is in doubt.

When going to the telephone to summon the surgeon the nurse should be prepared to answer any questions as to the patient's condition since his last visit.

VI. OBJECTIVE SYMPTOMS AND SIGNS

Every symptom is either objective or subjective in character. An objective symptom is one that is manifest to the observer through any of the senses, usually of sight, hearing, or touch. The patient may or may not be aware of it. A full enumeration and discussion of objective symptoms would require a volume in itself. Many of them must be observed and recorded by the surgeon or physician rather than by the nurse. Those symptoms (whether subjective or objective) which do lie within the field of observation of the nurse are: (1) temperature, pulse, and respiration, (2) initial symptoms which mark the onset of a disease, (3) premonitory symptoms which foretell the coming of a complication, (4) symptoms whose fluctuations from hour to hour are significant, (5) symptoms of sudden development. The initial, premonitory, and other symptoms which are of particular significance in the work of the surgical nurse are considered elsewhere. We can do little more here than present a list of some of the more important objective symptoms and signs without attempting to discuss them.

There are four symptoms which are of unique value in the study of disease. Three of these have been for many years the most constantly observed of all symptoms, while the fourth is rapidly coming to be recognized as of equal importance with the others, particularly to the surgeon. They may be called the index symptoms, since they are always present, they can be readily measured with accuracy, they are subject to rapid variations, responding promptly in many cases to changes in the progress of the disease, and their recorded measurements present a fair index of the patient's condition. They are: (1) the temperature of the body, (2) the respiration, (3) the pulse, (4) the blood-pressure.

The temperature and the blood-pressure have each only one element to be considered. It is the rise or fall measured on a scale in degrees of temperature in one case and in millimetres of mercury in the other. In the case of the pulse and respiration there are other elements beside frequency to be considered, so that each of these presents a group of symptoms rather than a single one. Changes in the regularity and volume of the pulse, as well as its rate, are to be observed, and the respiratory system presents a large group of symptoms in addition to the frequency of respirations. Observation of the blood-pressure must be made by means of a special and rather complicated instrument and is usually done by the physician. A falling blood-pressure is the most reliable premonitory symptom of shock, and is of special value on the operating table.

Certain objective signs with regard to the general aspect of the patient are to be observed. The position of the body is sometimes significant. It may be relaxed and flaccid from weakness, or stiff and rigid from pain, with knees drawn up to relieve hip or abdominal pain, sitting up through inability to breathe lying down (orthopnœa), curled up on one side through inability to lie on the other side or back, with arms thrown over the head to assist breathing in air hunger, etc.

The expression of the face is important in certain cases. Dulness, apathy, or lack of expression is seen in shock, in extreme weakness, and in toxæmia with fever. The so-called " anxious expression " is of special importance. It is difficult to describe but readily recognized when seen. It occurs in several acute affections of sudden development and grave import, such, for example, as obstructed breathing, peritonitis, and particularly hemorrhage.

Movements of the body may require to be noted, such as restricted movements from tenderness in joints or muscles, restlessness, tossing and turning from side to side, twitching of muscles, spasms, and convulsions.

Changes in the color of the skin should be observed. Chronic pallor will be observed and recorded by the physician in the history of the case. Acute or sudden pallor may be transient, as in nausea, or lasting or perhaps progressive, as in shock and hemorrhage. The pallor has a yellowish tinge in profound anæmia, in slow, long-continued hemorrhage, and after a severe acute hemorrhage. It is a bluish pallor, due to the blood settling in the small veins, in shock, and at the beginning of an acute hemorrhage. Cyanosis is the bluish color of the skin, such as is seen in the face after holding the breath. It means lack of oxygen in the blood, and is usually associated with difficult breathing (dyspnœa). The yellow color of jaundice is a chronic symptom and will be recorded by the physician. Excessive dryness or moisture of the skin may call for notice, particularly the drenching sweats that occur in septic infection, usually during sleep. Local swelling of the skin, without redness, may be due to œdema, a watery infiltration, or, rarely, to emphysema;

that is, an infiltration with air or gas. This latter condition occurs sometimes when the lung has been wounded, the air finding its way into the subcutaneous tissues. Infection with the gas bacillus also produces it. On pressure the skin yields with a soft crackling that can be felt and heard, or the skin may become so tense with gas that tapping on it gives a drum-like note. When observed it should be reported at once. The abdomen should be observed, particularly as regards distention with gas, after operations involving the peritoneum.

The following observations should always be recorded by the nurse:

Symptoms connected with the nervous system: excitement, delirium, mental dulness and slowness in response, excessive weakness, unconsciousness, coma.

Sleep: its time, duration, and character, quiet, restless, with sudden startings, etc.

Chills: time, duration, severity, degree of cyanosis if present.

Vomiting: time, amount, character, including consistency (watery, mucous, particles of food, fresh blood, coffee-ground material, due to altered blood, etc.); color (watery, yellow, brown, green, etc.); eructations of gas, regurgitation (spitting up mouthfuls of fluid), etc.

The excretions: perspiration if excessive; urine, time when voided, amount (measured) and character if abnormal (very dark in color, very cloudy, bloody, containing sediment, very strong odor, etc.).

Vaginal discharges, including the occurrence of menstruation.

Movements of the bowels: simply the number and time if normal. The character should be noted if abnormal in any respect (fluid, watery, watery with particles, bloody, containing mucus, undigested food, etc.); the color, if black from the presence of altered blood or clay colored from the absence of bile. After an operation for gall-stone disease, with common duct obstruction and jaundice, particularly when the stools have been clay colored before the operation, the color of the stools should be regularly noted during the period of morbidity. The result of enemas should be recorded (retained or partly retained, not returned, returned clear, returned discolored, yellow or brown, slightly or moderately, etc., with few or many particles or hard masses, etc.). "Good result" on the record means a liquid or partly formed stool normal in amount and character.

VII. SUBJECTIVE SYMPTOMS

Subjective symptoms are those that are manifested only in the consciousness of the patient. They are, in other words, the sensations and feelings experienced by the patient. We may divide them into four groups: (1) symptoms affecting the special senses (sight, hearing, touch, taste, smell), (2) pain, (3) organic sensations, (4) feelings.

1. Symptoms connected with the special senses are important in the specialties which deal with diseases of the eye and ear and nervous system, and in some instances in general surgery, but they belong as a rule within the field of observation of the doctor rather than the nurse.

2. Pain is the most universally recognized symptom of disease. Its office seems to be principally that of directing the attention insistently to the seat of the disease or injury. It varies in intensity in every grade, from barely noticeable pain to pain so agonizing that loss of consciousness ensues. It varies also in character. We have many words descriptive of pain, the aptness of which every one recognizes, such as sharp, dull, aching, gnawing, boring, shooting, throbbing, smarting, burning pain, etc. One striking characteristic of pain is its distinct localization. There is no such thing as general pain, although pain is sometimes felt as more or less vaguely diffused through a part of the body. Pain may be continuous or paroxysmal (coming " in spells "). It may be constant or elicited only on movement or pressure (tenderness). Pain may be felt at the seat of disease or " referred " to some other area, or both. Examples of referred pain are the pain felt in the knee in hip disease, and that under the left shoulder-blade in gall-stone disease. Wherever inflammation is present localized pain associated with tenderness is always felt. When reporting a complaint of pain on the part of the patient, its exact location should be given. First the region of the body should be mentioned, head, neck, chest, abdomen, back, arm, forearm, hand, thigh, leg, foot; then the part of the region affected, back or front; upper, lower or middle part; also whether on the left or right, outer or inner side. If pain in the wound or in a joint is complained of, only the affected part need be mentioned. The character of the pain should be given in the patient's own descriptive words.

3. Organic sensations are those connected with the internal organs, such as hunger, thirst, want of appetite (distaste for food), (the sense of having had enough); nausea, sensations of fulness or emptiness in the region of the stomach; the desire to micturate or go to stool and their abnormal forms (dysuria, strangury, tenesmus); vertigo, swimming in the head, sensations of vague discomfort in one region or another, etc. Organic sensations are characterized by being very vaguely localized. They vary in intensity but not so sharply or through such an extended scale as in the case of pain. When very intense they merge into painful sensations. Some of these mentioned are physiological and natural, and become symptoms only when exaggerated or suppressed.

4. **Feeling** means strictly the experience of pleasantness or unpleasantness arising from and associated with a sensation or perception. We speak of feeling happy or amused or sad as the result of some occurrence or experience. Feelings of admiration or of disgust are aroused by others. We also speak of feeling thirsty or hungry or dizzy, and not incorrectly, since the idea expressed may include the pleasant or unpleasant experiences associated with these organic sensations. It is therefore not easy to draw a sharp line between feelings and organic sensations as symptoms. The symptoms which we may classify under the term "feeling" are in reality experiences of pleasantness or unpleasantness associated with organic sensations that are so vaguely sensed, and so unlocalized, that they fail to be recognized as sensations at all. Such are the feeling of general well-being of the convalescent or the person in buoyant health, "feeling fine," or of vague general discomfort, "feeling badly"; feelings of lassitude, of languor, of fatigue, of weakness, of faintness; also "feeling stronger," "feeling better," "feeling like getting up," etc. These feelings of the patient, however vague and unanalyzable, may be nevertheless symptoms of definite value. Knowing how the patient feels helps us often to estimate correctly his vital status, to picture to ourselves his position at the moment on the road between health and disease. Feelings are, however, peculiarly liable to exaggeration or the reverse, and they lack the weight of evidence, as well as the precision, of objective signs. It is to be remembered also that all the subjective sensations and feelings of the patient will, if above a certain grade of intensity, always be accompanied by definite objective signs. Thus, with intense pain there will be, beside the expression of the face, the writhing movements and the cry or moan, rapid respiration,

dilated pupils, tense pulse, drops of perspiration on the skin, a large amount of clear urine, nausea, faintness and syncope. With nausea there will be pallor of the lips and later vomiting, and so on. The patient's "feeling badly" will often be found to be a reflection of a change for the worse in his temperature, pulse, etc., and may be the first thing to call the observer's attention to the change. A sudden complaint of "feeling badly," therefore, always calls for an observation of the index symptoms.

VIII. MEASUREMENTS AND QUANTITATIVE ESTIMATIONS

1. Measurement means the exact determination of quantity or magnitude of the thing measured. It is done by comparing the magnitude to be measured with some smaller magnitude of the same kind which has been selected as a standard unit for the comparison. We say a line is so many inches long, a vessel contains so many fluidounces. Immaterial forces, such as the force of gravity or the intensity of light or heat, can be measured as well as material things. A man weighs so many pounds, an electric light bulb is of eight, sixteen or thirty-two candle-power, the temperature of the air is so many degrees, and so on. Quantitative determinations are of the greatest importance in scientific study as well as in the daily business of life, and there are many applications of this method in medicine. The body temperature is measured by the clinical thermometer. Exact measurements are employed in chemical analyses in the clinical laboratory. The blood-pressure is measured by a special instrument. There are many instruments of diagnosis designed for the purpose of making exact measurements, particularly in the field of ophthalmology. The tape line is used to measure various departures from the normal in the body. The amount of urine is measured in ounces or cubic centimetres, and the same is true of the amount of fluid administered by mouth or by rectum or subcutaneously. Doses of medicine are measured by weight or volume. Time measurements are employed in determining the rate of the pulse and respiration.

In the observation of symptoms, however, we are met at once by an apparently insuperable difficulty. Many of them are, for various reasons, not susceptible of measurement. For example, we cannot measure by any available means the amount of perspiration, or of discharges saturating a dressing, or the degree of cyanosis or of pallor, or the amount of pressure that will produce pain in a tender spot. For measurements of pain we have no unit for comparison and no way to apply it if we had one. In the case of pain and other subjective symptoms, there is the added difficulty that they are not within the experience of the observer. It is the patient who experiences them, and the observer therefore must depend on the patient's own report, which is often exaggerated or sometimes the reverse.

2. Quantitative Estimations: The Scale of Seven.—As a substitute for measurement, in the case of these unmeasurable things, we may employ a graded series of quantitative judgments. In regard to many things that we can observe but cannot measure we are able at once to form a judgment of magnitude in three grades, *small*, of *moderate* amount, *large*; or *weak*, of *moderate* strength, *strong*; or *slight*, *moderate*, *severe;* and so on. We can easily add two more grades, one at each end, as *very weak* or *very strong*, and finally we can introduce an intermediate grade between weak and moderate, and another between moderate and strong which we may call respectively *rather weak* and *rather strong*. We have thus a scale of judgments of magnitude of seven grades, which is as far in the direction of subdivision as we can safely go. If the seven divisions be designated by numbers, the even numbers (2, 4, 6) stand for the three primary judgments, and the odd numbers (1, 3, 5, 7) for the intermediate grades.

Our scale then stands thus:

(1) Very small.	Very weak.	Very slight.
(2) **Small.**	**Weak.**	**Slight.**
(3) Rather small.	Rather weak.	Rather slight.
(4) **Medium.**	**Moderate.**	**Moderate**
(5) Rather large.	Rather strong.	Rather severe.
(6) **Large.**	**Strong.**	**Severe**
(7) Very large.	Very strong.	Very severe.

In practice it will be best to make first an offhand judgment on the primary scale (Weak, Moderate, Strong) and then, more deliberately, a supplementary judgment, which will be either the same as the first, or one point above or below, thus—primary judgment, moderate (4), supplementary judgment, rather slight (3). In bedside notes the numbers may be used, out in the permanent record the descriptive words should always be written out. Thus (4), (3) will read, " moderate, or rather slight " as applied to whatever is being estimated.

These quantitative judgments, of course, have no claim to rank as exact measurements, and there will be rather wide variations in the judgments of different individuals. In regard to subjective symptoms, the estimate must be based on the patient's own report, but this can often be supplemented by the observable manifestations of the symptom. In the case of pain, for example, rather severe pain (5) may be taken to be that which will be clearly evident in the expression of the face; severe pain (6) will show in the voice, or by cry or moan; while very severe pain (7) will be manifested by such other signs of pain as pallor, quickened respiration, moist skin, etc., so that even here we do not have to depend on the patient's report solely, except in the case of the slight and moderate degrees which are usually of less significance. These objective signs should always be recorded as observed.

When a quantity of fluid is to be estimated, it may be done by a rough guess at the amount, as for instance, "about two drachms" or "about four ounces." When this is done the abbreviation (est.) should be added to indicate that the amount is estimated and not measured. The degree of accuracy required in measurement, or the limit of permissible error, varies according to the object in view. The weight of a dose of atropine should be correct within a thousandth of a grain, while a dose of Epsom salts may vary a number of grains without harm. The amount of urine frequently requires to be measured with accuracy, but the amount of vomited material need only be roughly estimated.

The measurements to be regularly made by the nurse include the temperature, rate per minute of the pulse and respiration; the quantity of urine voided and of liquid taken; the amount of salt solution given, under the skin or by rectum; enemata and medicines.

3. The record made by the nurse should be (1) brief, (2) a simple statement of the facts recognized by sight, hearing, or touch, without an expression of opinion as to their cause, (3) accurate, (4) clear. Vague statements should be avoided. Each observation should be recorded by itself, and the time of its occurrence stated.

CHAPTER XV

MEASURES FOR THE COMFORT AND WELL-BEING OF THE PATIENT

A LARGE part of the work of the nurse is carried out under either standing or special orders written down in the order book by the surgeon or physician in charge of the case, and her responsibility is then limited to obedience and the proper exercise of the technical knowledge and skill acquired in the practice of her profession. The doctor is the one who is responsible for the treatment of the disease or affection which brings the patient under his care. It is his part to determine what remedial measures shall be employed, and it is the part of the nurse to carry out, under his orders, such of them as come within her province.

There is, however, a part of the nurse's work in which she is left to act largely on her own responsibility, without general or special written orders, in applying the knowledge and skill she has acquired in the course of her training with regard to the proper care of the sick. This field of the work of the nurse concerns the general well-being and comfort of the patient. It is, from the patient's point of view, the most important part of nursing, and it often calls for the highest degree of discretion and good judgment on the part of the nurse. Pain and suffering, both physical and mental, are inseparable from disease and injury, and in their alleviation efficient nursing plays the principal part.

It is assumed that the nurse is instructed in regard to the general hygiene of the sick-room, the care of the bed, the bath, adequate ventilation and the flushing of the room with fresh air at suitable intervals, the proper arrangement of light, the serving of food in attractive form, and prompt attention to the essential needs of the patient, the prevention and care of bed-sores, and the alleviation of the many small discomforts incident to every illness. We shall consider in this chapter some points in surgical nursing to which insufficient attention is often given by the nurse, and it must be said by the surgeon as well, resulting in much unnecessary discomfort to the patient, and sometimes in lasting injury.

I. POSITION IN BED

The dorsal position, prone on the back, is the position in which the patient is usually placed in bed immediately after operation. It is the natural position of complete relaxation and exhaustion and can be maintained longer than any other without discomfort. There are, however, grave objections to prolonged lying on the back. It is a contributing cause of hypostatic pneumonia and of cystitis, and a direct cause of bed-sores. Change of position by turning the patient on the side, if necessary with supporting pillows under shoulder and hips, should be encouraged and even insisted on whenever possible. There are only a few conditions in which a continued dorsal position is unavoidable, and abdominal operations are not among them, in spite of the common practice of keeping these patients on the back. The methods of treating fractures of the thigh and hip, which are still most frequently employed, compel the patient to lie on his back for many weeks, but even here restful changes of position can be managed without harm, if proper discretion and care are used; indeed, the patient will soon learn to ease himself by shifting his body about, and may have to be cautioned against too free movements. After abdominal operations a pillow placed under the knees so that the thighs are slightly flexed adds greatly to the comfort of the patient. The head and usually the shoulders may be supported with pillows after all operations as soon as the patient finds them comfortable.

The covering should be warm and light and not too smoothly and tightly tucked in around a weak and helpless patient. One point in this connection needs particular emphasis. Patients who are bed-ridden for a long time are very prone to develop foot-drop, the feet becoming fixed in an extended position by the contraction of the calf muscles, a condition that may take weeks or even months to overcome after convalescence is established, the patient meantime being seriously crippled. This annoying complication is wholly preventable and the principal cause of it is the careful smoothing and tucking in of the lower bed coverings, which adds so much to the neat appearance of the ward while at the same time it fixes the weakened patient's feet in the extended position as if with immovable splints. In all cases, whether surgical or medical, where the patient is confined to the bed for a long time, the bedclothes over the feet should be supported by a cradle, or at least left loose, and careful attention should be given to the position of the feet.

II. APPLICATION OF HEAT AND COLD

Applications of heat and cold by means of hot-water bags or bottles, ice-bags, or of cloths wrung out of hot or cold water, are measures within the discretion of the nurse. Keeping the patient warm with water-bottles and blankets is a routine procedure after all severe operations followed by shock, but is one that is liable to grave abuse. To make clear why this is so, and what is the real object to be attained, an explanation is necessary. The so-called warm-blooded animals, including birds and mammals (of which latter class man and the four-footed domestic animals are examples), possess a heat-regulating mechanism, under the control of the nervous system, which maintains a balance between the production of heat within the body by the chemical activities of the cells, and the loss of heat from the surface, through radiation and evaporation, so that the actual temperature of the body is kept at a nearly constant level. Thus the temperature of the circulating blood is independent of surrounding conditions. It is the same in winter as in summer, in the arctic as in the tropical regions. In the case of the cold-blooded animals this is not so; their body temperature varies with their surroundings. The temperature of reptiles and fishes is at all times the same within a few degrees as that of the water or air within which they live. This is their normal condition, to which they are adapted, and they are able to withstand very great changes in body temperature without ill effect. Some of them can survive chilling even to the freezing point. Warm-blooded animals are therefore called homœothermic, that is, with unvarying heat; while cold-blooded animals are pœcilothermic, that is, with changing heat. Warm-blooded animals are able to endure only a limited change of temperature. Cases are on record of persons exposed to extreme cold, without sufficient protection to maintain the body heat, who have recovered after the rectal temperature has fallen to 76° F., but when the rectal temperature has fallen to 70° F. death invariably ensues. Thus when men "freeze to death," they die before the circulating blood has reached what is regarded as a comfortable room temperature. Now under certain conditions the human body becomes in a sense pœcilothermic, that is, it tends to assume the temperature of the surrounding medium, although it does not become adapted to sustain such changes without harm. Prematurely born infants are in this condition, and those born at term are partially so for a time. But the condition of pœcilothermism of particular interest to us is a surgical one. In surgical shock and in severe hemorrhage the heat-controlling mechanism fails. The temperature tends to fall to that of the surrounding medium, and such patients may "freeze to death" through exposure to ordinary room temperature. In these conditions the loss of heat must be prevented by proper coverings and the surrounding temperature maintained at or a little above the normal level. The water-bottles surrounding the patient therefore should be warm but not hot, since the object is, not to raise the patient's temperature, but to prevent loss of heat from the surface. An additional reason for having the water in the bottles at a moderate temperature is the great liability of the unconscious patient to be badly burned by contact with a bottle that is even moderately hot. This unfortunate accident has occurred, at one time or another, in almost every hospital. It results not only in great and prolonged suffering to the patient, but often in expensive litigation against the hospital authorities. The accident is inexcusable because it is so easily preventable. The usual teaching is that the bottles should be placed at a distance from the patient, with layers of blanket between in order to prevent burning, but this is not the proper remedy. The patient, tossing about, is sure to come in contact with the bottles in spite of this precaution. The temperature of the water in the bottles must be low enough so that they cannot possibly burn.

Sloughs may also be caused by the ice-bag if it is kept too closely or too long in contact with the skin. Several layers of gauze should always be placed between the bag and the surface of the body, and the bag itself should be removed for a short time at least every hour or two.

Hot wet dressings form the best local treatment for all forms of septic infection. When frequent changes of such dressings are desirable this duty may be entrusted to the nurse. Local heat is employed also for the relief of pain, and this is almost the sole indication for the application of cold.

III. MEASURES FOR THE RELIEF OF PAIN

We have always at hand a method of relieving pain, certain, easy, and practically instantaneous; but this easy method carries with it, unfortunately, an almost equal facility for doing incalculable harm. The first principle, therefore, in the treatment of pain is that morphia, the great anodyne, is to be resorted to only when absolutely necessary. The nurse is not privileged to administer it without orders from the physician, but such orders are frequently provisional, so that the immediate responsibility for deciding when it shall be given rests often upon the nurse. No hard-and-fast rules for her guidance can be laid down, but a few suggestions of a general character may be made. When morphia is positively ordered the nurse has no choice but to administer it: she may, however, interpret as provisional an order not so phrased, if there is a reasonable presumption that it was intended as such. She may accept as final the patient's refusal to take it. The nurse should never insist on the patient's taking morphia against his will, except perhaps in the case of the routine pre-operative hypodermic. When morphia has been provisionally ordered it should usually be withheld for all degrees of pain up to and including moderate pain (number 4 in the scale of seven). In severe and very severe pain (6 and 7) it should be given at once unless the pain is tending to diminish, in which case it may be delayed for a time while other simple means of relief are tried. Number 5 in the scale (rather severe pain) is the dividing line where the nurse must act according to her best judgment. The patient should be told that he is better off without morphia if he can endure the pain, and he should be encouraged in every way in a voluntary refusal to take it. Of course it is exactly in the cases where the giving of morphia is most undesirable that the patient's own report as to the degree of pain from which he is suffering is least reliable. It is particularly against repeated daily doses of morphia that the patient must be guarded by every possible means. In the last stages of a hopeless and painful disease most of us feel that these rigid rules may properly be relaxed. The other less dangerous and also less efficient anodynes may be given with more freedom, but even with these great discretion should be used.

The simple means for the relief of pain vary with the location, character, and cause of the pain. Inflammatory pain is always associated with tenderness on pressure and, if the superficial tissues are involved, with redness of the skin and swelling. The application of cold, elevation of the part when possible, and removal of pressure help to give relief. The first principle in the treatment of pain from trauma is rest; that is, keeping the part still. Cold and elevation also assist here. Neuralgic pains are usually aggravated by cold: heat and stimulating local applications (such as cause a burning sensation and redness of the skin) help them. Cramp pains in the muscles are relieved by rubbing, pressure and heat. Aching in the back and limbs caused by strain from lying in the same position for a long time is a frequent source of great discomfort to patients. Even very slight changes of position from time to time give the greatest relief. Smarting pain from slight abrasions of the skin, as at the sharp edge of a bandage, are treated by removal of the cause of irritation and protection with a dry powder or a soothing ointment.

Burning and smarting pain, and itching, due to the effect on the skin of irritating secretions, may be relieved by cleanliness and drying powders, or by simple alkaline lotions, such as carbonate of soda (1 per cent. solution), or oxide and precipitated carbonate of zinc (two drachms of each to four ounces of glycerine and rose water). The most aggravated cases of this form of irritation occur when an intestinal fistula has formed involving the upper part of the small intestine. The active digestive secretions from this portion of the digestive tract play dreadful havoc with the skin when they are poured out constantly upon the surface of the abdomen, and the resulting suffering of the patient is constant and almost unendurable. The condition is rare, but the suffering is very difficult to control when it occurs. Fecal matter soiling the surface from fistulæ communicating with the lower part of the intestine causes little or no irritation of the skin.

Pain and discomfort from abdominal distention with gas is a common occurrence after operations in which the peritoneum has been incised and sutured. It lasts for two or three days or until the bowels have moved freely. No sure means of preventing it has been discovered, or, at any rate, none is generally known and practised. Hot fomentations, enemata and the passage of the rectal tube give some measure of relief. Morphia, of course, controls the pain but tends to aggravate the distention. Pain from the operative wound itself is not, as a rule, either severe or lasting. Provisional orders for hypodermics of morphia to relieve it are commonly given. There is undoubtedly a tendency towards too great laxity in this respect both on the part of the surgeon and the nurse, and the suggestions already given for the carrying out of such provisional orders should be carefully observed. A number of other painful conditions may be met with, following operations. Practically all of them arise from some form of trauma suffered by the patient on the table. The backache already referred to is common. It is difficult to relieve and it frequently lasts for many days. Every effort should be made to prevent its occurrence. Sore tongue, sore throat, and sore jaw result from the efforts of the anæsthetist to overcome obstructed breathing. A too tight or improperly adjusted bandage may give rise to much discomfort or even pain. A distended bladder from retention of urine is a common source of discomfort after operation. Every effort to avoid the use of the catheter must be made, but it is unsafe to delay more than twelve to sixteen hours at the most. Too great emphasis cannot be laid upon the necessity for strict asepsis in this procedure. The bladder is extremely susceptible to infection and the resulting cystitis is a serious complication.

Finally, every effort should be made to assist the patient in maintaining a healthy mental attitude towards pain, particularly in the long-continued chronic cases where the normal mental control is apt to be severely tried. Cheerfulness and a hopeful outlook help greatly to lighten the acuteness of physical suffering; laughter is a great anodyne for the slighter grades of pain. The sole function and business of pain is to seize upon and hold the attention, and if it can be prevented from doing this by any means at all its power is gone. In its higher degrees of intensity the demand of pain upon the attention is imperative and cannot be denied, but for the slighter grades any object of interest that can occupy the mind is a potent antagonist. Whenever the attention becomes fixed on something else pain, if present, rapidly falls in the scale of intensity and may even vanish momentarily from consciousness like a dissolving view. It is a commonplace observation that the patient feels better during the doctor's visit, not, of course, because of any soothing virtue in his presence, but because the patient's attention is attracted strongly away from his own sensations of pain or discomfort. On the other hand, moderate pain seems to become more severe if the mind dwells constantly upon it, and a morbid mental outlook tends to bring into the focus of consciousness all those numberless, slight, fugitive and meaningless pains to which every one is subject but which pass unnoticed in health.

IV. WATER AND FOOD

1. The need for water is the most imperative requirement of all living things, and the distress arising from prolonged deprivation of it is probably not surpassed by any other form of suffering.

One of the most unpleasant memories that patients who have had an operation performed under ether anæsthesia carry away with them is that of discomfort from thirst. For this reason, and also because of the great value of water as a remedy in certain conditions, it is important that the principles involved in the administration of water in surgical cases should be very clearly laid down.

In the first place, water should be administered freely in all surgical cases and at all times. There are, it is true, a few conditions, to be enumerated below, in which water by mouth must be withheld for a time, but this does not mean that water is not to be given at all; on the contrary, when it cannot be taken by mouth it should be given by one of the other two possible methods of administering it; namely, by direct injection into the tissues, usually under the skin, or by the rectum. Either of these methods is a more direct way of introducing water into the circulation than giving it by mouth. There is very little absorption of water through the walls of the stomach or small intestine. It is absorbed rapidly in the colon and rectum. When injected under the skin it passes almost directly into the circulation. Water may be given by rectum in one of two ways: either by the continuous drop method or by the injection of from eight to twelve ounces every two to four hours. Either plain water or normal physiological salt solution may be used. The latter must always be employed when water is to be given by subcutaneous injection: in this case it must, of course, be absolutely sterile.

In all forms of infection the administration of water in large amount is by far the most important part of the internal treatment. It aids in the rapid elimination of the toxins from the blood through the excretions. In cases of severe sepsis the patient should be made to take at least a half glass of water every half hour when awake. It is desirable that water should be taken abundantly for several days before an operation, and also afterwards, as soon as the stomach will retain it. Rectal injections of water should be resorted to after all operations when vomiting continues for more than a few hours.

Thirst is a distressing symptom immediately after almost every operation when a general anæsthetic has been used. There are several causes for this.

In the first place, the preliminary hypodermic of morphia and atropia usually given tends to check the secretions in the mouth and throat, leaving the mucous membrane abnormally dry, and the anæsthetic itself aggravates this condition. There is also a considerable loss of body fluids at every operation, resulting from the preliminary purging, from vomiting, from perspiration and from hemorrhage. From these causes many patients after operation suffer acutely from thirst, and this is increased by the common practice of withholding water altogether, or giving it very sparingly, for the first twelve hours or until the stomach will retain it. When water is withheld because of continued nausea and vomiting, the administration of saline solution or plain water by the rectal route helps greatly to relieve thirst by supplying the body with the necessary amount of fluid. Frequent rinsing of the mouth with water adds to the patient's comfort, by relieving the dryness of the mucous membrane. In the presence of nausea hot water is better borne by the stomach than cold. It is more palatable when given in the form of weak tea. Sipping cold water in small quantities is not to be recommended. It does not satisfy the patient's thirst, and is quite as certain to induce vomiting as when given in larger amount. After operations of such a nature that the act of vomiting in itself does no particular harm the restrictions against giving water need not be so rigidly observed. The washing out of the stomach which ensues is rather an advantage than otherwise, tending to hasten the return of that organ to its normal condition, by relieving it of a load of ether-saturated secretions that have accumulated during the operation.

The surgical conditions in which water by mouth must be withheld are three, or at most four, in number: (1) after operation of such a character that the act of vomiting is apt to do violence to the wounded tissues, as for example operations on any of the organs within the abdomen and particularly upon the stomach itself; (2) in cases of acute intestinal obstruction, and (3) in general peritonitis. In the two latter conditions it is useless to give water by mouth, since it cannot be passed on to that part of the intestine where it will be absorbed. Systematic stomach washing and, of course, appropriate operative interference are indicated in these cases. We may include in a fourth group all other cases in which from whatever cause the stomach immediately rejects whatever is put into it.

2. The principles governing the feeding of surgical patients may be briefly stated in very simple terms. The disturbance of

digestion caused by the anæsthetic makes it necessary to administer nourishment very sparingly until the stomach has recovered its tone. The rule is that, in uncomplicated cases, after the patient's bowels have moved, usually on the third day, almost any wholesome food may be given in reasonable quantities.. It is unnecessary to restrict the patient to a liquid diet through the period of healing. When fever is present the rules that govern feeding in medical cases with fever apply. After operations upon the stomach or intestines nothing is to be given by mouth for the first twenty-four hours. On the second day albumen water and water or weak tea may be given in small quantities at a time every two or three hours. On the third day broths and light gruels may be given. The amount and variety of food are increased gradually until at the end of a week a fairly full diet is attained.

V. ATTENTION TO BANDAGES AND DRESSINGS

The nurse should regularly observe the dressings over the wound to detect staining with blood during the first few hours, and later for soiling with discharges from the wound, or with urine or fecal matter. Concealed dressings, such as packs of gauze in the uterus or vagina, for example, may sometimes be overlooked. The nurse should consider that she shares with the surgeon, in some measure at least, the responsibility for seeing that these are removed at the proper time, and should call his attention to them if he has allowed them to remain more than three or four days.

Pressure from bandages too tightly applied is a not infrequent source of discomfort and even pain to the patient. A sharp fold cutting into the skin at the edge of the bandage may be trimmed away by the nurse. She cannot, of course, except in emergency, take the responsibility of cutting the bandage to any great extent, but she should report to the surgeon any complaints the patient may have made. Bandages around the chest, applied while the patient is relaxed and unconscious on the table, are particularly apt to be too tight. The resulting restriction to chest expansion in the act of breathing, at first felt as a minor discomfort, becomes after some hours a positive torture. As the nurse may some time be entrusted with the duty of relieving this condition, it is well for her to know how it should be done. At the side of the patient's body farthest removed from the wound the bandage is cut with the scissors, beginning at one edge and extending two-thirds of the way across towards the opposite edge. Four inches away from this first cut a second cut is made, beginning at the opposite edge and extending two-thirds of the way across. Both cuts include all the thickness of the bandages down to the skin. These two cuts overlap each other in the middle third of the width of the bandage, lying parallel and four inches apart. The bandage then opens up like a lazy tongs gate, allowing free chest expansion but not disturbing in the least the dressings over the wound. A strip of adhesive plaster or a small piece of bandage pinned across each gap at the upper and lower edge then makes all secure.

When splints or a rigid plaster-of-Paris bandage have been applied to a limb, pressure over some concealed point may give rise to severe sloughing if neglected. Every complaint of the patient as to pain or discomfort within a rigid splint or bandage, no matter how trivial, should be given careful attention and should be reported without fail to the surgeon. If such a rigid dressing has been applied to a limb without including the hand or foot, as the case may be; and if at any time the hand or foot becomes blue and markedly swollen or numb, then the bandage must be cut through its whole length and thickness (but not otherwise disturbed) so as to allow the circulation of the part to be restored, and if the surgeon is not accessible within a reasonable time the nurse must assume the full responsibility of doing this. Slipping or displacement of a bandage from being too loosely applied is a less common occurrence, but one that must be borne in mind and, of course, attended to and reported whenever it occurs.

VI. PRECAUTIONS IN ACUTELY INFECTED CASES

The precautions to be taken in acutely infected cases (particularly those infected with the gonococcus) naturally divide themselves into three categories: those for the protection of the patient infected; those for the protection of the other patients or the household of the infected person; and those for the protection of the nurse.

1. The Patient.—All care should be taken to prevent the transference of the infection from its original site to any other field. If, therefore, the vulva and vagina are acutely infected, great care should be taken to prevent the further infection of the urethra, or the carrying of the infection to the eyes. The former is attained by the avoidance of catheterization and the careful and persistent cleansing of the parts. The second danger is avoided by explanation to the patient of the great danger to her sight from any transfer of the infection by hands or clothes to the eyes and by careful oversight to prevent the use of any cloths or implements by the patient that might by any chance have come into contact with the infectious matter.

2. The Household or Other Patients.—To prevent the spread of infection to others, the patient should be subject to what would amount to a mild isolation. Great care should also be taken that others do not use the same towels, wash cloths, or other toilet articles, without careful preliminary sterilization.

3. The Nurse.—For self-protection, the nurse should take great care in her treatments to the patient; in her handling of infected dressings; and in her cleansing of her hands after each dressing.

As an additional precaution, no nurse who is attending such a case (this pertaining particularly in those hospitals where the services are not carefully segregated) should be permitted to attend obstetrical patients.

CHAPTER XVI

ROUTINE NURSING IN OPERATIVE CASES

I. PREPARATION OF THE PATIENT FOR OPERATION

The preparation of the patient for operation, while apparently a very simple procedure, requires the same forethought and careful attention to detail that characterizes any of the other procedures of surgical and gynæcological nursing. While the various steps are more or less routine in character (and may, at times, appear somewhat senselessly so), a reasonable and logical cause may be found at the foundation of each procedure, and (this reason once understood) the conscientious nurse will appreciate the importance of adhering as strictly as possible to the minutiæ of preparation.

A. Bowel Function.—As, unfortunately, a large proportion of our patients, particularly in gynæcological work, are inclined to a more or less obstinate degree of constipation, the necessity of a thoroughly evacuated intestinal canal should be emphasized. Our methods in this direction may be included under the two main heads of diet and purgation. The amount of food detritus in the alimentary canal is limited by the reduction of the diet for a variable length of time before the operation. A strict liquid diet for twenty-four hours is generally sufficient, nothing but water in small quantities being administered for the last eight or ten hours. As regards purgation, the method largely depends upon the individual preference of the operator. Some place their confidence in broken doses of calomel followed by a saline, the treatment being started twenty-four hours before the operation; others depend upon a single dose or repeated doses of a saline alone; while yet others give a single dose of one ounce of castor oil twenty-four hours before the operation. But, whatever the purgative used, its administration should sufficiently precede the hour of operation to permit of thorough and repeated evacuation of the bowels before the patient is taken to the operating room. And it is equally true that, whatever the form of purgative used, nearly all surgeons agree upon the use of a final cleansing soapsuds enema several hours before the operation. The word "cleansing" should here receive emphasis. The process is more than the simple administration of an enema. To be cleansing, the enema must be repeated until a clear return is obtained, and this may require several repetitions.

To Summarize.—The patient is put upon liquid diet for twenty-four hours before the proposed hour of operation, with water only for the last eight or ten hours. She is given one ounce of castor oil (or other purgative) at the same time. Assuming the time of the operation as 9 A.M. she receives at 6 A.M. soapsuds enemata until a clear return.

The Reasons.—In abdominal operations, the degree of shock to the patient is increased or decreased proportionately to the extent to which the intestines are handled during the process of operating. It is perfectly evident that distended intestines are bound to be more liable to injury and manipulation in keeping from the field of operation than those which are flat and empty and easily pushed and kept to one side. It is also very evident that a thoroughly emptied intestinal canal is less likely to extrude large quantities of infectious material into the abdominal cavity, if injured, than one which is greatly distended with gas and food detritus. Finally, the work of the surgeon is much facilitated by the absence of the coils of distended intestines constantly crowding the field of operation and, consequently, the operation is made shorter and the liability of the patient to shock much lessened. In addition to these arguments that apply directly to the time of operation, there are those that might be called the post-operative considerations; *e.g.*, the diminished distention and gas pains of the patient after reacting from the anæsthetic; the lessened likelihood of extreme nausea and vomiting; and the reduced danger of intestinal obstruction from paralysis or mechanical causes.

B. Field of Operation.—This, the second consideration in the preparation of the patient, is based upon the necessity for as nearly perfect asepsis as is possible, and consists in two procedures,—the shaving of the field and the sterilization of the field. While the methods of attaining asepsis differ as widely as do those of purgation in the previous paragraphs, we again have practical unanimity upon the subject of thorough shaving the day before the operation. This is the widely accepted course, although it is true that many of our best surgeons do not require the shaving until the day of the operation. Where a soap (or other) poultice is used in the preparation, this early shaving gives the poultice from twelve to eighteen hours in which to accomplish its work before the final preparation. Where the iodine preparation is used, it gives the field of operation time to thoroughly dry out, the presence of the soap and water used in shaving interfering with the antiseptic action of the iodine. The process of shaving should be a thorough one, care being taken, however, to avoid the making of any abrasions of the skin surface. As a general rule, it is better that both abdomen and vulva be shaved for every gynæcological operation, unless otherwise directed.

The next step in the preparation of the field of operation consists in the various steps that are taken with the idea of sterilizing the skin. While it is acknowledged that perfect sterilization of the skin is impossible, yet this desirable condition can be nearly enough approximated by the methods in vogue to render danger of extraneous infection practically *nil*, if the technic of preparation is conscientiously followed. The effort has, naturally, been to find a method of skin sterilization that would combine simplicity with the aseptic advantages of the most complicated methods. The two methods now most popularly accepted are the old one where green soap and water scrubbing is followed by the successive washing with alcohol, ether and a solution of bichloride of mercury in the strength of 1–1000, and the newer where the field of operation is simply painted with the tincture of iodine (or a solution of equal parts tincture of iodine and 95 per cent. alcohol) and permitted to dry. Either of these methods gives the desired degree of asepsis and, as a result, the newer being the simpler is coming into widespread recognition. Whichever method is employed, the time of application is generally the same, on the table, after or during the administration of the anæsthetic.

II. ROUTINE TREATMENT AFTER OPERATION

In the average operative case, where there is no serious complication or sequela that may cause the introduction of new elements of care or treatment, the large majority of surgeons have what might be described as an elastic routine treatment. By this we mean that in each operator's experience a certain method of procedure has seemed to give the best results in the greatest number of cases, so he adheres to that routine where it is not contra-indicated for one reason or another. While it would, of course, not be feasible to enumerate all of the methods of attaining the same end that have grown up among the various operators of large experience, an effort will be made to draw what seems a fair average from the wealth of material; to give a general outline of what has proved acceptable to many, and to give the reasons for each step, so that it may be understood and the reason for variation in any particular technic appreciated.

1. Minor Steps for the Comfort of the Patient.—The patient who has undergone a laparotomy is brought back to the ward with an abdominal wall that has been cut, to a greater or less extent; that has been pulled by retractors in the effort to reveal the abdominal contents; and that has had its contents more or less extensively handled. Any one who has endeavored to relieve a plain, old-fashioned cramp by drawing up the knees will see a reason for putting a pillow under the patient's knees as soon as she shows signs of reacting from the anæsthetic. The great discomfort caused by the necessity of lying continuously in the same position is hard to appreciate by those who have not undergone the experience, but it is sufficiently great to warrant the frequent turning of the patient from side to side as she complains of the position she occupies. The feeling that a patient must remain flat on the back for an indefinite length of time has long passed into the disuse that it deserved. These two simple aids (the pillow under the knees and the change of position) will add more to the comfort of a patient than all the possible assurances of a rapid recovery or that the pain will soon wear off.

2. Administration of Water.—After an anæsthetic two points arise in regard to the administration of water. The patient is generally very thirsty and, at the same time, very nauseated. On the treatment there is a difference of opinion. One body believes in the administration of very small (teaspoonful) quantities of hot or cold water, with the idea of alleviating the thirst without increasing the nausea. Others give larger (two ounces, or more) quantities, generally of hot water, with the idea of assuaging the thirst, regardless of the nausea, believing that, if the patient does vomit, this is a very efficient way of washing the stomach of the ether that has been swallowed during the administration of the anæsthetic.

3. Nourishment.—The nausea following anæsthesia does not render it advisable to administer any nourishment for several hours after reaction. As soon, however, as the nausea permits, it is desirable to start nourishment in such a form as is easily assimilated by the already upset intestinal tract. Albumen water is generally used as a starter, being given first in teaspoonful doses, increased as circumstances permit until several ounces are being given. Other liquids are usually not administered until the completion of the first twenty-four hours after the operation, at which time full liquid diet (without milk) is instituted. But, why is milk omitted? Owing to the anæsthetic and the manipulation of the intestines during the course of operation, there is a varying degree of intestinal paralysis for the first few days after an operation. This condition naturally favors the formation and retention of gas. Intestinal gas is one of the most prominent causes of abdominal pain following laparotomy. With a large number of people, milk ingestion and gas formation are practically synonymous. It would seem wise, therefore, to leave the addition of milk to the dietary until after the resumption of the bowel function,—an effort being made to establish this at the expiration of from 48 to 72 hours after the operation.

4. Bladder Function.—The question of attention to and the care of the bladder function is one that is all too apt to be slighted, when one considers its importance and the number of different ways in which its neglect may cause trouble and confusion to the attendants, as well as both these and suffering to the patient. There should be no routine resort to the use of the catheter in after-treatment. This may seem an extreme statement, but a little consideration of the reasons behind it will show, at least, the possibility of its importance. With some physicians, it is the practice to have the patient catheterized every eight hours after the operation until she voids. This custom is rather one of the past than of the present, but is one that can still be observed. This routine should decidedly not be followed, except in operation for the correction of displacements of the uterus,—and the reason for the custom in the latter class of cases will be given later.

The ingestion of liquids for the last eight or twelve hours before operation and for several hours after the return from the operating room is greatly diminished. From this cause and from the effects of the anæsthetic upon the renal secretion, the output of urine is greatly diminished during the 24 hours immediately following operation. It should, also, be noted that in the ordinary routine preparation for laparotomy the bladder is catheterized just before operation. With the recent catheterization remembered and the reduced urinary output considered, it is evident that there will not, ordinarily, be any call for post-operative catheterization until at least 12 (and probably more) hours after operation. And an appreciation of the dangers of repeated catheterization will make every one hesitate before resorting to a measure of this sort unless there are undoubted indications for its use. As a rule, then, the catheter should not be called into use until at least 12 hours after an operation, and then only in the presence of some definite indication and after resorting to such measures as we may to encourage the patient to void. The indications for the use of the catheter are, of course, a distended bladder which must be relieved or as a diagnostic aid in suspected suppression of urine. The aids to inducing spontaneous evacuation of the bladder are: (*a*) the sound of running water, which is not infrequently efficacious; (*b*) the pouring of warm water over the vulva, which will sometimes succeed when the preceding measure fails; (*c*) lastly, the administration of an enema, with the return of which the bladder is frequently evacuated. If these measures fail, it is then time to resort to the use of the catheter. Naturally, there are times when it is not desirable to use enemata so early after operation, and in such cases it is sometimes necessary to use the catheter earlier.

In operations upon the round ligaments for retrodisplacement of the uterus, the weight of the distended bladder upon the uterus is to be avoided during the first 24 hours after operation, lest the success of the operation be endangered through the strain placed upon the transplanted ligaments. In such cases, there is no way of avoiding use of the catheter and it is customary, in some hospitals, to have the patient catheterized every eight hours after the catheterization on the table for the first 24 hours or more. But it must be borne in mind that the catheter demands all of the precautions used for any aseptic proceeding that involves the entrance into any of the clean cavities of the body. An infection of the bladder is a serious matter for both the surgeon and patient, and the accompanying danger of an ascending infection to the kidneys must be an ever-present bugbear of warning to the person bearing the responsibility of the catheterization. It is a point upon which there is no possibility of overemphasis and upon which reiteration is perfectly excusable. A bladder infection, while possibly not the most unusual accident of surgical technic and possibly, also, not the most inexcusable, is in all probability the most unexcused, with the possible exception of an abscess following hypodermic medication.

5. Bowel Function.—For somewhat the same reasons that apply to the bladder function, the bowel function is partially inhibited during the first few days following an operation that involves manipulation of the abdominal contents. The action of the anæsthetic, combined with the handling of the intestines and the absence of foodstuffs that have a marked residue, gives the double effect of partial paralysis of the intestinal walls and the absence of the normal bowel stimuli. There is, therefore, no object in the early administration of enemata and cathartics, save the possible presence of large quantities of gas. The custom has therefore gained common use of refraining from the use of any intestinal stimulant during the first two or three days after laparotomy, at which time the resumption of the bowel function is encouraged by the administration of a simple enema. From this time on, if simple enemata are successful, the bowels are moved once daily by this measure until the seventh day. Should, however, the simple enema prove insufficient to attain the desired end, a hypodermic injection of physostigmine salicylate gr. 1/40 and strychnine sulphate gr. 1/30 may be given and followed in half an hour by a purgative enema. The added stimulating effect of this procedure will frequently succeed where the simple enema fails. After the seventh day, should the bowels still prove recalcitrant, the enemata should be discontinued and some medicament that has a stimulating effect upon the intestinal musculature substituted,—such preparations as the pill of aloin, strychnine and belladonna, cascara, or something similar generally proving satisfactory.

6. Opiates.—Only passing mention will be made of this rather important problem in operative after-treatment, as the subject is one that rests solely in the hands of the attending surgeon and can be decided by him only. Opiates are, as would be naturally supposed, indicated where the pain is sufficiently severe to require attention and the simpler methods prove inadequate. The preparations most frequently used are the sulphate of morphine, the sulphate or phosphate of codeine and the hydrochloride of heroin. These medicaments are generally administered by hypodermic injection and in doses up to gr. 1/4, gr. 1/2 and gr. 1/12, respectively. Owing to their increased effect upon the intestinal paralysis already existing, it is generally accepted that no more should be given than is absolutely necessary for the comfort of the patient and then discontinued at the earliest possible moment. In the limited use occasioned after operation, the question of habit formation does not usually come up for consideration.

7. Dressings.—The question of dressing is one that depends upon the suture material used and the condition of the wound. Where the wound is clean and absorbable suture material is used, there is generally no necessity for dressing the operative wound until the fourteenth day. Where non-absorbable suture material is used and must be removed, the time for dressing depends upon the nature of the material and the method of its use. If the non-absorbable suture material is fine silk used as a running skin suture, it may be removed from the fifth day on, dependent upon the method of closure employed for the rest of the abdominal wall. If silkworm-gut through-and-through sutures are used for support they should be removed about the tenth day, as they have a tendency to cut out and cause considerable irritation and discomfort. If a subcuticular silver wire suture is used for skin approximation, it should be removed about the fourteenth day.

8. Sitting Up.—After the average gynæcological laparotomy, the patient may be permitted to sit up out of bed for a few minutes on from the tenth to the fourteenth day. The custom varies considerably with different surgeons, but the above limits may be accepted as the early and late limits of the conservative element. In minor cases, such as curettage, trachelorrhaphy, and perineorrhaphy, the patient may be permitted to get up anywhere from the seventh to the tenth day. It should, however, be understood that permission to get up out of bed after a laparotomy does not convey the idea of a whole day (nor even a half day) sitting in a chair. The first venture should not be for more than a few minutes,—half an hour at the outside. The next day, the length of time may be somewhat increased and repeated in the afternoon. By this gradual method, the strength of the patient is increased by degrees corresponding to her endurance. If she does not feel any fatigue after the first day, the natural inference is that she will bear a longer siege on the second day than will the patient who is exhausted by a fifteen minutes' seance on the first attempt.

9. Going Home.—If all has gone well from the time of the operation and there has been no seriously run-down condition already existing to make the convalescence protracted, the patient may ordinarily be permitted to return to her home at the expiration of three weeks after the operation. Of course, this period is not a definite nor an invariable one. The condition and home circumstances of one patient may be such as to make an early return desirable, and, in another, quite the contrary may be the case.

10. Belts, Binders and Supports.—The question that is frequently asked by a patient, following an abdominal operation and preceding her return to her home, concerns the advisability or necessity of wearing some form of abdominal supporter. In a well-nurtured woman, with muscular, firm abdominal walls, the use of a support is to be discouraged. If the abdominal walls are greatly relaxed and weakened from the extended presence of a large tumor or, if there has been infection present that necessitated the use of prolonged drainage, it may be well to use some form of corset or binder that will give the necessary support until the walls have regained their natural strength and tone.

CHAPTER XVII

POST-OPERATIVE COMPLICATIONS

No effort will be made to consider this rather extensive subject from the view-point of the surgeon, as the diagnosis and treatment of the different conditions should not devolve upon the nurse. An effort will, however, be made to so present the more common of these complications that the nurse will get a fair picture of the cardinal signs and symptoms in each case, with the idea of showing the great importance of accurate charting of even the most routine and, apparently, unimportant events. The causes, so far as known, will be included in the description, in order to promote the intelligent coöperation between physician and nurse that is so important for the best interests of the patient.

I. SHOCK

The cause of operative (or post-operative) shock is not thoroughly understood. The predisposing causes are, however, fairly well recognized and accepted. Among the more important of these are prolonged anæsthesia; undue exposure of the patient before, during or immediately after operation; excessive handling of the viscera; loss of blood; extensive trauma; and severe toxæmia. The occurrence of shock, as might be expected, is also influenced by the character and extent of the operative procedure.

The occurrence may be at any time from during the operation to a few hours after the return of the patient to her bed.

The signs and symptoms are pallor; coolness of the skin surface, frequently accompanied by cold sweat; fall of the temperature, possibly to subnormal; rapid, irregular and weak pulse; increased and irregular respirations; more or less mental dulness; and a general appearance of some severe crisis.

II. HEMORRHAGE

Post-operative hemorrhage (disregarding the classes into which it has been divided) is one of the most serious and, fortunately, most rare of the complications or sequelæ with which we have to deal. The causes are generally one of three: the failure to ligate a severed vessel at the time of operation; the slipping of a ligature on a tied vessel; or, in the later cases, opening of a vessel due to the separation of a slough. The occurrence may be at any time during the first week.

The symptoms may come on suddenly or gradually, dependent upon the size of the vessel involved and the lack of interference with the flow by surrounding tissues. In the more gradual form of hemorrhage, there is a steady increase in the pulse rate with a corresponding decrease in volume; the respirations become more rapid and shallow; the temperature falls, frequently to subnormal; there are pallor, restlessness, precordial distress, dizziness, pain at site of hemorrhage and, frequently, fear of approaching death.

Where the vessel is a large one and there is no interference with the flow, the change is sudden and marked. The sharp pain (particularly if the hemorrhage is intraperitoneal) is quickly followed by the restlessness, pallor, air-hunger, rapid fluttering pulse, precordial distress, fear of impending dissolution and, in the end, death. In the latter cases, the patient may have passed through the succeeding stages so quickly that death will have supervened before the house physician can be summoned.

III. ACUTE DILATATION OF THE STOMACH

The onset of this condition is apt to be sudden and alarming. Large quantities of fluid, out of all proportion to the amount ingested, are vomited. There are frequent eructations of gas. And collapse is an early symptom. The temperature is either not elevated, or only slightly so. The pulse is rapid and weak. The respirations are increased in frequency and often show marked dyspnœa. There is distention in the region of the stomach, without any visible peristalsis.

IV. INTESTINAL OBSTRUCTION

The most common cause of post-operative intestinal obstruction is the formation of intestinal adhesions. These may act by causing kinking of the intestines or by the formation of bands. Other less common post-operative causes are volvulus, hernia and intussusception.

Obstruction of the bowels may occur at any time, from days to months after the operation. The symptoms, in the more acute forms, are distention; pain; anorexia; nausea; vomiting, the latter becoming progressively worse and finally in many cases containing fecal matter; increase in rapidity of pulse and respiration, accompanied by a low and frequently subnormal temperature; and inability to move the bowels by enemata. In such cases, there is generally early collapse unless the condition is promptly relieved by operative measures.

V. INFECTIONS

The infections (as the name would indicate) are the result of the presence or introduction of pathogenic bacteria. They may be either local or general.

1. The simplest of the **local infections** is the stitch abscess and, after that, the mild wound infection. Of course, the latter may vary in degree from a very simple matter to a fairly serious one, but, in the general run of cases, it is one of the simplest of the post-operative complications. The cause of such infections is, necessarily, the introduction of some pathogenic microörganism either from within or from without. The staphylococcus is the most common organism found in these cases, although B. coli communis, B. pyocyaneus and others are found not infrequently.

The occurrence is generally from the third to the eighth day and is accompanied by an elevation of temperature (102° to 103° F.), local pain and tenderness, headache, loss of appetite and general discomfort. The symptoms are, in other words, those that would be expected to accompany a mild infection.

2. **Sapræmia.**—This condition is due to the absorption of the products of decomposing tissue which is acted upon by the bacteria of putrefaction. The onset is sudden, generally within a few hours of the exposure of raw surfaces to absorption from decomposing tissues. The symptoms (which may arise from a few hours to several days after operative or obstetric procedure) are a sudden rise of temperature to from 102° to 104° F., frequently accompanied by a chill; a rapid and full pulse; increased respirations; anorexia; headache; thirst; and, sometimes, nausea. The face is flushed; the tongue coated; and the urine is scanty and highly colored.

3. **Peritonitis.**—Peritonitis may be either local or diffuse. The local form may be caused by mechanical, chemical or bacterial agents. The symptoms are the same as would be expected in a localized inflammation in any other region, with the symptoms peculiar to intra-abdominal affection superimposed. We, therefore, have pain, tenderness, elevation of temperature, increase

of pulse and respiration, anorexia and possibly nausea and vomiting. In addition to those, we have abdominal distention, general or localized rigidity of the abdominal muscles, sometimes a palpable tumor and, probably, either diarrhœa or constipation, the latter being more common.

Diffuse peritonitis is due to the presence of pathogenic micro-organisms in the abdominal cavity under conditions that favor the extensive spreading of the inflammatory process. These conditions may be dependent upon the method of introduction, quantity of infectious material, character of the organism or reduced resistance of the patient. The onset is gradual, the symptoms usually making their appearance from twenty-four to forty-eight hours after operation. At first, there is localized pain, which afterwards is general throughout the abdomen. This is intense in character, accounting for the position generally assumed by these patients—with the thighs flexed on the body and the shoulders elevated in the effort to relieve the tension of the abdominal muscles. During the earlier stages, the abdominal muscles are contracted—the walls being at times retracted as a result. Later there is extreme distention. The respiration is of the thoracic type—also as a result of the abdominal tenderness and distention—and the tympany marked. A very rapid pulse is generally an early symptom, being accompanied by a rise of temperature to from 101° to 104° F., which may reach as high as 110° shortly before death. The elevation of temperature is, however, not constant, as, in rapidly fatal cases, it sometimes remains practically normal throughout the course of the disease. There is early and persistent vomiting, which may, during the later stages, become fecal in character. The action of the bowels is not constant, either diarrhœa or constipation occurring; the latter, however, being the more persistent and common symptom. Hiccough is also a very common symptom, appearing early in the course of the disease and being persistent in character.

4. **Septicæmia.**—Septicæmia is a result of the presence of bacteria and their products in the blood stream. The most common of the organisms found in this condition are the Streptococcus pyogenes and the Staphylococcus pyogenes aureus and albus. The symptoms arise in anywhere from a few hours to several days, being usually ushered in by an initial chill. There is an elevation of temperature to from 103° to 105° F., usually

15

with a slight daily remission. The pulse is small and rapid and the respirations are usually increased in number in proportion to the pulse. The other symptoms are those common to all infections: anorexia, nausea, vomiting, scanty and highly-colored urine, and, sometimes, diarrhœa.

5. Pyæmia.—This condition, which is becoming daily more rare (particularly as a sequela of operative procedure), may be described as septicæmia complicated by the formation of multiple abscesses. We have, therefore, the presence of bacteria and their products in the blood stream as is the case in septicæmia and, further, we have the formation from time to time during the progress of the disease of abscesses. These abscesses may be superficial (in which case the condition is apt to be more favorable) or they may be located in the most inaccessible regions, as the lungs. The condition is usually fatal, except in its mildest forms. The symptoms are those of septicæmia, at the beginning, but, as the disease progresses, the initial chill is repeated at irregular intervals, probably with the formation of new abscesses. With each chill there is a following more pronounced rise of temperature. With the evacuation of the abscess contents (either by incision or spontaneous rupture), there is temporary improvement in the condition of the patient, to be followed by another chill, another rise of temperature and gradually diminishing strength as the disease progresses. The duration of the condition may be abbreviated where the infection is particularly virulent or where the resistance of the patient is already greatly lessened by preëxisting disease. Usually, however, the course is prolonged (sometimes for weeks), the patient steadily losing ground, but having short periods of temporary improvement.

VI. PULMONARY

The most common of the pulmonary complications of convalescents from operative measures are lobar and bronchopneumonia. The predisposing causes are a lowered resistance from any cause, and undue exposure of the patient before, during or after the operation. The exciting causes are bacteria and, more rarely, the inspiration of foreign materials.

The onset and course of the lobar form do not materially differ from the pure form of the disease, except as the diagnosis may be clouded by the other conditions following operation. The early pain in the chest, the chill and initial rise of temperature, the increase of pulse rate with disproportionate increase of respiratory rate, the cough and characteristic sputum, and the recovery by crisis are all similar, although the onset may be missed or confused with other possible sequelæ or complications.

In bronchopneumonia, the onset and course of the disease are very much less characteristic and the diagnosis must rest upon a careful study of symptoms, the exclusion of other trouble and, finally, the findings on physical examination, which, too often, are very indefinite.

VII. URINARY SYSTEM

There are four conditions of the urinary system that, while not confined in their appearance to following operations, do, with varying degree of frequency, complicate convalescence. These are, in the reverse order of their possible serious import, retention of urine; retention with overflow (sometimes called "paradoxical incontinence"); incontinence of urine; and suppression of urine.

1. Retention of Urine.—Simple retention of urine is a very frequent and, usually, a very slight sequela of operations under general anæsthesia. The tentative diagnosis is usually made by either the nurse or the patient. If the introduction of a catheter is rewarded by a free return flow of urine, the diagnosis is, naturally, confirmed. There are, however, two very real dangers associated with this very simple condition, one very remote and the other imminent. There is always the possibility, however remote, of the overdistended bladder rupturing, with the occurrence of a diffuse peritonitis an almost certain accompaniment. There is, besides, the not infrequent occurrence of cystitis (from incorrect technic) to be considered and guarded against.

2. Retention with Overflow.—The dangers of this condition are identical with those of the preceding, somewhat increased by the possibility of a delayed or mistaken diagnosis of the true condition. Here, while in truth an almost complete retention is present, there is often sufficient dribbling of urine to give the false impression of incontinence. Where the suprapubic area is covered by dressings after an abdominal operation, it is sometimes difficult to determine by examination the presence of an overdistended bladder. Where, however, there is the possibility of such a condition existing, all doubt may be easily removed by the passage of a catheter.

3. Incontinence of Urine (Enuresis).—This condition is not a very common one as a sequela of surgical procedure, most frequently occurring as a result of temporary paralysis of the bladder sphincter or actual injury thereto in the course of the operative procedure. The constant dribbling of urine or the occasional gush as the bladder becomes distended is of itself very distressing to the patient, although (if of the simple form) it generally is of very short duration. Where the amount of urine discharged in the course of several hours is such as to indicate a normal secretion for that length of time, there is very little room for confusing this condition with any other,—retention with overflow being the one most nearly resembling it and eliminated by the amount of urine discharged.

4. Suppression of Urine.—This condition (fortunately not a very frequent complication of operations) is necessarily serious. The failure of a patient to void urine within twelve hours after operation should be followed by catheterization for the purpose of deciding between the two possibilities of retention or suppression of urine. The early diagnosis and prompt institution of treatment are essential for the welfare of the patient.

In summary of the various features that may characterize these more common sequelæ of operations (more particularly abdominal operations), it is evident that a careful charting of the subjective symptoms of the patient—the temperature, pulse and respiration—so that any marked deviation from their normal ratio may be noted; of the absence or presence of nausea, vomiting or hiccough; the absence or presence of bowel movements, with the character of the movement and the fact that gas is or is not passed; the voiding or retention of urine, whether the former is voluntary or involuntary, profuse or scant and dribbling; the presence of cough; and the presence, location and character of pain, is a matter of the utmost importance, particularly in those conditions where an early diagnosis is practically imperative for the welfare of the patient.

CHAPTER XVIII

ANOCI-ASSOCIATION

I. SHOCK AND FEAR

No one will be inclined to question that great anxiety and fear, together with the emotional strain incident to physical pain, may have a decided influence upon a patient's fitness to meet the ordeal of an operation, and hence become a factor in the operative risk, but it is only in very recent years that any systematic study has been directed to this subject. That both strong emotion and physical injury play an important part in causing the condition we know as shock has, of course, always been recognized, but our knowledge of the true nature of this causal relation was of too vague a character to be of any practical use to us in suggesting ways of preventing and treating the condition of shock. We have had, in consequence, almost nothing in the way of a standardized technic for the management of patients with reference to this aspect of our problem.

We owe to Dr. George Crile a series of experimental and clinical researches which throw a wholly new light upon this subject. The practical result of these studies has been the development of a new technic in the management of patients who are to be operated upon. These new methods have now been in actual use in the Lakeside Hospital in Cleveland, Ohio, where Dr. Crile is the visiting surgeon, and in a few others for several years, and have resulted in a most striking reduction in operative mortality and in post-operative morbidity. That part of the new method which consists of manipulative measures is quite simple and can be easily described. Another and very important part, however, which relates to the control of the patient's contact, mentally, with the conditions which surround him from the time an operation is first proposed until it is over and he is restored to health, cannot be so easily presented in the form of exact directions. Here much will depend upon the personality of the surgeon and also of the nurse who is in immediate charge of the case. The part of the nurse will be of great importance, and in order that she may enact it well it is necessary for her to understand as clearly as possible the nature of the problem.

Let us ask at the outset the question, What are the principal physical phenomena attendant upon extreme fright, *i.e.*, the symptoms of fear? They are rapid action of the heart, increased rate of respiration, pallor of the skin, sweating, dilatation of the pupils of the eyes, muscular relaxation, organic sensations of weakness described in common language as a " sinking " feeling, and disturbance of the digestive functions. Now let us ask a second question of the same kind. What are the symptoms caused by severe and prolonged muscular exertion? The answer is exactly the same: muscular exertion carried to the point of extreme exhaustion gives rise to the same condition in the body as does the emotion of fear at its highest intensity. We may now ask a third question: What are the symptoms of shock resulting from severe physical injury? Again the answer is the same; word for word, the answer to the first question will stand for an answer to the second or the third. We can, of course, point out minor differences, but in all essentials the effects of fear, of exhaustion from severe exertion, and of shock from severe injury are identical and as a matter of fact one cannot always tell at the first glance whether a man is badly scared, or badly hurt, or exhausted from overexertion.

Wherever we find effects so closely corresponding as in these cases it is natural and reasonable to assume that the causes which produce these effects are also identical. Let us see, therefore, if we can find any common cause at work in each of these three widely different conditions. In what exact way does fear cause these phenomena; in what way does muscular exertion cause them; how does physical injury cause them? Now in the second case, that of severe muscular exertion, the answer seems obvious enough. It is a case of exhaustion; the muscles have done a tremendous amount of work and are, as we say, tired out. If we put it in mechanical terms we may say that the muscles have used up all the energy-giving substances from which their power is derived, and they lose power just as a steam engine does when all the coal in its furnaces is burned out, and all the water in its boiler is turned into steam. There has been in this case an immense draft upon the reserve energy of the body, and, because we are familiar with the idea, it seems natural to us that the whole body should share in the exhaustion which follows, and it is easy to understand that the nerve-cells of the brain, which control and direct the movements of the muscles, should especially partake of the effects of muscular exhaustion.

Now fear and injury both, under natural conditions, produce intense muscular effort. For both arouse the instinct of self-preservation, which expresses itself in two forms, the impulse to fight and the impulse to run away. Perhaps a third form may be distinguished in the instinct to struggle when in the actual grip of something that hurts. Whichever form the instinct takes, great expenditure of muscular energy is called for, with an equal expenditure, though one that is silent and invisible, in the cells of the brain whose activity drives the motor mechanism. When the impulse of flight predominates emotion takes the form of fear. With the fighting impulse another emotion appears, that of anger, which, when in high intensity, also leads to rapid exhaustion. In the case of the struggle against anything that hurts, the emotion aroused seems to be a blending of the other two.

Even when the grosser physical manifestations of these emotions, such as actual flight or struggle, are suppressed, there are inner physical effects connected with them, beyond the reach of the will, that apparently produce the same exhausting effects. Probably, also, the very effort to suppress the more visible muscular exertions is itself highly exhausting. In Dr. Crile's researches, actual microscopical study in the laboratory of hundreds of animal and human brains and of thousands of nerve-cells has shown changes characteristic of cell exhaustion, resulting from each of the three causes, physical exertion, physical injury and fear.

Dr. Crile has also shown that even in an animal anæsthetized by ether the impulses received by the brain along the nerves leading from the part of the body that is injured bring about changes that produce exhaustion in the brain-cells almost as severe as if no anæsthetic had been used. When nitrous oxide and oxygen was the anæsthetic used, the evidence of exhaustion in brain-cells was much less. When a part of the body was completely cut off from connection with the brain, as by division of the spinal cord, then no amount of injury of this disconnected part would cause any appearance of exhaustion in brain-cells or any symptoms of shock. We have here then two new facts which can be practically applied in the prevention of shock. First, we have learned that ether, while it obliterates consciousness, does not protect the brain from incoming impulses which excite to an exhausting waste of energy; while gas-oxygen anæsthesia, on the other hand, does protect the brain to some extent. In the second place, we now know that if the sensory nerves leading from the wounded part can be temporarily blocked (*i.e.*, rendered incapable of carrying nerve impulses), as by the infiltration of the tissues with a local anæsthetic, then no exciting stimuli will reach the brain-cells and there will be no waste of energy and no shock.

Further, the character of an emotion is largely determined by memory. Our conscious life from moment to moment is a mosaic of remembered things and of new impressions of things that are happening. New impressions call up old experiences through the association of ideas, and our resulting action and emotion will depend upon the character of the associations that are aroused. These associations are broadly of two kinds, those that suggest beneficial effects (bene-associations) and those that suggest harmful effects (noci-associations). The new technic involves the avoidance of suggestions or associations of harm, and for the description of such a technic Dr. Crile has coined a new word—anoci-association.

II. THE TECHNIC OF ANOCI-ASSOCIATION

Every major surgical operation, even when the risk is small, is an ordeal of so serious a character that few men or women can meet it without considerable emotional stress. It is not true, of course, that every one who is to be operated on is seriously frightened. On the contrary, every surgeon knows how rare it is to see any patient yield to craven fear, and he is an almost daily witness of examples of serene and unfaltering courage that have never been overmatched upon the field of battle. The brave are able to overcome fear and to control their actions in spite of it, but they are not therefore exempt from emotional stress and the drain which it involves upon the vital forces. In ordinary cases this is not perhaps of much importance, but in critical cases it may be a decisive factor in the operative hazard. There is, therefore, nothing fantastic or visionary in any rational attempt to reduce this factor as far as may be possible. That every effort should be made to prevent the shock-producing effect of actual trauma needs, of course, no argument whatever.

It is the aim of the anoci-association technic to bring under control at every possible point these two factors in the operative risk, the harmful effects of emotion and of trauma. It applies to the whole period of a patient's surgical experience, from the first consultation with the surgeon up to final recovery. This period may be divided into four parts: (1) from the first consultation to the time of entering the hospital; (2) from the entrance to the hospital to the beginning of the anæsthetic; (3) the anæsthetic, the operation, and the recovery from the anæsthetic; (4) the convalescence. There are four critical periods when the mind of the patient is particularly susceptible to harmful suggestions: (1) the first contact with the surgeon; (2) the first entrance to the hospital; (3) the time immediately before the operation, when the patient at last comes face to face with the dreaded ordeal; (4) the time when consciousness returns on recovery from the anæsthetic.

As Dr. Crile says: "It is only experience and a sympathetic understanding of the sensibilities of patients that enables any surgeon, at the time of diagnosis and recommendation of operation, to reduce to a minimum the first personal contact. The pre-operative stay in the hospital can be made least harmful by the highest degree of efficiency on the part of the nursing and resident staff of the hospital, and by considerate attention to the details on the part of the operating surgeon." As to the fourth period, "inconsiderate nursing, rough dressings, and tactless contacts in the hospital during convalescence" are to be avoided.

The technic at the operation itself can be very briefly summarized. A small dose of morphine and scopolamine is given an hour and a half or two hours before the operation, except, of course, in the very young or very old, or in badly handicapped patients. Nitrous oxide with oxygen is the anæsthetic employed, and it is administered by a trained anæsthetist (preferably a woman, in Dr. Crile's opinion). The patient is carefully handled and placed on the operating table in proper position to avoid back strain, preferably on a warm water bed. The tissues in the field of operation are infiltrated with a local anæsthetic solution (novocaine 1–400) as completely as if the operation were to be done under local anæsthesia only. In abdominal operations the area of the peritoneum, which is incised and later sutured, is infiltrated with a 1–200 solution of quinine and urea hydrochloride, which has the property of producing local anæsthesia lasting several days. The object of this is to minimize post-operative pain and gas distention in the abdomen, which is so common after abdominal operations. The greatest possible gentleness in the manipulation of tissues throughout the operation itself is an important feature in the technic. The patient is closely watched during recovery from the anæsthetic, and verbal suggestion is made early to the dawning consciousness that the ordeal is successfully passed and that all is well.

The psychic shock at the critical period when the patient faces the operation in the immediate present is of special importance in cases of exophthalmic goitre, the symptoms of which have a curious resemblance to those of fear. In such cases Dr. Crile has succeeded in avoiding altogether the harmful suggestions at this crisis by accustoming the patient to harmless inhalations administered each morning by a nurse who is a skilled anæsthetist, the patient on the final morning passing into complete anæsthesia without knowing that the day selected for her operation has arrived. Of course the patient's full consent has been previously obtained that the operation may be done at any time that the surgeon may select.

III. THE NURSE'S PART IN THE ANOCI-ASSOCIATION TECHNIC

Except at the very beginning, the nurse's contact with the patient corresponds rather closely with that of the surgeon. During the whole time within the hospital, except at the operation itself, her contact, particularly with woman patients, will be even more close and intimate, certainly more continuous, than that of the surgeon himself. At the critical points of entrance into the hospital, and recovery from the anæsthetic more depends upon the nurse than upon the surgeon.

We may consider the conduct of both surgeons and nurses in relation to the effect produced upon the mind of the patient under two aspects. The first is general and concerns the atmosphere in which the patient finds himself upon entering the hospital and the spirit which animates each unit in the surgical organization. This atmosphere and this spirit are, of course, simply a reflection of the quality of the organization itself, and are not assumed or cultivated with any reference to what the patient may think about them. Nevertheless the presence of the right atmosphere, the character of which may perhaps be best indicated by the two words *efficiency* and *sincerity*, is vital for good anoci-association work and must receive due consideration.

The second aspect referred to is particular and personal, since it concerns the actual conduct of surgeon and nurses when they come in contact with the patient. The prime requisites of right conduct from the anoci-association view-point are supreme tact and sympathetic understanding of the individual patient. We will consider the general aspect first.

What qualities and what attitude, in the persons into whose hands the patient has committed himself in the face of a trying ordeal, will make the strongest impression upon his mind in the way of encouragement and reassurance? Not sympathy; a friendly personal interest and active attention to matters pertaining to his comfort and well-being make a strong appeal, of course, but sympathy alone is a poor comfort in the presence of danger. A passenger on a storm-threatened vessel will be very little helped by the knowledge that the captain and other officers are exceedingly sorry for him. What he wants to see in these men are evidences of disciplined order, keen attention to every detail of the situation, and a serene confidence in their ability to meet any emergency that can arise. It is the same in the hospital; the impressions which the mind of the patient should receive are: first, that of a coördinated group of workers (surgeon, anæsthetist, internes, nurses), highly trained, familiar with every point in the situation, keenly interested, alertly attentive to their several duties, and working together with machine-like precision; second, that the whole purpose and attention of this disciplined body are for the moment directed to bringing the patient's own case to a successful conclusion, with an interest in this object as keen as, let us say, that of a crack athletic team to win a championship game.

There is one other impression that the patient should not fail to receive, and that is of the absolute certainty in the minds of every member of the hospital team that in this particular case they are going to win, *i.e.*, as regards the patient's life risk in the operation. There is no faking about this. We *must* win, and in order to do this we must be certain of winning beforehand. That is the first rule for the players of every game worth while, either in the field of sport or in the serious affairs of life. It is the doubters who lose, they and sometimes the complacent ones; ours, however, must not be the certainty of those who are complacent, but the certainty of those who can afford to take no chances.

We have used the words efficiency and sincerity in summing up this first or general aspect of anoci-association work. Sincerity in this connection does not mean, of course, the absence of a proper reticence, still less the exercise of a brutal frankness in what we say to a patient. What is meant is simply the absence of shams and a loyalty to the patient's interests that is genuine and unqualified.

The consideration of the second aspect, that which relates to the management of the individual patient, presents considerable difficulties. Few general rules can be laid down. Each patient indeed is a separate problem. The reasoning and methods, for example, which are applied to a phlegmatic woman from the slums will be quite different from those which should be employed in the case of a highly-strung, nervous woman accustomed to luxurious surroundings. It is in this consideration of each patient as an individual that many nurses and doctors fail. It is here that the exercise of supreme tact becomes an essential part of the anoci-association technic. Tact means touch, here the sensitive mental touch in contact with the mind of the patient. A tactful person recognizes instinctively certain aspects of the mental attitude of another individual which are not openly manifested; the concealed feelings, as of distrust or antagonism, the suppressed emotion, as of fear or hunger for sympathy or annoyance at some real or fancied slight. Tactful conduct adapts itself skilfully to these subtly perceived conditions and wins its way against all resistance, even from the most stubborn personality. It is often said that tact is an inborn quality and cannot be acquired. But while there is much to justify this view, it may be pointed out that tactful conduct is a reflection of a habit of mind, the habit of putting oneself in another's place, and this habit, like any other, can be cultivated and acquired by determined and sustained effort.

As to sympathy, rightly understood, there can be no question of its value and importance. An unsympathetic atmosphere begets distrust. It is true, as has already been suggested, that sympathy in the sense of commiseration or compassion is of little use in guarding the patient from those harmful associations which we wish to avoid. Such sympathy is doubtless soothing to a tortured mind, but it carries no suggestion of security; it suggests, if anything, the contrary. Sympathy that is effective and helpful is not emotional but intellectual; its office is to understand, not to commiserate; its purpose is to bring the person who is its object, by the light of a clearer knowledge, to a view-point corresponding to its own. If the object aimed at is to be attained, our sympathetic understanding must have such an effect upon the patient's mind as to make it share in our feeling of confidence in the methods which we employ and our own certainty in the good result.

Both before and after entering the hospital the patient's contact with friends and acquaintances is a source of noci-associations which is to a large extent beyond our control. Some people, because of ignorance and prejudice, are almost incredibly brutal and tactless in what they say to a patient. On the other hand, these friends are often our most helpful supporters in bringing a patient to operation in a cheerful and confident attitude of mind. Within the hospital the patient's contact with other patients may be the means of arousing the emotion of fear. In the free wards of a hospital (the male wards part cularly) the patients who have already been operated on sometimes take a mischievous delight in initiating the newcomers with hair-raising accounts of their own experiences. The nurse may have better opportunities than the surgeon to learn of and counteract the hurtful suggestions from both these sources. Patients who have passed the ordeal can do much to help us if we can secure their interest and coöperation. Proper hospital discipline and tactful management on the part of nurses, internes and surgeon can do much to avert harmful contacts of the patient with friends or other patients.

With regard to definite rules of conduct, only a few suggestions of a general character can be given. The first is not to talk too much. The nurse should say as little as possible and volunteer nothing at all about operative risks. In the first place, it is the duty of the surgeon to impart the knowledge to which the patient is entitled in regard to the quality of danger that is to be encountered, and all such questions should be referred to him for an answer. In the second place, overanxiety in insisting upon the absence of danger may have an effect quite opposite from that intended. Mere optimistic assurances carry little weight with patients, who are apt to regard these as perfunctory and possibly insincere. On the other hand, the nurse need not hesitate, when questioned, to give free expression to her own confidence that the result will be good derived from her personal experience and observation and from a just pride in the achievements of the organization in which she is a unit. In doing this, however, it is best to avoid all reference to anatomical or operative technical details. The methods of surgery can, as a rule, have only a morbid interest for one who lacks the training needed to see them in their proper setting as a means to an end, and they are full of possibilities of harmful suggestions to the patient. Perhaps the most difficult achievement in conduct will be found in maintaining such a proper reticence without veering from the straight path of sincerity and truth. To deceive a patient deliberately is neither right nor fair play nor justifiable on grounds of expediency; for if once a suspicion of being deceived, or that knowledge of important matters is being withheld, has found lodgement, it will be very difficult to regain the confidence that has been lost. Sometimes, indeed, the impulse of a great compassion may lead one to give comforting assurances without strict regard to the truth, but this practice should never become a rule of conduct. Moreover, since a reticence that is too obvious may have the appearance of insincerity, it is probably better that all discussion of grewsome details or other distressing matters should be frankly forbidden rather than that shifty attempts at evasion be made in response to the patients' questions about them. At all times every effort should be made to keep the brighter side of the picture in the focus of attention.

The moment when consciousness returns after reaction from anæsthesia has been mentioned as one of the critical periods of emotional stress. Although recovery from nitrous oxide and oxygen anæsthesia is far more rapid than from ether, in neither case, of course, does consciousness return all at once. Recovery is by progressive stages, the higher mental faculties concerned in the exercise of reason and will being the latest to awaken, and meantime all the harmful associations that have been so carefully silenced and controlled may return with unrestricted sway. Before the heavy eyelids can open the mind gropes blindly in the dark for the broken threads of memory, and the first recall of the actual situation, like the sudden remembering of a great trouble on waking from sleep, is apt to come with a shock that brings potent suggestions of uncertainty and doubt as to the result of the operation with a corresponding emotional strain. The preliminary dose of morphine and scopolamine has an undoubted calming influence upon the patient both at the beginning of the operation and at the time of the recovery from the anæsthetic. The effect of these drugs is to inhibit emotion and memory, but this does not, of course, alter the psychic situation at the sudden recollection of a dreaded ordeal, with its attendant possibilities of arousing the emotion of fear. When full consciousness returns the patient is apt to ask repeated questions about the operation and to be not very easily convinced that all is as it should be. Since it is almost invariably a nurse who is with the patient at this time, upon her devolves the duty of giving the assurances needed to dispel the harmful associations that may arise, and it is important for her to know how this may best be done. With regard to this point Dr. Crile has suggested a method which is of unique interest and value.

It appears at first glance like utterly ridiculous folly even to try to think of a way to tide an unconscious patient over this crisis. What wizardry can we conjure up to control the mind in sleep? Yet the method of doing this is very simple and almost invariably successful.

In sleep all paths by which knowledge reaches us from the outer world are obstructed, but not all equally so. Vision is wholly cut off. We are blind in sleep, the eye cannot receive and convey any message whatever to the brain. Not so the ear; except in the profoundest sleep this avenue between the brain and the world without is never wholly blocked. Our dreams, as every one knows, are often affected and controlled by sounds that do not waken us. A sleeper may even make what appear to be intelligent movements in response to spoken commands and have no recollection of so doing when he wakes. It is through the ear, therefore, and through this avenue alone, that we can reach the anæsthetized patient, before consciousness returns, with a message of comfort and reassurance.

At the first sign that the patient is passing from profound unconsciousness into the borderland of sleep, a change in the respiratory rhythm, or a movement of the head or hand, a quiet, assured voice speaks clearly into her ear, "The operation is over and everything is all right." Again and again, through the slow struggle up out of the dark, the voice repeats its message, always in clear, deliberate tones and with the simplest phrasing. It ceases when the eyes first open with a conscious look.

The contrast of such an awakening with that we have just described is curiously interesting. When full consciousness returns, the patient's expression is not one of pitiful anxiety and doubt, but rather one of immense relief. Often she appears quite happy and contented. She asks no questions; she feels no need of asking, for she *knows* that the dreaded ordeal is over and that all is well. How this knowledge came to her she cannot tell you and will be puzzled for a moment if you ask her, but not troubled with any shadow of doubt. Absolute conviction is in her mind, a certainty like that of intuitive knowledge, and she accepts it gladly and without question.

Miss Florence Henderson, anæsthetist at the Mayo Clinic, uses the same method of verbal suggestion at the beginning of the administration of an anæsthetic. She points out that, "Suggestion plays an important part in the induction of anæsthesia." And, "The assurance of the anæsthetist, when the patient is in the subconscious state, that he is all right and that nothing will be done until he is unconscious, aids markedly. The mind is very susceptible to suggestion in this state, and the suggestion that everything is as it should be is usually accepted."

In Dr. Crile's clinic at the Lakeside Hospital the introduction of the anoci-association technic has been followed by a reduction in the surgical mortality from 4.8 per cent. to 1.7 per cent. The diminution of post-operative discomfort has been especially notable.

Finally, it should be pointed out that whatever disagreement there may be among surgeons as to the value of the operative technic advocated by Dr. Crile, the use of nitrous oxide anæsthesia, and of a combination of local and general anæsthesia, there is no disagreement at all about the importance of the general principle of anoci-association; and as Dr. Bloodgood has said, we cannot safely reserve our application of this technic for the more serious cases. The mastery of any technic can only be acquired by incessant practice, and we must employ this one in all cases or else we shall fail with it in the critical ones where the need for it is imperative. With surgeons and nurses alike the application of the principle of anoci-association should become a fixed habit or second nature in the personal management of all patients, no matter how trivial the case.

PART V—THE OPERATION

CHAPTER XIX

THE OPERATING ROOM, ITS OUTFIT AND SUPPLIES

I. THE OPERATING-ROOM ORGANIZATION

The operating department in every hospital is apt to be a subject of special pride with every one connected with it. There is perhaps some danger that this very proper feeling may concern itself too much with the imposing but comparatively unimportant material aspects of the equipment, and too little with the real essentials; namely, efficient organization, conscientious exactness in every small detail of the technic, and good team work at the operation itself. The spotless white walls and floors, the glittering glass furniture, the polished battery of sterilizers, the neat array of shining instruments, the many ingenious devices for various purposes,—all these make an attractive picture, but they furnish in themselves little or no evidence as to the actual quality of the work that is being done in the department. The whole object, both of the equipment and the organization, is to safeguard the patient from the operative dangers, and the attainment of this end depends not upon the showy outfit but upon the spirit and efficiency of the workers themselves.

The details of the operating-room organization vary considerably in different institutions. The persons essentially concerned with the work of the operating room may be enumerated as follows:

(1) Surgeons of the Attending Staff, the Resident Surgeon, and sometimes other surgeons not connected with the institution, who operate there on their private patients.

(2) Assistants, usually the hospital internes. In hospitals which have the "open door" (that is, where outside surgeons are allowed to operate on their own patients), the surgeons may sometimes bring their own assistants with them. Usually a first and a second assistant are required at each major operation.

(3) Anæsthetists. These are, as a rule, graduates in medicine who have specialized in this field. They are appointed and paid by the institution and are responsible for all the anæsthetics given there. They give to the internes, and sometimes to graduate nurses who desire to fit themselves for this work, systematic instruction in the administration of anæsthetics. Some surgeons

of wide experience are of the opinion that women make the best anæsthetists, and there is reason to believe that this may become eventually, to some extent at least, one of the nursing specialties.

(4) The operating-room nurse has entire charge of the operating rooms. She is responsible for the care of the rooms and equipment, the preparation and sterilization of the various materials used in an operation, and the training of the pupil nurses assigned to work in the operating room. The position of operating-room nurse is a permanent one and is usually filled by a graduate nurse who has had special training and experience in the work.

(5) Senior assistant nurses who have had a month or more of experience in the operating room. In a very active service, where several operations are going on at the same time in different rooms, there should be a senior assistant nurse in immediate charge of each separate operating room, acting under the direction of the operating-room nurse.

(6) Other pupil nurses assigned to the operating room for a definite period during the course of their training.

(7) Operating-room orderlies, who do the heavy work, such as lifting the patients, cleaning the rooms and such special duties as may properly be assigned to them.

It is, of course, the surgeon himself who is chiefly responsible for the results of his operations, but these results depend always in large measure upon the quality of the preparatory technic, and in many operating rooms a number of surgeons operate, some of whom, at least, have little or no authority over the operating-room organization. It is, therefore, upon the operating-room nurse that the weight of responsibility rests for efficient operating-room administration, and it is in many cases chiefly from her that the inspiration comes for those who work under her direction. Her position is one of the most important in the surgical department of any hospital and is, or should be, one of the chief prizes of the nursing profession. Efficiency in operating organization is shown by a perfect and absolutely reliable preparatory technic; by the absence of vexatious delays in the preparation between one operation and another that is to follow it; and by the prompt supply of such needs as may suddenly arise in an emergency during an operation. The final mark of efficiency is what may be called good team work at the operation itself, by which is meant that each person does his own part at

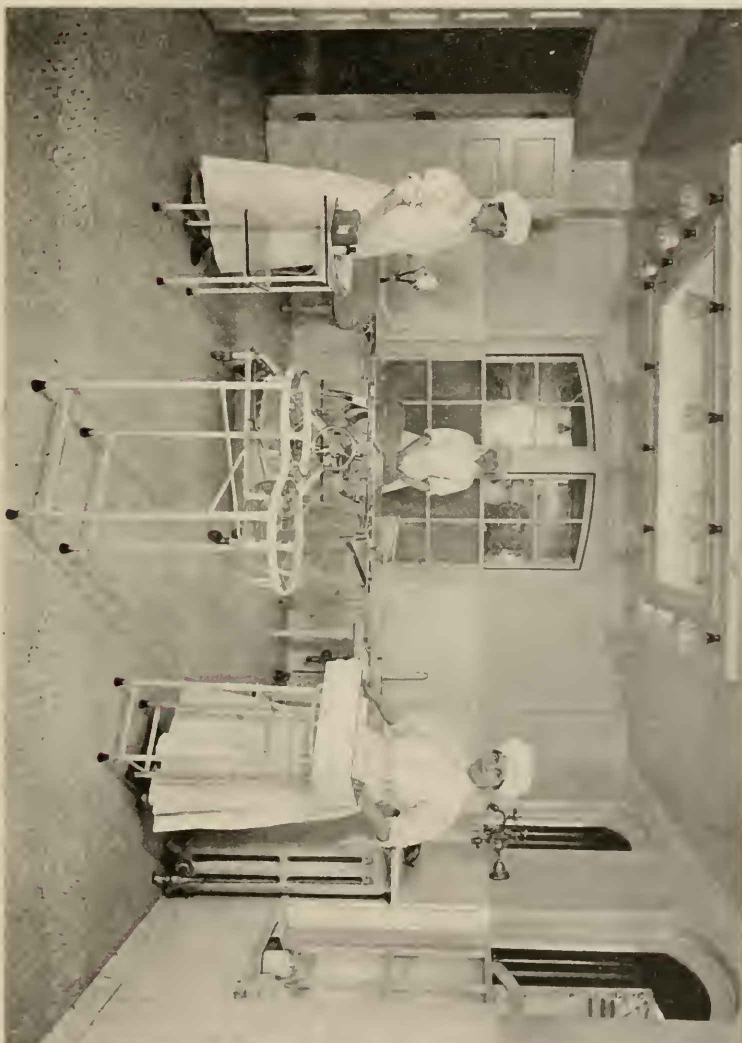


Fig. 79.—Operating room.

the right time without getting in the way of any one else, that the surgeon carries out each successive step of the operation in a systematic manner, and that assistants and nurses are able, so far as possible, to anticipate his needs.

II. THE OPERATING SUITE

The number of rooms used by the operating department may vary from three or four to ten or twelve. Separate rooms are

Fig. 80.—Sterilizing room.

necessary for four different uses: (1) the operating rooms proper (Fig. 79), (2) the sterilizing room (Fig. 80), (3) the surgeons' dressing and preparatory room, (4) the supply room. In addition to these, separate rooms may be provided in the operating suite for the following purposes: nurses' dressing room, separate preparation rooms for surgeons and nurses for hand cleansing, etherizing rooms, recovery rooms, instrument room, and a laboratory room for the rapid examination of specimens. In a hospital with an active surgical service, there should be at least two operating rooms; there need rarely be more than three or four except in the largest institutions. The essential features of a good operating room are ample space, abundant north light, floors, walls and ceilings finished with some material that is smooth, non-porous, and water-proof, and absence of crevices or corners from which it is difficult to remove dust. In the other

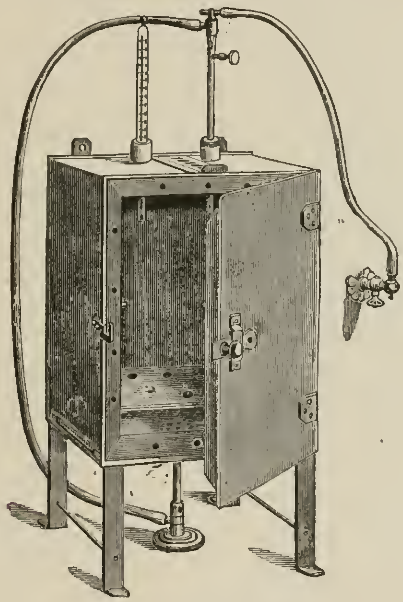


Fig. 81.—Hot-air sterilizer.

rooms size and light are less important, but all should be so arranged as to be easily cleaned.

III. THE OPERATING-ROOM FIXTURES

These comprise the arrangements for heating and for artificial lighting; the plumbing fixtures, including basins and sinks; the closets and the steam connections for the various sterilizers; the lockers in the dressing rooms, and the lockers and shelving in the supply room; and finally the sterilizers.

1. The Hot-air Sterilizer.—This is much used in the laboratory for the sterilization of glassware and other apparatus (Fig. 81). It is not usually a part of the furniture of the operating room. It consists of a double-walled chamber or oven with a door,

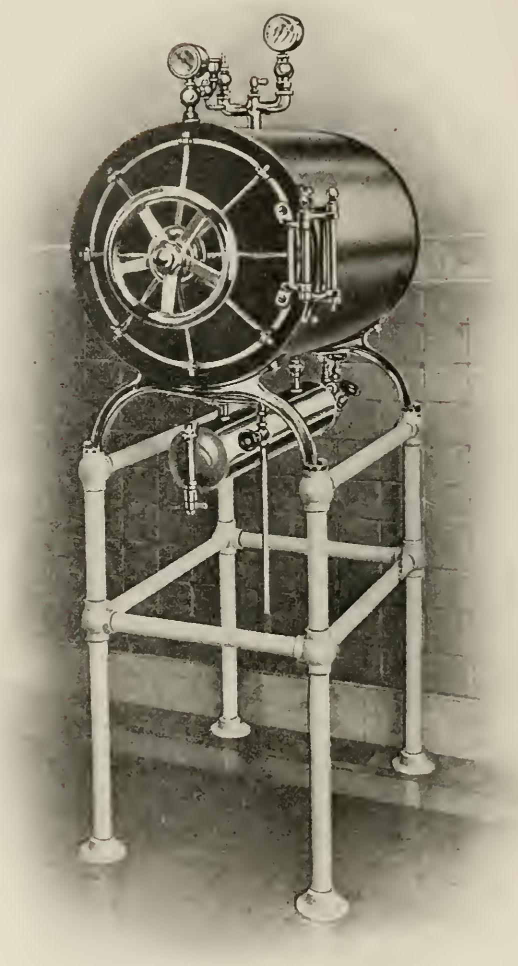


Fig. 82.—Autoclave.

and a strong gas flame underneath so arranged that the heat enters between the double walls.

2. The Autoclave (Figs. 82–83).—This is also a double-walled chamber with a door, but the door is made to fit air tight, and to

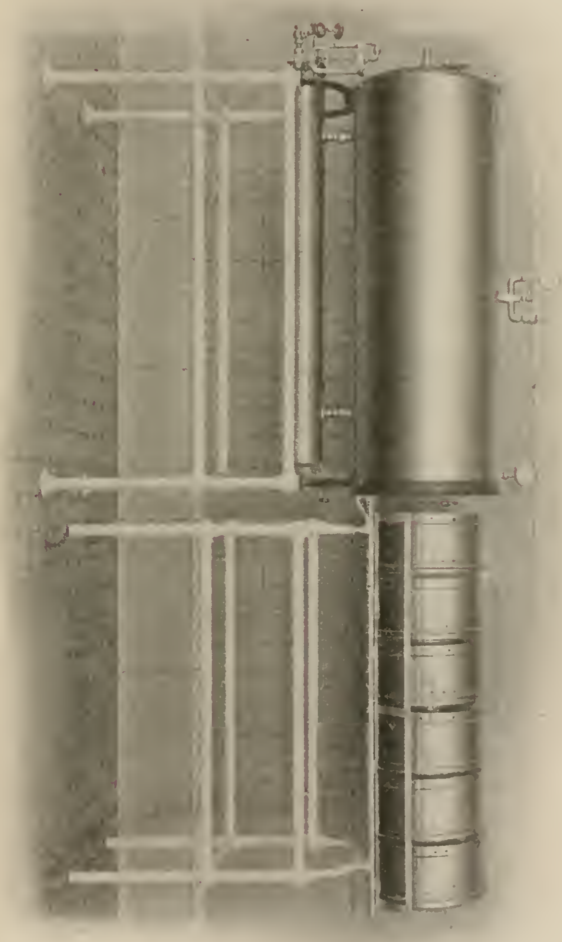


Fig. 83.—Autoclave with drums for dressings.

withstand strong pressure from within the chamber without leaking. Provision is made for turning the steam at will into the chamber itself, or into the space between the double walls, so as to apply dry heat within the chamber for the purpose of drying the dressings and other goods after they have been sterilized. Provision is also made to exhaust air from the chamber, by means of a valve, when the steam is turned into it, since steam in an

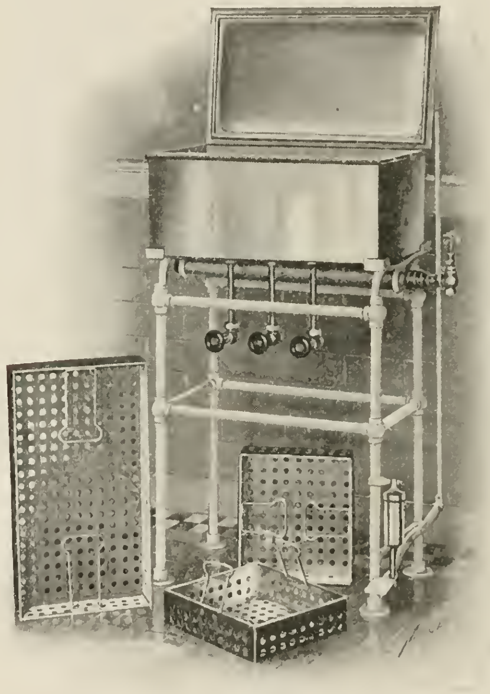


Fig. 84.—Instrument sterilizer.

air-filled chamber does not have its full effect. The water which produces the steam may be contained in the autoclave itself, heat being then applied by means of gas jets. In all large hospitals, however, the steam is obtained from the boiler-room and turned into the autoclave by means of valves.

The nurse should be thoroughly instructed in the use of the autoclave. So many different forms are in use that it is impossible to give specific instructions here. A failure to employ this apparatus properly means a failure in one of the most important parts of the aseptic technic. Moreover, the danger of careless handling of high-pressure steam sterilizers should always be remembered.

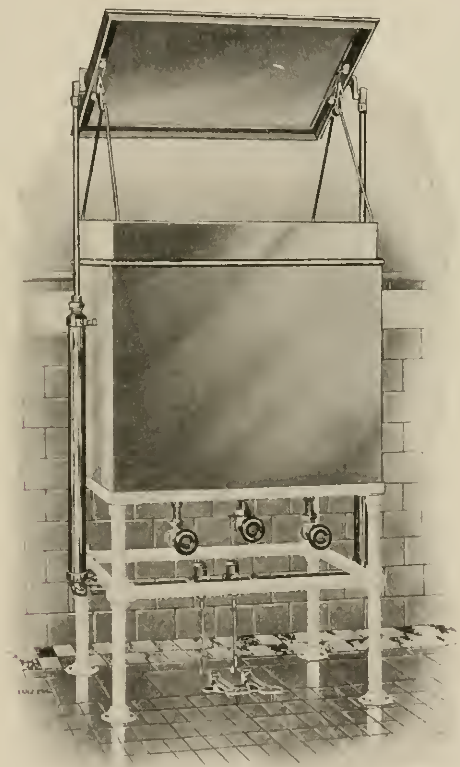


Fig. 85.—Utensil sterilizer.

3. The Instrument Sterilizer (Fig. 84).—This is a simple metal container of suitable size and shape in which water can be boiled. Heat may be applied by means of gas or of steam from the boiler-room.

4. The Utensil Sterilizer (Fig. 85).—This is a larger apparatus similar to the instrument sterilizer, used to sterilize basins and other large objects by boiling water.

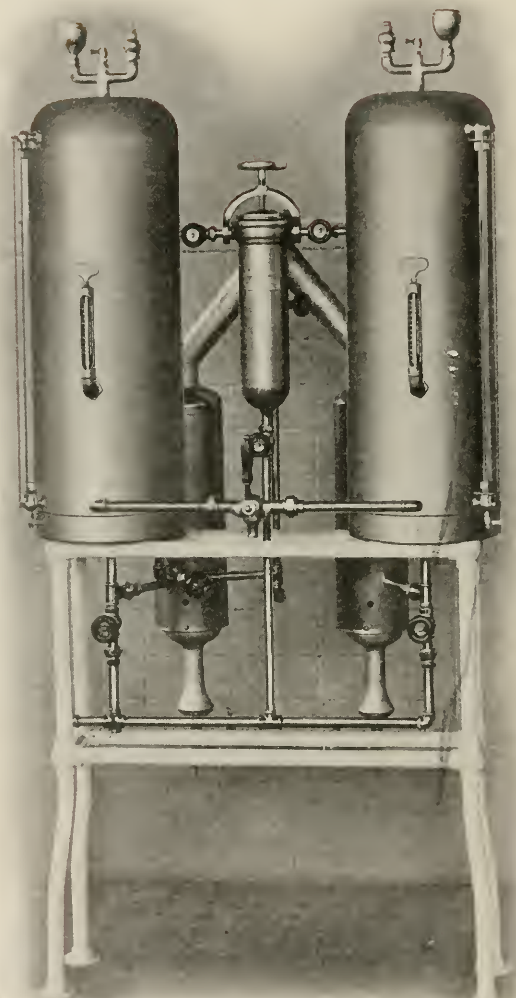


FIG. 86.—Water sterilizers.

5. Water Sterilizers (Fig. 86).—These are large tanks in which water is sterilized by means of steam coils. Two tanks are provided in order that both hot and cold sterile water may be available at all times.

The basins for hand washing are so arranged that the hot or cold water can be turned on or off, without touching anything with the hands, by means of levers acted on by pressure with

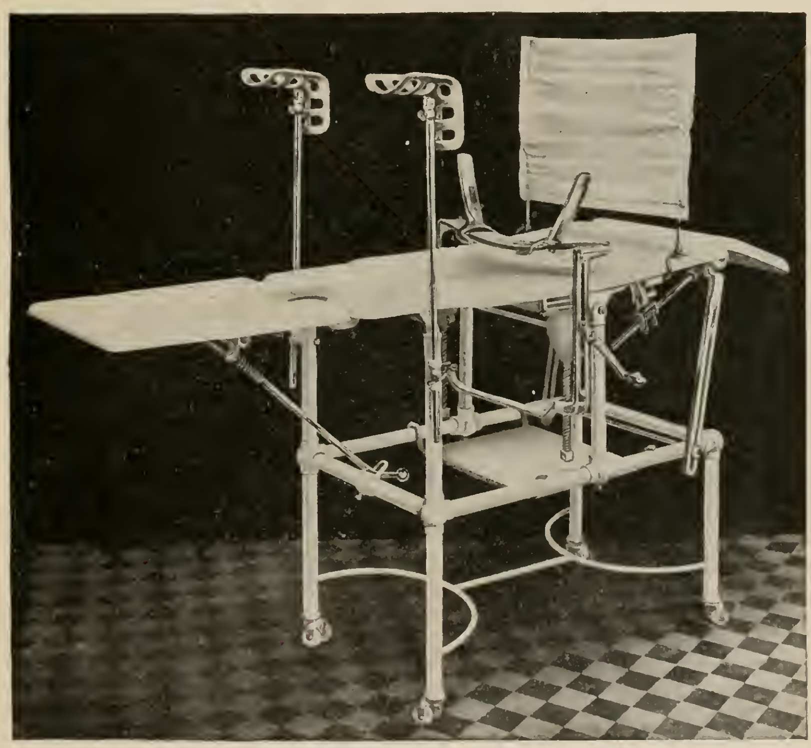


Fig. 87.—Operating table.

the foot or knee, the mixture of hot and cold water being delivered through a single goose-necked spigot at any desired temperature, so that the hands can be washed in a running stream.

The doctors' dressing rooms are provided with a sufficient number of lockers with individual keys. The supply room is fitted with lockers and shelving with glass doors for the storage of supplies. The operating-room nurse should have a master key fitting all the locks.

IV. THE OPERATING-ROOM FURNITURE AND UTENSILS

The furniture in the operating suite is all made of enamelled iron and glass, and designed in the simplest possible forms in order to facilitate cleaning. In the operating room itself, the operating table (Fig. 87) is, of course, of first importance. There is a great variety of operating tables in use, some of them extremely complicated. In all the object aimed at is to facilitate the placing of the patient in the various positions described in another chapter. In nearly all the whole table can be tilted so as to raise or lower the patient's head. Frequently changes of position have to be made during the course of the operating.

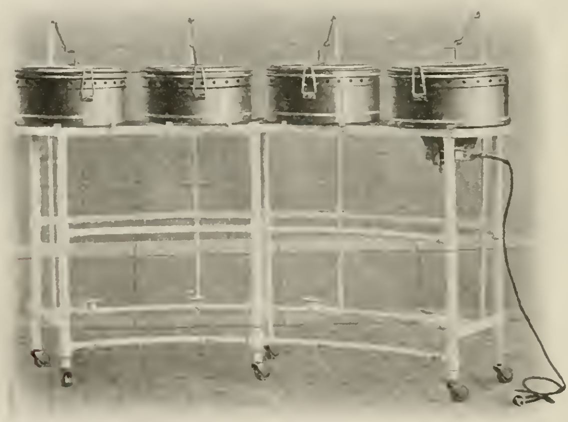


FIG. 88.—Drums filled with sterile dressings on stand.

The nurse should familiarize herself with the mechanism of the table in use in the operating room where she is in training. The remaining furniture of the operating room should be restricted to absolute essentials. A table for instruments and dressings, a stand or support for the drums containing the sterilized dressings (Fig. 88), basins set in stands for hand-rinsing solutions and for wringing out abdominal pads from hot salt solution, a stool, a small table, and the nitrous oxide gas oxygen apparatus for the anæsthetist, and two or more stretchers on rubber-tired wheels for conveying the patient between his bed and the operating table constitute the articles of furniture which will be required in every operation.

The utensils needed consist of a number of glass or enamelled ware dishes and basins of suitable sizes and shapes for holding the various solutions used in the surgical toilet, and for the reception of pus or other fluid evacuations, of specimens removed at the operation and of soiled sponges and dressings. As adjuncts to the operating table itself a pad or mattress will be required for the patient to lie on, preferably of rubber and distended with air, in any case rubber covered; also both hard and soft cushions in several shapes and sizes to support the patient's head and other parts of his body as occasion may require. At times the surgeon will need a stool to sit on and at other times a footstool to stand on for convenience in some special manipulation. Infusion of fluid into the rectum and of normal salt solution under the skin or into a vein may be required in the treatment of shock during an operation. The apparatus required for this purpose is known as an irrigator stand (Fig. 89) and consists of a glass receptacle for the fluid, preferably graduated, having an opening at the bottom to which five or six feet of rubber tubing is attached. The other end of this is armed with a suitable nozzle or hollow needle. The glass irrigator is supported on a stand arranged so that it can be raised or lowered to any desired level. Since it may be called for at any time on short notice in an emergency, the irrigator with its tubing and needles should always be sterilized and ready for instant use at every major operation. A rack with a definite number of hooks on which to hang the gauze pads that have been used in an abdominal operation is considered an essential piece of furniture in many operating rooms. It is useful to make sure that the pads are properly counted, in order that none may be accidentally left in the abdominal cavity. The other rooms of the operating suite will be almost bare of furniture. Space must be found, preferably in a separate room, for one or

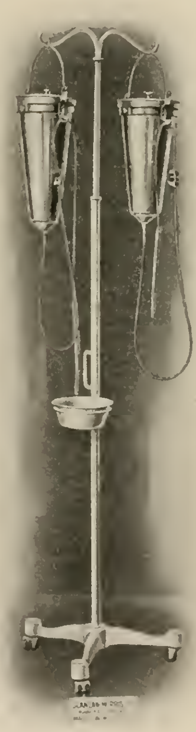


Fig. 89.—Irrigator stand.

more instrument cabinets, made of glass and iron, with glass doors and shelves on which the instruments are arranged in order; also for a glass and iron shelf rack on which bottles and jars containing various materials used in operative work may be placed. For the rest a few glass-topped tables and enamelled iron chairs or stools are all that is permissible.

V. THE OPERATING-ROOM SUPPLIES

The description of surgical instruments, of the methods of preparing the various materials used in the course of an operation, such as sutures, ligatures and dressings, and the preparation and uses of the different solutions employed are subjects too extensive to be included here and must be reserved for separate consideration.

To begin with the articles required for the surgical toilet, the first is soap. It is probable that the selection of the particular kind to be used is not a matter of very great importance. The requisites are active cleansing powers and freedom from irritating properties. The finer toilet soaps fall short in the former respect and the stronger kitchen or scouring soaps are too irritating to the skin. The official green soap of the pharmacopœia is most commonly used. It must be diluted with boiling water for the double purpose of reducing it to the requisite thinness and lessening its irritating properties. In some operating rooms, a hard soap containing pumice is used. Perhaps one of the best is the Schleich marble-dust soap, the formula for which is given in another chapter. Brushes are usually employed in hand cleansing, but are often objectionable on account of the injury their constant use inflicts upon a delicate skin. Thorough scrubbing with a piece of soft gauze is equally efficient and far less irritating. The use of anything that tends to roughen the skin of the hands of one who takes part in an operation is an error in technic. Nail cleaners with sharp points or edges are to be avoided; and also any solution to whose irritating properties there is found to be an individual susceptibility.

The operating-room dress for men consists of a two-piece suit of light-weight cotton material for which the street clothing is exchanged. Over this a rubber apron is worn, and over all the operating-room gown. A close-fitting cap of cotton material covers the hair. The mouth and nose are covered with a mask to prevent droplet infection when talking near the wound. The simplest form of mask consists of six thicknesses of gauze sewed into a square, four and a half inches on the side, with tapes at the corners to tie round the head and neck. Special shoes for the operating room may be of canvas or leather, according to individual preference. Rubber gloves, into the gauntlet of which the sleeves of the gown are tucked, complete the toilet. Buttons are troublesome, since they come off in the laundry. Draw-strings, tapes and safety pins are preferable as fasteners. The gowns open at the back and are fastened with tapes; they reach below the knee and are best made with detachable sleeves reaching from above the elbow, so that only the sleeves need be changed between clean operations. In passing from an infected to a clean case the whole gown must be changed, and this must be done also in passing from one clean case to another if detachable sleeves are not used. The two-piece suits are freshly laundered for each day, but not sterilized. The use of freshly laundered caps, not sterilized, is not a serious break in technic. Rubber aprons must be sterilized after use in operating on an infected case. Gowns, sleeves, masks, and gloves must be freshly sterilized for each operation, with the exception, already noted, as to the gown. For women the gown will be of suitable pattern and made reaching to the feet. The caps must be more voluminous and fastened with draw-strings to secure them over the hair. Gowns for visitors are sleeveless, made like a long cape to cover hands and arms. A sufficient number of these various garments of suitable sizes is kept on hand and a freshly laundered supply always ready. Rubber gloves of at least three sizes must be provided. A glove that is too tight becomes painful after being worn for an hour or two, and one that is too loose is a source of awkwardness. Some surgeons have gloves manufactured for their individual use over moulds made from plaster casts of their own hands, insuring a perfect fit. Gloves are easily torn or punctured at an operation. When this occurs the punctured glove must be at once discarded and a fresh one put on. A glove so injured can be easily patched with a piece cut from an old glove and applied over the defect with rubber cement.

For the protection of the patient on the operating table, the materials required are blankets, rubber sheeting, sheets and towels. Of the sheets and, particularly, the towels, a very abundant supply is necessary. The so-called laparotomy sheet is a plain sheet with an opening fourteen inches long in the centre

17

of the sheet. The upper end of the opening is eighteen inches from the top hem of the sheet. The edges of the opening are hemmed. The sheet covers the patient's whole body from the neck to the feet, the field of operation being exposed through the opening in the centre of the sheet. The gynæcological, perineal or lithotomy sheet is made in the form of two loose bags shaped to cover the patient's feet and legs when in the lithotomy position. The remaining portion of the sheet covers the lower part of the abdomen and the perineum. A twelve-inch slit exposes the field of operation.

Besides the rubber gloves, sheeting and aprons already described, there are a number of other articles made of rubber which find a place among the operating-room supplies. Kelly pads are placed under the patient's thighs when in the lithotomy position; rubber tubing in several sizes is used for many purposes; a roller bandage made of pure rubber is known as the Esmarch bandage and is used to compress a limb for the purpose of controlling hemorrhage. For the same purpose is the rubber tourniquet, a piece of elastic tubing with a chain and hook attached to fasten it after it is in position. This should always be applied over several thicknesses of toweling wrapped smoothly about the limb. These articles, together with rubber catheters, stomach tubes and rectal tubes, should perhaps be classed with the instrumental outfit. To prevent deterioration all articles made of rubber should be kept dry, dusted with talcum powder and at an even temperature. Extreme cold and heat, or marked changes of temperature, and particularly any oily substance, cause rapid deterioration of rubber.

Glassware in a variety of forms will be required, including measuring glasses or graduates, holding 10 c.c., 100 c.c. and 1000 c.c.; bottles and jars for containing chemicals; and empty bottles and jars for specimens. Glass tubing in various sizes and forms is used for many purposes: for irrigator nozzles, to connect rubber tubing, for drainage tubes and for female catheters. Medicine glasses and drinking glasses will be often needed. Medicine droppers, eye droppers and glass syringes of different sizes will be occasionally called for. The graduated glass irrigators have already been described. Large and small laboratory flasks of thin glass which can be sterilized will be needed for normal salt solution. Trays and small dishes for various purposes, glass rods and microscopic slides and test tubes should be included in the outfit. A few test tubes plugged with cotton and sterilized and others containing culture media for making bacterial cultures should always be at hand.

A rather long list of drugs and chemicals will be kept in stock. Those in crystalline or powdered form will include: bichloride of mercury, boracic acid, permanganate of potash, oxalic acid, iodoform, iodine, bismuth subnitrate, carbonate of soda, bicarbonate of soda, oxide of zinc, salicylic acid, common salt, silver nitrate, novocaine. Solutions of some of these, of appropriate formulæ, will be kept in stock, and others will be made up as required. Plaster-of-Paris and talcum powder will also be needed.

In tablet form or in sterile solution in sealed glass ampoules for hypodermic use in suitable doses there will be needed: morphia, atropia, strychnia, pituitrin, cocaine, epinephrin (adrenalin), strophanthin, novocaine, quinine and urea hydrochloride, caffeine and sodium-benzoate. Combination tablets of some of these and a sufficient variety of doses of each of them will be required. The list of drugs in liquid form will include: alcohol, carbolic acid, benzine, tincture of iodine, balsam of Peru, aromatic ammonia, ether, glycerine, hydrogen peroxide, collodion, olive oil, whiskey, amyl nitrite (in "pearls"), ammonia water, rubber cement. In semiliquid form vaseline, green soap, glycerite of starch, bone wax and various ointments should be at hand.

Suppositories containing opium and certain astringent drugs are frequently used after operations on the rectum. It is, of course, impossible to enumerate all the special formulæ that are used in different institutions.

Of the various woven fabrics included in the operating-room supplies, the most important item is the so-called absorbent or hospital gauze. There will be several grades of this, some of very loose weave for absorbent dressings, some of closer weave for use in making such articles as masks, abdominal packs and roller bandages. Unbleached muslin will be used for making covers for dressing material when being sterilized, retractors used in amputations, roller bandages and a number of special forms of binders and bandages. Crinoline is used for plaster-of-Paris bandages and for the so-called starch bandage. Cotton fibre is employed in several forms. The ordinary cotton wadding of commerce has comparatively few uses in the operating room. It is non-absorbent because of the oily substance which it contains. A piece of it cannot be made to sink in water. It is sometimes used where elastic pressure is desired under a firm bandage. Absorbent cotton is the same material from which all the oil has been abstracted. A piece of it should instantly sink to the bottom when dropped into water. Hospital wadding is non-absorbent cotton made in the form of sheets glazed on both sides. It is used to cushion splints and to pad limbs under a plaster-of-Paris bandage. A thick felt, such as harness makers use, is employed to protect bony prominences where a carefully fitted plaster splint or jacket is applied.

A number of miscellaneous articles, some of them of great importance, remain to be mentioned. Adhesive plaster is employed to fix dressings over a wound and has an astonishing variety of other uses. The Z. O. (zinc oxide) plaster is least irritating to the skin. The so-called " Janus " plaster, faced on both sides with adhesive material, is useful to prevent bandages from slipping. Gutta-percha tissue is employed almost universally for protecting wound surfaces and for wrapping gauze drains. Silver foil is used in many operating rooms as a wound dressing, particularly after skin grafting.

A full supply of material for splints should be on hand in the operating room. The number of special forms of splints on the market is too large to be described in detail. The forms of splint material most generally useful are the splints of woven wire which can be cut and bent to any desired size and shape and the splints made of thin, soft wood. A form of wooden splinting of the thinness of veneer is useful to incorporate in dressings where a firm, even pressure or a certain degree of rigidity is desired. It comes in pieces three by eighteen inches. Larger and heavier splints of wood one-eighth inch in thickness are supplied which can be cut to any size or shape desired.

CHAPTER XX

OPERATING MATERIAL

I. CLASSIFICATION

A considerable part of the nurse's time, during her course of training in the operating room, will be taken up with the preparation of the various materials employed in the course of the operation itself and to cover and protect the wound after the operation until the completion of the healing process. This work of preparation is of fundamental importance for the surgical technic, and it is necessary to describe it with some exactness. It must be remembered, however, that the practice in different institutions in the preparation of operating material varies considerably in minor points, and that the methods given here are not to be regarded as in any sense exclusive, for the form in which these materials are made up is largely a matter of personal preference with the surgeon, and no two workers will ever agree exactly as to what methods and means are the best. What we shall attempt to do in this chapter is to make clear the purpose for which these articles are used and to describe some of the methods of preparing them that are of proved efficiency.

The things which ordinarily come in temporary contact with the wounded tissues in the course of an operation are (1) the gloved hands of the surgeon and his assistants, (2) the instruments which he employs, (3) pieces of absorbent gauze or cotton made up into convenient shapes and sizes. These latter articles serve three distinct purposes: (1) to keep the wound "dry" (that is, to soak up blood, pus or other fluid which tends to fill the wound and obscure the surgeon's view of the field of operation); (2) to push to one side any tissue or organ that tends to get in the surgeon's way and hold it there for the time so that it will not obstruct his view or his work; (3) to protect surrounding parts from contamination with septic material when a localized infection is being dealt with.

Any one of these things (gloves, instruments, gauze) may become a source of infection in a clean wound by conveying septic bacteria into it, as a result of imperfect methods of sterilization or of carelessness in handling them after sterilization, and when this occurs we speak of it as " contact infection." There are other materials which come in contact with the wounded tissues and remain in contact with them until the first dressing, or for a longer time, or even permanently. The most important members of this class are drains, sutures and ligatures. When infection from any of these possible sources occurs it is known as " implantation infection."

Materials used to cover and protect the wound are known as dressings, and are put up in a great variety of forms. They are usually made of absorbent gauze, although cotton and occasionally other materials are also used. These dressings are also possible but less dangerous sources of wound infection.

Other articles, such as adhesive straps, bandages and binders, serve the purpose of holding the dressings in place. These need not be sterilized, but they must, of course, be fresh and clean.

II. MATERIALS WHICH COME INTO TEMPORARY CONTACT WITH THE WOUND

1. Sponges.—Sea sponges were used in operations in the pre-aseptic era, but had to be discarded because they could not be kept clean. The name is retained for the pieces of gauze or cotton that are now used for the same purpose.

Large crushed sponges are made of gauze 18 inches square. The raw edges are tucked under and the gauze crushed with the hand.

Small crushed sponges are made of gauze 9 inches square prepared in the same way. These latter are used as stick sponges or " sponges on a stick," by which is meant that the sponge is caught by the blades of a long-handled clamp and used to sponge out the bottom of a deep cavity.

A very convenient form of sponge is the folded strip sponge. It is made from a piece of gauze 18 inches long and 10 inches wide. One end should be selvage or folded in one inch to secure an end free from ravels. The gauze is folded lengthwise, bringing each long edge to the centre of the piece. It is then folded once again lengthwise. This gives a strip of folded gauze 17 inches long and 2½ inches wide, with no raw edge except at one end; this end is held between the left thumb and index finger; the index, middle and ring fingers are placed together closely, the strip is wrapped about the three fingers up to within two inches of the selvage edge; and the end is folded down diagonally toward the tips of the fingers and tucked under the roll. The sponges are used in this form at the operation and can also be quickly unrolled when a long, narrow strip is needed to sponge out a deep cavity.

A small wad of cotton wrapped in a three-inch piece of gauze and tied with thread is a useful and economical form for use in free sponging or on a stick.

Small pledgets of cotton rolled into balls are desirable in some operations on the brain where the tissues must be handled very delicately.

2. Packers or Laparotomy Sponges.—These are also known as tape sponges. They are used in operations within the abdomen to keep the intestines out of the way and to protect them.

Large tape sponges are made as follows. Cut the gauze from the bolt in fifty-inch lengths. Use the full width of the gauze doubled once lengthwise. Turn the ends in one inch to secure smooth edges; bring the ends together and sew across top and sides; at one corner sew a ten-inch length of tape, preferably black in color. This gives a strip of four thicknesses of folded gauze, free from raw edges, twenty-five inches long and eighteen inches wide. This size is very convenient to pack off intestines during the removal of large tumors. The tape is kept outside the abdominal cavity and fastened with a clamp at its free end to prevent its being accidentally left in the abdomen. The safeguards against this inexcusable happening cannot be too numerous or too carefully adhered to, for it is surprisingly easy to overlook even a large sponge in the abdominal cavity.

Medium tape packers are made from twenty-four inch lengths of gauze. After turning raw edges in one inch at each end, the gauze (already doubled once on bolt) is folded lengthwise in three folds; the ends and side are sewed, and a tape is sewed to one corner. This gives a strip of six thicknesses of gauze six inches wide and twenty-two inches long. Three smaller sizes of packers are made in a similar manner to measure when finished six by six inches, four by four inches, and two and a half inches by two and a half inches. The smallest size is not often used, but is very convenient at certain times. At the Mayo clinic three sizes of packs are used, (1) 4 x 8 inches, (2) 5 inches by 3 yards, (3) 3 inches by 2 feet. The latter are used for packing about the gall-bladder. All are made of eight thicknesses of gauze, with hemmed edge and tape at the corner.

3. Retractors or retractor bandages are used in amputations to hold the skin and muscle flaps out of the way while the bone is being divided with the saw. They are made of two thicknesses of unbleached muslin, twenty inches long and eight inches wide. The bandage is split for two-thirds of its length into either two or three tails and the edges stitched together. The two-tailed form is used in amputations of the upper arm or thigh and the three-tailed form for amputations of the forearm or leg where there are two bones to be divided.

III. MATERIALS WHICH ARE TO REMAIN IN THE WOUND FOR A TIME OR PERMANENTLY

1. Sutures are stitches used to hold the divided tissues together so that they may heal in the proper position. All sutures except those uniting the skin or mucous membrane remain permanently in the wound. Skin stitches are usually removed at the first dressing on the fourth to the ninth day after the operation. When each stitch is tied separately and the threads cut short the suture is called an interrupted suture. A continuous suture is one where the tissues are sewn together in the ordinary way with a long thread and only the first and last stitches are tied. Deep or buried sutures are those which are taken in any of the tissues under the skin. Sutures are of two kinds as regards the material of which they are composed: (1) those made of thread or wire which will remain permanently in the tissues or (when in the skin or mucous membrane) will be cut and removed at a later time, and (2) those made from animal substances which will hold the tissues in place while the healing process is going on and then will become gradually absorbed. For the latter class of sutures and ligatures two different materials are employed. (1) Catgut, so-called, is the same material that is used for violin strings, except that for surgical uses much smaller sizes are selected. It is made from the fibrous coat of the intestines of sheep cut into strips and twisted. The word catgut is supposed to be a corruption of "kitgut," kit being an old name for a small violin. (2) The material known as kangaroo tendon consists of strands of varying thickness separated from the strong tendinous bundles found in the tail of the kangaroo.

The sterilization of these materials presents a problem of peculiar difficulty. The strength and pliability of sutures derived from animal tissues are rapidly destroyed under the influence of high temperature applied in the ordinary way. Catgut, from the nature of its origin, is almost certain to have embedded in its strands some of the bacteria contained in the intestinal canal, and among these are not infrequently found, particularly in the domestic animals, the spores of anthrax and tetanus bacilli, which are highly resistant to every method of sterilization. Catgut was doubtless sometimes the cause of infection in wounds in the early days of its use, owing to the crude methods employed in its preparation, and it may become a source of danger even now through lack of proper care or the use of an imperfect method of sterilization. At the present time we have available a number of processes whereby catgut can with certainty be made sterile without impairing its desirable qualities. Some of these are described below. The most reliable methods are, however, so difficult and exacting that many institutions prefer to purchase their catgut prepared and sterilized ready for use from commercial houses which make a specialty of this work. The catgut and kangaroo tendon supplied by these firms come in small coils of convenient size placed in glass tubes with alcohol and hermetically sealed. When this prepared catgut is used the only further preparation necessary is to sterilize the outside of the tube by boiling with the instruments. The tubes are scratched with a file to facilitate breaking. To break a tube the instrument nurse wraps it in sterile gauze and bends it in a direction away from the file mark. The alcohol in the tube serves the double purpose of acting as a preserving fluid and of demonstrating that the tube is actually sealed. A small crack in a tube, or an almost invisible opening sometimes left at the point of sealing, may escape notice, but if either is present the alcohol will rapidly evaporate, and such a dry tube must always be discarded.

The materials for non-absorbable sutures are thread, wire (of silver or other metal), the so-called silkworm-gut, and horsehair. Thread used for sutures is either silk or linen, usually dyed black, although white silk and linen in the natural color are much used. The finest size compatible with sufficient strength is to be preferred. For ordinary use No. A to No. C black sewing machine twist or surgeons' iron dyed silk (No. 2), and tight twisted, iron-black Irish linen (Nos. 25, 35, and 50) are suitable. Linen thread impregnated with celloidin to make it non-permeable is known as Pagenstecher's linen. The thread, whether silk or linen, is cut into two-yard lengths, wound on glass spools and sterilized in the steam sterilizer with the dressing materials or by boiling with the instruments. For suturing arteries and veins the finest silk obtainable is required, prepared in a special manner described below.

The so-called silkworm-gut is really composed of the same substance as silk thread. This is the secretion which the silkworm spins into a fine filament in making its cocoon. The " gut " is made by killing the worm when ready to spin and drawing out the silk in the form of a coarse strand. It is a stiff, wire-like material, looking like spun glass, is very strong and is now used principally as a " tension " suture in closing abdominal wounds. It is sterilized by boiling. Horsehair is not much used as a suture material at the present time, and only for skin stitches. It is prepared by washing in soap and water and in ether and sterilized by boiling for ten minutes in one per cent. soda solution. Silver or other wire when used as a suture material is wound in small coils and sterilized with the instrumental outfit.

2. Ligatures.—These are used for controlling hemorrhage by tying around the bleeding vessel or around a pinch of tissue held by a " clamp " at the bleeding point. The materials used are silk or linen thread and catgut of the same sizes and prepared in the same way as that used for sutures. Catgut is always to be preferred for this purpose in suppurating wounds, and is also used by the majority of surgeons at the present time as the ligature material of choice in clean wounds. Silk or linen is, however, preferred for ligating large arteries as giving greater security against secondary hemorrhage. Catgut when wet becomes soft and easily stretched and the knots are apt to slip. In the use of any ligature material the finest threads compatible with sufficient strength are to be preferred. Repeated boiling or steaming makes any thread brittle, and silk or linen ligatures should never be resterilized for use more than once.

A few surgeons, and some of them among the most eminent in the profession, are very strongly of the opinion that catgut should not be used as a ligature or suture material except in the presence of septic infection. Where sepsis is already present the use of absorbable ligatures is necessary because a foreign body in a septic wound tends to prolong suppuration indefinitely, whereas a sterile foreign body in a clean wound does no harm. It is not proper for the nurse to become a partisan in any matter where there is a difference of opinion among surgeons in regard to the technic, but it may be well to state briefly the objections to the use of catgut, in order to emphasize the necessity of care in its preparation. The objections as summarized by Dr. Halsted are " the relatively high cost of catgut, its bulkiness, the inconveniences attending its use and sterilization, its inadequacy, the uncertainty as to the time required for its absorption, and the reaction which it excites in the wound." Catgut, particularly in the larger sizes, is a source of slight but distinct irritation in a wound. The best manufacturers very properly urge that surgeons should use by preference smaller sizes than now commonly employed. This irritating property is doubtless responsible for the fact that few now use catgut for skin stitches. As stated above, catgut is thought by many surgeons to be an unsafe ligature material for large arteries, since the bite of the tie may become loosened by softening and stretching of the strand, and an ordinary double knot is apt to slip. The absorption of catgut is accomplished through the dissolving action of ferments in the tissue juices and by phagocytosis, and this process is a slow one. In cases reoperated on, a catgut knot may often be found still unabsorbed weeks or months after it was put in place. With an aseptic technic that is up to the proper standard no trouble need be feared from silk or linen sutures and ligatures.

3. Methods of Preparing Catgut.—If only the surface of a strand of catgut needed to be sterilized the problem would be a comparatively simple one, but unfortunately in the process of manufacture septic and other bacteria are quite certain to become embedded in the centre of the strand and may there retain their vitality for a considerable time. The most serious, although fortunately not a very frequent, danger arises from the presence of spores of the tetanus bacillus. This organism is commonly found in the intestinal contents of the domestic animals, including the sheep, and there is always a possibility that catgut may contain its spores. The method of sterilization must, therefore, be sufficient to destroy with certainty this most resistant organism. Of the several methods of sterilization previously described it is obvious, in the first place, that we are debarred from the use of one, namely, moist heat in any form, since this will so soften and weaken the catgut as to render it useless. There is, however, a partial exception to this in the case of catgut hardened in formalin.

Chemicals in watery solution are unavailable for the same reason, and the strand is found to be exceedingly resistant to alcoholic solutions, so that bacteria embedded in the centre of the thicker strands will remain unaffected, even after immersion for a long time in an alcoholic solution of a powerful disinfectant. A long strand of catgut so prepared may be placed in culture media and incubated at a suitable temperature for some days without any growth resulting, but if the same strand be cut into quarter-inch lengths an abundant growth will follow. This fact has been repeatedly demonstrated in the case of catgut prepared in iodine solution at the laboratory of the Michael Reese Hospital. Gaseous disinfectants will not, of course, penetrate a catgut strand. There remains, therefore, only dry heat to be considered, and for this a much higher temperature is required than in the case of moist heat; 150° C. or 302° F. for one hour is the minimum requirement for sterilization by dry heat. Now moist heat means not heat in any liquid but heat in the presence of water. Dry heat means not heat in dry air necessarily but heat in the absence of water. Boiling in alcohol, therefore, is an application of dry heat. The boiling point of alcohol in the open air is 170° F. Alcohol boiled under fifteen pounds pressure in the steam sterilizer may give, at the most, a temperature of 250° F., far below the requisite point. For the proper application of dry heat, therefore, we need some material which will not affect the catgut and which has a boiling point sufficiently high to allow a temperature of 300° F. to be reached. This is accomplished by the use of some of the oily hydrocarbons. Two of the methods here given are based on this principle.

Two varieties of catgut are used, known as "plain" and "chromicized." The latter has been chemically treated by a process similar to one of the methods used in tanning leather, the object being to cause delay in the process of absorption. Thus the manufacturers will furnish "ten," "twenty," or "thirty day" catgut. The rate of absorption varies, however, with the character of the tissues in which the catgut is used. Absorption in skin and muscle is slow, in serous or mucous membranes it is extremely rapid. The preparation of plain catgut, preliminary to its sterilization, consists in immersion in ether for several days and then in alcohol, the object being to remove any fatty material that may be present, for this, if allowed to remain, tends to weaken the catgut under the influence of a high temperature. Chromicized catgut has been first treated with ether and alcohol as above and then placed in a solution of bichromate of potash, six grains to the pint of 95 per cent. alcohol, or in a 4 per cent. aqueous solution of chromic acid for twenty-four to thirty-six hours.

First Method.—Dry heat (method of Reverdin). The catgut is cut into eighteen- to thirty-inch lengths and made into coils about the size of a silver quarter. The coils are strung on an asbestos thread and suspended in a double-walled oven in such a manner that they do not come in contact with the metallic walls or floor of the oven. The temperature is gradually raised, through a period of several hours, until it reaches 150° C (302° F.), and maintained at that level for one hour. Close attention is necessary in carrying out this method, or the catgut is likely to be brittle. At least two hours should be consumed in gradually raising the temperature to the desired point.

Second Method.—Dry heat sterilization in cumol (Kronig's method). On the first day the coils are placed in the dry oven in the manner already described and the temperature gradually raised to 116° C. (240° F.) and maintained at that level for one hour. On the second day the strands are immersed in cumol and heated very gradually up to 155° C. (310° F.), at which temperature they are kept for two hours. An asbestos-lined kettle is used. An iron basin filled with dry sand is placed over a powerful gas flame and the kettle partly embedded in the sand. On the third day the cumol is removed and the dry-heat process is repeated exactly as on the first day. On the fourth day the coils are immersed in alcohol and heated in the steam sterilizer under 25 pounds pressure for one hour. On the fifth day the fourth-day process is again repeated. This is essentially the method employed by the manufacturers, except that the coils are placed in glass tubes at the beginning of the process and these are filled with alcohol and sealed in the blow-pipe flame at the end of the third day's sterilization.

Third Method.—Dry heat sterilization in alboline (method of Dr. Willard Bartlett). The preliminary preparation and the first day's sterilization are exactly the same as described under the first method. The coils are then placed in an asbestos-lined kettle containing liquid alboline. They are left immersed in the alboline in a warm place for twenty-four hours, or until the strands become semitranslucent. The second and in this case final sterilization is done by heating over a sand bath as described under the second method. Heat is applied gradually until at the end of an hour and a half the temperature of the alboline has reached 320° F. At this temperature it is maintained for one hour. This completes the process. The gut is stored in a one per cent. iodine solution in alcohol. This should be contained in a large-mouthed glass jar with ground glass stopper. The coils are transferred to the jar from the hot alboline with a sterile instrument. The jar itself should be provided with a closely fitting cover of metal or heavy Manila paper (to protect the lip from dust), and the whole sterilized by dry heat at 150° F. for one hour before it is filled with the solution. The coils should be drained of alboline and rinsed in the same solution before being placed in the jar. The lip of the jar should be wiped with a sterile bichloride sponge whenever the stopper is to be taken out for the purpose of removing with a sterile instrument the coils of catgut as they are required.

Fourth Method.—Iodine sterilization (method of Claudius). The coils after the preliminary preparation are simply immersed in a 1 per cent. solution of iodine in alcohol. They remain permanently in this solution, and must have been subjected to it for two weeks before they are used. This method is in use in many institutions. It is open to suspicion from the theoretical stand-point, but a very extensive experience in practice seems to show that it is reliable for smaller sizes of catgut at least; for the larger sizes, however, it is probably unsafe.

Kangaroo tendon may be sterilized in the same manner as catgut, but it does not stand the high temperatures so well.

4. Drains.—These are placed in infected wounds to provide for the escape of pus, and sometimes in very extensive clean wounds to prevent accumulation of blood or serum in the wound. In this latter case the drain is always removed at the first dressing. In infected wounds the drains remain usually for a longer time. The materials used for drains are glass tubing, rubber tubing, strips of gauze and gutta-percha tissue, or the so-called rubber dam used in dentistry. The manufacturers supply glass drains of suitable sizes and shapes and of properly annealed glass so that they may not be broken easily. Rubber tube drains are made as wanted from tubing of suitable size, usually from 1/4 to 3/4 inch in diameter, and four to six inches long. Side holes are usually cut in the tube, and it is sometimes split lengthwise either in a straight line or spirally. A "dressed tube" drain is made of rubber tubing wrapped first with several layers of gauze and then with gutta-percha tissue. A "cigarette" drain or "wick" is made from a strip of gauze wrapped with gutta-percha tissue or rubber dam. One end of the strip, free from ravellings, should extend beyond the gutta-percha wrapping for about half an inch. Another form is made from a square of gutta-percha tissue placed between two single thicknesses of gauze and rolled. A folded strip of gutta-percha tissue or several strands of some ligature material twisted together will sometimes be called for when a very small drain is required. Glass and rubber are sterilized by boiling: gutta-percha tissue melts at a low temperature and must be sterilized by storing in 1–1000 bichloride solution. These drains are usually made up as needed at the operating table. For drainage of the gall-bladder a rubber tube of 1/8-inch lumen, about 14 to 18 inches long, will be needed. The tube is "dressed" at one end with selvage gauze and gutta-percha tissue, and will be fitted over a glass connection tube at the other end with which to attach it to a longer tube at the bedside.

5. Medicated Gauzes.—Gauzes impregnated with iodoform and other chemical substances are still in use to some extent. They are a survival of the antiseptic as distinguished from the present aseptic era in surgery, and their use is becoming more and more limited. They are still used in drains to some extent, and to pack in septic wounds. The formulæ for these gauzes are given elsewhere.

6. Other materials are occasionally buried in a wound to accomplish various purposes. Horseley's bone wax is used to check hemorrhage in bone, steel plates and screws to fix fractures, the Murphy button in making an intestinal anastomosis, and so on. Most of these belong rather to the instrumental outfit than to the classes of operative material to be prepared by the nurse which are under consideration in this chapter.

IV. WOUND DRESSINGS

1. Gauze.—The forms and sizes in which gauze dressings are put up vary considerably in different institutions. It is not claimed that those presented here are superior to others. They may serve as types of the various forms of dressings in use.

(1) *Fluffs* are made of three-quarters of a yard of gauze cut from the bolt, opened out singly, the raw edges turned in and crushed in the hand. In use they are shaken out and arranged

in loose masses over and about the wound. This makes a soft, comfortable and very absorbent dressing.

(2) *Pads* are made of pieces of gauze cut in various lengths from the full width of the bolt (one yard) and folded into square or oblong shape, with raw edges covered in, making pads of various sizes and from four to twelve layers of gauze in thickness. Common sizes, for example, will be 4 by 4, 4 by 9, and 8 by 12 inches.

(3) *Compresses* are made of thick layers of absorbent cotton cut into square or oblong shape in convenient sizes and covered on both sides with a double thickness of gauze. The cotton is elastic and enables a firm and evenly distributed pressure to be made in the neighborhood of the wound by compression with the roller bandage.

(4) *Gauze rolls* are made from six yards of gauze, already doubled once lengthwise on the bolt, folded end to end, and then folded in three parts lengthwise and rolled. This makes a roll of gauze of twelve thicknesses, six inches wide and three yards long. They are put on like a roller bandage, loosely, in dressing wounds of the neck, breast, shoulder and arm, as a spica after hernia operations, and after operations on the lower extremity.

(5) *Tampons* are used to pack cavities, and are made either of pledgets of cotton or wool tied on a string, or more usually of narrow strips of plain or medicated folded gauze.

(6) *Uterine gauze* tape or packing is made from a strip of gauze 2 inches wide and 5 yards long. A somewhat closer weave of gauze than that usually employed for dressing material is to be preferred. The gauze is folded from each side to the centre line, and folded again on the centre line, making a tape-like strip ½ inch wide. Each strip should be packed in a glass tube (large test tube) which is plugged with cotton, and the cotton plug and lip of tube covered with a few turns of gauze bandage fastened with adhesive plaster, and sterilized under steam pressure.

(7) *Vaginal packing* is made from a strip of gauze half the width of the bolt (18 inches) and 5 yards long. The selvage and raw edge are folded to centre line, then folded to centre line again and doubled on centre line. This gives a strip of eight thicknesses of gauze 2¼ inches wide. Another method is to turn in the raw edge, roll the gauze toward the selvage edge, and pull through the hands in the form of a rope. This is coiled and steril-

ized in a muslin wrapper or in a large glass tube, plugged as in the case of the uterine gauze.

(8) *Rectal Plug.* A large dressed tube wound with gauze to the thickness of one inch and covered with vaseline or protective is used in the rectum, after hemorrhoid operations.

(9) *Silver foil* as a dressing material for wounds is used to cover the lips of the wound before the gauze dressings are applied. It comes laid between sheets of thin tissue paper sewed together at one edge in the form of a book. The sewed edge is trimmed off with scissors and the package is then placed between two pieces of thick binding board, wrapped with muslin and sterilized in the steam sterilizer.

2. Gutta-percha tissue, designated usually as "protective," is made from the dried sap of a tropical tree. Its principal commercial use is as an insulating material, particularly in the manufacture of ocean cables. In surgery it is employed in the form of thin sheets as a protective covering for wounds, and in making cigarette drains. Immersion in bichloride solution is the only practical means of sterilizing it.

3. Crepe lisse, or fine silk bolting cloth, is sometimes used, fixed to the skin with collodion, to draw together the lips of small wounds. Fine batiste, gauze or silk, dipped in celloidin, may be used to protect wider areas of the skin in the neighborhood of a wound. A coarse linen net impregnated with celloidin is recommended for fixing and holding skin grafts in place. These materials are sterilized and are cut to suitable sizes for each individual case at the time they are used.

V. MATERIALS FOR THE FIXATION OF WOUND DRESSINGS

Strips of adhesive plaster two or three inches wide are universally employed to fix dressings in place over abdominal wounds particularly, but also in many other situations. The plaster is not sterilized and may or may not be covered with a binder or roller.

Roller bandages are made from one to six inches in width and ten yards long. The material is unbleached muslin or gauze of a tighter weave than that used for dressings, usually thirty to forty threads to the inch. Four inches is the widest muslin bandage that can be advantageously used. It is a convenience and an economy to use wider gauze bandages (six inches) in fixing large dressings in the operating room. The bandages are not usually sterilized except for special cases. The supply of roller bandages in the several sizes should be abundant. The method of preparing them is described in another chapter.

The abdominal binder is a broad belt, made to encircle the abdomen, overlapping in front and to be fastened with safety pins. It is made of a single or double thickness of unbleached muslin, and in a number of sizes. Standard sizes are 14 inches by 1 yard, 16 by 40 inches, 16 by 46 inches.

The scultetus or many-tailed bandage is an abdominal binder of which each end is divided into six or eight tails, leaving a solid piece at the back about ten or twelve inches wide.

A better form is made of four strips, each seven inches wide, the top three 46 inches and the lowest 50 inches long. These are laid together so that each strip overlaps the one above it by one-half its width, and sewed securely throughout the middle twelve inches, thus leaving four tails at each end. The advantage of this binder is that it can be made to fit very smoothly over the abdomen. A sufficient number of safety pins must be used to secure all the loose ends.

The T-bandage is used to fix perineal, vulvar or rectal dressings in place. It consists of a four-inch belt with one or two strips three inches wide sewed to its middle at right angles to it. This bandage can be readily improvised from strips of suitable length taken from a four-inch muslin roller.

VI. METHODS OF ASSEMBLING AND STERILIZING OPERATING MATERIAL

Sponges and, particularly, abdominal packs must be put up for sterilization in packages each containing a definite number, so that strict account of them can be kept, in order to guard against the possibility of one of these articles being left in the abdominal cavity. The covers in which the goods are wrapped are made of heavy unbleached muslin doubled and stitched together. The towels are put up in packs one dozen or one-half dozen in each. Each sheet and gown is placed in a separate package. Single packages of gauze dressings of every kind should be kept on hand, put up, for example, as follows: fluffs and pads, one dozen in each package; gauze rolls, one or two in each package; large crushed sponges, one dozen in each package; stick sponges and folded sponges, two dozen in each package; tape packers, one-half dozen in each package. These are only illustrative, the practice varying in every point in different operating rooms. The essential thing is to have an established and definite system. It is well to have a plan whereby the responsibility can be fixed for errors in counting. For example, sponges and packers may be counted separately by two nurses whose names, on a slip of paper, are included in each package.

The Operating Unit Package.—Large packages containing everything necessary for a particular operation are prepared and put up either in large muslin wrappers or in metal drums manufactured for the purpose. These drums are 12 inches in diameter and 9 to 12 inches high. The drum is pierced with a row of holes around the circumference at the top and bottom. A sliding band with corresponding holes enables these to be opened or closed at will. The openings are for the purpose of enabling the steam to penetrate to the contents of the drum, and are closed when the drum is taken from the sterilizer. When ready for use the drum is placed on a stand so arranged that the cover may be lifted by means of a foot lever (Fig. 88). For example, the laparotomy package or drum may contain 18 towels, 1 laparotomy sheet, 1 small sheet, 2 large, 4 medium and 2 small packers, 2 packages of sponges, 2 of fluffs, 2 of large pads, a small wad of cotton for application of iodine, etc., 4 gowns, 1 binder. There will, of course, be more or less variation in the make-up of these packages in different operating rooms.

Sutures and Ligatures.—The preparation of these for ordinary use has already been described. Special methods of assembling the sutures used in operating upon the intestines and upon arteries and veins are usually employed.

For intestinal sutures fine silk or linen is cut into fourteen-inch lengths and threaded on No. 7 milliner's needles. These are then basted, in parallel lines about half an inch apart, into strips of muslin or small towels, one-half dozen in each. The strips are then folded, enclosed in muslin wrappers, and sterilized in the steam sterilizer. The thread must be fastened, either by tying into the eye of the needle with a single knot about two inches from one end, or better by transfixing the thread with the point of the needle, two inches from the end, and drawing the perforated thread down to the eye. This fastens the thread without adding the bulk of a knot. These threaded needles, as they are called, are also much used in ordinary work, including the suturing of the skin. Small, curved, round needles may be used in place of the straight needles by those who prefer them.

Operations involving the suturing of large arteries and veins, so as to preserve the continuity of the circulation, present a problem in technic of very great difficulty on account of the tendency of the blood to clot wherever the walls of the vessels have been injured, and the danger of leakage due to the powerful pressure of the arterial blood stream. The methods for such suturing have been developed in recent years to a high degree of perfection, but their use requires great skill on the part of the surgeon, attainable only by careful practice, which is best secured by experimental work on the lower animals.

Straight needles threaded with silk are used, both of a degree of fineness not obtainable through ordinary commercial channels, and they must be prepared in a special manner. The Kirby needles (made for lace makers) Nos. 16, 17 or 18, with Alsace thread No. 500, were originally recommended by Carrel for this purpose. No. 00000 (five naught) silk, furnished by Belding Bros. & Co. of New York, and No. 12 ground down needles, made by H. Milward and Sons, are recommended in a recent work by Bernheim. For the preparation of arterial sutures the technic given by Bernheim may be accepted

FIG. 90.—Needle and thread for suture mounted and ready for sterilization (Bernheim).

FIG. 91.—Flask containing liquid vaseline and four mounted needles for arterial suture. Sterilized and kept as stock.

as standard. The special fine silk is cut into twelve-inch lengths, threaded into the tiny Kirby or Milward needles and the ends drawn even. The thread is not tied or fixed in the eye of the needle. The needle is pinned into a small piece of writing paper about ½ inch by 1 inch in size (Fig. 90), and the doubled thread wound about the needle in a figure-of-eight, the ends being caught in a slit in one corner of the paper. Four needles so threaded are placed in a small flask containing two ounces of liquid vaseline (Fig. 91), which is plugged with cotton and capped with gauze, and sterilized in the ordinary way in the steam sterilizer. At the operation the flask is emptied into a dry sterile medicine glass placed on the operating table. The sutures are not to be touched by the instrument nurse, but handled only by the operator. Two or more sterile medicine droppers, with fine points, are provided to be used for washing out, with normal salt solution and liquid vaseline, the blood-vessels where the sutures are being applied.

CHAPTER XXI

SURGICAL INSTRUMENTS

THE nurse who enters, for the first time, upon operating-room duty is likely to experience a sense of strangeness and confusion far surpassing any that she may have known in other branches of her work. Not only is the work itself unfamiliar to her, but the very utensils and instruments are frequently unknown to her even by name, and much less so by use. The effort of this chapter will be to familiarize the nurse not only with the names and appearances of the more common instruments but also with the grouping in which they occur in different operations and the order in which they may be demanded during the different successive steps of these operations. It is hoped that this discussion will render easier the recognition and selection of the different instruments when called for and, also, the proper arrangement and prompt delivery of instruments during operations.

It may be stated, in general terms, that every operation (not solely manipulative in character) calls for the use of five general classes of instruments: cutting, clamping, holding, exposing, and sewing. Each of these classes must, necessarily, include many different varieties to suit the particular demands of the region and nature of the particular operation. An effort will be made to give a general description of the different instruments occurring in each class, the more definite and accurate description being left to the illustrations.

1. Cutting Instruments.—These are, broadly speaking, knives and scissors (Fig. 92) for work in the soft tissues and drills, trephines (Fig. 93), curettes (Fig. 94), cutting forceps (Fig. 95), chisels (Fig. 96) and saws (Fig. 97) for work in bony tissue. The knives may again be divided into three main classes: scalpels, bistouries and amputating knives. The scalpel is a small, straight knife, with the blade and handle generally made of one piece of metal, and the blade flat, convex towards the edge and constituting from one-third to one-fifth of the total length of the knife. The bistoury is very similar, except for a lighter, narrower blade, which may vary greatly in shape with the purpose for which destined. The amputating knife is a much larger and more formidable looking instrument. The blade is apt to be nine inches, or even more, in length, possibly double-edged, and the handle only sufficiently large to furnish an efficient grip to the hand. It is scarcely necessary, or indeed possible, to describe the scissors. The general character is known to all and the different varieties are legion. It is sufficient to say that surgical

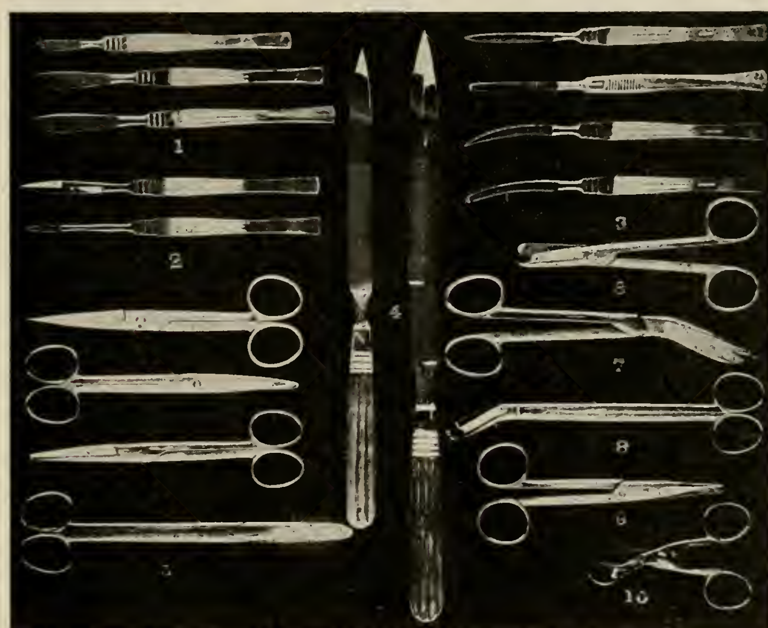


Fig. 92.—Cutting instruments: knives and scissors. (1) Scalpels; (2) tenotomy knives; (3) bistouries, straight and curved, sharp and blunt; (4) amputating knives—Liston's, Catling (double edge); (5) scissors, sharp and dull points; (6) Littauer's suture scissors; (7) Lister's bandage scissors; (8) Emmet's uterine scissors; (9) Mayo scissors; (10) "American" umbilical scissors.

scissors vary in type from the very small (adapted to the most delicate work) to the heavy, scissors-like, bone-cutting forceps that are capable of cutting through a rib.

The drills used in bone-work vary in size from one small enough to make a hole for the passage of moderately fine silver wire to the heavy, burr-tipped drill now largely used to supplant the old circular saw (or trephine) in cranial operations. The saws, also, vary largely, both as to size and shape. The trephine

FIG. 93.

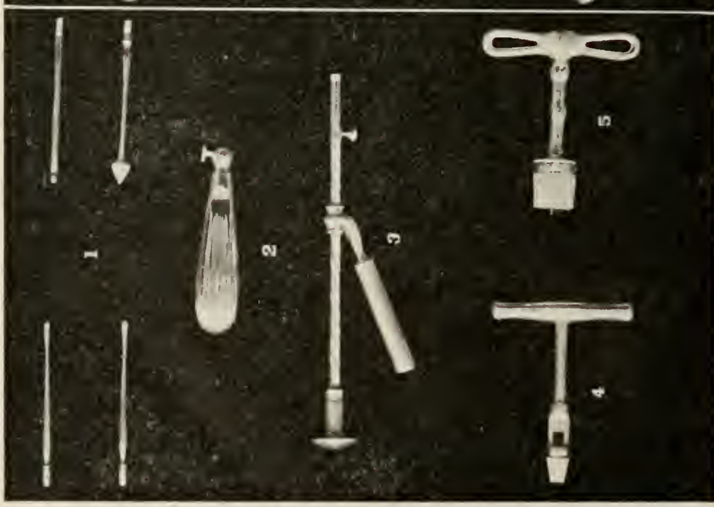


FIG. 94.

FIG. 93.—Cutting instruments: bone drills and trephines. (1, 2) Bone drills with handle; (3) Hamilton's bone drills with handle; (4) DeVilbiss's conical trephine; (5) Galt's conical trephine.

FIG. 94.—Cutting instruments: curettes. (1) Placenta curette; (2) Thomas's curette; (3) Sims's curette; (4) spoon curette; (5) "Berlin" rinsing curette; (6) Blake's curette; (7) Martin's curette; (8) Volkmann's curette; (9) Lauer's curette; (10) Buck's curette.

FIG. 95.

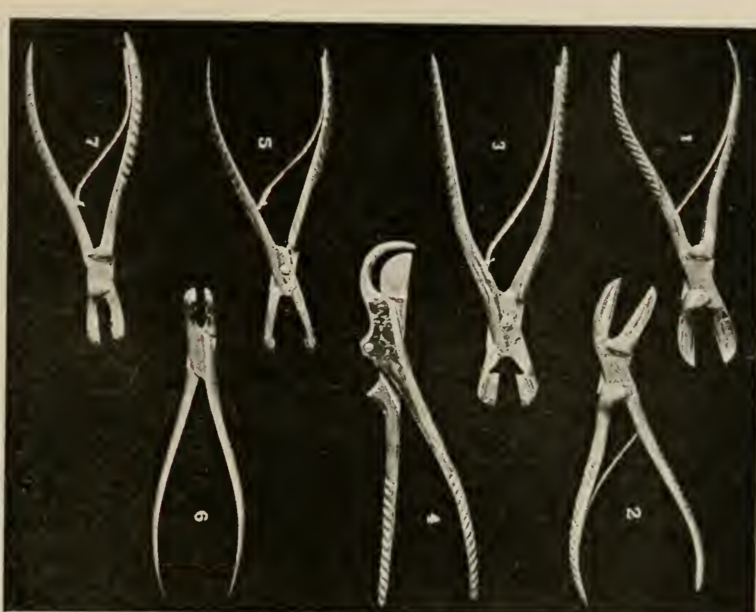


FIG. 96.

FIG. 95.—Cutting instruments: bone cutters. (1, 2) Liston's bone cutters; (3) Velpeau's bone cutters; (4) Gluck's rib shears; (5) Luer's rongeur; (6, 7) Darby's rongeur.

FIG. 96.—Cutting instruments: chisels and gouges. (1, 2) Schwartze's chisel and gouge; (3, 4) McEwen's chisel and osteotome (a chisel has an edge beveled on one side); (5) Brun's and McEwen's gouges; (6) Halsted's raw-hide mallet and common lead-filled mallet.

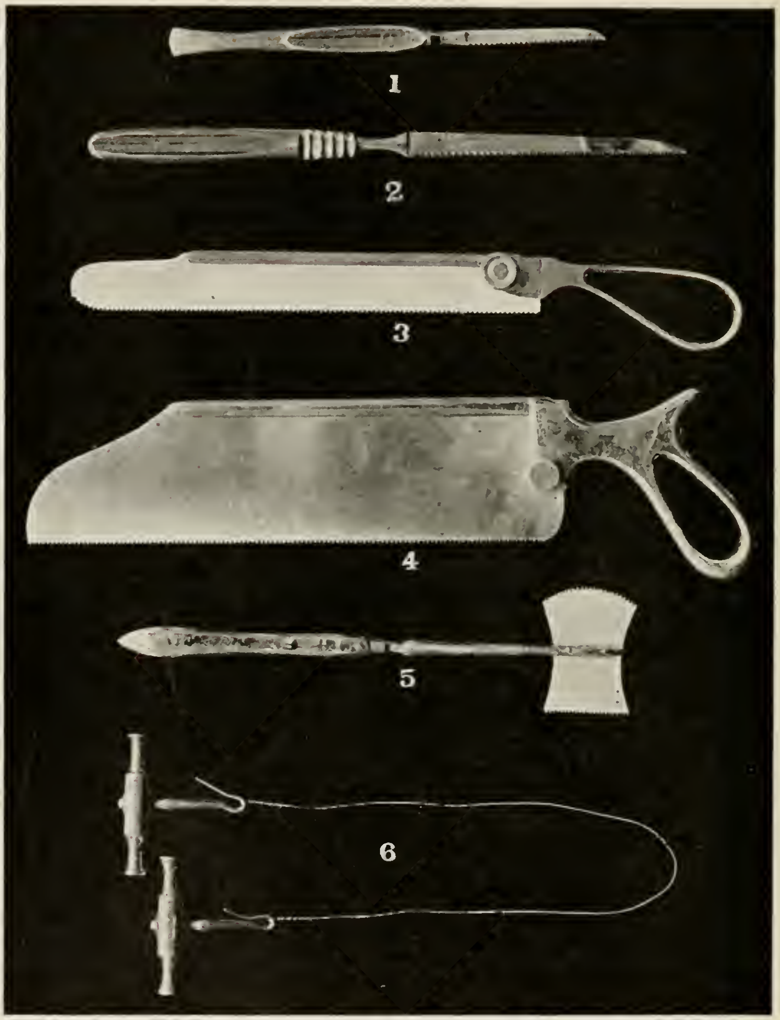


Fig. 97.—Cutting instruments: bone saws. (1, 2) Metacarpal saws; (3) metacarpal saw (lifting back); (4) Satterlee's saw; (5) Hey's skull saw; (6) Gigli's wire saw. (For bow type of saw see Fig. 129.)

(mentioned above) is nothing more than a ring of metal with a saw edge, used for removing a circular button of bone from the skull in intracranial operations. The Gigli saw is a pliable wire, roughened so as to more resemble a file than a saw and used for work where the instrument can be passed around the bone to be cut and the work done through a small aperture with minimum danger to the soft tissues. Bone-cutting forceps are generally fairly heavy instruments, built on the scissors principle and with strong cutting edges, which may be either straight or curved to resemble a scoop. A curette is merely a metal scoop with a handle sufficiently substantial to furnish a good grip. It might be mentioned that the use of the curettes is not confined to bony tissue, one of the most marked exceptions being the long-handled curette used for scraping the uterus.

2. Clamping Instruments (Figs. 98–101).—These instruments may be described, in general terms, as any planned for the temporary control of the escape of fluid from its containing part. The reason for the very broad limits of this definition will, perhaps, be better appreciated when the extremely broad application of this type of instrument is understood. The principle of construction is very nearly related to that of the scissors so far as appearances go. The difference lies in the absence of a cutting edge; the close approximation, under pressure, of the flattened blades, when closed; and a catch locking device near the ends of the handles. As would be supposed, the most common type and use of this instrument is for the temporary prevention or control of hemorrhage. The different instruments vary in size from comparatively small ones designed for the seizure and control of a single bleeding vessel to the quite heavy ones, expected to grasp a large section of tissue (possibly containing several large vessels) and prevent the possibility of bleeding. Any particular instrument of this type may, of course, be applied to a small opening in a tumor containing fluid or even in the bladder, for the purpose of temporarily preventing the escape of septic material into the abdominal cavity. Another large class of clamping instruments is designed for operations upon the digestive tract. The blades (Fig. 101) of these are longer, more springy and less rigid and generally covered with rubber tubing to prevent permanent injury to the delicate gut. A third group is designed for temporary control of the circulation in operations upon the vascular system.

3. Holding Instruments (Figs. 102–103).—It must be acknowledged that this class of instruments is scarcely a distinct entity in itself, as instruments designed for other purposes (particularly those of the clamping type) are frequently made use of in this connection. There is, however, one broad class here

Fig. 98.

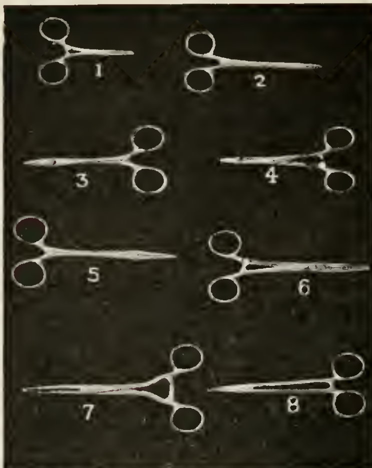
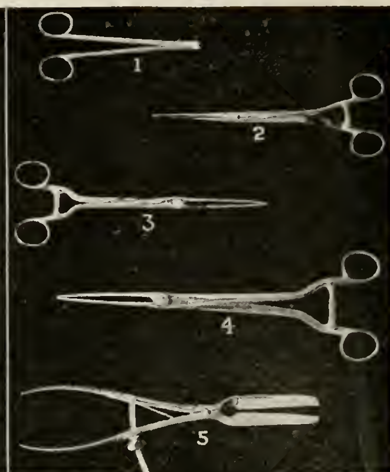


Fig. 99.



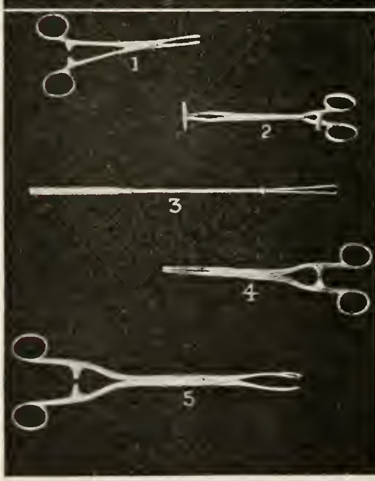


Fig. 100.

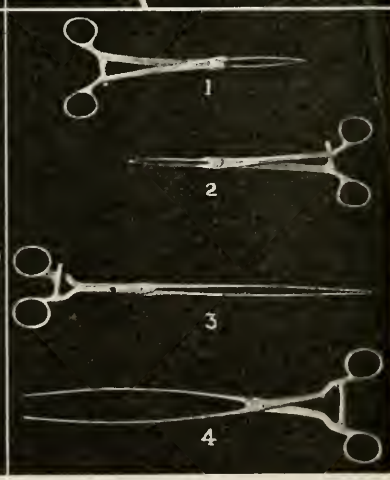


Fig. 101.

Fig. 98.—Clamping instruments: hæmostatic clamps. (1) Kocher's; (2) Halsted's mosquito; (3) Taite's; (4) Pean's; (5) Halsted's; (6) Kocher's; (7) Kelly's; (8) Ochsner's.

Fig. 99.—Clamping instruments. (1) Von Blunk's; (2, 3, 4) Pean's; (5) Kelsey's hemorrhoidal clamp.

Fig. 100.—Clamping instruments. (1) Kelly-Murphy; (2) Pean's "T" clamp; (3) straight sponge stick; (4) Foerster's straight clamp; (5) Foerster's curved clamp.

Fig. 101.—Clamping instruments. (1, 2) Intestinal clamps; (3, 4) stomach clamps (1, Wright's; 2, Kocher's; 3-4, Mayo-Robson).

included and, in addition to that, numerous auxiliaries that have this object. The prominent general class of holding instruments

Fig. 102.

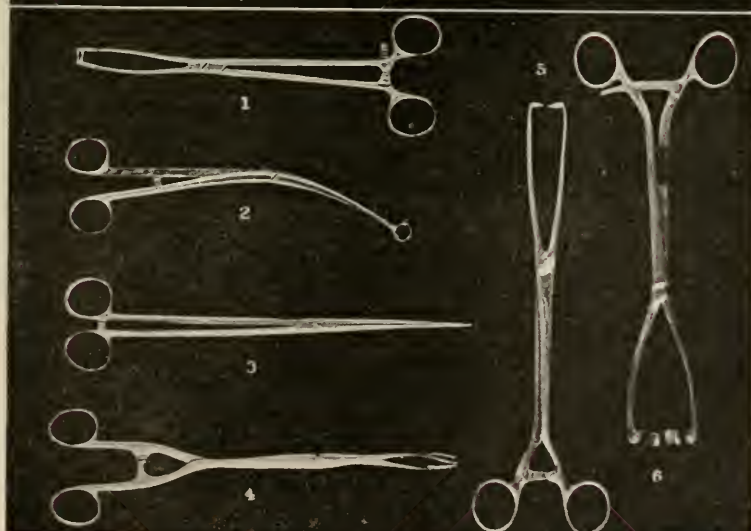


Fig. 103.

Fig. 102.—Holding instruments. (1) Halsted's mouse-toothed forceps; (2, 3) dressing forceps; (4) tongue holding forceps (Houze's); (5) bone clamps (Holden's); (6) Ferguson's lion-jaw bone-holding forceps; (7) sequestrum forceps (Van Buren's); (8) Doyen's tissue-holding forceps; (9) tenaculum.

Fig. 103.—Holding instruments. (1) Richter's volsellum forceps; (2) Skeene's volsellum forceps; (3) Emmet's; (4) Foerster's sponge or dressing forceps; (5) Richter's; (6) Collins's uterus holding forceps.

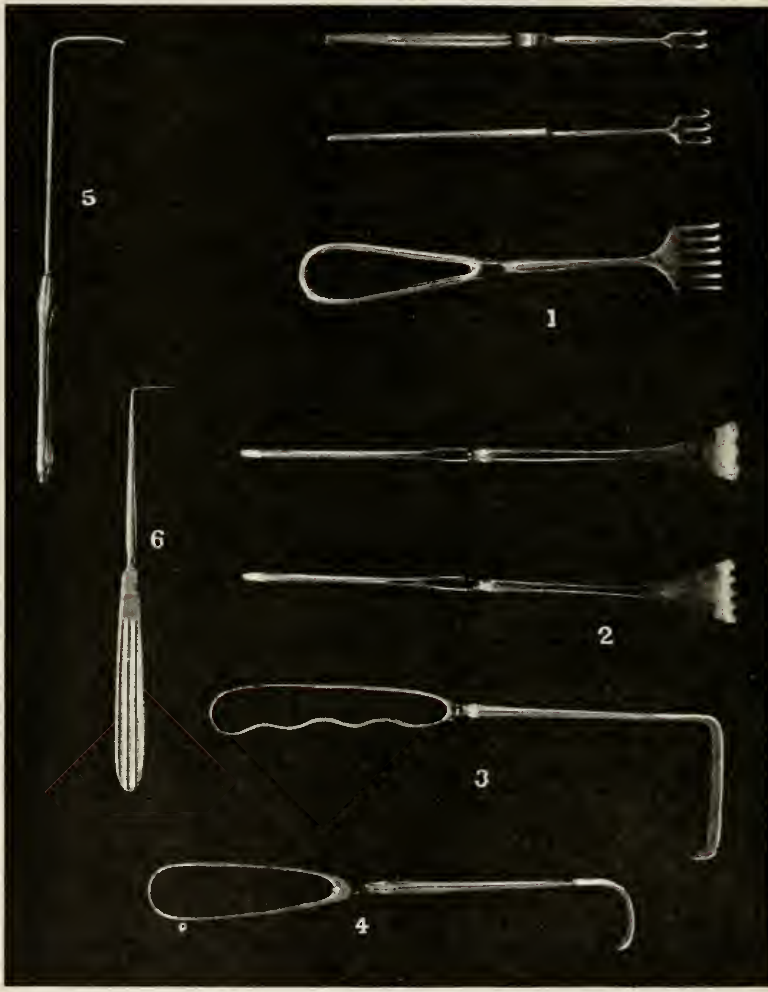


Fig. 104.—Exposing instruments: retractors. (1) Sharp hook retractors (Simon's, Volkmann's); (2) Halsted's; (3) Kelly's; (4) Richardson's; (5) Langenbeck's; (6) Freer's retractors.

is that of the dissecting forceps (Fig. 102, Nos. 1, 2 and 3). These are otherwise variously described as tissue forceps, or thumb forceps. The names "dissecting," or "tissue," forceps are somewhat descriptive of their use. They are really the left hand of the operator. They closely resemble large tweezers in appearance and, with them, the operator grasps and steadies the tissues immediately under his attention, using them for the thousand and one purposes for which the fingers of the left hand would ordinarily be called into play were they not too slippery and cumbersome for delicate work. These instruments are generally described as smooth or mouse-tooth (or even rat-tooth, or merely tooth) forceps, according to whether the grasping tip is or is not armed with teeth to make a more secure hold possible. They

Fig. 105.

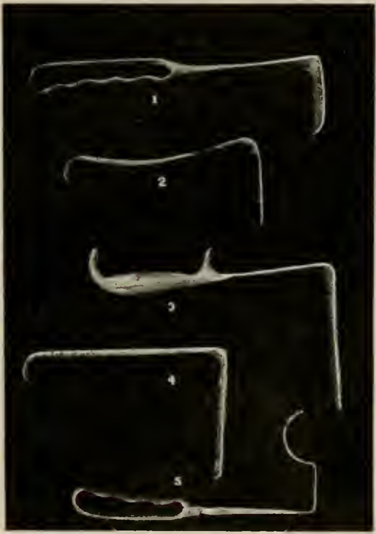


Fig. 106.

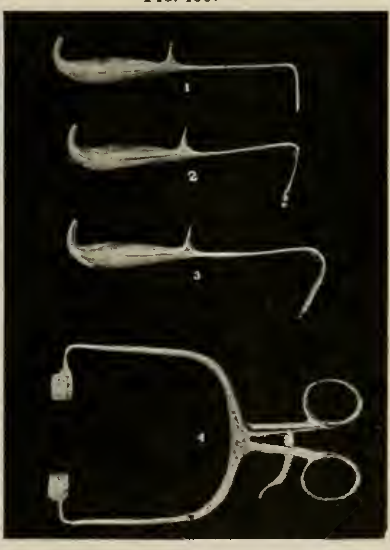


Fig. 105.—Exposing instruments: retractors. (1) Kelly's; (2) Langenbeck's; (3) Doyen's; (4) Jackson's; (5) Young's vesical (bladder) retractor.
Fig. 106.—Exposing instruments: retractors. (1, 2, 3) Young's; (4) Simpson-Mayo.

are made comparatively short for work on the surface or in easily accessible localities and twelve inches or more in length for work in less accessible cavities. In addition to this class, brief mention may be made of such instruments as tongue-holding forceps (Fig. 102, No. 4), for seizing and making traction on the tongue; and the numerous forceps of the clamp type designed for the proper seizure and exposure of the uterus in gynæcological operations. The latter instruments are known as single or double tenaculum forceps (Fig. 103, No. 2), volsellum forceps (Fig. 96, Nos. 1

Fig. 107.

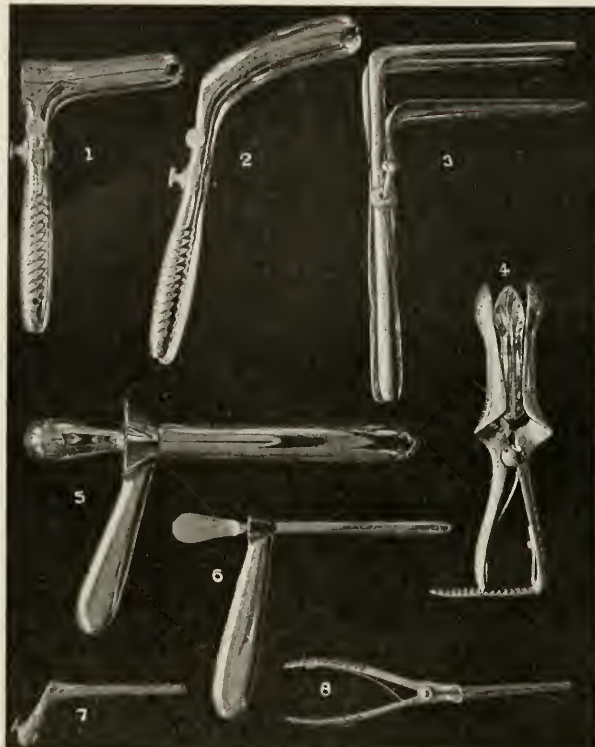


Fig. 108.

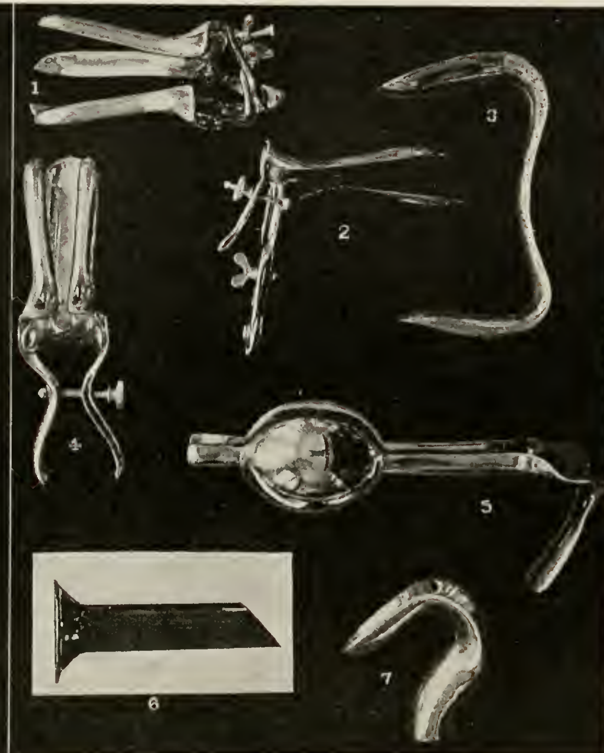


Fig. 107.—Exposing instruments: specula. (1) Bodenhamer's rectal speculum; (2) Pratt's sigmoid speculum; (3) Halsted's rectal; (4) Mathieu's rectal; (5) Kelly's rectal; (6) Kelly's urethral; (7) Caro's urethral; (8) Pratt's urethral speculum.

Fig. 108.—Exposing instruments: specula (vaginal). (1) Ashby's; (2) Graves's; (3) Sims's; (4) Nelson's; (5) Auvard; (6) Ferguson's; (7) Edebohl's.

and 5) and uterine elevating forceps, according to whether the grasp is rendered secure by a single, unopposed fine point; two opposed fine points; several opposed heavy teeth; or a somewhat encircling grasp independent of teeth (Fig. 103, No. 6)

4. Exposing Instruments (Figs. 104 to 108).—Exposing instruments are, as a rule, broad-bladed, blunt hooks, known as retractors, of varying sizes that are used to draw back the edges of the wound in order to give a better exposure of the deep structures. Beyond the limits of this definition come the atypical retracting instruments—generally called specula (Figs. 107 and

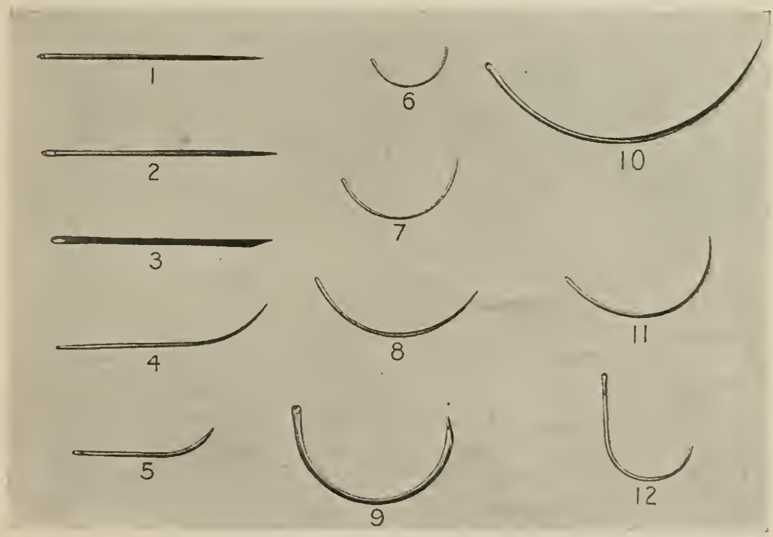


Fig. 109.—Surgical needles: (1) Glover's needle; (2) triangular point; (3) Halsted-Hagedorn; (4) surgeon's half curved; (5) Emmet's half curved; (6, 7) intestinal needles; (8) surgeon's full curved; (9) Halsted-Hagedorn, full curved; (11) Kelly's; (12) Lister's.

108). These serve the same purpose, but in a somewhat different way. They are used in order to expand closely approximated canals communicating between the outer air and the body cavities. Thus, we have nasal, aural, vesical, vaginal and rectal specula. They may accomplish their purpose by the simple introduction of a tube that gives a free field of vision through its lumen (tubular specula), or by the separation of blades that force back the adjacent tissues (bivalve or trivalve specula).

5. Sewing Instruments.—The sewing instruments may be divided into needles (Fig. 109) and needle holders (Fig. 110).

While it is not necessary to use a needle-holder in surface sewing, it is quite common for operators who have become used to the holder in deep work, where it was necessary, to also use it on the surface where this is not the case. The needle-holder is generally some modification of an instrument of the clamping type, which holds the needle firmly and permits untrammelled work in the less accessible localities. The needles used for surgical sewing are, if anything, more varied as to construction and application than the other surgical accessories, which seem limited only by the individual preference of the operators using them. Needles may, however, be generally subdivided, according to shape, into straight and curved, and, according to section, into round and cutting. The use of the straight needle is almost necessarily confined to readily accessible parts, as in other regions the recovery of the point after passage might be a matter of considerable difficulty. These needles may, in turn, be either round or cutting. The round, straight needle does not materially, if at all, differ from the ordinary household needle. It is best adapted (as are all of the round needles) for work in delicate or friable tissue, where the danger of the stitch cutting out is ever present and must be reduced to a minimum. It may be said that the generally accepted use of the fine, round needle (whether straight or curved) is in visceral work where serous surfaces are to be united. This includes operations upon the intestines, stomach and urinary bladder. Large, round needles are also used in work upon the liver, kidneys and sometimes the uterus. The cutting needle (either straight or curved) does not, necessarily, differ very greatly, in appearance, from the round. Its use is primarily in tissues where some resistance to the passage of the needle may be expected and where the danger from causing hemorrhages or of the suture tearing out is slight. The cutting quality is obtained by the type of point and cross-section. We have, thus, spear-pointed needles; the triangular sectioned needle, somewhat like an old-style bayonet; and the flattened needle, with a single, sharpened cutting edge near the point. The degree of curve of a needle may vary from that only slightly departing from the straight to that which is almost a perfect semicircumference of a small circle. In addition to these may be mentioned the large needles and ligature carriers that unite, in one instrument, the functions of needle-holder and needle (Fig. 111).

6. Auxiliary Instruments.—The number of instruments sup-

FIG. 110.

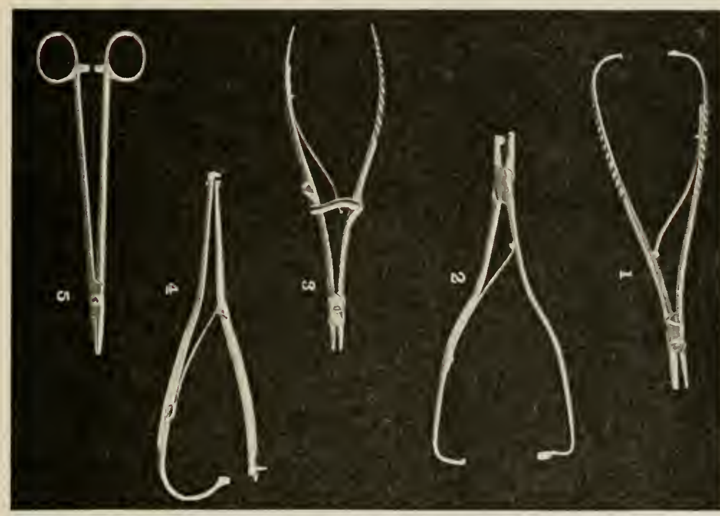


FIG. 111.

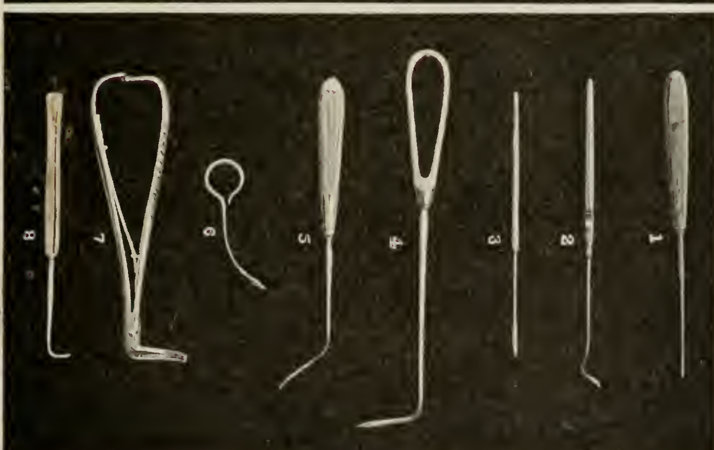


FIG. 110.—(1) Mathieu's needle holder; (2) Richter's; (3) Noble's; (4) Hagedorn's; (5) Hegar's needle holder.
FIG. 111.—Sewing instruments: ligature and suture carriers. (1) Reverdin; (2) Whitehead's (staphylorrhaphy); (3) Peaseley's; (4) Emmet's; (5) Carsten's; (6) Moony's; (7) Cleveland ligature carrier; (8) aneurism needle.

Fig. 112.

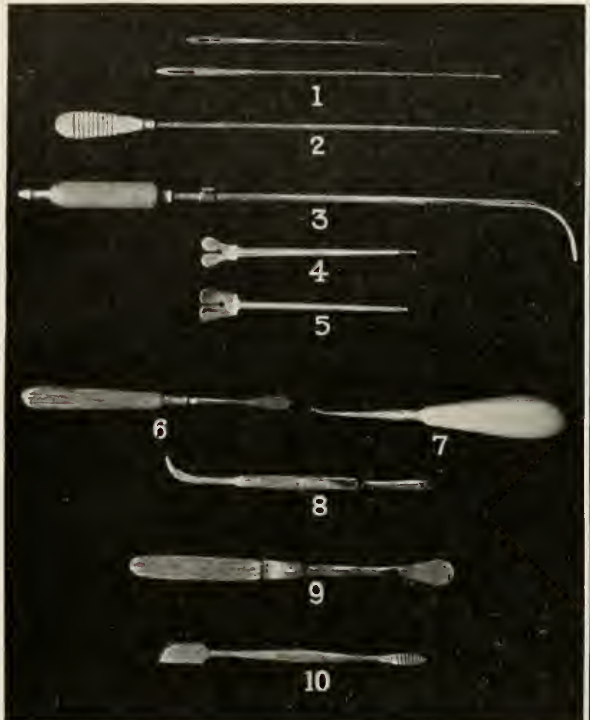


Fig. 113.

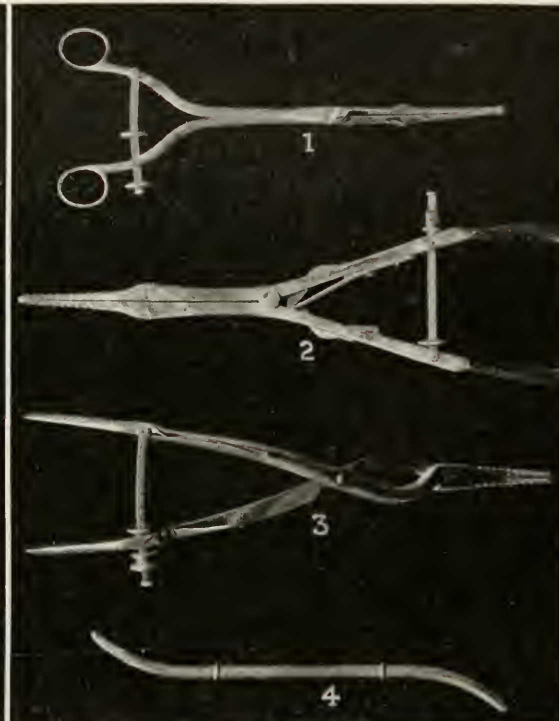


Fig. 112.—Auxiliary instruments: probes, directors, dissectors. (1) Silver probe; (2) uterine sound (Sims's); (3) Thompson's stone sound or searcher; (4) probe-pointed grooved director; (5) plain grooved director; (6, 7) blunt dissectors (Massachusetts General Hospital pattern); (8) Allis's blunt dissector; (9, 10) periosteal elevators.

Fig. 113.—Auxiliary instruments: dilators. (1) Palmer's; (2) Goodell's; (3) Wathen's uterine dilators; (4) Pratt-Hank's.

plementary to, but not definitely identified with, the above groups covers a field that cannot be comprehensively covered within the limits of a single chapter, or indeed of a single small book. We shall, however, make a brief study of a few of the more important—those in general and frequent use. For this purpose, we shall consider five classes of instruments: searchers, directors, dissectors, dilators and evacuators.

A. The probes are the truest type of searchers (Fig. 112, Nos. 1 and 2). They are of varying size to permit of introduction in passages of the smallest size and large passages whose known dimensions are fairly constant and ordinarily of a fairly soft metal to permit of shaping by hand so as to follow the curves of the passage. Their function is diagnostic,—the exploration of a cavity or passage that is not subject to visual or digital examination.

B. The directors (Fig. 112, Nos. 4 and 5) are a less commonly used group, somewhat resembling the searchers in general characteristics, but supplied with a grooved track along which the back of a knife or scissors blade may be passed accurately in a given direction, without danger of additional and unintended injury to the parts.

C. The dissectors (Fig. 112, Nos. 6–8) are absolutely or moderately blunt-bladed instruments, used in the careful separation of tissues in regions where the use of a knife or scissors might cause unnecessary or objectionable destruction of tissue.

D. The dilators (Figs. 113 and 114) are instruments used for the purpose of enlarging already existing orifices either as a means of treatment or in order to render the subjacent parts more readily accessible. They may be graduated in size, so that the introduction of successive instruments produces gradual dilatation; cone-shaped, so that the gradual introduction of the single instrument produces the same result; or bladed, so that the gradual separation of the blades, under pressure, procures dilatation. Their most common applications for curative purposes are to strictures of the œsophagus, urethra and rectum and dilatation of the uterine cervix for dysmenorrhœa. For purposes of rendering the parts more accessible, they are most commonly employed in dilating the female urethra, the sphincter ani and the uterine cervix (in the last case, to permit thorough curettage).

E. The evacuators (Figs. 115 and 116), as their name would suggest, are designed to remove foreign or excessive fluid from

Fig. 114.

Fig. 114.—Auxiliary instruments: dilators. (1) Wale's bougie; (2) Pratt's dilator; (3) (4) Kelly's; (5) Weiss's urethral sound.

Fig. 115.

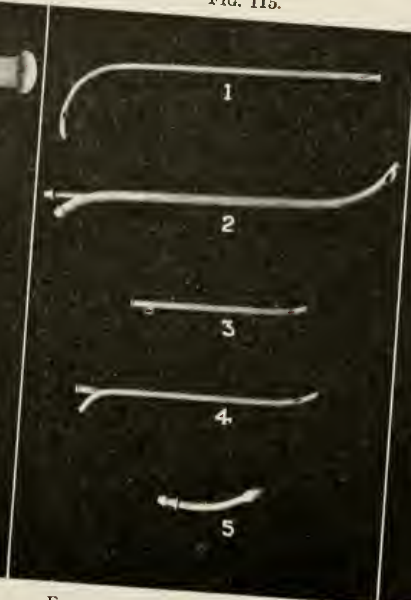


Fig. 115.—Auxiliary instruments: evacuators (catheters). (1) Male; (2) Hagner's double current; (3) female; (4) female; Nott's double current; (5) Skeene's self-retaining (female).

Fig. 116.

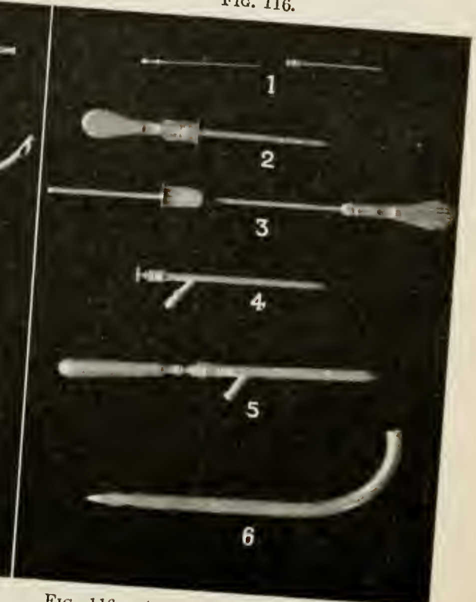


Fig. 116.—Auxiliary instruments: evacuators (trocars and caunulæ). (1) Exploring; (2) Buch's; (3) reversible; (4) Ochsner's (gall-bladder); (5) Emmet's ovarian; (6) Tait's ovarian.

body cavities. They vary from the simple aspirating needle (Fig. 116, No. 1), used to remove fluid from joints or other localities, for diagnostic purposes, to the heavy trocar and cannula (Fig. 116, Nos. 2–5) used for evacuating large ovarian cysts, before removal, and include the various catheters (Fig. 115). The trocar and cannula consists of a tube (the cannula) which is supplied with an accurately fitted, pointed, metal core (the trocar), the point of which projects beyond the tube. This is used by forcing the point through the cyst wall (or even the abdominal wall), removing the trocar and leaving the cannula in place, where it acts as a tubular drain.

The Care of Instruments.—The first requisite of the proper care of all metal surgical instruments is that, when not in use, they be dry when put away and that they be kept in a dry place. After using, the instruments should be boiled to destroy any infectious material that may have adhered during operation. They are then mechanically cleansed in soap and water, supplemented, when necessary, for the removal of rust or firmly adherent particles, by sand soap, Dutch cleanser, or some similar preparation. After cleaning, they are carefully dried with cloths, the locks lubricated with vaseline or some thin oil, and put away in a dry instrument case. When instruments are used only at infrequent intervals, as may be the case in private offices or with special instruments, it is well to apply a light coat of some thin oil, after drying. Cutting instruments should not be sterilized in a tray with numerous other instruments, as the edges may be nicked or dulled by contact.

Hollow instruments such as trocars and cannulæ and hollow needles for hypodermic and aspirating syringes need special care to prevent plugging of the tube with rust. Absolute alcohol should be run through such instruments after thorough cleansing, and a wire smeared with oil or vaseline should always be inserted in the hollow needles before putting away. Instruments with elaborate joints should receive particular attention to see that no moisture remains at places not easily accessible. A costly instrument may be easily ruined by carelessness in such particulars.

CHAPTER XXII

THE ASEPTIC TECHNIC

I. DEFINITIONS

The word technic means the correct manner of procedure, in all of its minutest details, which is employed in the proper carrying out of any piece of work requiring special knowledge and skill. It is, in other words, the right way of doing things. Every form of creative or manual activity in which man applies himself, including even art and literature, has its own technic; that is, the right way of doing that particular thing. An error in technic is a departure from the recognized procedure with the result of a decrease in efficiency, or a failure to attain the best possible result in the final product.

Let us consider, as a homely illustration, the preparation of food. Every one knows that a slight and to the novice apparently insignificant variation in the manner of preparing and cooking an article of food may make all the difference between a wholesome, appetizing dish and a nauseating mess. In other cases the contrast is not so great. One way of cooking will produce a dish that is fairly good, while a slightly different way will add to it a delicious delicacy of flavor infinitely superior to the other product. Again, there may be several ways of preparing a dish giving results a little different but about equally good. Finally, there will be cases where there is no general agreement, even among the most expert, as to which of two or more methods is the best.

The technic of general surgery covers every surgical procedure, from the giving of a hypodermic to the most extensive surgical operation, and in this field also we shall find the same differences as those indicated in our illustration, but the results of technical errors will be vastly more serious. In the first case we shall have, instead of a spoiled dish, perhaps prolonged illness or even loss of life of a patient who, if things had been done for him in the right way, would have had every chance of a speedy recovery. In the second case the bad results of the use of the less efficient of two methods may not be so obvious, and yet very serious in reality, since in comparing a long series of operations the technical error may show its effect in a much higher mortality. Of the third case, where several methods are equally good, there are many instances in surgery, and there are also not a few under the fourth where technical details are still a matter of dispute.

It is clear, therefore, that the technic of surgery, like that of any other art or industry, does not consist of a set of cut-and-dried rules to be learned by rote. Its practice requires knowledge and understanding of principles and causes and the intelligent application of this knowledge to particular cases under widely different conditions; nor is it rigid and unchangeable, but rather subject to constant improvement as new facts and methods are discovered.

In the technic of surgery there are three quite distinct divisions. The first is the aseptic technic, which is concerned with the methods of preventing infection in wounds. The second part of the operative technic relates to the manner of performing the operation itself. It concerns the work of the surgeon almost exclusively. Practically all that concerns the work of the nurse in connection with it is contained in the chapter on operative steps. The most important general principles of operative technic are sharp knife dissection, avoiding tearing of the tissues, or any unnecessary trauma; exposure of the operative field with the least possible mutilation of overlying parts; perfect hæmostasis at every stage of the operation; avoidance of constriction of large masses of tissue in ligating vessels; suturing so as to restore proper anatomical relations; obliteration of dead spaces; avoidance of undue tension in closure. Every separate operation has its own technic, the result of constant study and trial to find the most efficient way. The path of surgery is strewn with discarded bits of operative technic, many of them the result of much ingenuity and labor, which have, however, been found wanting in some important particular. A full discussion of the subject would constitute a treatise on operative surgery. The third division of the surgical technic concerns the management of the individual patient before, during and after an operation; how he can be brought to the best possible condition, both physical and mental, to meet the ordeal that is before him; how he can be carried through that ordeal with the least risk, the minimum amount of suffering, the smallest drain upon his vital forces, and how he can be brought to full restoration of health in the shortest possible time.

By the term "sterilization" we mean the absolute destruction of all single-celled organisms. An object or a material is sterile when it contains no living organisms, either upon its surface or within its substance. "Disinfection" is an older term with a somewhat less precise meaning. It is used rather loosely to indicate either the destruction or rendering inert and incapable of harm any of the infectious or pathogenic organisms. The word "antiseptic" is used in a somewhat similar way, its meaning, however, being restricted to the effect upon the bacteria concerned in septic infection.

Thus since we know that we cannot sterilize the hands or the skin of the patient in the region to be operated upon, we speak of disinfecting them when we use the best means we have for rendering them as free as possible from living organisms. When we apply a chemical solution, such as bichloride of mercury, to a wound, with the purpose of cleansing it, we call it an antiseptic solution. Such solutions do not accomplish the purpose intended very efficiently, for several reasons. In the first place, we know of no chemical which will kill bacteria that is not also destructive to the tissue cells. Moreover, the bacteria are not all on the surface, but embedded in the tissues, so that the solution does not reach them. Finally, we have to contend with the fact that solutions which will readily kill bacteria in the laboratory will often be rendered more or less inert when in contact with organic material. "Aseptic" means freedom from septic bacteria. Thus we say a wound is aseptic when it contains no septic organisms.

When, by some injurious effect brought to bear upon them, bacteria are not killed but are rendered inert or inactive, so that they cannot grow or multiply, at least for a time, we say that they are "inhibited." The effect of our disinfectant and antiseptic solutions, particularly in the more dilute preparations, is often to inhibit bacteria rather than to kill them.

The thermal death point for bacteria is the temperature at which they are killed, in the presence of abundant moisture, after an exposure of ten minutes. For many of the pathogenic bacteria this temperature is not very high: 60° C., or 140° F., is the thermal death point for the typhoid bacillus, 65° to 70° C. for the tubercle bacillus, and a somewhat higher temperature for the pyogenic bacteria.

II. THE FIRST PRINCIPLES OF ASEPSIS

1. Given proper coaptation, or fitting together, of wounded tissues, and rest (*i.e.*, prevention of motion in the wounded part), almost the sole remaining obstacle to prompt wound healing lies in the invasion of the wound by one of about half a dozen species of bacteria known as the septic or pyogenic group. When these are absent wounds heal normally; when they are present septic disease results in the wound, delaying healing or preventing it altogether.

2. All men and all the higher animals, probably, are chronic carriers of this group of bacteria, and everything handled by man is quite certain to be contaminated with them.

3. The constant dwelling place of these germs is upon the skin and mucous surfaces of the body, the tissues of the interior of the body being normally free from them.

4. Although it is possible for wounds to be infected in several ways, for example through the air, or through the blood stream (since bacteria occasionally find their way into the blood and may survive there for short periods), yet practical experience shows that almost the sole cause of wound infection is the conveyance of bacteria by contact, or by direct implantation into the wound of some germ-bearing material.

5. Prevention of infection in wounds, therefore, requires that everything that comes in contact with a wounded surface must first be rendered sterile, *i.e.*, entirely free from living, single-celled organisms.

6. The most efficient means of sterilization is heat, and this should be the method employed wherever possible. In order to sterilize any article it must be subjected to dry heat at 150° C. (302° F.) for one hour, or to steam at ordinary pressure for one hour, or to steam at fifteen pounds pressure for thirty minutes, or to boiling water for ten minutes. These represent the minimum requirements in practical work.

7. Any object that has been sterilized which afterwards comes into even momentary contact with an unsterilized object thereby ceases to be sterile.

8. The sterilization of the skin is the most difficult problem in the aseptic technic, because the application of heat as a sterilizing agent is impracticable and because bacteria are contained in the crypts of the skin glands and follicles, where disinfecting solutions cannot readily reach them.

III. STERILIZATION BY HEAT

The only reliable method by which objects or material can be sterilized within a short time, measured in minutes, is by the application of heat in some form. Dry heat means heating in the air, as in an oven. Moist heat may be employed in the form of water or of steam. Steam may be employed either as free flowing steam or confined under pressure in a closed air-tight chamber.

The factors which must be taken into account in sterilizing by heat are, (1) the susceptibility of the organisms to be killed, (2) the degree of temperature to be employed, (3) the time of exposure, (4) the presence of moisture, and (5) the liability of the articles to be sterilized to be themselves affected by heat. Bacteria in the active or "vegetative" stage are, as has been said, killed at a comparatively low temperature; but bacteria in the resting stage, *i.e.*, the spore-forming bacteria, resist the temperature of boiling water or free steam for more than an hour. In sterilizing culture media in the laboratory a method known as "fractional" or "discontinuous" sterilization is used in order to make sure of the destruction of the spore-forming organisms. This consists in repeating the sterilizing process for three days in succession, the object being to allow the spores which may be present to grow out into the vegetative form during the intervals between the successive sterilizations, they being then readily killed when heat is next applied. This method applies only to liquids or moist materials, since spores will not grow out when dry.

The higher the temperature the less the time of exposure needed. The temperature of the flame kills bacteria instantly, but most objects to be sterilized would themselves be destroyed by such high temperatures. We have to determine the time of exposure therefore in accordance with the degree of heat that can be safely used. Dry heat will scorch or injure most materials at a higher temperature than from 150° to 180° C. (365° F.). An exposure of an hour to dry heat at this temperature is necessary to destroy spore-forming bacteria. Dry heat does not penetrate easily into packages of woven goods.

Moist heat is more efficient than dry heat as a sterilizing agent, *i.e.*, at the same temperature. Thus moist heat at 100° C. (212° F.), which is the highest temperature we can obtain from boiling water, or free steam, is about equal in sterilizing power, with the same time of exposure to dry heat at 150° C.

To obtain the most efficient sterilization by means of heat we must employ moist heat, in the form of steam, at a higher temperature than 100° C., and to do this it is necessary to apply the steam under pressure in an air-tight and steam-tight chamber. The apparatus employed for this purpose is known as a pressure sterilizer or autoclave.

The temperature at which water boils, and therefore the temperature of the steam given off, depends on the pressure upon the water surface. In the open air this pressure is due to the weight of the atmosphere, as is shown by the fact that water boils at a lower temperature at high altitudes than at the sea level. When water boils in a closed chamber the steam given off itself rapidly increases the pressure on the surface of the water. When the pressure at a given temperature becomes just sufficient to check the further giving off of vapor from the surface, the space above the water is said to be saturated with steam. Now if the water is further heated more vapor will be given off, and the pressure will be increased. The atmospheric pressure at sea level is about 15 pounds to the square inch; if we add another 18 pounds of pressure, the temperature of the saturated steam in the autoclave will be about 275°F., or 135° C. Moist heat at this temperature will kill all bacteria, including spores, after an exposure of twenty minutes. This is about the temperature used in the operating room for the sterilization of dressings and other materials. So long as the steam is in contact with the surface of the water the closed space will be filled with saturated steam, whatever the temperature may be. But if the steam is cut off from the surface of the water, or the water is all boiled away, and if then the steam is still further heated, its condition changes, it becomes "dry" steam and its sterilizing power will then be only equal to that of dry air at the same temperature.

IV. OUTLINES OF THE ASEPTIC TECHNIC

1. Methods of Sterilization.—The various methods in practical use and the manner of using them have already been described. It is sufficient here to present a summary of their application to the sterilization of the different materials employed in operative work.

(1) *Articles to be Sterilized by Steam.*—Covers for the operating and instrument tables (rubber sheets and cotton sheets); sheets and towels to drape and cover the patient's body, except the

field of operation; gowns, masks, and caps for the operator and assistants; sponges, packs, silk and linen sutures, and ligatures; gauze for dressings; flasks of saline solution, olive oil for lubricating catheters, camphorated oil for hypodermic use, vaseline, zinc ointment, etc.

(2) *Articles to be Sterilized by Boiling in Water, or One Per Cent. Solution of Carbonate of Soda (Washing Soda).*—All metal instruments (except the cystoscope); rubber gloves; sealed glass tubes containing catgut and kangaroo tendon sutures and ligatures furnished by the manufacturers; glass and soft-rubber catheters and drainage tubes; basins and irrigators.

(3) *Articles to be Sterilized by Dry Heat.*—Glassware; catgut (in preparation).

(4) *Articles to be Sterilized by Chemical Solutions.*—Gutta-percha tissue (in 1 to 1000 bichloride of mercury solution); skin of the patient in the field of operation (iodine and alcohol, or bichloride solution); hands of the operator and assistants (alcohol, bichloride solution, permanganate of potash and oxalic acid solutions, etc.); gum catheters (bichloride); Kelly pads (1–20 carbolic).

(5) *Articles to be Sterilized by Formalin Vapor.*—Cystoscopes; gum catheters; and perhaps a few other special instruments.

2. Assembling and Handling the Sterilized Outfit.—The various articles required for an operation, sponges, packs, dressings, towels, sheets, etc., are put up in individual packages before they are sterilized, and the total requirements for a single operation (*i.e.*, all those that are to be sterilized by steam) are assembled in one or two large packages or drums. In these they are carefully arranged in due order, those that are to be used first on top and those that will be needed later at the bottom, so that there need be no pulling about of the various articles to get what is wanted at any time. First, towels and sheets for covering instrument and dressing table; next, nurses' and operators' gowns, caps and masks, covers for the operating table, operating sheet with hemmed opening in centre; lastly, towels for surrounding the field of operation. Articles which are to come into contact with the wound itself, sponges, packs, and dressings, may be in a separate drum or package. All sponges and packs should be counted twice, preferably by two nurses separately, at the time they are put up, all packages containing the same number. The time for sterilization of this outfit should be arranged so that it will be ready shortly before the operation. In the steam sterilizer the packages or drums should be subjected to ten minutes' vacuum, thirty minutes' steam, followed by ten minutes' vacuum. Instruments and all articles that are sterilized in boiling water are arranged in a tray in the instrument sterilizer, boiled ten minutes, and brought direct to the instrument table in the tray, from which they are taken by the nurse and placed on the table in proper order.

The operating force is divided into two groups: the clean group, consisting of the operating surgeon, two assistants, and one or two nurses; and the not-sterile group, consisting of the anæsthetist, one or two nurses, and an orderly. Each member of the clean group, after being cleaned up, gowned and gloved, must see to it that no part of his clothing comes in contact with any article that has not been sterilized, particular care being taken that the hands touch nothing not surgically clean. The first lesson to be learned is that the face is never surgically clean. All handling of unsterile articles is done by the not-sterile group, all handling of sterile articles by the clean group. Thus, packages are opened by the unscrubbed nurse, their contents are removed by the clean nurse.

3. Preparation of Members of the Clean Group.—Two points are to be considered here: (1) the cleansing and disinfection of the hands, and (2) the manner of putting on the sterilized gowns, gloves, masks and caps. The methods in use for hand disinfection vary according to individual ideas. All the methods include the two steps of thorough scrubbing with soap and water for ten minutes, followed by immersion in some antiseptic solution for five minutes or more, for example, in 70 per cent. alcohol (one minute) and 1–1000 bichloride (five minutes). One point already referred to needs particular emphasis. There is a great deal of difference in the susceptibility of the skin of different individuals to the irritating effects of antiseptic solutions. When any such solution makes the skin of the hands rough it is an error in technic for that individual to continue the use of that solution. The same is true of the use of the scrubbing brush. A piece of gauze is equally efficient for hand cleansing, and should be used instead of the brush whenever the latter is a source of irritation. Superlatively clean hands are a necessity, but an irritated skin is a greater source of danger than the failure to use strong antiseptics. Alcohol at least can always be used.

There are three methods of putting on rubber gloves: the wet method, the dry method and the method with a sterile lubricant, usually glycerite of starch. When the wet method is to be used, the gloves are brought from the sterilizer and dropped into a basin filled with bichloride (1–2000), or sterile salt solution (0.6 per cent.), the latter for those to whom bichloride acts as an irritant. In putting on the gloves the first point is that the bare hand is never to touch the outside of the glove. The edges of the gloves are folded forward towards the fingers like a cuff. The thumb and finger of the left hand catch hold of this cuff and lift the right-hand glove (filled to its full capacity with the solution) out of the basin. The right hand is then wriggled into the glove as far as it will go, of course spilling out the water in so doing. The last of the solution is drained out by lifting the hand and stretching the glove at the wrist. It is not right to allow this overflow of solution from the glove, which necessarily carries washings from the skin, to flow back into the basin containing other gloves. The hands should be held over another basin while putting on the gloves. If when lifting up a glove full of solution a leak is discovered, the glove should be discarded. The left glove is put on in the same way, with special care that the gloved fingers of the right hand do not touch the skin of the other hand. The cuffs are not turned back until the gown has been put on. The one great advantage of this method is that before putting on the gloves one can be certain that they are not perforated. A glove that has a hole in it is probably worse than no glove at all.

When the dry method is used, the gloves after coming from the sterilizer must be thoroughly dried between sterile towels, and then turned inside out and dried again; all this must be done by a "clean" nurse wearing sterile gloves, and is a rather tedious process. Dry sterile powder in a sterile container must be furnished to facilitate putting on the gloves. The same care must be exercised as before not to touch the outside of the gloves with the fingers. When glycerite of starch is used the wet gloves, fresh from the sterilizer, are laid on a sterile towel, the hands are smeared with the sterile lubricant and the gloves put on in the manner described. Wet gloves cannot be put on without a lubricant unless they are filled with water. When either of the two latter methods is employed it is the duty of the nurse who attends to the sterilization of the gloves to see that they have no holes in them when they come from the sterilizer. This can only be done by lifting them with sterile forceps while filled with water, so that any leak will show itself. After the gloves are on the gown is picked up and held at arm's length while it is unfolded and the hands slipped into the armholes; the arms are then held straight in front while the unscrubbed nurse pulls the gown into place by means of the tapes, which are then tied at the back. The cuffs of the gloves are then pulled over the sleeves. The unscrubbed nurse also adjusts the sterile cap and mask for each member of the clean group, who must not use their own hands for this purpose. The toilet of the patient, who may be considered a member of the clean group, consists of two steps: disinfection of the skin in the field of operation and covering all the rest of the body except the face with sterile sheets and towels. Tincture of iodine diluted with alcohol is now almost universally used for skin disinfection in the field of operation. The first thing to be remembered is that the skin should be absolutely dry. Scrubbing with soap and water should be done on the previous day, as should also the shaving. If it is necessary to shave immediately before the operation this should be done dry with the use of benzene. The skin should also be free from grease, and to this end a preliminary washing with some oil solvent (ether, turpentine, benzene) may be employed. The method employed at the Mayo clinic, copied from that in use at the clinic of Dr. Bastianelli in Rome, consists of applying two solutions to the skin. The skin is first lightly rubbed with a solution consisting of one part of iodine crystals to 1000 parts of benzene. Tincture of iodine, diluted one-half with alcohol, is then painted over the skin. One coat is enough. A wide area about the proposed wound should be covered. Blisters may result in skin creases if the solution is allowed to run into them and dry slowly. Bichloride or other antiseptic watery solution should never be employed to supplement the iodine disinfection, for blistering is sure to follow if this is done. At the close of the operation the iodine is washed off with alcohol to which a few drops of an alkali (soda, potassa, ammonia) have been added. To drape the patient, towels are first arranged about the field of operation; the operating sheet with its hemmed opening then covers the entire body of the patient except his head; finally, four towels are arranged about the opening in the sheet.

4. Conduct During the Operation.—It goes without saying that the same care must be continued to avoid contact with unsterile articles, particularly by the hands. If accidental contact with the hands occurs the gloves should be changed. This should also be done if a glove is perforated by a knife or needle during the course of the operation. Instruments that touch anything not sterile should be instantly discarded and resterilized by boiling before being used again. When any hollow viscus (stomach, intestines, appendix, gall-bladder, urinary bladder, ureter, pelvis of the kidney) has been opened in the course of an operation, all instruments that have been used within the cavity of the viscus and the needles and sutures employed in its closure are contaminated and should never be replaced among the other clean instruments, or handed back to the surgeon for use in a later stage of the operation, for instance in closure of the wound. Such instruments should be discarded as soon as the surgeon has finished using them, and the instrument nurse should avoid touching them with her gloved hands. Towels about the wound should be changed when they are soiled or, in any case, before the wound is sutured. Strict count must be kept of packs and sponges so that none may be left in the wound.

5. Conduct Between Operations.—Every operation is a thing by itself. A complete new outfit is required for each operation, no part of the preparation for a previous operation being carried over for the next. The long hand scrubbing need be done only once on each operating day, its repeated performance being too severe upon the skin, but fresh sterile gloves must be put on for each operation. Care of the operating room has been described elsewhere. Its chief requirement is strict cleanliness, without too much reliance upon the antiseptic solutions used to wipe the articles of furniture. Accumulations of dust in forgotten places to be blown about in the air must not be permitted. Open-air ventilation is desirable, but all windows should be screened. Flies and other insects must be absolutely excluded. For all who take part in the work of the surgical operating room the obligation of habitual personal cleanliness arises from reasons more imperative than the standards of good breeding. Particular care should be taken of the hands. The nails should be attended to and should neither be allowed to grow too long nor be cut too short. Suppurating wounds or the dressings from them should never be handled without gloves. The mouth and, particularly, the teeth should receive scrupulous attention. Neglect of the dentist is a serious error in the aseptic technic. After being used in an operation all instruments and basins must be resterilized by boiling in water before being put away, or before they are used in another operation.

V. THE SUPER-TECHNIC

The aseptic technic presented in the foregoing outline represents in substance that which is now in use in the majority of operating rooms. There are, of course, some variations in minor details. Considered from the theoretical standpoint this technic falls very far short of the standards of perfection. Experience shows, however, that it is sufficient to insure the absence of septic infection in the great majority of clean operative wounds. A perfect technic is probably impossible at the present time, and it may be here pointed out that super-refinements in minor details, applied haphazard here and there, do not as a rule bring us measurably nearer that goal. There are, however, some classes of operations where the tissues involved are peculiarly liable to infection, and where, moreover, infection is particularly disastrous. The principal operations of this group are those that involve the opening of the larger joints, the transplanting of tendons, and the so-called open operations for fractures. In these cases experience seems to justify certain additional precautions and the adoption for these particular cases of what may be called a super-technic.

Instruments, sponges, sutures and ligatures are given a double sterilization time. Silk or linen sutures, sometimes used for artificial extension of tendons in transplanting, are boiled for an hour in bichloride solution. The knife used for the primary skin incision is laid aside and a new knife used for the deep dissection. As soon as the skin is incised particular care is taken in fastening towels by means of clamps to the subcutaneous tissue so as to cover all the skin and its cut edges. Only instruments and sponges are allowed to enter the wound, the gloved hands being kept altogether out of it. The gloves do not touch that part of an instrument which enters the wound. The instrument nurse, therefore, must pick up instruments only by the handles, and in handling ligatures and sutures she must use instruments altogether, not touching them with her gloved hands. In threading a needle she picks up the needle with one clamp and the thread with another. The surgeon will use extreme care so as to avoid constriction of tissue, will never use a drain, and in closing the wound will avoid tension as much as possible.

VI. BREAKS IN THE ASEPTIC TECHNIC

We have emphasized the importance of a rigid adherence to the aseptic technic in every smallest detail. The strength of this obligation, in fact, cannot be overstated. And yet, as we have pointed out, there are (from a theoretical standpoint) a number of weak places in the aseptic precautions as now practised. We ignore infection from the air. We cannot sterilize the skin. Septic bacteria may be, and probably sometimes are, carried to the wounded tissue through the blood stream. It is true, also, that wounds frequently heal without suppuration in spite of rather glaring departures from the accepted standards of aseptic practice. These facts seem to furnish a reasonable excuse for a certain amount of carelessness and indifference. Since wounds may suppurate in spite of all precautions, and since some do not suppurate when precautions are neglected, what is the necessity for all this trouble? The most convincing answer to this question lies in an appeal to the teachings of experience. The aseptic technic as we have it is the result of a vast amount of scientific and practical study extending over a period of many years. The most striking result has been the demonstration of the immense preponderance of the danger of infection by contact or implantation over all other forms. Experience proves conclusively that the means we have, if properly carried out, are adequate to prevent infection in practically all clean operative wounds. Suppuration in a wound from unavoidable causes is so rare that in no single instance have we the right to assume that the infection was not due to a technical error. Whenever in a hospital a series of infected wounds occurs we may be certain that there is somewhere a broken link in the chain of precautions against contact infection which will reveal itself to a sufficiently rigid investigation. Obviously, then, the utmost vigilance should be exercised, at all times, to forestall any such unfortunate occurrence.

It is impossible to enumerate all the possible breaks in the technic. It is needless to repeat such old stock illustrations as that of a nurse picking up an instrument from the floor or of a surgeon holding an instrument in his teeth. Such gross breaks do not occur any longer, if indeed they ever did. The technical errors which still occasionally appear are far more subtle and complex in character. It will be best, perhaps, to illustrate the subject with a few actual instances. It should be said at the outset that these happened in different hospitals and in different cities, the actual place, in the cases selected, being unknown to the writers themselves. It is probable that the same things have happened in a number of institutions. The instances are true in substance, although as they are related from memory accuracy in details is not vouched for.

In a large hospital, during a period of one month, there occurred some twenty cases of infection in wounds. The majority were insignificant stitch abscesses; in other cases the entire wound broke down and suppurated freely; there were a few cases of severe sepsis; one died. On investigation it was found that a new force of nurses had been assigned to the operating room at the beginning of the month. These inexperienced nurses had been put in charge of the autoclave without sufficient instruction in its use. After placing the goods in the chamber and closing the door, the vacuum valves had not been opened to remove the air from the chamber before turning in the steam. As a result none of the sponges, packs or dressings used during this period had been properly sterilized.

In another hospital a large number of stitch abscesses occurred; a few of the infections were rather severe, but, fortunately, there were no fatalities. Bacteriological examinations showed that in every instance the colon bacillus was one of the organisms present. The colon bacillus, it will be remembered, is a normal inhabitant of the intestinal canal. An investigation disclosed the fact that in some of the wards of the hospital the preparation of the patients for operation had been done in a hasty and careless manner. The giving of the enema was frequently postponed till the last minute, many of the patients going to the operating room before a satisfactory result had been obtained. As a result soiling of the operating table with liquefied fecal matter was a rather common occurrence. The orderly who carefully cleaned up afterwards, using the customary antiseptic solutions, was observed to wipe the instrument tables with the same cloth.

A surgeon, having observed a few unexpected infections following some of his operations, suspected that something was amiss in the technic in his operating room. He could find nothing wrong, so he asked a competent friend to see what he could discover. The friend arrived in the operating room an hour before the operation and watched the preparation. He could find nothing to criticise except in one particular. The instrument nurse was the unfortunate possessor of a very delicate skin. Her hands were rough and sore as a result of the rigorous hand disinfection which was insisted upon. This condition was aggravated by prolonged wearing of the rubber gloves which were required to be put on while filled with bichloride solution. In order to save her hands as much as possible she opened the packs and sponges and distributed the instruments with bare hands, putting on the gloves at the last moment before the operation. It is probable that such a break as this would not have led to results sufficient to arouse the suspicion of the surgeon, except for the inflamed condition of her hands, which encouraged the growth of septic bacteria upon them in spite of the disinfecting solutions which were employed.

The few random instances here cited show how widespread may be the origin of breaks in the aseptic technic. The fault in one case is traced to insufficient preparation in the ward and a later careless technic by the operating orderly. Another series of infections was due to the sterilization of dressings by insufficiently instructed nurses. A third series found its origin in the hands of the instrument nurse herself. Other cases might easily be given where the fault lay with the surgeon alone, or when it was traceable to weakness in other links in the aseptic chain. With such results before us in the form of concrete instances, it is clear that there is little present danger of over-refinement or over-emphasis of this, the most important single development of modern surgery.

CHAPTER XXIII

PREPARATION FOR AN OPERATION AND THE OPERATING-ROOM PERSONNEL

I. PREPARATION OF THE OPERATING ROOM

1. Necessary Equipment.—In considering the question of the necessary equipment along any line, the subject should be introduced with the caution that lists of implements or materials should not be systematically memorized, as this process is not only an unnecessary strain upon the memory, but is almost sure to lead to the forgetting of something. The question should always be approached with a definite understanding of the requirements of the occasion and then treated logically and by a process of systematized reasoning. Such will be our endeavor in this and subsequent similar descriptions, in order to demonstrate the greater ease and reliability of this method over the memory-taxing one.

A. For the Patient.—An operating table. A tray with the necessary articles for preparing the field of operation and for catheterizing. The necessary sterile towels and covers.

B. For the Anæsthetist.—A stool upon which to sit while giving the anæsthetic. A stand holding the necessary anæsthetic supplies, towels, hypodermic outfit, etc. A stand prepared for the subcutaneous administration of salt solution.

The stand for the anæsthetist should contain: (1) ether mask, freshly covered; (2) mouth gag; (3) tongue forceps (Fig. 102, No. 4); (4) two cans of ether, sealed; (5) three large safety-pins; (6) six small towels; (7) a piece of gutta-percha tissue, 3 by 5 inches; (8) sterile vaseline to protect the skin from ether; (9) a one-ounce bottle of sterile olive oil or castor oil for use in the eyes when irritated by ether; (10) three or four curved clamps, such as the Kelly-Pean (Fig. 129, No. 8); (11) ten or more folded strips of gauze, 2 by 6 inches, for clearing mouth and throat from mucus.

In addition there will be provided for the anæsthetist a hypodermic tray containing two hypodermic syringes, sterile, with the following preparations and drugs, in suitable doses, preferably contained in sterile ampoules ready for instant use: strychnia, atropine, caffeine, nitroglycerin, adrenalin, digitalin, morphine, camphor in oil, camphor in ether.

For the administration of nitrous-oxide-oxygen anæsthesia special forms of apparatus are required, of which there are many styles on the market. If the operating room is not provided with one of these, a large iron flask of compressed oxygen gas should be at hand for use if required.

The outfit for subcutaneous infusion of saline solution should include: iodine-alcohol preparation (equal parts) for skin sterilization; a two-litre flask of sterile normal saline solution, warmed to 120° F.; an irrigation stand (Fig. 89) with sterile glass graduated container, covered with sterile towel; three sterile infusion needles, with sufficient length of sterile rubber tubing to make connections.

C. For the Operator and Assistants.—For each a separate wash stand with foot pedals for the control of the running water. Upon each stand should be a tray containing a sterile scrub brush, an orange stick (or nail file) and another tray containing green soap. A stand with three basins containing, respectively, alcohol (50–95 per cent.), bichloride of mercury solution (1–1000) and sterile water. Basin of bichloride solution with rubber gloves. Gowns. If the operation is vaginal or perineal, there should also be a stool for the operator.

D. For the Scrubbed Nurses.—The same supplies for scrubbing as for the doctors, but in another room. Also gloves and gowns. A table upon which the instruments and suture materials are to be arranged. A table upon which the sponges, packers, towels, covers, dressings, etc., are to be arranged. A stand with two basins containing, respectively, a solution of bichloride of mercury (1-1000) and a solution of salt (0.9 per cent.).

E. For the Unscrubbed Nurse.—One basin upon the floor on either side of the operating table for used sponges, for the count of which she is responsible.

Lastly, the sterilized instruments for the operation are brought in and put upon the instrument table already mentioned.

The equipment of the room having been enumerated, we can now summarize and particularize as to the necessary preparation of the different articles. As a general statement, we may say that everything in the operating room should be kept mechanically clean. In addition to this, everything that will stand boiling should receive it before each operation. In the case of tables and other large articles that cannot very well be put in a sterilizer, after mechanical cleansing with soap and water, they should be thoroughly gone over with a solution of bichloride (1–1000) or carbolic (1-20). The walls should be frequently gone over with damp cloths to prevent the accumulation of dust, and at regular intervals with cloths wet in an antiseptic solution. The floor should be kept scrubbed down with soap and water and gone over with an antiseptic solution. At regular intervals the room should be sealed and fumigated with formalin vapor. Non-absorbable sutures and the instruments are sterilized by actual boiling for at least ten minutes, as are the gloves. Absorbable suture material is generally put up in sterile containers, frequently in an antiseptic solution, after careful sterilization by heat, chemicals or a combination of both. Dressings, towels, sponges, packers, covers and gowns are sterilized by exposure to live steam under pressure in an autoclave.

II. PREPARATION OF THE NURSE

1. Cap.—As the primary purpose of all preparation on the parts of operator, assistants, and nurses is the prevention of the introduction of extraneous infectious material into the wound or field of operation, the procedure naturally divides itself into two steps: the sterilization, so far as possible, of those parts brought into closest contact with the patient, and the covering of what is not sterile with sterilized material. As the falling of hair or dandruff into the wound, on the instruments, dressings, or on the field of operation would be a source of constant danger, caps (either sterile or freshly washed) are supplied, which have a draw-string that brings them in snugly to the head, closely covering the hair. This cap is generally applied before scrubbing.

2. Scrub.—The materials for the nurse's scrub are the same as those already enumerated for the doctor's. The nails (which should be kept trimmed short) are carefully cleaned with the orange stick, both beneath and around the borders. The hands and forearms are thoroughly scrubbed with the brush and green soap (both sterile) and water for five minutes *by the clock*. The hands and forearms are then thoroughly gone over with alcohol and then the bichloride solution.

3. Gown and Gloves.—The sterile gown is then put on, some one who is not scrubbed fastening it in the rear. Finally, the sterile gloves are put on, the sleeves of the gown being tucked into the wrist piece of the gloves. It should be fully appreciated that the wearing of gloves does not in the slightest excuse the neglecting of full attention to the scrub. Should the gloves by any chance be torn or pierced by a needle during the course of the operation, unclean hands would be just as serious a jeopardy to the patient as though gloves had never been worn. The scrubbing should therefore be quite as conscientious with the use of gloves as without them.

III. OPERATING-ROOM PERSONNEL

Having considered the equipment and preparation of the operating room for use, as well as the methods of preparation adopted by the different individuals, it is advisable that we should review the personnel of the operating-room staff and the duties pertaining to each of its members. In covering this field, we shall endeavor to adhere to a logical order of discussion, as has been our effort in the preceding pages. The order of discussion chosen will be based upon the relation of each individual to the patient, rather than to the operating room or to the hospital. The patient and table being so placed that the field of operation receives the best possible light, the first duties in regard to the patient are assumed by the anæsthetist.

1. **Anæsthetist.**—The importance of the duties and the responsibility of this member of the operating staff are becoming so widely recognized in all well-conducted hospitals that it seems scarcely necessary to emphasize them in this place. There does, however, exist among some people an unfortunate attitude toward this important position that would tend towards its belittling. The two individuals immediately responsible for the life and welfare of the patient are the surgeon and the anæsthetist, and the responsibility is equally divided. Let those who would question this conclusion take the question home and ask themselves how much care they would take in selecting their anæsthetist as well as their surgeon. The answer is foregone. The anæsthetist should be a specialist in his particular line as well as the surgeon. Wide experience, sound judgment and invariable coolness and decision are as much the requirements of the one as of the other. The anæsthetist should have the deciding word as to the choice of the anæsthetics,—his special knowledge along these lines particularly fitting him to judge which would best serve the interests of the patient. He administers the chosen

anæsthetic and it is for him to say when anæsthesia is sufficiently deep for the operation to begin; what the condition of the patient is at the various stages of the operation; when, if at all, the administration of stimulants becomes indicated; and when the condition of the patient indicates the advisability of hastening the termination of operative measures. If stimulants or restoratives are indicated, it is within the province of the anæsthetist to decide upon the medicament and the method of administration, and even to undertake the administration. And, in conclusion, it may be of interest to note that this field of operative work is one into which the graduate nurse is taking an increasingly important part, the anæsthetic work in some of our most important clinics being in the hands of nurses.

2. As regards the duties of the **operator,** little need be said, the term and its attendant duties and responsibilities being well recognized and self-explanatory. In abdominal operations, he generally stands at the right of the patient.

3. The **first assistant** stands upon the opposite side of the table from and facing the operator, in abdominal work, and at his right side in vaginal, perineal, or rectal operations.

4. The **second assistant** stands on the same side of the table with and at the right side of the operator, in abdominal work, standing at his left in minor operations.

5. The **nurse in charge of the instruments** stands between the first assistant and the instrument table, in abdominal operations, and between the operating and instrument tables in minor operations.

6. The **nurse in charge of sponges,** dressings, etc., stands between the operating table and the dressing table, at the left of the first assistant and opposite the second assistant (Fig. 117).

7. The **unscrubbed** ("dirty") **nurse** has no particular station, but does not leave the operating room except by the direction of the operator or one of the assistants.

8. The **orderly** should be without the operating room but within easy call, so that there will be no delay in his attendance if needed.

This brief summary of the personnel of a properly equipped gynæcological operating room places seven persons on continuous duty throughout the course of each operation, and should, as a result, impress upon each individual how great must be the care of each and every one of those concerned to prevent the slipping in of those little errors of technic that, possibly of little apparent significance, so jeopardize the success of the operation and the welfare of the patient. It is scarcely necessary to point out that the probabilities of such slips must increase directly with the number of personal links in the aseptic chain, and this un-

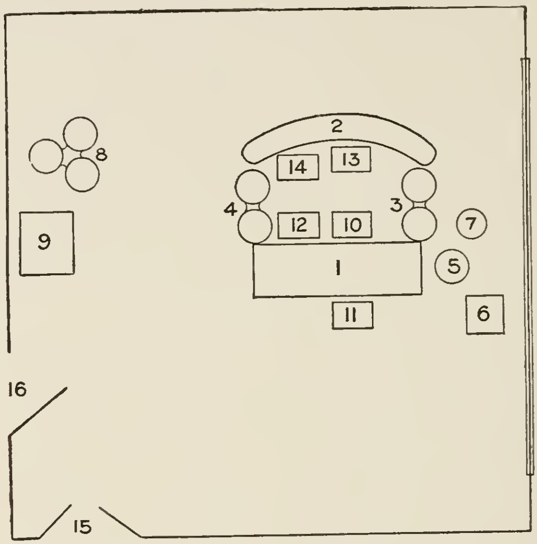


FIG. 117.—Diagram of arrangement of operating room. 1. Operating table. 2. Instrument and dressing table. 3. Solution stand for surgeon. 4. Solution stand for nurse. 5. Stool for anæsthetist. 6. Table for anæsthetist. 7. Irrigation stand. 8. Solution stand for hand preparation. 9. Table for basin of gloves. 10. Surgeon. 11. First assistant. 12. Second assistant. 13. Instrument nurse. 14. Sponge and dressing nurse. 15. Door leading into main hall of operating suite. 16. Door leading into doctors' scrub room or dressing room.

avoidable increase in the staff should be accompanied by an equal effort to avoid the slightest possibility of error.

IV. DUTIES OF OPERATING-ROOM NURSES

In our discussion of the operating-room personnel, we included three nurses as necessary for the proper conducting of the work. These should be, in order of seniority, the unscrubbed nurse, the nurse in charge of instruments and sutures and the nurse in charge of dressings, sponges, etc. In those smaller hospitals with but one operating room, the graduate nurse in charge of the operating room should fill the duties of unscrubbed nurse. In the larger hospitals with an operating suite consisting of several rooms, the ideal arrangement would be to have a graduate in charge of each room; but, should this be impossible, the term of service in the operating room should be for at least three months, the first month at the sponge table, the second at the instrument table and the third as unscrubbed nurse. As the duties of this position are developed, the reasons for the emphasis placed upon it will become apparent.

1. Unscrubbed Nurse.—The unscrubbed nurse is responsible for the final preparation of the patient upon the table. She catheterizes the patient and gives the final scrub, or applies the iodine solution where the iodine preparation is used. She makes sure that the solution basins for the surgeon and for the nurse are filled with the proper solutions; that the instrument nurse has all the necessary instruments and sutures; and that the sponge and dressing nurse has the proper supplies for the operation. In addition to these duties is that one which involves the greatest responsibility,—the keeping count of the sponges used and making them balance with the number issued, so that there can be no possibility of one remaining in the abdomen. This responsibility is shared with her by the sponge and supply nurse, but the final burden of whether or not a sponge is missing lies with her. She must see that the surgeon does not close the abdomen with a sponge remaining therein, unless he so does upon his own responsibility after due warning.

This nurse, in addition to her duties towards operator and patient, should bear in mind the fact that the anæsthetist may need her assistance. She should be ready to anticipate his wants and to help him if called on in a sudden emergency. The ordinary emergencies which the anæsthetist may have to meet in the course of an operation are three in number: (1) Obstructed breathing, indicated by cyanosis of the face. This may be due to the tongue or jaws dropping back, or to accumulation of mucus in the throat. The remedy is to lift the lower jaw up, to draw the tongue forward, and to wipe out the mouth and throat with a swab of gauze on a clamp. (2) The patient may stop breathing, due to central paralysis. There are three common measures used to meet this emergency: artificial respiration, rhythmic traction of the tongue and lowering the patient's head. Artificial respiration may be done by the Silvester method (see Chapter XXIX) or by the Marshal-Hall method, which consists in compressing the lower segment of the ribs by the hands placed on either side.

This forces the air out and the natural expansion of the ribs draws the air in. It is not so efficient as the Silvester method and far less efficient than the Shafer method, but the latter is not available with the patient in the dorsal position on the operating table, Rhythmic traction on the tongue (Laborde's method) consists in seizing the tongue with forceps, drawing it out of the mouth, and alternately making strong traction and relaxation at the rate of about fifteen times a minute. This acts as a powerful stimulant to the respiration. (3) Shock or collapse may occur, particularly towards the latter part of a prolonged operation. Its approach will be indicated by pallor of the face, rapid pulse, shallow respiration and lowered blood-pressure. The measures used to combat this condition are numerous. The principal ones are: (*a*) a hypodermic injection of one of the stimulants contained in the hypodermic tray; (*b*) elevation of the foot of the table to allow blood to gravitate to the head; (*c*) warm salt solution sometimes with coffee given by rectum; (*d*) infusion of normal saline into a vein, under the skin of the breast or thighs, or directly into the abdominal cavity through the wound; (*e*) artificial warmth; (*f*) bandaging the extremities so as to empty them of blood in order that the brain may have all the blood that can be given it. Both arms and both legs should be bandaged from the toes and fingers to the trunk. Flannel, gauze or muslin bandages may be used. The bandages should be applied with even pressure, but very firmly. No padding need be used under them.

2. Instrument and Suture Nurse.—It is the duty of this nurse to apply the sterile covers to the instrument table and to arrange upon it the instruments when they are brought to her. She is to arrange them in an orderly manner so that she can have them promptly as required. She must have the various suture materials threaded in suitable lengths and sizes upon suitable needles when they are needed. Finally, as she becomes more experienced, she will find that anticipation of commands has succeeded compliance to them and that she has everything at the hand of the surgeon or the assistant without the need of any warning that it will be required. And this attainment marks her entrance as an integral part of what should be a perfect and harmonious machine working together for the best interests of the patient.

3. Sponge Nurse.—This nurse, being the least experienced of the operating-room staff, is given that position which, while in no way inferior in importance and responsibility, requires less intimate knowledge of the various steps in the technic of the different operations at which she may attend. In outlining her duties, we will assume that the precaution (so necessary in every well-conducted operating room) of putting up all supplies for operating use in definite quantities has been observed. She arranges her sterile towels, covers, sponges, packers and dressings upon the table (which, as with the instrument table, has a sterile cover) in an orderly manner that will enable her to supply the articles required with promptitude. She will open packages of sponges only as required for use, making a careful count of the contents of each package as opened to see if its contents agree in number with the routine. She will remember how many of each article she has issued to the operator and convey this information to the unscrubbed nurse, upon demand. She will see that all packers are wrung out of hot sterile salt solution before being passed to the operator; that they have hæmostats or some other identifying mark fastened to the tapes; and will keep the same careful count as of sponges. The grave responsibility assumed by this member of the operating staff, although shared by others, should be constantly in her mind and prevent any lapse that may be regretted when the time for prevention has passed and naught but regret is left.

V. CARE OF THE ANÆSTHETIZED PATIENT

This particular aspect of the subject of surgical and gynæcological nursing must, necessarily, begin in the ward before the patient starts for the operating room. Steps must there be taken to foreguard the patient from exposure to draughts and chilling on the way to the operating room and also on the table during the first stages of anæsthesia. The body should be protected by a warm gown and the limbs by clean Canton flannel or woollen leggins. The patient should then be warmly wrapped in blankets for transportation to the operating room. The patient should be transferred from the carriage to the table in the same coverings that she wears to the room. All of the many forms of operating table in use at the present time are primarily designed, as they should be, for the convenience of the operator, but it is unfortunate that in most cases the comfort of the person lying on the table is not thought worthy of even secondary consideration.

In the anæsthetized patient all the muscles are completely relaxed, and in this condition he is peculiarly liable to injury from lying for a long time in a strained and unnatural position. Two points are especially to be remembered. If an arm or a leg is allowed to hang over the side of the table (Fig. 118), pressure of the sharp edge will inevitably cause a painful injury, from which the patient will suffer acutely for many days. If one of the large nerve trunks happens to lie in the line of pressure, paralysis of the muscles supplied by it will follow which may not be recovered from for weeks or months. Pressure from straps or upright posts attached to the table may also be responsible for injuries of this kind.

Fig. 118.—Position for breast operation, showing improper position of arm resting on edge of table. Arm should be held by nurse to prevent pressure.

The curve of the back where it does not touch the table should be properly supported by a cushion or pillow. Without this precaution the relaxed and unconscious patient is subjected to severe strain of the spinal ligaments and muscles, and this is exaggerated when, as in gall-stone operations (Fig. 119), a hard support is placed under the lower ribs, if the small of the back is not supported at the same time. From this cause patients often suffer agonizing backache for days after an operation. The temperature of the operating room should be kept between 75° and 85° F. to prevent any danger of chilling. During the progress of the operation, those parts of the patient that are not necessarily exposed for operative purposes are kept warmly wrapped and covered in blankets. In some of the hospitals, this desirable end is additionally sought by the use of a hot-water cushion for the top of the operating table. The operation being completed and the dressings applied, the patient is once more warmly wrapped throughout with warm blankets and returned to her bed. Before leaving the operating room, any wet places are wiped dry and any wet clothing is removed, to preclude the possibility of the patient being permitted to remain in the ward in wet clothing.

VI. APPLICATION OF THE FIRST DRESSING

Before removing from the operating table, the first dressing (that will, ordinarily, remain in place from ten days to two weeks)

FIG. 119.—Pillow support under back for operation on gall-bladder.

is applied. This consists of sufficient sterile gauze to thoroughly cover and protect the wound and its immediate vicinity and absorb any discharges that may occur. The gauze may be arranged in pads or the loose form described as fluffs or handkerchiefs. In an abdominal operation this dressing is held in place by from two to four strips of two-inch adhesive plaster, the number of strips depending upon the length of the wound.. Care should be taken that the lowest strip of plaster (that nearest the symphysis) is placed far enough down to fully cover and keep covered the lower angle of the abdominal wound. Where it is expected that frequent redressings will be necessary, as in infected cases, instead of the solid adhesive strip, small strips are fastened at the sides with tapes attached to permit their being tied across the dressing. This dressing being applied, the patient is lifted from the table, the back wiped dry and the patient laid upon the carriage, the abdominal binder being already in place upon the carriage. The binder is then brought across in front and pinned with safety pins, darts being made in the sides with safety pins to make the binder fit more snugly and evenly. As the binder generally has a tendency to slip up, it is well to apply a towel or strap of some kind, running from the side of the binder around the thigh in a loop and returning to be fastened at its starting point. With such an anchor applied on each side, it will be impossible for the binder to work up around the waist upon the return of the patient to bed, as is not infrequently the case with the ordinarily applied binder.

VII. CARE OF THE PATIENT AFTER OPERATION

The gown, if wet, is now removed, the patient warmly wrapped in blankets that have been kept heated during the operation and returned to her bed. The patient should be accompanied on the return trip from the operating room to the ward by a physician, as a precaution against any sudden emergency arising on the trip and causing trouble for the lack of a physician's presence. When the patient is returned to her bed, she should not be without a nurse in constant attendance until she has fully reacted from the anæsthetic. While under the effects of an anæsthetic, it would be a very simple matter for the patient to draw particles of vomitus into the air passages and become asphyxiated or set up an aspiration pneumonia, as the result of neglect. It is, also, not infrequent for patients to give the first evidences of post-operative shock during this period, with the natural consequence that neglect of immediate remedial measures may lead to results of a fatal character. The nurse on duty at the bedside during this period should watch the patient carefully, keeping an accurate record of the pulse and watching the general condition. She should have a pus basin at hand to receive the vomitus and see that the face is kept clean and the mouth free from particles of vomitus. The pus basin may be placed at the side of the patient's face and when vomiting occurs the patient's head and shoulders should be turned to this side, by means of a hand under the opposite shoulder, so that the vomitus will be discharged into the basin and there will be a minimum of danger from aspiration of particles.

CHAPTER XXIV

SELECTION OF INSTRUMENTS

The selection of instruments for operations (while ordinarily included in the duties of the assistant) not infrequently devolves upon the operating-room nurse. Owing to individual preferences on the part of different operators, it is impossible to prescribe hard-and-fast rules regarding the instruments used, but there are, however, fairly definite sets used in certain procedures. Variations from these, while numerous, may be considered as unimportant and, in the case of staff surgeons, easily learned.

1. Dissecting Set (Fig. 120).—In practically every cutting operation, the dissecting set is the first employed. This consists of one or more scalpels; two dissecting forceps (one for operator and one for the assistant); two scissors (straight and of medium size); half a dozen small clamps (artery forceps); needles (either straight or curved, round or cutting, according to the preference of the operator); needle-holders (generally two where the operation is at all extensive); and sutures and ligatures. In dissections of somewhat extensive character, retractors should be added to this list.

With the above enumerated list of instruments as a basis, we may gradually build up the larger groups necessary for more extensive operations.

2. General Abdominal Set.—This outfit may be considered as a dissecting set, sufficiently augmented (Fig. 121) to permit of an exploration of the abdominal cavity. The number of artery clamps is increased to twelve. To these are added six medium-sized, curved clamps. In addition to the smaller-sized dissecting forceps, one long thumb forceps is included for the proper placing of pads for packing off the intestines and for such other uses as may require intraperitoneal manipulation. The retractors are increased by the addition of sets of two larger sizes than those used in ordinary dissections. The needles must include some fine, round ones for visceral repair and the suture material should include (for the same purpose) fine catgut, fine silk, or fine linen thread—possibly all three. This may be considered a set that will suffice for an exploratory laparotomy, but that must be

Fig. 121.

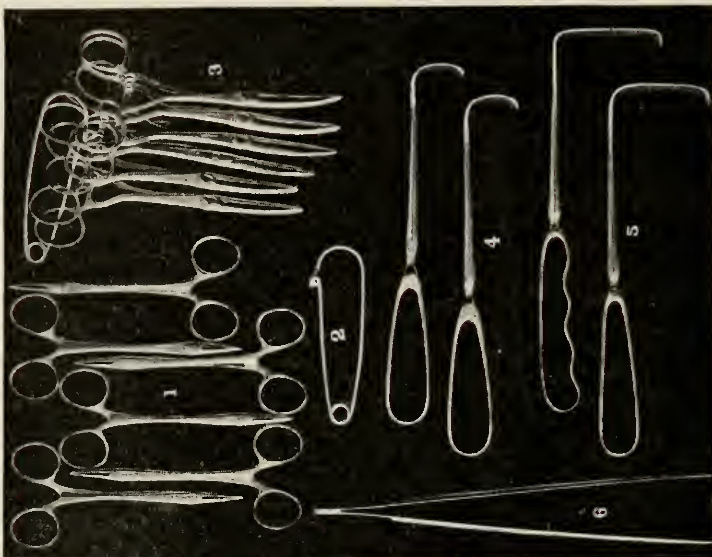


Fig. 120.

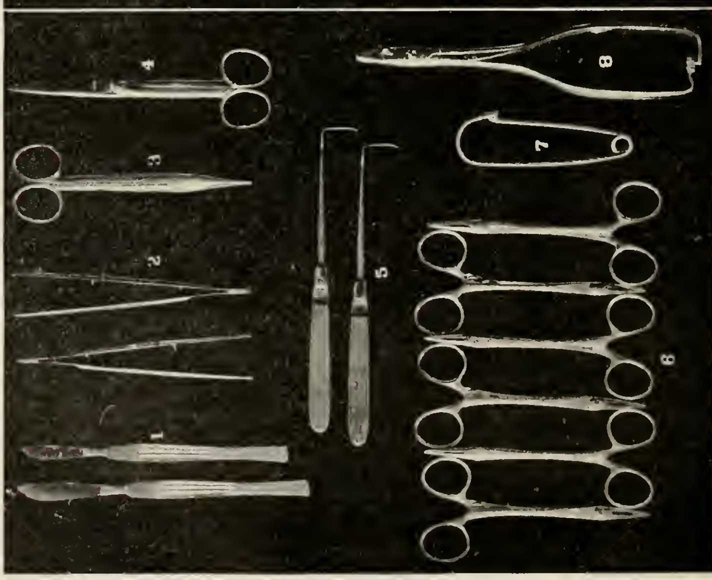


Fig. 120.—Dissecting set. (1) Scalpels; (2) mouse-toothed thumb forceps; (3) Mayo dissecting scissors; (4) scissors; (5) skin retractors; (6) hæmostatic forceps; (7) spring clip for holding clamps in case; (8) needle-holder (Richter's).

Fig. 121.—Additions for general abdominal set. (1) Hæmostatic clamps; (2) spring clip; (3) small curved Kelly clamps; (4) small

supplemented from one of the special abdominal sets, dependent upon the condition that is expected or may be revealed during the exploration.

With this as the basis for abdominal work, we can proceed to the sets formed around it for operations upon special regions and conditions.

3. Appendix Set.—The instruments necessary for operation are identical with those of the general abdominal set, with one or two possible additions. There may be (in addition to the two dissecting forceps already mentioned) one smooth thumb forceps for use in inverting the stump of the appendix. It is possible that a special clamp may be used for crushing the appendix before amputation and an actual cautery (either Paquelin or electric) for cauterizing the stump.

4. Gall-bladder Set (Fig. 122).—The gall-bladder set, also, is identical with the general abdominal outfit, certain additions being necessary for operations upon this organ. There should be a trocar and cannula, especially adapted to evacuating the gall-bladder. There should be scoops (or dull curettes) devised for the purpose of removing stones from the gall-bladder and ducts. A long, malleable probe for exploration of the ducts should also be at hand.

5. Stomach and Intestine Set (See Fig. 101).—For operations upon the stomach and intestines, practically the only additions to the general abdominal set are the specially devised clamps for use in operations upon the gastro-intestinal canal. The character of the operation and the expressed preference of the operator will decide the number and type of clamps used.

6. Kidney Set.—Operations upon the kidney require little variation from the general abdominal set. The needles preferable for kidney suture are round. In case of nephrectomy, large, heavy clamps will be desired for clamping off the pedicle before removing the kidney. Heavy silk will probably be subsequently required for a ligature. Any of the usual suture materials, as plain or chromic catgut, kangaroo tendon, silk, silkworm-gut, or silver wire, may be used in closing this incision as any of the others in surgical procedures.

7. Pelvic Set (Fig. 123).—The instruments required for pelvic (gynæcological) surgery are primarily the same as those for any general abdominal work, with such additional articles as may be indicated by the particular procedure in view. In the simpler

Fig. 123.

Fig. 122.

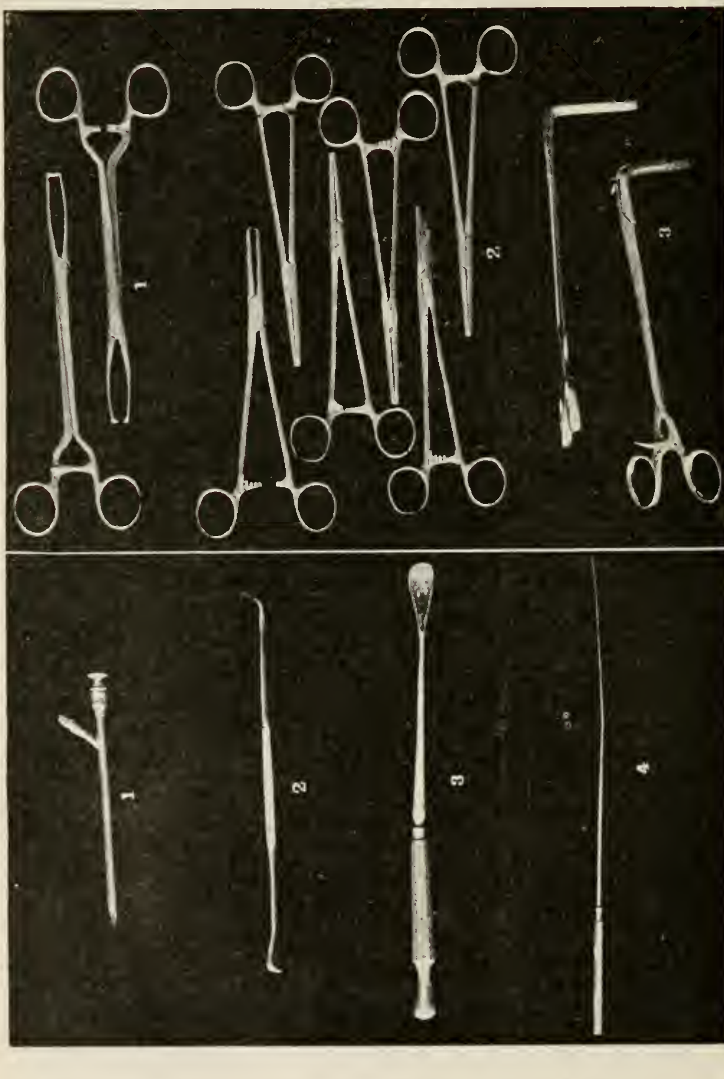


Fig. 122.—Additions for gall-bladder set. (1) Aspirating trocar and cannula; (2, 3) gall-bladder scoops; (4) probe.
Fig. 123.—Additions for pelvic set. (1) Volsellum forceps; (2) Ochsner's clamps; (3) Wertheim right-angled clamps.

operations, such as those for displacements, the only instrument absolutely necessary, beyond the general abdominal set, is one of those designed for seizing and elevating the uterus—a double tenaculum, a volsellum, or a uterine elevating forceps. With increasing gravity of the type of operation, the variety in instruments is only along the line of the addition of longer, heavier scissors and clamps. For a panhysterectomy for non-malignant condition, two long-handled scissors (one straight and one curved on the flat) and six long, heavy clamps (either straight or curved, as preferred by the operator) should be added. If the hysterectomy is on account of malignancy, two of Wertheim's right-angled hysterectomy clamps should be added and the number of medium-sized, curved clamps increased from six to twelve. The retractors should be of the largest size available for deep exposure.

8. Hernia Set.—The instruments for a simple hernia are identical with those for general work. The larger sized retractors are, generally, not needed, as is also the case with the long abdominal thumb forceps. It is well to add a grooved director and a blunt dissector, as these instruments are required by some operators.

9. Extensive Dissecting Set.—In operations requiring extensive and careful dissection (such as those performed for the radical cure of a malignant growth of the breast, or a complete removal of the glands of the neck) the routine dissecting set, as originally outlined, must be considerably augmented. The set for a radical breast operation has been described as " a dissecting set, plus all of the artery forceps in the instrument case," and this may be accepted as fairly accurate and almost equally applicable to an extensive neck dissection. It is also well, in those cases, to add a blunt dissector.

10. Rectal Set.—The instruments required for operations upon the anus and rectum will necessarily vary considerably with the type of operation to be performed. The basis, however, of this set (as of the others so far considered) is the ordinary dissecting set. For any operation upon the interior of the rectum or anus (through the anal orifice), some type of rectal speculum should be added to the dissecting set. Beyond this, the supplementary instruments must depend on the operation and route chosen.

A. For Hemorrhoids (Fig. 124).—Where the operation is to be by clamp and actual cautery, most of the instruments of the

FIG. 124.

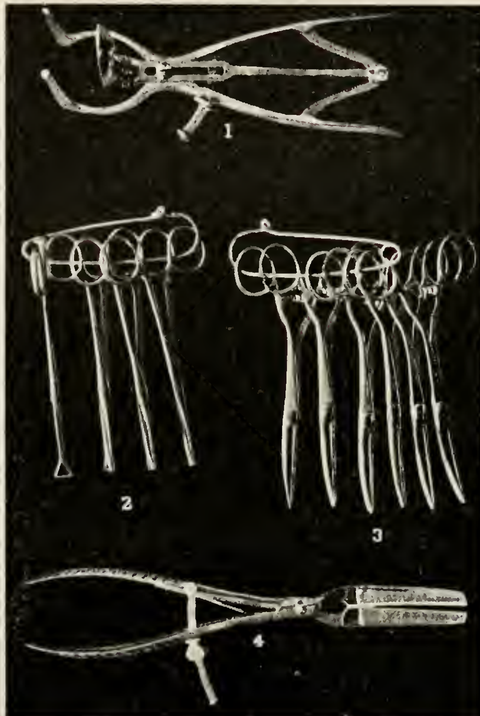


FIG. 125.

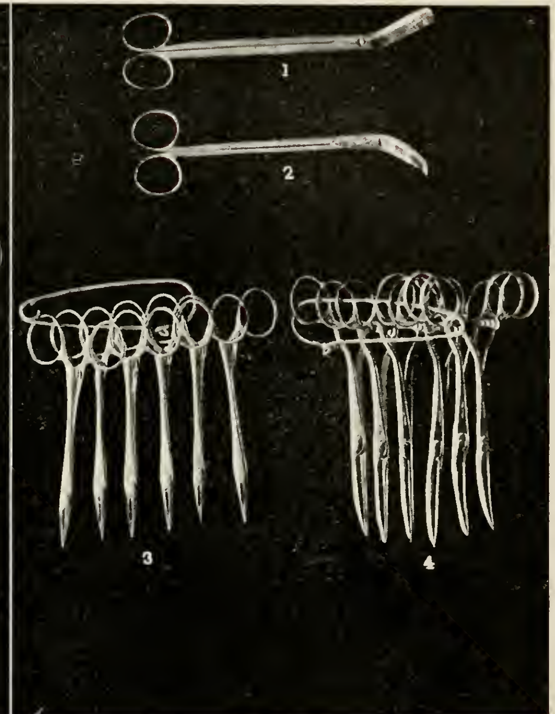


FIG. 124.—Additions for hemorrhoid set. (1) Rectal speculum; (2) hemorrhoid holding clamps; (3) small curved Kelly clamps; (4) hemorrhoid crushing clamp.

FIG. 125.—Additions for female perineal set. (1, 2) Emmett scissors (right and left); (3) hæmostatic clamps; (4) small curved Kelly clamps.

dissecting set are superfluous. Neither knives, scissors, artery forceps nor sewing materials are ordinarily required, although it is quite customary to have them ready in case of failure on the part of the cautery. The routine set would be a rectal speculum; two dissecting forceps; six small hemorrhoid forceps; one large hemorrhoid pedicle clamp; and an actual cautery. If the operation of ligation and excision is chosen, the simple dissecting set (with the addition of a rectal speculum and, possibly, two or three medium-sized curved clamps) will suffice. This same set, augmented by an additional half-dozen hæmostatic forceps, will suffice for the Whitehead operation. It is well to have salt solution irrigation ready for intrarectal operations of this type.

B. For Fissure or Fistula in Ano.—In either of these conditions, the dissecting set need be augmented only by the addition of a rectal speculum, a grooved director and a curved (sharp, blunt, or probe-pointed) bistoury.

C. For Resection.—Any resection of the lower bowel (by no matter what method or route) is bound to adhere more or less closely to the type described under extensive dissection. Practically the same set of instruments may be used, augmented by a blunt dissector and (if approached by the sacral route) also by certain instruments from the bone sets. These latter will probably be a Gigli saw, periosteal elevator and bone-cutting forceps.

11. Female Perineal Set (Fig. 125).—For the repair of lacerations of the female perineum, the usual dissecting set is once more the basis of selection. To it may be added six extra artery forceps, six medium-sized curved clamps and the right and left Emmett scissors specially designed for this work. Where a special type of needle (as the Peaslee, Reverdin, Ashton, or Hirst) is not employed, several fairly heavy, curved cutting needles should be supplied for the heavy, perineal sutures and a lighter, full-curved cutting needle for the intravaginal sutures. The suture materials most commonly used are silkworm-gut, chromic gut and kangaroo tendon.

12. Uterine Curettage Set (Fig. 126).—For curettement of the uterus, the following instruments are necessary: perineal retractor or vaginal speculum; volsellum, or double tenaculum forceps, or single tenaculum; uterine sound; small and large uterine cervical dilators; sharp and dull uterine curettes; uterine dressing forceps; scissors, and sponge holders.

FIG. 127.

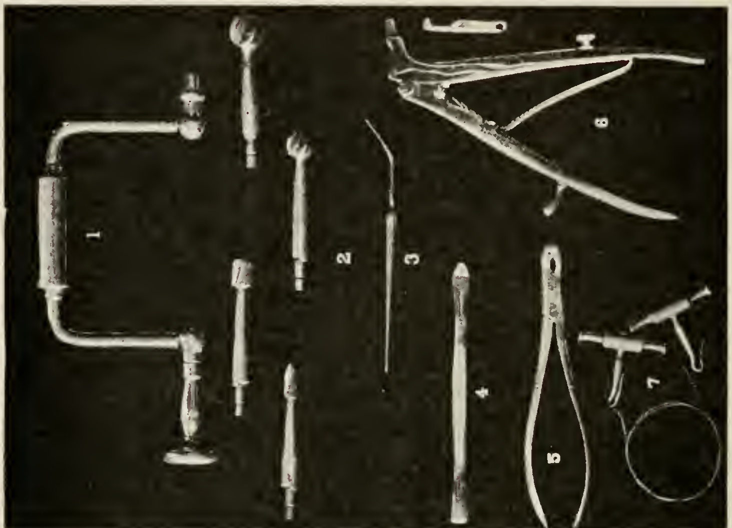


FIG. 126.

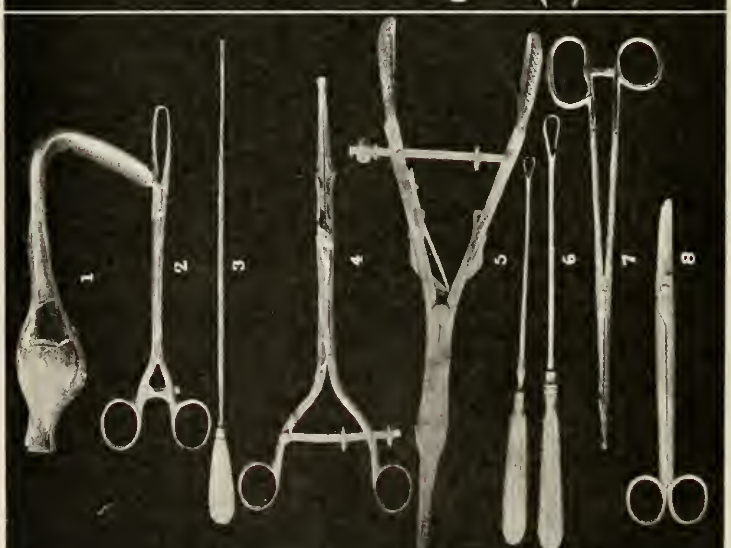


FIG. 126.—Uterine curettage set. (1) Perineal retractor; (2) volsellum forceps; (3) uterine sound; (4) small cervical dilator; (5) large cervical dilator; (6) uterine curettes; (7) uterine dressing forceps.

FIG. 127.—Cranial set. (1,2) Brace and burrs of Hudson's cranial set; (3) dural elevator; (4) periosteal elevator; (5) rongeur forceps; (6) cranial rongeur; (7) Gigli saw.

13. Trachelorrhaphy Set.—As repair of the cervix is generally preceded by curettage, the trachelorrhaphy set is formed by combining the curettage and dissecting sets.

14. Perineal Prostatectomy Set.—For perineal prostatectomy by Young's method a greatly augmented and supplemented dissecting set is necessary. The artery clamps should be increased to twelve or eighteen. Six medium-sized curved clamps should be added. In addition, there should be: three or four sizes of Young's prostatectomy retractors; two sizes of Young's prostatic lobe forceps; one Young prostatic tractor; one Young prostatic enucleator; and a metal urethral sound of suitable size.

The preceding groups, while not exhaustive, may be considered a fairly accurate general sketch of the types of instruments selected for use in those common operations upon the soft tissues that fall within the realms of general surgery and gynæcology. The following groups will apply to the surgery of the bony tissues and will (in their turn) make no pretence of being the only (or necessarily the best) selection of instruments for any particular operation. The effort will remain one to indicate an adequate selection that will be elastic to the demands of individual preference on the part of the operator.

15. Cranial Set (Figs. 127 and 128).—The instruments required for operations within the skull are: (1) those necessary for the scalp incision; (2) those necessary for opening the skull; and (3) those necessary for the intracranial work. These requirements will be met by a dissecting set in which the artery clamps are increased to twelve; an elastic tourniquet, for the control of hemorrhage; a cyrtometer for accurate location of the proper area; and the special bone set. This latter consists of a periosteal elevator; trephining set; Hudson cranial set; rongeur forceps; Gigli saw; chisels; and mallet. The Hudson cranial set includes a brace; several burr drills of different sizes and shapes; a fine dural separator; and a cranial rongeur forceps. Such instruments as may be required for the intracranial work vary so widely with the kind of operative procedure and individual preference that it is impossible to indicate them in this place. In those operating rooms where a great deal of brain surgery is done, the routine of the operator is soon mastered. In others, the operator should be asked to select such special instruments as he may desire.

16. Amputation Set (Fig. 129).—The amputation set may

Fig. 129.

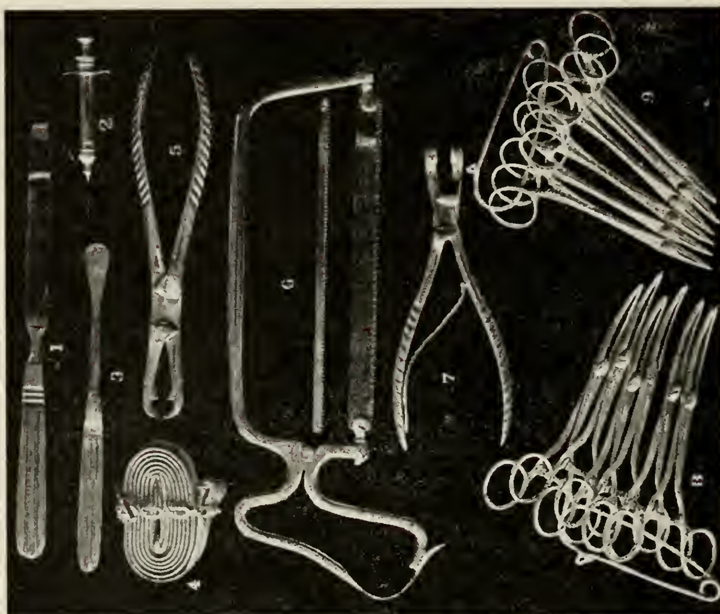


Fig. 128.

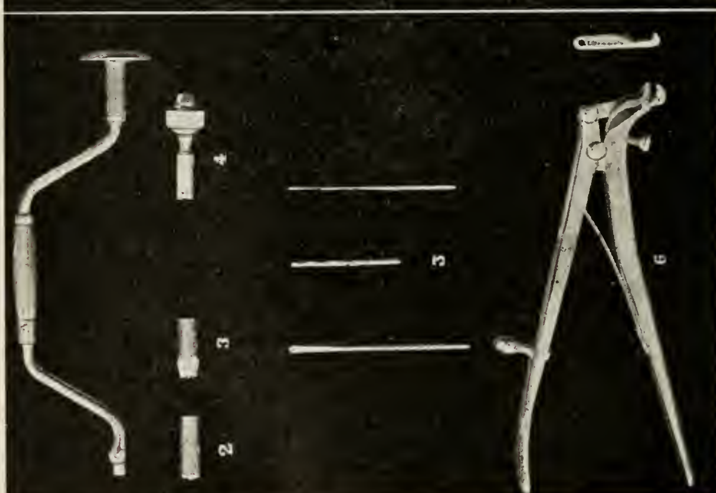


Fig. 128.—Bone and cranial set. (1) Hand brace; (2, 3) cranial burrs; (4) drill clutch; (5) bone drills; (6) DeVilbiss cranial rongeur.
Fig. 129.—Amputation set. (1) Amputating knife; (2) hypodermic syringe; (3) periosteal elevator; (4) Esmarch's flat rubber tourniquet; (5) lion-jawed forceps; (6) bone saw (Windler's); (7) rongeur forceps; (8) small curved Kelly clamps; (9) hæmostatic clamps.

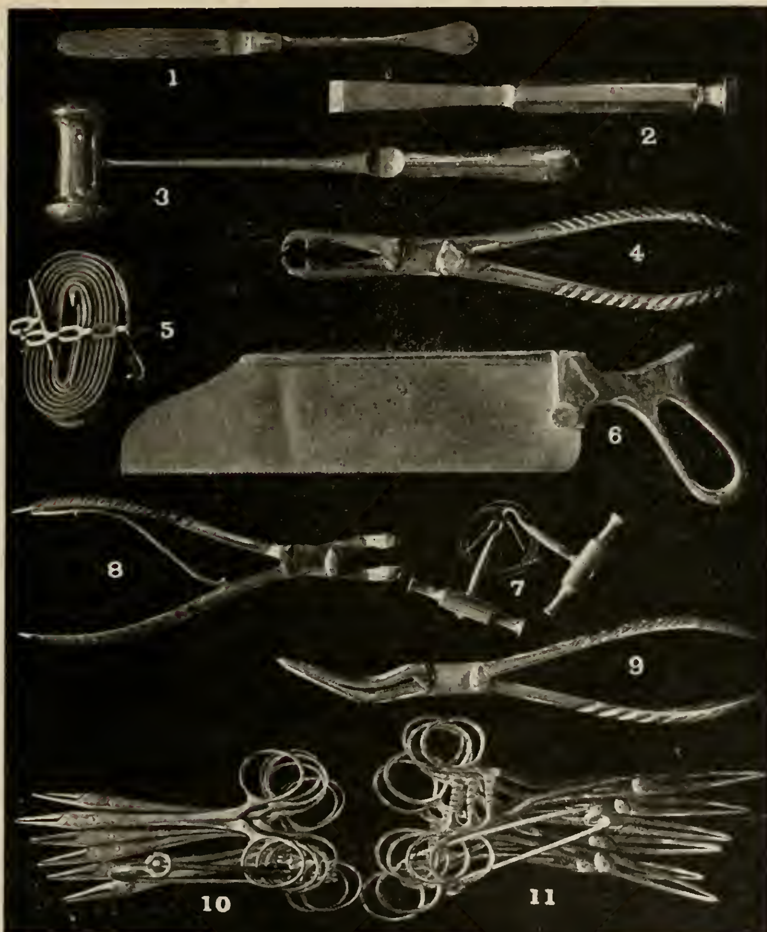


Fig. 130.—Joint resection set. (1) Periosteal elevator; (2) chisel; (3) mallet; (4) lion-jawed forceps; (5) tourniquet; (6) saw (Satterlee's); (7) Gigli saw; (8) rongeur forceps; (8) sequestrum forceps; (10) hæmostatic clamps; (11) small curved Kelly clamps.

vary from the very meagre outfit necessary for amputation or disarticulation of fingers or toes to the very extensive selection necessary for an amputation in the upper part of the thigh, or the Berger shoulder-girdle amputation. In the first-mentioned group, a dissecting set and a metacarpal saw or bone-cutting forceps will answer all requirements. In the more extensive

FIG. 132.

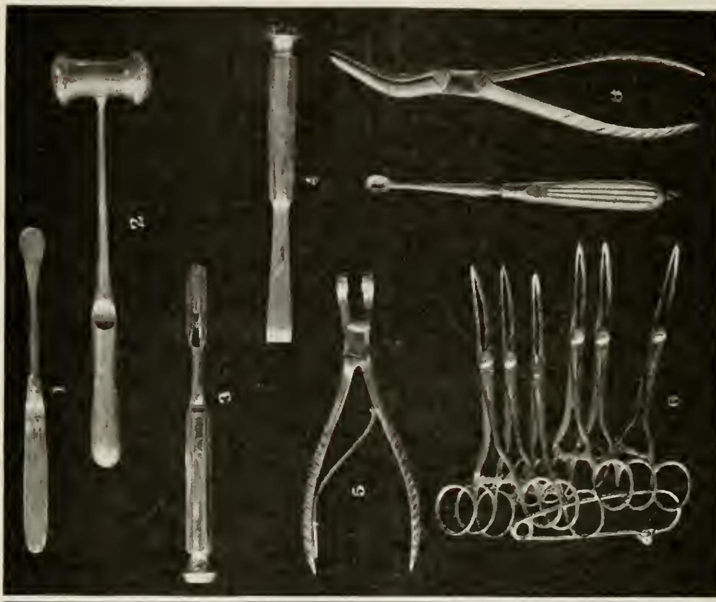


FIG. 131.

FIG. 131.—Rib resection set. (1, 2) Periosteal elevators; (3) Gluck rib shears; (4) bone-cutting forceps; (5) rongeur forceps.
FIG. 132.—Osteomyelitis set. (1) Periosteal elevator; (2) mallet; (3) gouge; (4) chisel; (5) rongeur forceps; (6) small curved Kelly clamps; (7) bone curette; (8) sequestrum forceps.

operations, these instruments are only the beginning. The first requirement is general hæmostasis, which is attained by an Esmarch (or other) tourniquet, sometimes supplemented by the use of Wyeth's transfixing needles. The dissecting set being the basis of the selection for work upon the soft tissues, the artery clamps are increased to eighteen in number and augmented by twelve medium-size curved clamps. To this set, add one or more large amputating knives. Hypodermic syringes and cocaine solution should be prepared for blocking off large nerve trunks before severing. For the bone work, saws (a Gigli wire saw and one of the butcher type); bone-cutting forceps; rongeur forceps; and lion-jawed holding forceps will be required. The needles and suture materials will depend upon the preference of the operator. In general, heavy silk is used for tying large vessels; catgut on full-curved cutting needles of moderate size for muscular and other subcutaneous sewing; and interrupted silkworm-gut on large, medium-curved cutting needles for skin suture.

17. Wiring or Plating Set.—For the wiring or plating of new or old ununited fractures the same reinforced dissecting set (already enumerated for amputation) is used. To this are added a periosteal elevator; bone-cutting and rongeur forceps; drills; heavy silver wire; bone-plates (Lane or Halsted) and screws; bone clamps, or lion-jawed forceps; and screw-driver.

18. Resection Set (Figs. 130 and 131).—The instruments necessary for the resection of joints are contained in the combination of the amputation and wiring sets.

19. Osteomyelitis Set (Fig. 132).—The operations for different forms of osteomyelitis (whether acute or chronic) practically always consisting in a radical removal of more or less extensive portions of the bone involved, the instruments necessary are included in the augmented dissecting set enumerated for amputation and such bone-cutting instruments as may be required. The bone set for this purpose will ordinarily consist of a periosteal elevator; a mallet; three sizes of chisels; three sizes of gouges; three sizes of curettes; and two or three sizes of rongeur forceps.

CHAPTER XXV

OPERATIVE STEPS

Practically every operator of large experience has a fairly definite and exact method of approaching each operation. The details may vary, but the succeeding order of the steps is almost invariable. In order to be a really intelligent assistant, the nurse passing instruments must, in the first place, be familiar with the general outline of the operative technic for the different regions and, after that, with the order in which each surgeon requires the instruments for the next step. It is not intended to convey the idea that the nurse must know what ought to be done and how to do it, but rather what the operator is going to do and with what instruments he will do it.

With certain general regions, the initial steps of the various operations are practically identical, so far as the nurse's duties are concerned. The immediate location of the disease condition (as well as its character) may vary considerably—thus affecting the site and character of the operative work. But this does not, ordinarily, call for any change in the instruments. For example, practically every abdominal operation (whether upon the gall-bladder or stomach, vermiform appendix or sigmoid flexure) will be inaugurated with the opening of the abdomen and the exposure of the contents of the field of operation. For this purpose, the operator will need a scalpel and toothed dissecting forceps, artery forceps, sponges, scissors and retractors. There should be added an additional dissecting forceps for the assistant.

In taking up the subject of operative steps, an effort will be made to present a number of the more general and important operations of general surgery and gynæcology, step by step, with an enumeration of the instruments that will be needed by the operator for each step. The operations will be considered in three general classes (operations upon the head; operations upon the trunk; and operations upon the extremities) and one or more operations considered, in detail, under each class.

I. OPERATIONS UPON THE HEAD

Under this class, only one operation will be considered.

A. Trephining, or Craniotomy, for Intracranial Hemorrhage:

STEP 1.—Localization of area.
Required instrument: cyrtometer.

STEP 2.—Skin incision.
Required instruments: scalpel; two tissue forceps; six fairly heavy artery forceps; and gauze sponges, two at a time.

STEP 3.—General hæmostasis.
Required instrument: elastic cranial tourniquet.

STEP 4.—Freeing of skin and periosteal flap.
Required instrument: periosteal elevator.

STEP 5.—Cranial resection.
Required instruments: trephines, or Hudson's cranial set; Hay's saw, or Gigli saw; rongeur forceps; and dural separator.

STEP 6.—Intracranial hæmostasis.
Required instruments: small gauze sponges, one at a time; four small artery clamps; free, fine catgut (or silk) for ligature; fine catgut (or silk) on fine, curved, round needle for ligating suture, in case free ligature is not used; a needle-holder; and suture scissors.

STEP 7.—Closure of incision.
Required instruments: four fairly heavy, curved cutting needles, threaded with silk or silkworm-gut; two needle-holders; two tissue forceps; and suture scissors.

A variation in this method of closure is that advocated by Dr. Cushing, where a number of straight, round needles (threaded with silk or linen) are used to transfix and approximate the wound edges. After proper approximation and hæmostasis have been thus accomplished, the sutures are drawn through, one at a time, and tied. When this method is used, a dozen needles (or more, should the length of the incision require them) should be threaded in readiness.

II. OPERATIONS UPON THE TRUNK

Under this branch of operative work, a number of operations will be selected that are typical of procedures in the different regions. It is not possible, of course, to describe, in detail, every operation that can be performed upon the trunk. It is hoped, however, that those described will give a sufficiently accurate general idea of the procedure to enable the nurse to readily grasp the details of these and other related operative procedures.

A. Resection of Portion of Rib for Empyema (Thoracotomy):

Step 1.—Incision.

Required instruments: two scalpels; two tissue forceps; six artery clamps; small sponges, two at a time as required; and small skin retractors.

Step 2.—Separation of periosteum.

Required instruments: scalpel; two tissue forceps; two small periosteal elevators; and two medium curved clamps, or tissue-holding clamps.

Step 3.—Resection of rib.

Required instruments: bone-cutting forceps; Gigli wire saw and handles; director or carrier for Gigli saw.

Step 4.—Incision of pleura.

Required instruments: scalpel; two tissue forceps; Mayo scissors; and two tissue-holding clamps for grasping edges of pleural incision.

Step 5.—Institution of drainage.

Required instruments: single, or double, fenestrated rubber tube; safety pin for transfixing tube, or silkworm-gut, threaded on curved cutting needle, for attaching tube to edge of skin incision.

Step 6.—Closure of skin incision.

Required instruments: two medium-curved cutting needles, threaded with silkworm-gut; two needle-holders; one tissue forceps; and one suture scissors.

B. Operation for Stones in the Gall-bladder (Cholecystotomy, where the gall-bladder is incised and drained; Cholecystectomy, where the gall bladder is removed; Cysticotomy, Hepaticotomy, and Choledochotomy, where the cystic, hepatic, or common bile-duct is incised):

Step 1.—Abdominal incision.

Required instruments: two scalpels; two thumb forceps; six artery clamps; sponges; straight, blunt-pointed scissors; and two tissue-holding clamps for grasping cut peritoneum.

Step 2.—Retraction of abdominal walls.

Required instruments: two medium and two deep abdominal retractors.

Step 3.—Exposure of field and protection of general abdominal cavity.

Required instruments: long thumb forceps (or long curved clamps); six long abdominal packers, wrung out of salt solution and with artery clamps fastened to ends of tapes; and six medium abdominal packers, similarly treated.

This step is common to practically all intra-abdominal operative procedures, the variation being in the sizes of the packers.

Step 4.—Incision and drainage of gall-bladder.

Required instruments: two round, curved needles, threaded with medium silk, for stay sutures; two artery forceps to carry needles; one mouse-toothed thumb forceps; one straight scissors; and one gall-bladder trocar and cannula; gall-bladder spoon.

STEP 5.—Removal of stones.

Required instruments: short, medium and long gall-stone scoops; short, medium and long gall-stone scoop forceps; and long probe for searching ducts.

STEP 6.—Drainage of gall-bladder.

Required instruments: two curved, round needles, threaded with No. 2 catgut; two needle-holders; one rubber tube, about eighteen inches long and one-fourth to one-third of an inch internal diameter; one toothed dissecting forceps; and one suture scissors.

STEP 7.—Closure of abdominal incision.

Required instruments: two toothed dissecting forceps; two curved cutting needles, threaded with No. 2 catgut; four large, medium-curved cutting needles, threaded with silkworm-gut; two curved cutting needles, threaded with No. 2 chromicized catgut or kangaroo tendon; and one suture scissors.

C. Removal of Vermiform Appendix. (Appendectomy):

STEP 1.—Abdominal incision.

Required instruments: same as for gall-bladder incision, with addition of small skin retractors and small abdominal retractors.

STEP 2.—Retraction of abdominal wall.

Required instruments: same as for gall-bladder operation.

STEP 3.—Exposure of field and protection of general abdominal cavity.

Required instruments: same as for gall-bladder operation, packers being medium and small size, instead of large and medium.

STEP 4.—Delivery of appendix.

Required instruments: two toothed tissue forceps; one blunt dissector; two medium-sized, curved clamps; and one medium-sized, straight, blunt-pointed scissors.

STEP 5.—Removal of appendix.

Required instruments: Cleaveland carrier, aneurism needle, or sharp-pointed artery clamp, for piercing meso-appendix; free, No. 2 catgut; scissors; scalpel; two cotton-wrapped applicators, one saturated with carbolic acid and the other with alcohol (or an actual cautery); and two medium heavy clamps.

STEP 6.—Inversion of appendix stump and closure of cæcal wound.

Required instruments: two round intestinal needles (either straight or curved), one threaded with fine silk or linen thread, and the other with fine (No. 00 or No. 0) catgut; two artery clamps for use as needle-holders; two toothed tissue forceps; one smooth dissecting forceps, for inverting stump; and one suture scissors.

STEP 7.—Closure of abdominal incision.

Required instruments: same as in gall-bladder operation, with addition of small abdominal and small skin retractors.

D. Operation for Radical Cure of Inguinal Hernia:

STEP 1.—Skin incision.

Required instruments: same as for abdominal incision in preceding operations, omitting abdominal retractors.

STEP 2.—Opening inguinal canal.

Required instruments: grooved director; scalpel; straight, blunt-pointed scissors; two toothed thumb forceps; and two tissue-holding forceps.

STEP 3.—Opening of hernia sac.

Required instruments: same as for Step 2.

STEP 4.—Attempted resuscitation of strangulated intestine (when present).

Required articles: six large abdominal packers, wrung out of hot salt solution, or two towels, similarly treated.

STEP 5.—Intestinal resection (when necessary).

Required instruments: six medium-sized gauze packers (or fluffs) wrung out of hot salt solution; four intestinal clamps, with rubber-covered blades; two curved, round needles, threaded with No. 2 catgut, for controlling mesenteric hemorrhage; scalpel; eight artery forceps; four round needles (straight or curved), threaded with fine silk or linen thread; two round needles, threaded with fine catgut (No. 00 or No. 0); one smooth and two toothed thumb forceps; two needle-holders; and one suture scissors; small sponges, as required, two at a time.

STEP 6.—Repair of inguinal rings and canal.

Required instruments: two toothed thumb forceps; two needle-holders; one curved, round needle, threaded with fine silk; four curved needles (cutting or round), threaded with kangaroo tendon, No. 2 chromicized catgut, or silk; skin retractors; and one suture scissors.

STEP 7.—Closing of skin incision.

Required instruments: two toothed thumb forceps; two needle-holders; four curved cutting needles, threaded with silkworm-gut; one curved cutting needle, threaded with No. 2 catgut; and one suture scissors.

In this closure, the silkworm-gut may be omitted and catgut alone used; or silk alone may be used; or a subcuticular suture of silver wire may be preferred.

This step may be preceded by the placing of a rubber tube, rubber tissue, or cigarette drain.

E. Shortening of Round Ligaments, for Retrodisplacement of Uterus (Baldy-Webster or Gilliam Operation):

STEPS 1 and 2.—Same as for gall-bladder operation.

Required instruments: same as for gall-bladder operation.

STEP 3.—Elevation and control of uterus.

Required instrument: one uterine elevating forceps, or one volsellum forceps, or one double tenaculum forceps.

STEP 4.—Operation upon round ligaments.

Required instruments: one toothed thumb forceps; one Cleaveland carrier, or sharp-pointed artery clamp, for piercing broad ligament and seizing round ligament; two tissue-holding forceps for holding and controlling round ligaments; two curved, medium-sized, round needles, threaded with silk or linen thread; two needle-holders; and one suture scissors.

STEP 5.—Closing of abdominal wound.

Required instruments: same as for gall-bladder operation.

F. Supravaginal Removal of Uterus and Appendages (subtotal panhysterectomy):

STEPS 1, 2 and 3.—Same as for round ligament operation.

Required instruments: same as for round ligament operation.

STEP 4.—Freeing of bladder.

Required instruments: one toothed thumb forceps; two tissue-holding forceps; one scalpel; and one medium-sized, blunt-pointed scissors.

STEP 5.—Temporary control of hemorrhage and section of broad ligaments.

Required instruments: one toothed thumb forceps; six large, straight, toothed clamps (Ochsner clamp); six medium-sized, curved clamps; and one long, curved, blunt-pointed scissors.

STEP 6.—Section of uterus and seizure of cervical stump.

Required instruments: one toothed thumb forceps; one scalpel; one long, curved, blunt-pointed scissors; and one volsellum forceps.

STEP 7.—Permanent control of hemorrhage and closure of cervical stump.

Required instruments: one toothed thumb forceps; six medium-sized, curved cutting needles, threaded with No. 2 catgut (double); two such needles threaded with No. 2 catgut (single); two needle-holders; and one suture scissors.

STEP 8.—Closing abdominal wound.

Required instruments: same as for round ligament operations.

MINOR GYNÆCOLOGICAL OPERATION. DILATATION AND CURETTAGE OF UTERUS; REPAIR OF LACERATED CERVIX AND PERINEUM

A. Dilatation and Curettage of Uterus:

STEP 1.—Exposure and seizure of cervix.

Required instruments: one perineal retractor, with weight; and one volsellum forceps.

STEP 2.—Exploration of uterine canal.

Required instrument: one uterine sound.

STEP 3.—Dilatation of cervical canal.

Required instruments: one small cervical dilator; and one large cervical dilator (Goodell's).

STEP 4.—Curettage.

Required instruments: one medium-sized, sharp uterine curette; one small, sharp, uterine curette; one uterine dressing forceps and narrow strip gauze for removal of small particles from uterus; and one heavy scissors, for cutting strip gauze.

B. Repair of Lacerated Cervix (Trachelorrhaphy):

STEP 1.—Placing of stay sutures.

Required instruments: one toothed thumb forceps; two medium-sized, curved cutting needles, threaded with silkworm-gut; two needle-holders; and two artery forceps for clamping ends of stay sutures.

STEP 2.—Denudation of cervical scar.

Required instruments: one toothed thumb forceps; and one scalpel.

STEP 3.—Suture of cervix.

Required instruments: four medium-sized, curved cutting needles, threaded with kangaroo tendon or No. 2 chromicized catgut; one toothed thumb forceps; two needle-holders; four artery clamps; and one suture scissors.

C. Repair of Lacerated Perineum (Perineorrhaphy):

STEP 1.—Placing of stay sutures.

Required instruments: one toothed thumb forceps; three medium-sized, curved cutting needles, threaded with silkworm-gut; two needle-holders; and three artery clamps for clamping stay sutures.

STEP 2.—Outlining and denudation of area of laceration.

Required instruments: two toothed thumb forceps; one scalpel; two Emmet scissors (right and left); and six artery clamps.

STEP 3.—Suture of angles.

Required instruments: four medium-sized, curved cutting needles, threaded with No. 2 chromicized catgut; one toothed thumb forceps; two needle-holders; four artery clamps; and one suture scissors.

STEP 4.—Suture of perineum, proper.

Required instruments: four large, curved cutting needles, threaded with silkworm-gut; two needle-holders; one toothed thumb forceps; four artery clamps; and one suture scissors.

STEP. 5.—Skin approximation.

Required instruments: one toothed thumb forceps; one medium-sized, curved cutting needle, threaded with No. 2 plain catgut; one needle-holder; and one suture scissors.

III. OPERATIONS UPON THE EXTREMITIES

A. Amputation Through the Thigh:

STEP 1.—Preliminary. Application of the tourniquet.

Required instruments: one rubber elastic band tourniquet or a piece of large rubber tubing, sufficiently long to encircle the limb several times; with this, should be furnished a towel, folded lengthwise in four thicknesses, and long enough to encircle limb under tourniquet.

STEP 2.—Outlining and dissecting the flaps.
Required instruments: one scalpel; one mouse-toothed forceps; one scissors; and six artery clamps.

STEP 3.—Partial division of muscles and exposure of sciatic nerve.
Required instruments: one amputation knife; one scalpel; one toothed thumb forceps; and one blunt hook.

STEP 4.—Cocainization of sciatic nerve.
Required instruments: hypodermic syringe, filled with 1 per cent. solution of cocaine.

STEP 5.—Further division of soft parts, down to bone.
Required instrument: one amputating knife, or one scalpel.

STEP 6.—Division of the bone.
Required instruments: one periosteal elevator; one wide muslin retractor, for muscles of stump; one bone saw; and one rongeur forceps.

STEP 7.—Securing and ligating blood-vessels.
Required instruments: one dozen (or more) artery clamps—straight and curved; one toothed thumb forceps; heavy silk, or linen, ligatures; and catgut (No. 1 or No. 2) ligatures.

STEP 8.—Suturing the muscles.
Required instruments: two large, curved needles, threaded with No. 2 catgut; two needle-holders; toothed thumb forceps; and one suture scissors.

STEP 9.—Closure of skin.
Required instruments: three (or more) large, curved cutting needles, threaded with silkworm-gut; additional silkworm-gut; two needle-holders; one toothed thumb forceps; twelve clamps for temporary securing of ends of sutures; three cigarette or small dressed-tube drains; and one suture scissors.
The instruments and sutures for this step must, necessarily, vary widely with the individual preferences of different surgeons.

B. Disarticulation at the Shoulder:

STEP 1.—Incision of skin and muscles.
Required instruments: one scalpel; two toothed dissecting forceps; one scissors; two skin retractors; and artery clamps as required, at least two being constantly at hand.

STEP 2.—Incision of capsule of joint and division of muscle attachments.
Required instruments: the same as for Step 1, with addition of periosteal elevator.

STEP 3.—Ligation of main vessels.
Required instruments: same as for Step 1, with addition of blunt dissector; and an aneurism needle threaded with strong silk, or linen ligature.

STEP 4.—Cocainization of main nerve trunks.
Required instruments: same as for Step 1, with addition of one blunt dissector; one blunt hook; and a hypodermic syringe filled with 1 per cent. cocaine solution.

Step 5.—Division of remaining tissue.
Required instruments: one amputating knife, or scalpel, and one toothed dissecting forceps.

Step 6.—Securing and ligating blood-vessels.
Required instruments: about a dozen clamps, straight and curved; and silk, linen, or catgut ligatures—as called for.

Step 7.—Suturing the muscles.
Required instruments: two (or more) large curved needles, threaded with No. 2 catgut; two needle-holders; one toothed thumb forceps; and one suture scissors.

Step 8.—Closing the skin wound.
Required instruments: the same as for the corresponding step in the thigh amputation.

CHAPTER XXVI

OPERATIONS IN PRIVATE HOUSES

It must be assumed, at the outset, that no hard-and-fast rules can be laid down for the preparation for and conduct of operations performed in private houses. The means and surroundings of the patient will be variable, as will the outfit and preparedness of the surgeon to cope with such occasions. Our effort must, therefore, be to lay down general principles that are to be observed so far as opportunity and the surroundings permit, and to indicate a few of those measures and makeshifts that are of use in the absence of a properly-equipped operating room.

1. The Room.—A large, well-lighted room should be selected. Where attainable (if the operation is to be by daylight), a room with a northern exposure is preferable, as this gives an even light throughout the day and any of the other exposures is under the direct glare of the sun at some hour of the day. All hangings, draperies, pictures, rugs, etc., should be removed the day before the operation; the walls and floors carefully cleansed (preferably being gone over with a cloth moistened in some antiseptic solution, either bichloride 1–1000 or carbolic acid 1–100 or 1–20); and any superfluous articles of furniture either removed or so disposed of as to be out of the way at the time of the operation.

2. The Table.—It may be accepted, as a general thing, that some portable form of operating table will be brought by the surgeon. Should this, however, not be the case, an ordinary kitchen table may be pressed into service—being carefully scrubbed until mechanically clean and then treated by the application of an antiseptic solution, in the hope of further promoting asepsis. The top of the table may then be covered with new oil-cloth or rubber sheeting, which is, in turn, subjected to the antiseptic wash.

3. Utensils and Supplementary Supplies.—In addition to the table used for the operation, there must be another table (or tables) sufficiently large to permit the proper laying out in an orderly manner of the various instruments, dressings and materials used in the course of the operation. These tables should be cleansed and covered in a manner similar to that described for the operating table. The instruments and sterile dressings will be supplied by the operator. Certain utensils and supplies should, however, be on hand and prepared for use before and during the operation. Sufficient linoleum, rubber sheeting, oil-cloth, or (in case of necessity) newspapers should be at hand to cover and protect the floor in the immediate vicinity of the operating table. There should be a chair for the anæsthetist and (where urethral, vulvar, vaginal, perineal or rectal work is to be done) also one for the operator. There should be three clean basins (which have been rinsed thoroughly with a strong antiseptic solution) and an ample supply of warm sterile water for the proper scrubbing of the hands and forearms of the operator, his assistant and the nurse. There should be green soap, a sterile scrub brush and a sterile orange stick for each of these persons. There should be two receptacles, one on each side of the table, for the reception of soiled sponges. In addition to the articles already enumerated, at least four other basins will be required: one each for alcohol and bichloride solution for use in preparation of the hands and arms of the operating staff; and one each for bichloride solution and hot salt solution to be used during the operation. These basins should be sterilized by boiling in a wash boiler, or by thorough immersion in an antiseptic solution. It is quite possible that, in some cases where the surgeon is unusually well prepared for operating under such conditions, a number of the above-mentioned articles may be dispensed with. But it is equally true that, in operations of emergency or where the most complete equipment is for any cause lacking, the necessity of various makeshifts may arise.

4. Artificial Light.—When, for any reason of urgency, the operation must be performed by artificial light, complications may arise that require great ingenuity for their subjection or that even render the question of operation absolutely impossible. It can well be seen that it would be almost, if not quite, out of the question to perform a delicate abdominal operation in a country house by the light of kerosene lamps. And the same might well be the case in many gas-lighted city houses. It is quite possible that, in a case where immediate operative procedure is imperative and transportation to a properly-equipped operating room out of the question, the use of a kerosene reflector or bicycle lamp, an acetylene bicycle lamp, or even an automobile searchlight might be possible. Where electricity is at hand, the problem is greatly simplified. Extension sockets are common; reflectors easily obtained; and powerful lights readily accessible.

5. Substitutes for Lithotomy Posts.—This subject has been fully considered in the chapter upon "Postures," the adjustable post, the sling and the two applications of the sheet as substitute for either being there referred to and described.

6. Kelly Pad.—The Kelly pad is here made the subject of particular remark because it has become to be almost universally considered a necessity in a large class of operative work and because, at the same time, it seems to be the most usual article to forget until needed. If a surgeon, in assembling his supplies for an operation, forgets anything, it is the Kelly pad. And most people would certainly not consider the lithotomy position complete without a Kelly pad under the hips. Fortunately, however, there are very few of the different articles of equipment so readily and easily replaced by the aid of a little ingenuity. A most acceptable substitute is made by rolling one (or two) bath towels lengthwise; curving them to the horseshoe shape; and covering them with rubber sheeting or oil cloth. A newspaper roll may take the place of the bath towel. In fact, a newspaper, home-made Kelly pad may be manufactured in a very few minutes and makes a very acceptable substitute. And very few homes are without newspapers.

7. Anæsthetic.—The choice of the anæsthetic to be used does not come under the duties or within the province of the nurse, but it is necessary that she should appreciate the dangers attending the use of ether in the vicinity of a free flame. This anæsthetic is more volatile than chloroform and highly inflammable and explosive. It, therefore, follows that unusual care must be exercised in its administration where any exterior cause for combustion exists. This caution is necessary, not only as regards gas-lights, oil lamps, etc., but extends to the use or presence of an actual cautery within close proximity to the anæsthetist.

8. Sterilization of Instruments, Water, Etc.—It may be accepted as the general rule for all operators, where the work is to be done in a private house, to sterilize their own instruments and bring them to the scene of operation in sterile containers. There are, however, exceptions to this rule and, at such times, the nurse must be prepared to accomplish this necessary procedure with the means at her command. The actual sterilization must, of course, be done by boiling, an ordinary wash boiler (preferably of small size) serving very well for the purpose. Some surgeons carry trays that are used for the combined purpose of instrument tray and sterilizer. In such cases, the instruments may be sterilized in the tray; the water poured off; and the instruments carried to the operating room and kept in the tray, which is now a sterile container. The nurse should take care that, before the operation, large quantities of water are sterilized by boiling, so that sufficient may have cooled off to permit of the tempering of the solutions used to a reasonable degree of heat. It is quite probable that the preparation of a sufficient supply of sterile water will be quite a tax on the kitchen equipment—as the amount required will run up into the gallons.

PART VI—SUPPLEMENTARY CHAPTERS

CHAPTER XXVII

GYNÆCOLOGICAL DISPENSARY

In the description of the gynæcological dispensary, an effort will be made to outline, as nearly as possible, the ideal arrangement, and, as this arrangement applies equally to office work, the description will have a double application.

1. Records.—Every gynæcological dispensary should have a card-index filing system, by which a continuous record may be kept of the patient's condition from the first visit. In the present day of large dispensaries, where the gynæcological is only one of many branches, this system is almost universal. The patient entering a large dispensary is first referred to the central or distributing office, where a general diagnosis is made from the complaint of the patient, this process merely deciding whether she should be referred to the medical, general surgical, gynæcological, or other branch of the dispensary. This being decided, she is provided with a small identification card, containing only the data regarding her name, the branch of dispensary to which referred, the date of her first visit and the doctor in charge of that particular service. This card she retains throughout her course of treatment, presenting it each visit. In addition, she is supplied with a larger history card, which is to be used as a permanent record in the files, and upon this are recorded her name, age, occupation, dispensary number, nativity, address and social condition. These data are filled out at the central office, where a record of the same data is kept. The patient carries this card with her on her first visit to the dispensary, where the attending physician adds a full history of the case, with results of examination, diagnosis and outline of treatment, filing it in his dispensary records and making the necessary notes at subsequent visits. In large dispensaries (particularly those of teaching hospitals) the history is sometimes taken by the assistant to the physician in charge—the patient thus coming to him with all the salient points of her condition already outlined and with the important question of diagnosis and treatment alone left to him. This arrangement requires a suite of four rooms: (1) the general waiting room, in connection with the central distributing office;

(2) the special waiting room for each branch of the dispensary (although this may be dispensed with by a proper apportioning of those parts of the general room that are in immediate proximity to the different branches); (3) special consultation room, where the assistant has his desk and takes the histories of the successive patients before they go to the physician in charge; and (4) the special examining and treatment room, where the physician in charge, the nurse, the examining table and the necessary supplies are found.

Naturally, in private practice, the central distributing office is lacking. The patient goes from the waiting room to the consultation room, where the physician makes his own record. From there she goes to the examining and treatment room. In this case, the function of the central office has been performed by the physician who has referred the patient to a gynæcologist for special diagnosis or treatment.

2. The Examining and Treatment Room.—This room should be well lighted, both naturally and artificially. The artificial lighting should include an electric head-lamp that will make possible accurate inspection of the vulva, vagina, bladder and rectum. Where gas light is used, a light and head-mirror should be at hand—the light placed so as to make its use convenient and satisfactory. There should be a desk for the physician, with the filing case and writing materials conveniently disposed. There should be an instrument case containing the necessary outfits for the examination and treatment of the bladder, vagina and rectum. Space should be supplied, in the instrument case or elsewhere, for a sufficient supply of sterile cotton, sponges and dressings. The examining and treatment table should be one of the standard types, especially constructed for its purpose and of the particular kind preferred by the gynæcologist in charge. In connection with this table, there should be a surrounding screen to afford additional privacy to the patient and a foot-stool that she can use as an aid in mounting the table and that the examiner can use as a foot-rest in bimanual, combined examinations. There should be at least two chairs, one for the patient and one for the physician—and it is better to have more, as a gynæcological patient is very likely to be accompanied by a friend or relative. There should be a table with all the necessary instruments arranged upon it and covered with a towel, so that a naturally nervous patient may not be rendered more so by the sight of glittering instruments. A table with three superposed, swinging shelves is best, so that the instruments for vaginal, rectal and vesical examination may be arranged upon the respective shelves quite independent of the other sets and conveniently reached when needed. Another stand should be at hand, containing sufficient supplies of the different solutions, medicaments, lubricant, etc. A sterile bladder-irrigating apparatus (whether regular irrigator, irrigating syringe, or ordinary funnel and tube apparatus) should be always ready for use. A sufficient supply of rubber gloves completes the ordinary equipment of a properly-conducted gynæcological examining and treatment room.

3. Instruments.—Every completely-equipped gynæcological dispensary should be supplied with all the instruments necessary for a thorough examination of the urethra and bladder, the vagina and uterus and the rectum and sigmoid. In some dispensaries it is customary to refer those cases where rectal or vesical complications are suspected to the special branch having charge of these conditions. Diseased conditions of these three regions may, however, be so closely interrelated as to make a proper differential diagnosis practically impossible without a careful examination of two (or possibly all three) systems.

The instruments necessary for vaginal and uterine examination and treatment are: (1) Specula, which should be of different types and sizes, to meet the different demands that may be made. There should be two or three sizes of the Sims speculum. There should be at least two sizes of the Graves or other good bivalve speculum. There should be at least three sizes of the Ferguson or other tubular speculum. And there should be a very small tubular speculum (possibly a large Kelly cystoscope) for the examination of children. (2) Tenaculum (either single or double) or volsellum. (3) Uterine sound. (4) Uterine dressing forceps. (5) Applicators. (6) Sponge holders. In addition to these articles of constant use, there are a number of others, less frequently required, that should be at hand. In this latter group are found the pessaries of various types, graduated dilators of the Hanks or Hegar type, and such other instruments of special application as may be required by the gynæcologist in charge.

The instruments necessary for urethral and vesical examination and treatment depend largely upon the type of instrument used by the gynæcologist. If the Kelly type of cystoscope be preferred, the outfit will differ quite materially from that required for the electrically-lighted instruments that are used in a water-distended bladder. The instruments required for the Kelly method of examination and treatment are, in addition to the head-light or light and head-mirror already mentioned: a dilator for the external meatus; several tubular bladder specula with obturators; a urinary evacuator; long forceps of the mouse-tooth or alligator jaw variety; and a ureteral searcher. Ureteral catheters are also generally included in this list, as of occasional use.

For the examination of the lower bowel, a very similar class of instruments is required to that used for bladder examination, the difference being chiefly a matter of size. The head-light or reflector is again required. A conical sphincter dilator, very similar in appearance to the urethral dilator, is utilized for gradual dilatation of the sphincter prior to the passage of specula. The specula should be four in number, varying (unlike the bladder specula) in length only. These are a short sphincteroscope; a short proctoscope; a long proctoscope; and a sigmoidoscope. These respective instruments are particularly adapted to the inspection of the sphincter region, the lower rectum, the upper rectum and the sigmoid flexure of the colon. There should also be a long-handled applicator and sterile cotton for use with it.

The different diagnostic instruments have been enumerated at some length, because it is important for the nurse who has charge of them and who is responsible for their care and preparation to have an accurate idea of the proper use and grouping of the different pieces. All of the instruments mentioned should be in readiness in a dispensary or office that pretends to thoroughly cover the field of gynæcological diagnosis and treatment. In those cases where the differentiation from conditions of the intestinal or urinary tract must be done in other branches of the dispensary, only the instruments for vaginal examination are kept in the gynæcological room.

4. Preparation for Examination.—Every complete gynæcological examination should consist of an examination of the abdomen, by inspection and palpation, and sometimes percussion; examination of the vulva, vagina and cervix by inspection; examination of the uterus and appendages by combined palpation through the abdominal wall with one hand and the vagina with one or two fingers of the other hand; and, finally, any indicated examinations of the lower bowel and urinary tract. Before taking her position on the examining table, the patient should remove her corsets and free any constricting bands about the abdomen or waist. The position used for the abdominal examination is the horizontal recumbent—the abdomen being thoroughly exposed, but the patient protected from undue exposure by draping with sheets. The positions used for the vaginal inspection are generally either the Sims or the dorsal. The latter is now given the preference because it is more readily attained; occasions less inconvenience to the patient; and is equally well adapted to the subsequent bimanual combined palpation. The knee-chest position is the one generally employed for examination of the bladder or rectum with the instruments enumerated above.

5. Drugs, Solutions, Etc.—This particular part of the dispensary outfit can, of course, be treated in only the most general way—as the routine of treatment must vary markedly with individual prejudices and preferences. For the convenience of the attending gynæcologist, some solution, as bichloride of mercury 1–1000 or carbolic acid 1–100, should be ready in connection with the cleansing of his hands. For purposes of local treatment to the cervix, vagina and vulva, such medicaments as iodine, potassium permanganate, argyrol, ichthyol, etc., are used in solutions of varying strength. A solution of boracic acid (from 2 to 4 per cent.) is one of the most common for bladder irrigation, being frequently followed by the instillation of a solution of argyrol or protargol. Whatever the drugs used or the strength of solution desired, it should be the duty of the nurse on service in the dispensary to see that all supplies are constantly on hand, in order to assure prompt and efficient service.

Draping of Patient for Examination.—For the combined gynæcological examination, the dorsal position is the usual one. After the corsets have been removed and all constricting bands about the waist loosened, the patient is placed on the table in this position,—the skirts being drawn well above the hips both front and rear. During this process, the patient is covered from the waist down by a sheet thrown lengthwise across her. The sheet is then gathered in the centre from the lower edge and fastened just above the pubes, a towel being placed over the vulva. The legs are then draped with the sheet, the ends being securely twisted around the feet of the patient.

While the preceding paragraphs were written as particularly applicable to the conduct of a gynæcological dispensary (which is the one where the services of a nurse are absolutely indispensable), the same general rules would apply to any other service to which the nurse might be assigned.

CHAPTER XXVIII

EMERGENCIES

I. ACCIDENTS

The surgical nurse will very properly be expected to know how to render first aid in cases of accident with which she may come in contact, and she will naturally be the one called upon to determine what is to be done when a physician is not at hand. The conditions under which she will then be compelled to act will be quite different from those to which her training has accustomed her. In the hospital ward she is rarely expected to take the responsibility in the face of an emergency. Her first duty, except in rare instances, is to summon the head nurse, an interne or the attending surgeon. When, however, she is asked to render first aid in a case of serious accident she will have to decide for herself, and at once, what is the best thing to do, and she must find a way to do it, usually in the absence of everything in the way of material or apparatus which she has been taught to believe essential in such a case. The accidental injuries encountered will vary infinitely in severity and in kind, and there will be an equal variety in the available means for dealing with them. The nurse will, perhaps, have to do something which she has never done before, but has only seen done by others and with every appliance at hand. The natural result will be a good deal of mental confusion, leading perhaps to doing the wrong thing or to doing the right thing awkwardly and with unnecessary delay. The first consideration then is as to the proper habit of mind with which to approach a problem of this kind. If the mental approach is right, the things to do will unfold themselves in the correct logical order and the right thing will be done speedily and efficiently.

In the first place, first aid in an accident is always a temporary expedient. We do not have to think at all of what is the proper treatment in such cases. The treatment will be undertaken later presumably by competent hands and with every needed appliance available. Our object is to check the immediate harmful consequences of the accident, and then to hold the situation *in statu quo* until proper treatment can be begun. In the second place, there is always just one thing to be done; *i.e.*, one crucial, necessary, immediate thing. Other things may be needed later, but there is always one thing to be done first, and we will call this the indication. Our mental approach to the problem then will be something like this. First we ask ourselves: what is the indication, what is the one immediate thing to be done? Next, what is the easiest and quickest way to do it? Lastly, we will ask what means we have at hand to accomplish the action decided upon. If we approach our problem in this manner we shall find that the first question will nearly always answer itself immediately. A brief consideration will enable us to answer the second question, and when finally we turn our attention to the available means at hand, it is surprising how easily we can find something that will answer the purpose.

We shall discuss in this chapter very briefly some of the more common surgical emergencies which the nurse may at some time have to meet, considering them from the standpoint which has been suggested, but first a few general indications must be presented.

The first is a warning against trying to do too much. Meddlesome interference in cases of accident often does great and sometimes irreparable harm. In cities or in any locality where an ambulance or a physician can be summoned at short notice, the indication, in a very large number of cases, will be to do nothing at all except to see that aid is summoned promptly and to administer to the patient's comfort pending its arrival. There are practically only two surgical conditions where instant measures must be resorted to in order to save life. These are (1) very profuse venous or arterial hemorrhage, and (2) arrest of respiration, as from drowning or electric shock, or asphyxiation from inhalation of gas, or external pressure on the throat, or a foreign body in the larynx. A third condition, that of profound shock or collapse, may also in some cases call for prompt measures of relief. We shall reserve our consideration of these until the last.

II. WOUNDS

Excluding the presence of active hemorrhage, the indication for first-aid treatment of a wound is the application of a sterile protective covering or one that is as nearly sterile as possible.

The most important thing is to keep the fingers or anything that has been much handled from contact with the wound. If competent medical aid can be had within a few minutes a wound not actively bleeding should be left alone. If a delay of some hours is unavoidable a protective dressing must be applied. Cleansing of an extensive wound should not be attempted usually as a first-aid measure. Clots of blood should not be removed, lest bleeding be started afresh. If sterile gauze or cotton is not at hand or cannot be quickly obtained from a nearby drug store, some substitute dressing must be employed. The thing to look for is something that has not been in contact with the human or animal skin. For this reason torn articles of clothing, while they answer well for bandage material, should not be used in contact with a wound except as a last resort. The inner folds of a clean handkerchief, towel or napkin that has not been opened since it was ironed are fairly sterile and may be placed in contact with a wound with a fair degree of confidence that this dressing material will not be the means of carrying septic bacteria into the wound. Paper from unhandled original packages (toilet paper, writing paper) may be used if nothing better is at hand. Doubtful materials can be sterilized by boiling in water when this is possible, or may be saturated with an antiseptic, bichloride of mercury (1–3000) or alcohol (for small wounds). Carbolic acid, except in very dilute solutions, is unsafe for large dressings, and in strong solutions is very dangerous. Most of the commercial antiseptic solutions are of small value. The best dressing for an accidental wound is dry sterile absorbent gauze, and next to this is a wet bichloride gauze dressing (1–3000). Bandages can nearly always be improvised from torn sheets or clothing.

As has been indicated, cleansing of an extensive accidental wound is not a first-aid measure. It should be done within a few hours by a competent surgeon, preferably at a hospital where everything needed is at hand, and with the patient under an anæsthetic. Necessary operative measures will be carried out at the same time. Tendons or nerve trunks may require to be sutured, and partial or complete closure may be done. A very large percentage of accidental wounds should not be closed. If cleansing of the wound is attempted it is best done by flushing with sterile normal salt solution. Disinfection of the skin about the wound, and also of the wound itself, is most efficiently done by equal parts of tincture of iodine and alcohol.

Infection by the tetanus bacillus is a serious danger in all wounds infected with dirt from a much-travelled public road or from a stable yard. A subcutaneous injection of 1500 units of antitetanic serum is an almost certain preventive if promptly given. The nurse may regard it as a part of her duty to help to educate the public to the conviction that this preventive measure should always be employed in such cases. It should be observed that superficial scratches and abrasions, so contaminated, are not likely to develop tetanus, since this organism will not grow in the presence of oxygen. It is the deep wounds, particularly those of the punctured variety, that are dangerous. Fourth of July accidents have always been peculiarly liable to tetanus infection. All such wounds should be laid wide open with free incisions by the surgeon, and should never be closed by sutures.

The gas bacillus is another anaërobic organism which may contaminate wounds from the same source. It is usually in deep and severely lacerated wounds that this organism finds favorable conditions for its growth. Once started its development is very rapid. The temperature of a patient so infected may rise to 104° F. within twenty-four hours after the injury. Free incisions and the use of peroxide of hydrogen are the best treatment. The mortality is very high. If the infection is in a limb, prompt amputation is usually necessary to save life. These measures for the treatment of wounds do not, of course, come within the province of the nurse, and are not classed as first-aid measures. They have been referred to here in order to emphasize the necessity of prompt surgical attention in cases of deep punctured or lacerated wounds contaminated with dirt from the highway or from horse stables and yards.

III. BURNS

The indication is a temporary protective covering, mainly for the relief of pain. Strips of gauze, handkerchief linen, or paper, wet with a solution of washing or baking soda (a teaspoonful to a pint of water, boiled), or picric acid solution (1–200), answer well. Sterile vaseline, machine oil, olive oil or linseed oil may be used. Carron oil, an old dressing for burns, is an emulsion of equal parts of linseed oil and lime-water. A dry charred burn should not be wet but dressed with a dry sterile dressing lightly bandaged.

IV. FRACTURES

1. A compound fracture is one in which there is an open wound communicating with the broken bones. Sometimes an end of a fractured bone protrudes through the wound in the skin. In a compound fracture the first indication is a protective dressing for the wound. If the end of a bone protrudes it should not be allowed to recede under the skin. Iodine-alcohol disinfection of the skin wound and of the protruding bone is good first-aid practice before applying the protective dressing.

2. For simple fractures, in which there is no wound, and for compound fractures after the wound has been dressed the indication is fixation of the fractured bones and, if possible, of the joint on either side of the fracture by means of some temporary or makeshift appliance. The means to be employed will vary with the location of the fracture. Clothing should be cut away to expose a wound, but as a rule should be left in place over a simple fracture, since it supplies good padding for the splints. In removing clothing remove from the sound side first; in putting on a garment start with the injured side. No attempt is to be made to set a fracture, but a limb which is bent at an angle may be gently drawn into a straight position.

3. Fractures at the Wrist.—A palmar splint of wood or pasteboard or other available material extending from the base of the fingers to the elbow will be required. The splint and also the back of the forearm should be well padded and the whole secured with a bandage.

4. Fractures of the Forearm.—A palmar and dorsal splint bandaged on not too tightly is the indication. A palmar splint fits the palm of the hand and the front of the forearm from the base of the fingers to within an inch of the bend of the elbow. The width of the splint corresponds to the width of the forearm. If a flat piece of wood or pasteboard is employed a half circle should be cut out to fit the ball of the thumb. A dorsal splint fits the back of the hand and forearm from the knuckles at the base of the fingers to the point of the elbow. If made of wood or other solid material the splints should be well padded. Two flattened rolls of newspaper, or any other paper, make excellent temporary splints for a fracture of the forearm. They are even superior to wooden splints if skilfully applied. No padding is required. A magazine opened in the middle and tied or bandaged about the arm will answer very well. Good splints can be made of straw or small twigs by tying the material into bundles about two or three inches in diameter. The splints may be secured by three or four ties or a bandage. A sling must always be improvised for these fractures. The coat sleeve or shirt sleeve may be pinned to the part of the garment covering the front of the chest, to answer the purpose of a sling.

5. Fractures at the Elbow=Joint.—No bandaging or splinting should be applied to these fractures as a first-aid measure. A well-fitting sling giving smooth support to the forearm and hand and to the elbow is all that should be attempted. Any makeshift fixation apparatus will be difficult to apply and will rarely be satisfactory. A bandage is very apt to cause dangerous constriction at this point even when the operator thinks the bandage has been put on loosely.

6. Fractures of the Upper Arm at the Shoulder, and of the Clavicle.—In all these the indication is the same, to fix the arm to the body. The hand of the injured side may be placed upon the opposite shoulder if this position is comfortable, and the whole arm and forearm fixed to the side by a bandage or swathe. In other cases the hand and forearm may be supported by a sling. A pad made of a folded towel or of paper or any suitable material that is at hand is to be placed between the arm and the side. If the shoulder injury is, or may be, a dislocation instead of a fracture, the arm may be held rather rigidly at a certain angle, and in this case it should not be forced to the side in a painful position, but should be supported and fixed in the position it naturally assumes.

7. Fractures of the Leg, Ankle and Foot.—The best emergency splint for a fractured leg is the pillow splint. The leg is placed in the middle of a full-sized pillow with the pillow case on. The open end of the pillow case lies at the foot. The pillow itself extends from the level of the sole of the foot to a short distance above the knee. The pillow is then wrapped about the leg and edges of the pillow case pinned together. The open end of the pillow case is then folded about the sole of the foot and pinned, thus supporting the foot. Four pieces of bandage or cord are then tied about the pillow, one above the knee, one at the ankle, and two between these. The pillow alone will answer, but it is much better to lay four splints of wood outside the pillow and under the bands, two behind and one on each side. Another emergency splint is the blanket splint. A blanket is folded so that its width is equal to the distance from just above the knee to the sole of the foot. Two sticks are provided equal in length to the width of the folded blanket. Each stick is then rolled up in an end of the blanket until the two rolls come in contact with the leg, one on the outer side and one on the inner side. The splint is then tied in place. Four firm rolls of heavy paper, or straw, twigs or other material tied into bundles about three inches in diameter, may be bandaged about the leg to make a very good splint.

8. **Fractures of the Thigh.**—These are the most difficult of all fractures to handle as regards the application of proper fixation and support so that the patient can be transported with comfort and without injury. First aid is of very great importance in these cases. Four board splints must be obtained if possible: one for the back of the thigh, about five inches wide and long enough to extend from the belt line to the middle of the calf; a long outside splint, four inches wide and long enough to extend from the axilla to the sole of the foot; another for the inner side of the thigh and leg long enough to extend from the foot to within an inch or two of the perineum. A fourth splint is needed for the front of the thigh, reaching from the groin to just above the patella. All these must be heavily padded with folded towels or sheets or any available material. They are to be fixed in place by about four ties about the leg and thigh, one about the pelvis and a broad swathe about the chest. The padding should be arranged with intelligence and care so as to conform well to the natural curves of the body and limb. If boards cannot be had, three or four round sticks of the requisite length may be tied together side by side and padded to represent each board. It is better to wait a considerable time to obtain the proper materials than to try to move the patient without proper support of the fractured limb. If suitable splints are impossible to obtain, some less efficient means of fixation must be resorted to. Place a pillow or something equivalent between the thighs and knees, and a smaller pad between the ankles, bandage the feet together, bandage the knees together, wrap the body with a blanket swathe extending from the waist line to the middle of the calf, and over this apply about the thigh any splint material that can be found.

9. **Fracture of the Jaw.**—A tight bandage from the chin to the top of the head fixing the lower to the upper jaw is all that is required.

10. Fracture of the Ribs.—A tight swathe, bandage or strips of adhesive plaster about the chest is the indication.

11. Dislocation.—No attempt need be made to distinguish between fracture and dislocation, when there is any doubt. In case of any crippling injury to a limb the indication is to give the limb fixation and support in the position that is most comfortable for it, until proper treatment can be undertaken. First-aid splinting is not required for dislocations, as a rule.

12. Injuries of the Knee-Joint.—The indication is fixation of the joint by a posterior splint, and elevation of the leg. An ice-bag may be applied, or cold compresses may be used to limit the effusion and swelling, with or without elastic compression over the knee by means of a bandage. A pillow splint will serve the purpose well as a first-aid measure.

13. Injuries of the Ankle-Joint.—If severe, an injury of the ankle should be treated as a fracture of the leg. If the injury is evidently only a sprain, a firm bandage with plenty of padding from the toes to the middle of the calf is indicated.

14. Injuries of the Hip-Joint.—For severe injuries in this region the indication for fixation and support is the same as for a fractured thigh. Most hip injuries can be safely transported, by very careful handling, without the aid of fixation appliances.

15. Diagnosis of Injuries.—Exact diagnosis need not be attempted in doubtful accident cases. It is the obvious injuries that call for first aid. The patient will usually be able to tell the location and even the character of the injury. An unconscious patient must be carefully examined to determine the extent and character of his injuries before one attempts to move him. Gentle lifting and manipulation of each limb in turn will usually reveal at once the presence of a fracture or dislocation. A serious wound will force itself promptly upon the attention. When there is doubt the clothing must be removed or cut away if necessary. Judgment must be exercised, of course, as to the severity of the injury. Slight injuries need little or nothing in the way of first aid.

V. TRANSPORTATION OF PATIENTS

Arrangements for transporting the patient will usually be made by the doctor who is summoned. Frequently the patient may have to be carried short distances by those who render first aid. When a patient can walk with help (that is, when he is able to bear part of his weight on the injured foot or leg) the one giving assistance should stand on the patient's sound side for the same reason that a lame man using one crutch or a cane uses it on the sound side. For helpless patients some substitute for a stretcher must be improvised, by means of boards, a shutter or door, or two poles with a blanket or two coats slung between. Those carrying a stretcher from each end should be instructed not to keep step. Two men carrying a patient in their arms should be instructed to keep step. A shuffling walk is the proper gait.

We come now, finally, to consider the first-aid measures which are of the greatest importance because they are life-saving in character. The occasions where they must be employed will come rarely to any individual, to many not at all, but when the occasion does arise it will be sudden and unexpected, and will tax to the utmost the presence of mind and resourcefulness of the person who is called upon to act. There will be little or no time for reflection, and success will depend largely upon clear understanding of the situation, and practice of the necessary manipulations, so far as possible, acquired beforehand.

VI. HEMORRHAGE

1. It is assumed that the surgical nurse is familiar with the elementary facts about the anatomy and physiology of the circulation of the blood; the relation of arteries, capillaries and veins; the action of the heart, the clotting of blood, etc. Her experience in the operating room should enable her to recognize the appearance of a spouting artery, the darker blood flowing from a vein and the general oozing of capillary hemorrhage. We shall first enumerate briefly the several methods for controlling hemorrhage in accidental wounds; next we shall consider the bearing which the location of the wound may have upon the problem of control of hemorrhage, and finally we shall point out the indications to be followed under the different conditions which may be encountered.

2. Methods for the Control of Hemorrhage.—The most efficient method for the control of hemorrhage is the ligature. A small pinch of tissue at the bleeding point is clamped with forceps of one of the several patterns in use. A ligature of sterile silk, linen, or catgut is then tied tightly about the tissue under the point of the clamp in a double knot. Or the ligature is threaded into a curved needle, passed through the tissue under the point of the clamp and tied. The latter method is used where the tissue is either very friable or very dense. These methods are a part of the operative technic and the nurse will see them constantly employed during her operating-room experience. They are, however, not available ordinarily in cases of accident, since the necessary instruments and ligatures will rarely be at hand or easily accessible. We must, therefore, as a rule, rely upon other methods for the immediate arrest of hemorrhage in cases of accidental wounds. These include, first, elevation of the part, which has important but limited uses; second, pressure in some form, the method of greatest importance and widest application; and, third, the use of means which either cause contraction of the small divided vessels or hasten the coagulation of the blood. These latter methods include heat and cold and the styptic or astringent drugs.

(1) *Elevation of the Part.*—This method is applicable only to the hand and arm, or the foot and leg. It is effective for venous and capillary hemorrhage, but will not control bleeding from an artery, although it somewhat diminishes the force of the arterial stream and is therefore of use in conjunction with other methods, even in arterial hemorrhage.

(2) *Digital Compression of the Brachial or Femoral Artery.*—Almost all the blood flowing to an arm or leg can be instantly cut off by pressing the main arterial trunk which supplies the limb between the fingers and a bony surface. For the brachial artery the inner border of the biceps muscle at the middle of the upper arm marks the place where the artery can readily be compressed against the bone. The hand grasps the biceps with the tips of the fingers at its inner border and the thumb on the outer side of the arm. The fingers feel for the pulsating artery and compress it against the bone. With the arm raised the axillary artery can be compressed against the head of the humerus, under the anterior axillary fold. These manœuvres can be easily learned by a little practice. The femoral artery can be felt in the groin just below Poupart's ligament, where it passes over a bony prominence. Strong pressure with both thumbs will usually be necessary to control it. Compression of other large arterial trunks, such as the common carotid, the subclavian and even the abdominal aorta, can be done with the fingers in some cases, but is too difficult and uncertain to be recommended to a novice.

(3) *Flexion.*—Strong flexion at the knee or elbow, with a

small pad between the flexed surfaces, may suffice to check hemorrhage from deep arteries in the foot and hand, which being protected by the plantar or palmar fascia are sometimes difficult to control by direct pressure.

(4) *The Tourniquet.*—Many forms of this appliance are described in the older surgeries. The only one now in practical use in the operating room is the elastic rubber band. An emergency tourniquet is made from a handkerchief, cravat, belt or strip of cloth torn from the clothing, tied loosely about the limb, and twisted tight with a stick. Such a tourniquet is to be applied only about the thigh or upper arm. It is useless about the forearm or leg. It should always be placed at least four inches above the injured tissues, and should be applied outside the clothing or with some form of padding under the band. It should never be allowed to remain in place more than three hours.

(5) *Pressure by a Bandage.*—A tight bandage applied over the wound dressing will control hemorrhage unless there is bleeding from a deep vessel which is protected from pressure by anatomical structures, as for example the deep palmar arch in the hand. A pressure bandage applied to a limb should extend from the fingers or toes up.

(6) *Packing the Wound.*—The nurse will probably see this method applied during her operating-room experience. The essential thing is that every crevice of the wound shall be filled with the packing material, so that equal pressure is made over the whole of the raw surface. It is not recommended as a first-aid measure unless the proper materials are at hand or the necessities of the case require it. It involves cleansing the wound. Packing is useless in the presence of clots. Sterile materials must be employed if possible.

(7) *Direct Pressure.*—This means that the thumb or first finger, or a small pad held by the fingers, is thrust directly into the wound and pressed against the bleeding vessel at the point where it is wounded. This is the simplest, easiest and quickest method for temporary control of the bleeding from a wounded artery or vein. The objection to it in accident cases is that the fingers are always dirty, in the surgical sense at least, and when they are brought in contact with the wound the chances of infection are greatly increased. Accidental wounds are presumably always infected, but as a matter of fact many of them will heal primarily if they are not handled, whereas nearly all of those

that are handled will suppurate. The method of direct pressure is in constant use in the operating room; the surgeon presses his gloved finger or a gauze sponge on the bleeding point even while he is reaching for a clamp. In accident cases the method is to be reserved for those cases of violent hemorrhage from large vessels which must be checked instantly if life is to be saved. All risks of infection are, of course, to be disregarded rather than let a patient bleed to death. When the bleeding vessel is once under the control of the finger, very moderate pressure will be found to be sufficient, and it can be easily maintained for any length of time that is necessary.

(8) *Heat and Cold.*—Hot water is the most efficient means for the control of capillary oozing. An ice-bag is useful to control subcutaneous bleeding.

(9) *Styptic or Astringent Drugs.*—These are useful only for capillary bleeding. They are not to be recommended in first-aid treatment.

3. The Indications for the Control of Hemorrhage According to Character and Location.—In cases of hemorrhage from wounds of the extremities or of the scalp we have the consoling thought that the bleeding can always be controlled. A tight band about the head will check bleeding from a scalp wound, and a pressure bandage over the dressing will control it. If there are clots under the scalp these should be first pressed out, as pressure will not be efficient while they remain. In active hemorrhage from wounds of the arm or leg the first indication is elevation of the part; the next is digital pressure on the main artery. If the bleeding is profuse a tourniquet can then be put on and tightened sufficiently to check the flow. With this in place the wound may be dressed at leisure and a firm bandage applied. The tourniquet can then be loosened, but left in place to be tightened again if necessary.

A ruptured varicose vein may result in a fatal hemorrhage in a surprisingly short time (five or ten minutes) if the patient remains standing or sitting in a chair. The recumbent position with elevation of the leg will check the bleeding instantly. A small pad bandaged over the bleeding point will control it.

Superficial wounds of the trunk, except at the points where the great vessels pass to the extremities and the head, rarely give rise to serious hemorrhage. Pressure bandages over the dressing, or sometimes over packing in the wound, are the only means of control as a first-aid measure. Hemorrhage into the great cavities of the body, as the result of penetrating wounds in the chest or abdomen, is beyond the resources of those who give first aid, and often beyond the resources of surgery.

Wounds of the great vessels at the root of the neck, in the axilla, and in the groin, give rise to frightfully violent hemorrhages, which may result fatally in from two to five minutes. In such cases there is nothing for it but to plunge the finger into the wound and find and compress the opening in the vessel itself. The rushing blood may guide the finger to the spot. Once it is found the bleeding stops instantly, and after that only moderate pressure is required, so that the situation can be kept under control, without undue exhaustion, even for many hours if necessary. Of course, not all the cases will come within the compass of this desperate remedy, and the opportunities for attempting it will be extremely rare, but if the chance comes it should not be missed for want of knowledge or of alertness. If the manœuvre is successful and the opening in the vessel has been plugged by the finger, then the patient's life is saved, barring later complications which need not be considered for the moment. If the bleeding is from a wound in one of the great veins the after-procedure is comparatively simple. Firm pressure through the skin in the course of the vein on the side of the wound away from the heart, and pressure at the same time on the side toward the heart, will usually control the bleeding while the finger is gently withdrawn and a tight gauze or handkerchief pack substituted for it. This can be kept in place by pressure with the hand, or a heavy weight may be placed over it and secured in position by a bandage. With a bandage alone in these situations it may be difficult to make efficient pressure.

With a wound in one of the main arterial trunks the case is quite different. Packing will not control the hemorrhage and the finger must be kept in place until a ligature or, at least, a clamp can be applied. This means a delay not only until the arrival of the surgeon but also until he has had ample time to prepare for an operation. The thing to do is deliberately to manœuvre the patient and oneself into a position as easy and comfortable as possible, carefully relax pressure until just about the least amount necessary is determined, then vigilantly maintain that pressure and prepare for a long wait. The ceaseless drumming of a great artery against the finger may sorely try the nerves of the imaginative, or even of the most phlegmatically disposed. Safety lies in keeping always before the mind the simple fact that the situation is absolutely under control. Even a slight muscular effort becomes very trying when continued for a long time. Intelligent attention must be directed to minimizing fatigue, by avoiding unnecessary exertion in making pressure, by slightly changing the position of the fingers from time to time so as to shift the effort from one group of muscles to another, and sometimes by resting a padded weight upon the hand.

Hemorrhage from the mucous membranes in the mouth, nose, vagina, or rectum is not often severe enough to be immediately dangerous. The application of cold externally and of ice water within the cavities is the first indication. Hemorrhages from the stomach (hæmatemesis) and from the lungs (hæmoptysis) are medical and not surgical conditions.

VII. ARTIFICIAL RESPIRATION

The principal indications for the employment of artificial respiration are drowning, and asphyxiation by illuminating or other gas. To these the most recent industrial conditions have added one more, that of electric shock.

There are two methods of artificial respiration in use at the present time, known as the Silvester method and the Shafer method. The latter is by far the more efficient. In addition there are now upon the market several very efficient machines for the production of artificial respiration (pulmotor, lungmotor). Most hospitals will be supplied with one of these. In the Silvester method the patient lies upon his back, in the Shafer method upon his face. For this reason the less efficient Silvester method is the one which must usually be employed when respiration fails upon the operating table. A patient cannot be turned upon his face in the midst of an operation, particularly an abdominal operation. In the Silvester method two operators are almost essential for efficient work. One on either side of the patient grasps an arm and lifts it strongly above the patient's head. The two arms are then brought down across the patient's chest, and pressure is made on the lower ribs, thus forcing the air out of the lungs. The two manœuvres are repeated about fifteen times a minute until the patient begins to breathe naturally.

Professor Shafer describes his method as follows: "Lay the subject, face downward, upon the ground, with the arms stretched above the head and the face to one side. The operator should at once place himself in position astride or at one side of the subject, facing his head and kneeling upon one or both knees. He then places his hands flat over the lower part of the back

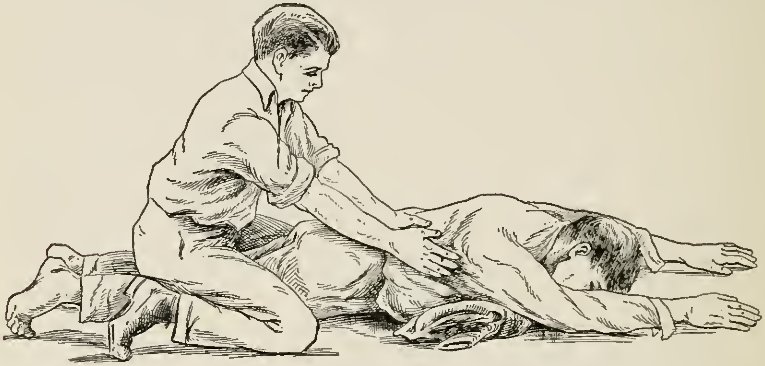


FIG. 133.—Shafer method of artificial respiration. First position: inspiration; pressure off.

(on the lowest ribs), one on each side, and gradually throws the weight of the body forward on them so as to produce firm pressure, which must not be violent, or upon the patient's chest. By this

FIG. 134.—Shafer method of artificial respiration. Second position: expiration; pressure on.

means air and water, if any is present, are forced out of the patient's lungs. Immediately thereafter the operator raises his body slowly so as to remove the pressure, but the hands are left in position. This forward and backward movement is continued every four or five seconds. In other words, the body of the operator is swayed slowly forward and backward upon the arms from 12 to 15 times a minute, and this should be continued for at least half an hour or until the natural respirations are resumed" (Figs. 133 and 134).

VIII. SHOCK IN ACCIDENT CASES

If there has been no hemorrhage the shock resulting from an accident is a condition akin to exhaustion from great exertion, as explained in the chapter on anoci-association. It is due to great emotional stress and the direct effect of the trauma upon the cells of the brain. Absolute rest and quiet with the application of external warmth are the indications. It is good practice to give a small hypodermic of morphia. Whiskey or brandy, or, better still, a teaspoonful of aromatic ammonia in water, relieves the sensation of faintness, but the supposed efficiency of these as stimulants is much in doubt in the minds of many experienced surgeons. Calm assurance and confidence on the part of those who attend the patient are factors of importance in psychic shock. When extensive hemorrhage has occurred another factor is added in the condition of shock for which active treatment may be required. The position with the head lowered and, in bad cases, firm bandaging of the extremities, from the toes to the groin, and from the fingers to the shoulder, are indicated in order to save all the blood available to supply the brain and the heart. Warm saline solution should be given by rectum or subcutaneously, the latter, of course, only under strict aseptic conditions.

CHAPTER XXIX

THE PERSONAL ATTITUDE OF THE NURSE

The personal attitude of the nurse is so closely dependent upon individual characteristics and the demands of particular circumstances that it is only with great difficulty that rules, or even suggestions, for governing it can be outlined. It is true, however, that in her multifarious relations with the hospitals, with the individual sufferer, with the public at large and with the medical profession, the question as to what her duty is in a particular case must often arise. And, necessarily, each of these problems must be to some extent related to the duty to self. The effort, here, will then be to outline, at times generally and at others specifically, what attitude her duty requires in these, her several relations.

I. ATTITUDE TO THE PATIENT

Of course, the first duty of the nurse (as of the physician or the surgeon) is to the patient upon whom she is attendant. This duty consists, broadly, in bringing into play all of those resources that have, by her training, been placed at her command for the relieving of the discomfort and suffering to which the patient is subject. The three cardinal virtues of the trained nurse are competency, cheerfulness and reserve. It may be safely assumed that the first of these exists in the great majority of trained nurses, whether graduate or undergraduate. But the other two are only in a degree less important and, probably, where not naturally possessed, more difficult of attainment. And even cheerfulness, which is in itself a gift, may be quite without avail if devoid of the balance of reserve. One may have a ready smile; a willingness to perform unceasingly and without complaint the numerous small and tiring routine measures for the comfort of the patient; a readiness to put up with minor, or even considerable, discomforts; and a ready flow of interesting conversation when the condition of the patient seems to warrant or require this diversion. But natural, or acquired, reserve should warn the nurse that, at times, silence is more acceptable than the brightest conversation; that her conversation should never include the interesting (and sometimes morbid) details of other cases; and that, above all and before all, any information, no matter how trivial, obtained in her professional capacity is under a seal that must be absolutely inviolate.

II. ATTITUDE TO THE SURGEON

The attitude or duty of the nurse to the surgeon must, necessarily, bear an intimate relation to her attitude to the patient. She must assume that he is competent to outline properly the treatment and she must see that his orders are faithfully executed. She must keenly and closely observe and record the varying condition of the patient from time to time, and, in case of emergency, see that the surgeon is promptly notified. She must be sufficiently familiar with the dosage and method of administration of powerful drugs to prevent errors of carelessness or ignorance in administration. And she should observe absolute and unwavering loyalty to the surgeon, where this does not certainly encroach upon her first loyalty to the patient.

This last statement brings up one of the most delicate points in the relations of the nurse to her environment. By all just reasoning, her first duty is to the patient. But she also owes an undoubted loyalty to the surgeon. And besides this loyalty, it must be presupposed that the broader education and greater experience along these lines of the surgeon will make him better fitted to judge of what is best for the patient than can be possible for the nurse. Nevertheless, occasions do arise when the competent nurse becomes convinced that the treatment outlined for the patient is wrong and, possibly, harmful. In this case, wherein lies her duty? In hospitals, the responsibility may fairly be placed upon the superintendent of nurses and the medical staff of the hospital. In private practice, however, the solution is not so simple. First, it is difficult for the well-balanced nurse to assure herself that her doubts are well founded. Second, if she speaks to the patient, without consulting the surgeon, she will have been disloyal to the latter, possibly without benefiting the patient, who may discharge the nurse and retain the surgeon. Third, if she speaks first to the surgeon, she may be discharged without opportunity to benefit the patient. The best and safest solution of this difficult problem would appear to be: (1) that the nurse assume that the surgeon is competent, conscientious and correct, until she is forced to a contrary decision; (2) that she then verify by the best means at her disposal her doubts preferably consulting some more experienced person, as the superintendent of the training school from which she graduated; (3) that she then, if further convinced, inform the family of the patient of her doubts and, after this warning, terminate her connection with the case; (4) that she notify the surgeon of her action; and (5) that she carefully refrain from suggesting or recommending any substitute or consultant for the regular attendant. By pursuing such a course, the nurse will have: (1) avoided acting with undue precipitance; (2) performed her duty to the patient; (3) avoided the possibility of suspicion of ulterior motive on her part; (4) been, at least, honest and open with the surgeon; and (5) conducted herself with due regard to decorum.

It is possibly well to caution the nurse against at any time indulging in comment to the patient, whether of praise or of criticism, concerning the ability of other surgeons than the attendant. There sometimes arises, in this connection, a feeling that the nurse, for one reason or another (even where no such intention exists), desires to create a comparison to the discredit of one practitioner, a course which, at best, is as unwise as it is discourteous.

III. ATTITUDE TO THE HOSPITAL

The nurse, whether undergraduate or graduate, who is engaged in hospital work, must occupy one of two positions to that institution, being either a member of the working organization, an integral part of the official family or a guest to whom the courtesy of the institution has been extended. In the one case, she owes at least community loyalty, and, in the other, an observance of the ordinary laws of hospitality. This means that it is her duty, so long as she remains within the hospital, to observe the internal rules of the institution. Her care of and attention to the patient must consider not only those duties that exist from a nurse to a patient, but must, also, include an endeavor so to perform her duties that no criticism of the hospital may come from the patient, as a result of her fault. It is frequently from the attention or inattention of individual nurses that patients form their opinions of a hospital, and it is upon the impressions of these patients that their friends decide as to the merits or demerits of a particular institution. It is not desired to suggest that a good nurse can offset all the defects of a badly-managed and ill-conducted hospital, but it is undoubtedly the fact that a careless, inattentive or neglectful nurse may undo the good impression that would, otherwise, be left by a perfectly-organized institution.

IV. ATTITUDE TO THE PUBLIC

The individual who enters upon a career that has for its purpose the cure or care of the sick accepts a broader responsibility than that of conscientious service to each individual sufferer. The constant trend of modern advance in the allied forces of the medical professions is towards the accomplishment of two ends, not in themselves directly aimed at the cure of individual cases: (1) the prevention of disease and (2) the early diagnosis of certain conditions in which the early institution of treatment offers the chief hope of cure. While the nurse cannot be the prime factor in either of these movements, her position as a trained member of one of the branches of these forces imposes upon her a responsibility that cannot well be avoided. Her advice will be frequently sought by relatives, friends and even mere acquaintances. Some of these opportunities, possibly the majority, will be outside the relatively narrow field considered in this volume, but the nurse whose wise counsel has contributed to the early diagnosis of a case of pulmonary tuberculosis, of carcinoma of the breast, stomach or uterus; or has, by impressing upon the prospective mother the necessity for competent medical supervision throughout pregnancy, aided in forestalling a threatened attack of eclampsia, may well feel that she has contributed her mite to the grand sum total of the effort of her fellow workers.

V. ATTITUDE TO SELF

While the profession of nursing must be largely based upon altruism, yet the nurse who utterly neglects herself will soon resign, perforce, the care of others. A fair general rule would be for the nurse to take as good care of herself as the best interests of her patient will permit. If the last case has drawn too heavily upon the vitality, do not undertake the care of the next until properly recuperated. When working under a steady strain, do not depend upon the stimulus of excessive tea and coffee drinking for support. If unable to rest when you should, do so when you can. Be sure to get some exercise in the fresh air and sunshine each day, even though rest seems more desirable and fatigue prevents enjoyment. When the body is under a heavy physical and nervous strain, do not make matters worse by adding an excessive burden to the digestive tract. Eat what is nourishing, simple and easily digested, preferably at all times, but certainly when on hard duty.

The keynote to the attitude of the nurse towards any part of her work or in any of her relations must be found in her attitude towards the work itself. If she feels that the work is worth while and that her best efforts are none too good for it, there is little danger of her falling short in her duty. The chief danger seems to lie in the changes effected by the period of training, when all of her values must be readjusted so as nicely to maintain the balance between the ideal as conceived and the real as practised. It is at this time that the ideals may be lost and the real nurse hidden under the veneer of cynicism that has become so usual a part of the life of to-day. And it is this that we most wish to avoid. If there are any attributes that the nurse should retain as an essential part of her equipment, the leading should be her natural sympathies and her natural or acquired ideals. These she should maintain amidst the most repulsive exhibitions of disease and the most sordid exhibitions of human degradation, retaining them, if necessary, upon no other evidence than that of faith alone, " the substance of things hoped for, the evidence of things not seen. "

CHAPTER XXX

AN EPITOME OF SOME COMMON SURGICAL AND GYNÆCOLOGICAL CONDITIONS

In this chapter a brief outline will be given of some of the more common surgical conditions which the nurse will encounter in hospital and private practice. The object sought will be not to teach how to make a diagnosis or how to treat a case, since these are not within the province of the nurse, but to aid her to obtain an intelligent understanding, though necessarily general and superficial in character, of the surgical diseases and affections which come under her care. Particular emphasis will be given to the nursing aspects of the case so far as possible in the space available.

I. MALFORMATIONS AND ANATOMICAL DEFECTS AND DERANGEMENTS

A. Congenital Deformities

Cleft Palate and Hare-lip. *Definition.*—In single hare-lip there is a cleft of the lip extending into the nostril on one side of the mid-line, more often the left. In double hare-lip there are two clefts with a projecting mass between (intermaxillary bones and mid-lip or prolabium), attached to the nasal septum. Cleft palate is a cleft in the mid-line of the roof of the mouth, either partial or complete, and usually coexisting with single or double hare-lip.

Causes.—Arrested development in early fetal life from unknown causes. (Maternal impression is not a cause.)

Symptoms.—Characteristic deformity; sometimes malnutrition in infancy from difficulty in swallowing; imperfect articulation.

Treatment.—Correction of the defect by a plastic operation. In closing the palate silver-wire sutures will be used. After an operation for hare-lip the narrowing of the breathing space to which the child has been accustomed may lead to cyanosis or even asphyxia if proper care is not exercised. The nurse should hold the lower lip down until the child has recovered from the anæsthetic if there is evidence that it is not getting sufficient air. After an operation for closure of a cleft palate the patient must be placed in a position so that saliva, blood, and mucus will flow from the mouth. An infant is held in the lap of the nurse with the face down; an older child is placed in a semi-sitting position, with the face turned to one side. Later the mouth may be sprayed with a mild solution (*e.g.*, dilute Dobell's) if the child does not cry or struggle, but not otherwise. Feeding is done with a spoon, giving meat or chicken jelly or soft gruels. Swabs of cotton or gauze must never be used in the mouth, lest they tear out the wire sutures.

Spina Bifida. *Definition.*—A congenital cleft of the bony arches of the vertebræ in the mid-line of the back, usually in the lumbar region, with defect in varying degree of the other tissues of the back, resulting in a sacculated protrusion of the structures of the spinal cord with its contained cerebrospinal fluid. The child is born with a tumor on the back, hemispherical in shape, often about the size of a man's fist, sometimes smaller or even larger. The tumor is a sac containing fluid, its walls consisting of the membranes and nerve elements of the spinal cord, with the overlying skin, and communicating with the spinal canal. The skin may be thinned to a parchment-like membrane, and is frequently ulcerated from chafing and pressure.

Symptoms.—Characteristic deformity. Sometimes, but not always, weakness or paralysis of the legs and of bladder and rectum. Pressure on the tumor may cause unconsciousness.

Treatment.—Operative closure of the defect when possible. The prospect of success is always very doubtful. Nursing care and constant vigilance are of the greatest importance to protect the tumor from injury before operation and from infection by soiling with urine and fæces afterwards. Spontaneous rupture from injury or ulceration may easily occur, resulting in escape of cerebrospinal fluid and usually followed by fatal infection. A large ring pad of gauze surrounding the tumor may aid in protecting it from injury.

Other Congenital Defects.—The most common, perhaps, are those connected with the genito-urinary apparatus and with the rectum. Exstrophy of the bladder, a protrusion of the bladder wall through a cleft in the anterior abdominal wall, imperforate anus, and defective development of the genital organs occur. These subjects are too complex for discussion here. The surgical problems involved are difficult and in many cases unsolved.

Many varieties of congenital deformities are met with. The most common is club-foot, with inversion of the sole and torsion of the whole foot. Congenital dislocations of the hip and other joints also occur. These conditions come under the care of the orthopædic surgeon. The treatment is in part operative and in part by fixation and support with proper apparatus.

B. Acquired Defects and Deformities

Many cases of deformity associated with impaired function result from paralysis of certain groups of muscles from injury or disease of the nerves supplying them, the deformity being caused by the subsequent contraction of the opposing group of muscles. The most prolific cause of these conditions is the disease known as infantile paralysis (anterior poliomyelitis), an infectious disease, caused by one of the filterable organisms, which attacks young children particularly. The disease itself has few and slight symptoms, as a rule, runs a rapid course, and often passes unrecognized. The organisms affect certain areas in the spinal cord where the motor nerves take their origin, and the result is paralysis, sometimes temporary, but often permanent, affecting a varying number of groups of muscles throughout the body, most commonly in the lower extremities. The treatment consists in exercise and stimulation, when possible, of the affected muscles after the acute disease has subsided, and in the use of suitable mechanical supports to aid function and prevent or overcome deformity. Sometimes the tendon of an active muscle can be transplanted so as to make it do the work of a paralyzed one.

In scoliosis there is lateral curvature and often rotation of the vertebral column, producing marked deformity, due often to weak muscles and habitual faulty position while sitting and standing during childhood rather than to any active disease. The treatment is by gymnastic exercises and mechanical support and correction. These cases belong preëminently to the domain of the orthopædic surgeon.

Rickets (rhachitis) is a disease of childhood affecting the nutrition and growth of bone. Resulting deformities, such as bow-legs and knock-knee, are sometimes of such a degree as to interfere with locomotion and require operative means to correct them.

A great variety of deformities occur as the late result of injuries (trauma) which have been improperly or unsuccessfully treated at the time of their occurrence. Thus fractures may unite with great shortening of the limb due to overriding of the fractured bones, or the bone fragments may unite at an angle, or they may fail to unite at all. Joints may lose their mobility, becoming fixed in one position (ankylosis); soft parts may be distorted by healing in a wrong position or by extensive scarring. Burns by heat or by acids or alkalies frequently cause deformity through the contraction of the resulting scar. The accidental swallowing of caustic substances, which happens with surprising frequency in young children, results, when not immediately fatal, in stricture of the œsophagus from cicatricial contraction. These conditions are too numerous and varied to be briefly summarized.

II. FOREIGN BODIES

When we speak of a foreign body in surgery, we mean the presence in any of the tissues or organs of the body of any solid inert substance that does not belong there. Thus, a bullet embedded in the tissues, or a peach-stone lodged in the œsophagus, or a pin in the trachea is a foreign body; but so also is a loose fragment of dead bone or a stone in the kidney or bladder, substances in this case not introduced from without, but formed where found as the result of disease.

Foreign bodies in the air-passages must always be removed. Those in the digestive canal commonly pass without harm, but sometimes require removal. Foreign bodies embedded in the tissues frequently become encysted and remain harmless indefinitely. In the presence of septic organisms, however, a foreign body is apt to cause a chronic suppurating sinus which persists until its removal. Foreign bodies left in the abdominal cavity after operation (sponges, packs, even instruments) deserve particular mention. This accident may happen so easily that every safeguard must be employed to prevent it. The accident fortunately rarely results fatally, but it is very distressing for the patient at the best on account of the prolonged morbidity and the necessity for a second operation. It is, of course, in the highest degree humiliating for the surgical team, every member of which should bear the full burden of the responsibility. The surgeon must know that he has left nothing behind. The sponge nurse must account for every piece of gauze that has been used and the instrument nurse for every instrument before closure of the wound.

III. TRAUMA

Definition and Causes.—Trauma means a wound or injury produced by external violence. The causes are, of course, innumerable, and the injury may vary from a mere scratch to any degree of severity.

The Lesions of Trauma.—The essential thing in trauma is what is called a solution of continuity in the tissues; *i.e.*, a separation as by cutting or tearing of structures which are normally united. So fine is the network of tubes and channels by means of which the cells of the body are normally kept bathed in fluid that even the slightest wound means the rending of some of these blood or lymphatic "vessels," as they are called, with a consequent escape of fluid into the surrounding tissues or externally, and the primary lesions of trauma are all associated with this escape of fluid. If the skin is divided there will be external hemorrhage more or less profuse and of three varieties. In arterial hemorrhage the blood is bright red and escapes in forcible, intermittent jets synchronous with the heart-beats. In venous hemorrhage the blood is dark and flows in a constant stream. Capillary hemorrhage is seen as an oozing from the whole cut surface. Capillary hemorrhage usually (except in bleeders) stops spontaneously within a few minutes, oozing of a pale red or straw-colored serum from the wound surface continuing for many hours. If tissues are injured without division of the skin the escaping fluid gives rise to lesions varying according to its character and location. *Ecchymosis* is the escape of blood in the deeper layers of the skin with discoloration (the familiar "black and blue" spots). A *hæmatoma* is a mass of blood in a cavity in the tissues produced by trauma, or a circumscribed effusion infiltrating and distending the spaces in the loose cellular tissue, particularly that under the skin. The blood clots and forms a swelling of varying size and density. *Œdema* is an effusion of serous (watery) fluid through the walls of the capillaries into the intercellular spaces and is often seen as the result of trauma, *e.g.*, in sprains. There is a swelling which has a dough-like feel to the touch, and the skin over it is paler than normal. Another form of swelling known as *emphysema*, due to the distention of the tissue spaces with air or gas, is occasionally seen in wounds of the lung and in gas bacillus infection. Severe or even fatal hemorrhage may occur into the great serous cavities of the body (the peritoneal, pleural, or pericardial cavities) or into the intestinal canal without escape of blood from the body, and this is known as concealed hemorrhage. *Abrasions* and *blebs* or blisters are surface lesions familiar to every one.

Wounds of Special Structures.—Wounds of the skin and subcutaneous tissue and of the muscles are relatively insignificant (apart from hemorrhage and infection), even when very extensive. Wounds of veins and arteries are serious in proportion to their size and in accordance with the promptness with which means of checking hemorrhage are applied. Wounds of the larger vessels are necessarily fatal unless instant help is given. Ligation of the main blood-vessels of a limb is, as a rule (with some exceptions), followed by the formation of a collateral circulation to supply the part with blood. In suitable cases closure by suture of a wound in a large blood-vessel can be done with restoration of the normal blood-channel. Wounds of the heart have been sutured with recovery of the patient. A cut tendon results in permanent loss of function unless the divided ends are sutured. Division of nerve-trunks results in immediate paralysis of the muscles whose function they control and in anæsthesia of areas of skin supplied by them. Nerve-trunks should have their divided ends accurately united by suture, this being followed by restoration of function after some months. In wounds of the larger vital organs (brain, lungs, heart, liver, kidney) the primary dangers are from hemorrhage, either from loss of blood or (in the brain) from the pressure by clots. In penetrating wounds of the serous cavities, including joints, and in wounds of the hollow viscera (stomach, intestines, bladder, etc.) the most serious danger is from infection. *Fractures* are wounds of bone, usually with displacement and laceration of the surrounding soft parts and a hæmatoma at the seat of fracture. Fractures are known as simple when the skin is unbroken; compound when the fracture communicates with an open wound; comminuted when there are many fragments; and impacted when the broken ends are wedged together. Simple fractures have no mortality, but always a long morbidity. Compound fractures, not infected, heal like simple fractures. If, however, infection takes place, the mortality is high and the morbidity (in cases not fatal) often indefinitely prolonged. Tearing of the ligaments and of the strong fibrous capsule which surrounds a joint results in displacements of the bony structures which form the joint, *i.e.*, *dislocations*. "Reduction" or replacement of the joint surfaces in normal position with fixation and early passive motion of the joint results almost always in complete restoration of function. A dislocation unrecognized for weeks or months is a very serious matter for the patient. Reduction will be difficult (often impossible without an open operation) and perfect restoration of function dubious. The X-ray should always be used when possible in the diagnosis of fractures and dislocations.

Symptoms and Signs of Trauma.—Obvious visible signs, laceration of tissue, discoloration of the skin, local acute swellings, etc., need not be further discussed. Division of tendons and division or injury of nerves are indicated by complete loss of power either to make movements of flexion or movements of extension at one or more of the joints below the seat of injury. With nerve injuries there will often be definite areas of insensibility of the skin as well. In fractures of the upper arm (humerus) the power to move the fingers, and the sensation on the back of the hand, should always be tested at the first inspection to detect a possible nerve injury. If a main artery is occluded, pulsation will be absent at the usual points where it is felt below.

The two most obvious signs of fracture are crepitus (the grating sensation conveyed to the finger by the rubbing together of the broken ends of the bone) and abnormal mobility at the seat of fracture. Where these are absent, as in fractures near joints, and in a fracture of one bone only of the forearm or leg, special points of tenderness on pressure on the shaft of one bone or near the joint suggest a strong suspicion of fracture. Dislocation is always to be suspected where there is abnormal fixation of a joint with more or less deformity.

Symptoms of Trauma in Special Regions.—In injuries of the head the most important point to be determined will be whether there is a depressed fracture or hemorrhage within the skull causing pressure on the brain. Paralysis of the arm on the side opposite to the injury is a positive sign of pressure in certain areas of the brain. Bleeding and, later, a serous discharge from the ear indicate fracture at the base of the skull. In other cases, persistent headache, mental dulness, and an abnormally slow pulse are suggestive of pressure. Characteristic changes in the retina soon appear in cases of intracranial pressure, which can be recognized by an examination with the ophthalmoscope, which must, of course, always be made by a specialist.

In injuries of the thorax, fracture of ribs will be indicated by sharp pain in the act of breathing; wounds of the pleura by sputtering of air in the wound; wounds of the lung by the coughing up of blood. Abdominal injuries are very varied. The most serious are wounds of large vessels leading to concealed hemorrhage, and wounds or ruptures of hollow viscera with escape of their contents, resulting in peritonitis. The symptoms of these conditions are given elsewhere (Chapter XVII). In crushing injuries of the lower abdomen or pelvis, blood in the urine should be looked for and the patient should be catheterized, if voiding of urine is delayed, lest a rupture of the bladder be overlooked. A suspicion of intestinal wounds must lead to an exploratory operation without waiting for symptoms.

General Principles in the Treatment of Trauma.—The primary indications which the surgeon will endeavor to meet in the treatment of an injury will be arrest of hemorrhage, if present; prevention of infection, if there is an open wound; restoration of the displaced tissues and structures to their normal relation so far as possible, and fixation of the injured part when this can be done. The great therapeutic agent in the treatment of trauma is *rest; i.e.,* prevention of movement and prevention of the exercise of function. Later, restoration of function, particularly of the joints involved, must be aided by passive and active exercise, which should be begun as soon as the healing process has advanced so far that it will not be hindered by these procedures. In the case of an injured limb, elevation is important to aid the return circulation, and all tension should be avoided either by stitches or bandages. Water should be given freely after injury. The treatment of shock from trauma has been discussed elsewhere.

The capacity of the human body to endure and to recover from trauma is amazing. If hemorrhage and sepsis can be controlled, recovery may, and often does, take place from the most appalling lacerations and dismemberments.

Burns.—The nature and varieties of burns have already been described (page 63). Since the burden of care from the frequent dressings that are often necessary in these cases sometimes falls upon the nurse, a few points will be given here as to the proper methods to be used. The raw surfaces should be disturbed as little as possible; the granulations should not be insulted by tearing off adherent dressings; exuberant granulations at the skin margins should be kept down by means of the silver caustic. In burns about a joint, healing should not be allowed to occur with the joint flexed. Methods of dressing that waste material and time should be avoided. The surgeon will prescribe the dressing that is to be used. We will assume, for convenience, that it is a boric ointment. Such an ointment is made more efficient in preventing adhesions of the dressings if it is made stiffer than the ordinary vaseline ointment by the addition of white wax. The dressing should be removed with care; it should not adhere to the granulations at any point. The granulating surface should not be touched. The skin edges may be wiped with a very mild solution, preferably sterile salt solution. Carbolic solutions should not be used. Every few days, the granulations at the skin margins may need burning down with a stick of lunar caustic. The ointment will be spread thickly on strips of sterile bandage gauze and applied overlapping the whole granulating area. A layer of absorbent cotton or gauze is then applied. A roller bandage should not be used to fix the dressing, as a rule. It is wasteful of material and time. Instead, a swathe made of muslin, or even a towel, should be pinned neatly about the part to hold the dressing in place. A few spiral turns of a roller may be added if necessary for security, and strips of adhesive added to prevent slipping. Such a dressing is easily and quickly removed with very little disturbance of the patient.

IV. SURGICAL INFECTIONS

The Septic Diseases.—Sepsis in wounds and the general symptoms of infection have been discussed in previous sections. Brief reference will be made here to some of the most common forms of septic disease.

(1) *Erysipelas* is an acute disease affecting the skin, due to infection with the streptococcus; characterized by fever, chill, and intense local redness of the skin, with œdema, the eruption tending to spread rapidly, and being accompanied with sensations of itching and burning. Idiopathic erysipelas, usually affecting the face, principally, has a low mortality. Erysipelas complicating wounds is frequently fatal. There is no standardized treatment. The use of antistreptococcic serum has been disappointing.

(2) *Diffuse Cellulitis or Phlegmon.*—This disease is a septic infection involving the subcutaneous cellular tissues. It is characterized by great swelling from infiltration, œdematous or semi-purulent in character, tends to spread rapidly, and is

associated with severe constitutional symptoms. The primary infecting agent is usually the streptococcus, but the *Staphylococcus pyogenes* also plays an important part as a secondary infection. Red streaks upon the skin running toward the trunk indicate involvement of the lymph-vessels. The hand and arm are frequently the seat of the infection, particularly among men who do rough and dirty work with their hands. The skin is often undermined with pus over large areas in the later stages. Sloughing of subcutaneous tissues including tendon sheaths may occur, causing serious disability after the inflammation has subsided. The treatment is by numerous free incisions, moist heat, either in the form of wet dressings or, better, the continuous bath. In this and in all other forms of septic infection the one most important medicine for internal administration is water. It is not enough to give the patient water when he calls for it. The nurse should see that the patient drinks a glass of water, or as much as he will, at least every hour.

(3) *Abscess* is a collection of pus in a cavity which has formed in some locality in the body as a result of necrosis of tissue-cells and liquefaction of the dead cell-bodies, due to the action of pyogenic bacteria which have invaded the tissues at this point. The staphylococcus is by far the most common offender. The pus itself is composed of myriads of leucocytes, which have migrated into the region in their rôle of defenders against infection. In a superficial abscess, the local symptoms will be swelling, redness, heat, fluctuation, or the sensation conveyed to the examining fingers as of fluid under the skin, and pain with tenderness on pressure. In deep abscesses, all these, except pain and tenderness (and even these at times), may be absent. The constitutional symptoms of sepsis will always be present. The treatment is incision for the purpose of drainage. During the acute inflammatory stage, before the abscess has fully formed, hot fomentations will hasten the process and add to the patient's comfort. Antiseptics are a useless addition to the fomentations. The drains used may be of rubber tubing or wicks of gauze. Irrigation of the abscess cavity is of doubtful utility in most cases. Drainage should be established as early as possible in order to arrest the process. Recovery without incident is the rule when this has been done.

(4) *Osteomyelitis* is a septic inflammation in bone. The staphylococcus is here also the most common cause, although the

streptococcus, and occasionally the typhoid bacillus, may become invaders. The way of access for the invaders is by the blood stream, except in compound fractures. There is often a history of some previous injury in the region infected. The disease is more common in early life. The process of disease is essentially the same as in abscess formation in the soft tissues, differing only because of the character of the tissue invaded. Necrosis in bone results in the formation of large detached pieces of dead bone, which may be discharged later or be removed at operation. The long bones of the lower extremity are the ones most commonly affected. The disease may have a very acute onset, but is often very chronic in its development, lasting for years. Later local abscesses and sinuses appear with constant discharge of pus and occasionally pieces of dead bone. The symptoms are local pain, frequently very severe, sometimes worse at night. There is usually local tenderness, and redness and swelling may be present. Constitutional symptoms are always present and may be mild or very severe. The treatment is operative.

(5) *Sepsis in Serous Cavities.*—Sepsis of the large joint cavities is always a serious matter. The local and constitutional reactions are usually very severe. The suffering is acute and prolonged and the result disastrous to the joint itself or even fatal to the patient. The symptoms are local swelling and pain (usually with a history of an open wound of the joint) and the constitutional symptoms of sepsis. Prompt operative treatment is required. Sepsis in the abdomen (peritonitis) is considered in another section. Sepsis in the pleural cavity is known as empyema. It occurs most commonly following an attack of pneumonia, being caused in this case by the same organism (the pneumococcus). The diagnosis is determined by the physical signs and the aspirating needle. The treatment is evacuation of the pus through an operative opening, usually with resection of a portion of a rib. Recovery is the rule. An important feature of the after-treatment is some form of respiratory exercise to expand the lung, as by blowing water through suitably-arranged tubes from one bottle to another.

2. Tuberculosis.—This disease, one of the most common to which man is subject, is caused by the invasion of the bacillus tuberculosis. It is sometimes acute, but usually runs a chronic course; may attack almost any tissue in the body; and gives rise to a very great variety of conditions of disease. The lesions produced by the organism are of the same kind in a general way as those produced by other organisms; *i.e.*, there is local death of some cells, with reproduction and increase of other cells in an attempt of the body toward defence and repair. In minor ways the lesions are different from those produced by other organisms, so that they can be recognized. The typical lesion known as a tubercle is a minute, grayish-white nodule which can be seen by the naked eye in cases of tuberculous peritonitis when the abdomen is opened. In larger masses, necrosis appears in a form known as caseation, from its cheese-like appearance. The principal forms of surgical tuberculosis are those affecting the lymphatic glands and the bones and joints. Large tumors of the neck are common from infection of the numerous lymphatic glands in this region with this organism. Very extensive operations are frequently done for their removal. Tuberculous disease of bones and joints results in slow disintegration of the structures affected, giving rise to distressing deformities. The treatment of these conditions is preëminently not an active treatment, except when the destruction of tissue is hopelessly far advanced. It is found that, if motion can be prevented and the pressure from gravity and from muscular contraction can be removed from the diseased bones, recovery will often take place without other aid. Prolonged fixation of the diseased area by means of suitable apparatus is the most important means of treatment employed.

V. TUMORS (NEW-GROWTHS, NEOPLASMS)

Tumors may be defined as new-growths of tissue occurring in an organism, which do not themselves perform any function and which tend by their presence or by their growth to injure or destroy the organism. They may be broadly classified, according to their terminal effects upon the organism, as: (1) benign and (2) malignant. According to tissue characteristics, they may be further classified as: (1) osteoma; (2) myoma; (3) fibroma; (4) lipoma; (5) cystoma; (6) epithelioma; (7) endothelioma (the first five of which are benign and the last two either benign or malignant); (8) carcinoma, and (9) sarcoma, both of which are malignant.

Causes.—The causes of the appearance of the various new-growths are not understood.

Symptoms.—The general and invariable symptom is the appearance of an abnormal growing mass in any of the tissues or organs of the body. According to the type of neoplasm and its location and manner of growth, there may be varying local and general manifestations of its presence.

Treatment.—The treatment, in general, consists in operative removal of the growth. Slow-growing or stationary benign tumors, which do not interfere with the functions of the organism and have no tendency to malignant degeneration, may be permitted to remain. In certain of the new-growths, as epithelioma of the lip or face and fibroma of the uterus, treatment by the Röntgen ray and radium may offer advantages over operative interference.

VI. OTHER ORGANIC DISEASES

1. Goitre (Struma). *Definition.*—A goitre is any abnormal enlargement of the thyroid gland that is not due to one of the benign or malignant new-growths. Goitres may be broadly classified as: (1) simple and (2) exophthalmic.

Causes.—The causes of goitre are not clearly understood. In the simple form there is a probability of some water-borne irritant being an excitant factor. The exophthalmic type is associated with a faulty functioning of the thyroid gland, the cause being unknown.

Symptoms.—The characteristic symptom common to both forms of goitre is the typical enlargement of the thyroid gland. This is frequently the only symptom in the simple type; but in exophthalmic goitre we have: (1) tachycardia; (2) nervous phenomena; (3) exophthalmos, and (4) more or less general emaciation.

Treatment.—The treatment is operative, consisting in the removal of such portions of the thyroid gland as may seem necessary to the surgeon.

2. Gangrene (Mortification). *Definition.*—Gangrene is a condition characterized by the death, in mass, of body tissues. It may be classified as: (1) moist and (2) dry.

Causes.—The cause of gangrene may be anything that completely destroys the circulation of a part or interferes with it sufficiently to prevent proper nourishment.

Symptoms.—In the moist variety the skin is frequently pale and cold at first, assuming a mottled appearance later—either purplish or greenish black. There occur: (1) softening of the mass; (2) the formation of blisters; (3) an offensive odor, and (4) the constitutional symptoms of sepsis. In the dry form there is a gradual drying and blackish discoloration of the part, accompanied by the loss of sensation and the formation of a definite line of demarcation between the gangrenous and healthy tissues. Constitutional symptoms are not so common as in the moist form.

Treatment.—The treatment is operative, consisting in excision (or amputation in the case of extremities), extending well into tissue having an ample blood supply.

3. Aneurism. *Definition.*—An aneurism is a sacculated or fusiform tumor directly associated with the lumen of a blood-vessel and having for its walls those of the vessel.

Causes.—Aneurisms may be congenital or result from disease of or injury to the vessel walls.

Symptoms.—The invariable symptom is the development of a soft, pulsating mass along the course of a large vessel. This, depending upon its location, may give rise to varying symptoms resulting from circulatory or pressure disturbance.

Treatment.—The medical treatment consists in rest and special medicinal, dietetic, and hygienic measures. The surgical treatment, which is particularly adapted to the treatment of external (superficial) aneurisms, consists, where possible, in an operative restoration of the parts to normal. In other cases, complete occlusion, by ligature, of the affected vessel may be necessary.

VII. ABDOMINAL CONDITIONS

1. Ulcer of Stomach or Duodenum. *Definition.*—Ulcers of the stomach or duodenum are, as the names would indicate, solutions in the continuity of the mucous lining of the stomach or the duodenum.

Causes.—They probably follow interference with the blood supply of the part. Gastric ulcer is more common in females of early adult life; duodenal in males between the ages of twenty and forty years. Both types are probably influenced by the hyperacidity commonly accompanying them.

Symptoms.—Symptoms are frequently absent in gastric and duodenal ulcer until the appearance of hemorrhage from either the stomach or bowels or the evidences of perforation. The usual symptoms are: (1) pain immediately following the ingestion of food in gastric ulcer, or one or more hours later in the duodenal type; (2) hemorrhage, and (3) dyspeptic symptoms, accompanied by nausea and vomiting.

Treatment.—The first treatment may consist of diet and absolute rest over an extended period. Where this fails, the treatment is operative—a gastro-enterostomy being performed or the ulcer excised.

Special Nursing Point.—Close watch should be kept for evidences of concealed hemorrhage after the performance of gastro-enterostomy.

2. Carcinoma of the Stomach or Intestine. *Definition.*—Carcinoma of the stomach or intestine is a malignant new-growth originating in the epithelial elements of these organs.

Causes.—The predisposing causes may be indicated, in the order of their importance, as: (1) age, about 97 per cent. occurring after the thirtieth year; (2) heredity, about 15 per cent. of gastric carcinoma giving a family history of carcinoma; and (3) previous ulceration or chronic inflammation. The immediate cause is not known.

Symptoms.—The usual symptoms are pain, digestive disturbances, vomiting, anæmia, and progressive loss of weight occurring in an individual after the thirtieth year. Progressive chronic intestinal obstruction is usually present in the intestinal form, and, during the advanced stages of both types, an abdominal mass is generally demonstrable.

Treatment.—The curative treatment depends upon an early diagnosis and radical operative removal of the entire growth. The palliative treatment consists in such measures as may add most to the support and comfort of the patient. In addition to diet and opiates, surgical intervention may be indicated to relieve symptoms of obstruction.

3. Appendicitis, Intestinal Perforation, and Suppurative Peritonitis. *Definitions.*—Appendicitis is an inflammation of the vermiform appendix. It may be classified as: (1) catarrhal, (2) ulcerative, and (3) gangrenous. Either of the latter forms may progress to perforation and consequent suppurative peritonitis.

Intestinal perforation is a perforation of all the walls of any portion of the intestinal canal.

Suppurative peritonitis is an inflammation of the peritoneum resulting from invasion by one or more species of the pyogenic microörganisms and accompanied by pus formation. It may be either circumscribed or diffuse.

Causes.—Appendicitis is a disease of both sexes, being somewhat more frequent in the male; occurring chiefly in early adult and middle life, and depending to some extent upon heredity and diet. The principal causes of its occurrence are, however, the presence of anatomical defects, foreign bodies, and pathogenic microörganisms.

Intestinal perforation is usually a result of inflammation, ulceration, or injury. Its most common single cause is one of the forms of perforative appendicitis.

Suppurative peritonitis is caused by the introduction of one or more species of the pyogenic microörganisms into the peritoneal cavity. This may be the result, among other causes, of a perforating gastric or intestinal ulcer; a perforating or rupturing appendicitis; or the leakage or rupture of a pyosalpinx.

Symptoms.—The symptoms of appendicitis, in the order of their occurrence, are: (1) abdominal pain, usually epigastric in location; (2) nausea or vomiting; (3) general abdominal tenderness, with point of maximum intensity in right lower quadrant, and (4) fever.

The symptoms of intestinal perforation may be very indefinite, particularly as this condition is merely a sequel to a preëxistent pathological process. Rupture, or perforation, of the appendix may be followed by immediate diminution or cessation of the existent symptoms, but later gives rise to those of a circumscribed or diffuse suppurative peritonitis. Where the perforation occurs at the site of an ulcer elsewhere in the intestinal tract the symptoms are: (1) sudden, violent pain; (2) abdominal muscular rigidity; (3) nausea or vomiting, and (4) elevation of temperature. The last two symptoms are those introducing the suppurative peritonitis and will be followed, if the peritonitis is diffuse, by (5) abdominal distention and, if circumscribed, by (6) the presence of a palpable abscess mass.

Treatment.—The treatment of these conditions is operative, consisting in removal of the appendix, where acute catarrhal appendicitis exists; in suturing of the perforation and drainage or removal of the primary diseased organ, and drainage in the other conditions.

Special Nursing Points.—After operation for any acute suppurative process in the abdominal cavity, close watch should be kept for the early symptoms of intestinal obstruction. When nursing any patient where intestinal perforation may occur (as gastric or duodenal ulcer, typhoid fever, or appendicitis), the occurrence of sudden abdominal pain should suggest the immediate summoning of the attending physician.

4. Intestinal Obstruction (Ileus). *Definition.*—Intestinal obstruction is that condition in which, from any of several causes, the intestinal contents cannot pass through that part of the alimentary tract situated between the pylorus and the anus.

Causes.—Intestinal obstruction may be due to: (1) bands or adhesions; (2) intussusception, the invagination of one portion of the gut into an immediately adjoining section; (3) volvulus, twisting of the intestine and mesentery; (4) thrombosis of the mesenteric artery, or (5) adynamic ileus, a paralysis of the muscular coats of the bowel.

Symptoms.—The symptoms of intestinal obstruction are: (1) absence of bowel movements or the passage of flatus; (2) nausea, followed by vomiting, which becomes persistent and may, during the later stages, contain fecal matter; (3) abdominal pain; (4) abdominal distention; (5) visible peristalsis; (6) rapid pulse; (7) thoracic type of breathing; and (8) elevated temperature in the form due to thrombosis of the mesenteric artery, but normal or subnormal temperature in the other forms. In intussusception a sausage-shaped mass may sometimes be palpated.

Treatment.—The treatment is operative and varies with the immediate cause. An early diagnosis is of vital importance.

5. Tuberculous Peritonitis. *Definition.*—Tuberculous peritonitis is an inflammation of the peritoneum, characterized by the formation of numerous tubercles.

Cause.—The immediate cause is the invasion of the peritoneum by the tubercle bacillus.

Symptoms.—The symptoms are vague. In a typical case they would be somewhat as follows: (1) digestive disturbances; (2) abdominal discomfort, at times amounting to pain; (3) progressive general loss of weight; (4) abdominal enlargement due to free or encysted fluid, and (5) irregular temperature elevation.

Treatment.—The operative treatment consists solely in opening the abdomen and evacuating the fluid. All other treatment is dietetic and hygienic.

6. Hernia (Rupture). *Definition.*—A hernia, in the sense here used, may be defined as any protrusion of an abdominal viscus through a normal or abnormal opening.

Causes.—Among the predisposing causes to hernia, age, sex, and heredity all play important parts. The exciting cause may be anything that increases intra-abdominal pressure, as sneezing, coughing, lifting heavy bodies, or even straining at stool.

Symptoms.—The only symptom of a simple, reducible hernia is the presence of a soft tumor at one of the normal abdominal openings (femoral, inguinal, or umbilical). There may be some soreness in the mass. If the mass gives a definite impulse on coughing and is easily reducible, it is almost certainly a hernia. Strangulated hernia, in addition to the local symptoms mentioned above, gives the symptoms of intestinal obstruction.

Treatment.—In the simple, reducible form the hernia may be treated by the application of a suitable truss. Always in the irreducible and strangulated forms, and preferably in the simple form, the treatment should consist in an operative restoration of the parts to normal. In the advanced strangulated form intestinal resection may be necessary.

7. Gall-stone Disease (Cholelithiasis). *Definition.*—Gall-stone disease is a condition of the gall-bladder characterized by the formation of one or more concretions within its cavity.

Causes.—The primary cause is probably bacterial infection, although obstruction to free drainage and the so-called gall-stone diathesis may play an important contributing rôle.

Symptoms.—The symptoms are: (1) history of long-continued digestive disturbance and probably one or more attacks of colic; (2) sudden onset of violent colic-like pain, which usually subsides in from a few minutes to several hours; and (3) vomiting. In the obstructive form (common duct stone), (4) jaundice, (5) clay-colored stools, and (6) fever are usually added to the preceding symptoms. The pain in gall-stone disease is frequently referred backward and upward towards the right shoulder or scapula.

Treatment.—The treatment is operative, consisting in the removal of the stones and drainage of the gall-bladder.

Special Nursing Points.—After all operations on the bile-passages, careful notes should be kept regarding the character and amount of drainage and the character and color of stools.

VIII. EPITOME OF GYNÆCOLOGICAL DISEASES

The diseased conditions encountered in the care of gynæcological patients may be broadly divided into four classes: (1) malformations and displacements; (2) injuries; (3) inflammations, and (4) new-growths. It is, of course, quite usual for a combination of two or more of these conditions to occur in a single patient.

1. Malformations and Displacements

1. Atresia or Stenosis of the Vagina. *Definitions.*—Atresia is the absence or closure of the normal opening. Stenosis is a narrowing of the normal opening.

Causes.—Atresia may be due to a congenitally imperforate hymen or to a later adhesion of the vaginal walls, following injury or inflammatory process. Stenosis may be congenital or may result from the contraction of scar tissue following injury or inflammation.

Symptoms.—The symptoms of atresia would be, in the order of their appearance, amenorrhœa, uterine colic of a progressive severity as the successive menses are dammed back, and, finally, the possible occurrence of reflex convulsive seizures. Stenosis would probably give no early symptoms, but would be a subsequent cause of dyspareunia.

Treatment.—The treatment would consist, in either case, of an operative restoration of the parts to normal, the operative procedure varying extensively with the location, extent, and cause of the condition in each particular case.

2. Anteflexion of the Uterine Cervix. *Definition.*—Anteflexion of the cervix is an acute bending forward of the uterine cervix, the body of the uterus maintaining its normal anterior position.

Cause.—Anteflexion of the cervix is congenital in origin.

Symptoms.—Where any symptoms exist, they are those of an obstructive dysmenorrhœa; namely, uterine colic preceding full establishment of flow; frequently clotting of the early flow; not infrequently sacral or lumbosacral intramenstrual pain, and occasionally pain in the region of the uterine appendages. There is generally a slight leucorrhœal discharge.

Treatment.—The treatment is operative, varying from a simple dilatation and curettage to more extensive plastic operations designed to straighten the uterine canal by shortening the posterior cervical wall.

3. Retroversion of the Uterus. *Definition.*—Retroversion of the uterus is a swinging backward of the uterine body towards the pouch of Douglas, the uterine cervix at the same time swinging forward towards the anterior vaginal vault.

Causes.—Retroversion of the uterus may result from congenital causes; relaxation of the intra-abdominal uterine supports; destruction of cervical, vaginal, and perineal uterine supports by child-birth lacerations; or the sagging backward of a uterus that is for any reason much increased in size.

Symptoms.—In a fairly large proportion of cases of retroversion of the uterus, it is highly probable that no symptoms occur. Where these do occur, they are apt to be somewhat indefinite, suggesting rather than positively indicating a pelvic disorder. The usual symptoms would be dysmenorrhœa, sacral or lumbosacral backache, mild leucorrhœa, and, possibly, constipation.

Treatment.—The treatment of retroversion of the uterus resulting from any of the first three causes mentioned above would be an operative restoration of the parts to normal. Where the condition results from the fourth cause, the use of local and general medication, accompanied by the manual restoration of the uterus to its normal position and its retention there by vaginal packing or pessary, would be tried before operative measures were employed.

4. Retroflexion of the Uterus. *Definition.*—Retroflexion of the uterus is an acute bending backward of the uterine body towards the pouch of Douglas, the vaginal portion of the cervix maintaining its normal position pointing posteriorly.

Causes.—Retroflexion of the uterus results from the same causes as does retroversion. It is quite probable, however, that a more relaxed condition of the uterine musculature is necessary for the occurrence of the former.

Symptoms.—The symptoms of retroflexion of the uterus are composed of a complex of those accompanying retroversion of the uterus and anteflexion of the cervix. Unlike retroversion, symptoms are very likely to occur. These would be dysmenorrhœa (usually of the obstructive type that accompanies anteflexion), sacral or lumbosacral backache, leucorrhœa, and constipation, the last mentioned being of more frequent occurrence and more obstinate type than that usually encountered in retroversion.

Treatment.—The treatment is similar to that for retroversion.

5. Prolapse of the Uterus. *Definition.*—Prolapse of the uterus is a descent of the uterus to a position lower than the normal, usually carrying with it the immediately adjoining structures. It may be divided, according to the extent of the process, into the following three degrees: (1) descent of the uterus, where there is only a moderate departure from the normal level; (2) incomplete prolapse, where the departure is more marked, but the uterus does not protrude from the vagina; and (3) complete prolapse, where the uterus protrudes from the vagina, inverting and carrying with it the vaginal wall and forming what is really a hernia of the pelvic contents.

Causes.—The causes may be congenital or acquired. The most serious of the latter is destruction of the pelvic floor by child-birth lacerations. Increased size of the uterus, accompanied by relaxed ligaments and perineal lacerations, would form the usual causal elements.

Symptoms.—The symptom that most usually causes the patient to seek medical advice is a protrusion of the cervix from the vulva. Accompanying or preceding this, there are apt to occur leucorrhœa, a dragging pain throughout the pelvic region, backache, and, possibly, dysmenorrhœa.

Treatment.—The treatment is nearly always operative, although in the milder degrees the use of tampons and pessaries may first be tried.

II. INJURIES

1. Laceration of the Uterine Cervix. *Definition.*—Laceration of the cervix is a tearing of the uterine cervix by the application of direct violence. The tear may be unilateral, bilateral, or stellate, and usually follows child-birth.

Causes.—The most usual cause of cervical laceration is the passage of the child during labor, although the cervix is occasionally torn during the process of instrumental or manual dilatation.

Symptoms.—In the majority of cases there are probably no symptoms beyond a slight leucorrhœal discharge. Where the laceration is very extensive, it may be contributive to a displacement of the body of the uterus, and will then be accompanied by the usual symptom of such condition.

Treatment.—The treatment consists in operative repair. This is important, even where no severe symptoms occur, as unrepaired lacerations are the usual site of carcinoma of the cervix.

2. Laceration of the Perineum. *Definition.*—The term "laceration of the perineum" is used to include any break of the tissues at the posterior margin of the vaginal introitus due to violence. These lacerations are sometimes classified into three degrees for the sake of convenience, the first degree including tears of the skin and subcutaneous tissue only, and not really extending into the true perineum; the second degree including more severe tears involving the levatores ani muscles, but not the sphincter ani or rectum; and the third degree including the most severe type, those involving the sphincter ani muscle and even the rectal wall.

Causes.—The vast majority of perineal lacerations are the result of child-birth, either following over-distention and consequent rupture by the passage of the child or by the use of instruments by the accoucheur. Perineal laceration occasionally follows a fall, as on a picket fence.

Symptoms.—In the first-degree perineal lacerations symptoms are usually lacking. In the milder second-degree lacerations the same is frequently true. In the more severe second-degree lacerations there are leucorrhœa, constipation, resulting from the pouching forward of the anterior rectal wall to produce a rectocele, and quite probably accompanying symptoms of pelvic congestion due to a more or less marked degree of uterine descent, which frequently follows this destruction of the pelvic floor. In third-degree lacerations the symptoms are those of severe second-degree tears, combined with incontinence of fæces resulting from the torn sphincter ani muscle and irregular bleeding from the everted rectal mucosa.

Treatment.—The treatment of those cases of perineal lacerations which give rise to symptoms is operative and, in the more severe cases, requires a higher degree of operative skill than almost any other form of gynæcological surgery.

III. INFLAMMATIONS

Pathological conditions of inflammatory nature may attack any of the genito-urinary organs and may, starting in one region, spread progressively throughout these systems. It may be accepted that, in general, all inflammatory conditions are evidences of the reaction of the organism to the presence of foreign bodies. In the vast majority of gynæcological inflammations these foreign bodies are of bacterial origin and, consequently, the inflammation is the evidence of an infection. Of the pathogenic microörganisms, those most frequently found in gynæcological infections are the *gonococcus*, the *B. coli communis*, the *streptococcus*, the *staphylococcus*, and the *B. tuberculosis*. Of these, the gonococcus is much the most frequent cause of serious trouble. The streptococcus and staphylococcus appear to be normal inhabitants of the vagina, only occasionally causing serious trouble, and the colon bacillus is a near neighbor, being a normal inhabitant of the large intestine and occasionally causing trouble by migrating to the urinary or genital tract.

1. Vulvitis. *Definition.*—Vulvitis is an inflammation of the vulva, or external genital organs.

Cause.—The usual cause of vulvitis is infection with one of the pathogenic microörganisms, generally the gonococcus. The condition may, however, result from irritating, non-infectious vaginal discharges; from urine in diabetic and some other conditions; from thread-worms coming from the rectum; or from uncleanliness.

Symptoms.—First are the classical local symptoms of inflammation—heat, pain, redness, and swelling. There is more or less mucopurulent discharge. There may be constitutional symptoms, as general malaise, moderate fever, and headache.

Treatment.—The determination of the immediate cause of the condition is of the first importance. This may require the examination of smears made from the local discharge; of the urine, or of fæces. Where the condition proves infectious, the treatment is local and general. The local treatment consists in maintaining cleanliness by frequent irrigations with a mild antiseptic solution and in the direct application of germicides, such as argyrol or silver nitrate in solution, or one or more medicaments combined in powder or ointment form. The general treatment consists of rest in bed, free catharsis, and a fairly free diet. Great precautions must be taken to prevent further conveyance of the infection. The materials used for applications should be burnt. No one else should use the patient's towels or washcloths. All dressings and napkins should be thoroughly soaked in an antiseptic solution before washing.

2. Vaginitis. *Definition.*—Vaginitis is an inflammation of the vagina.

Causes.—The causes of vaginitis are identical with those of vulvitis, which it frequently accompanies, except that it is not likely to accompany diabetes.

Symptoms.—The symptoms are the same as those for vulvitis, except for the greater frequency of constitutional symptoms and the presence of a discharge that evidently originates from above the vulva.

Treatment.—The treatment during the acute stage is the same as for vulvitis. Absolute rest in bed is possibly of more vital importance, as danger of extension to the uterus, tubes, and pelvic cavity is more immediate. After the acute stage has subsided, various local applications may be made by douche, swab, or tampon.

3. Endometritis. *Definition.*—Endometritis is an inflammation of the lining of the uterus.

Causes.—Endometritis may be caused by the introduction of any of the pathogenic microörganisms that could give rise to vaginitis or vulvitis, and is frequently the result of an upward extension of these conditions. It may also result from the periodic or continuous congestion accompanying malformations or malpositions of the uterus.

Symptoms.—During the acute stages the symptoms of endometritis are those common to any inflammation of the upper genital tract: (1) leucorrhœal discharge, generally of a purulent or mucopurulent character in the infectious cases; (2) local pain in the pelvic region, either median or lateral; (3) menstrual irregularity, occurring as metrorrhagia, menorrhagia, or both; and (4) constitutional symptoms, consisting of elevation of temperature and, frequently, loss of appetite. During the subacute and chronic stages the constitutional symptoms are usually lacking; the discharge becomes more decidedly mucous in character; the menstrual disorders diminish or disappear, and the pelvic pain becomes less intense or disappears.

Treatment.—The treatment during the acute stage is similar to that of vaginitis. If, after the subsidence of the acute stage, marked symptoms persist, the treatment is usually operative, although local applications may be made to the endometrium in the hope of achieving a cure without resorting to surgery.

4. Salpingitis. *Definition.*—Salpingitis is an inflammation of the Fallopian tube. It may be unilateral or bilateral. According to its type and degree of progress, salpingitis may be classified as follows: (1) salpingitis, an uncomplicated inflammation of the Fallopian tube; (2) pyosalpinx, an enlarged and inflamed Fallopian tube which contains free pus; (3) salpingo-oöphoritis, an inflammation of both Fallopian tube and ovary; (4) tubo-ovarian abscess, an inflammation of both Fallopian tube and ovary that has gone on to abscess formation; and (5) pelvic abscess, a condition in which one or more of the preceding conditions is complicated by the presence of walled-off pus in the pelvic cavity.

Causes.—The causes of these different varieties of salpingitis are the same as those of endometritis.

Symptoms.—The symptoms are, in varying degree, those already enumerated as characteristic of pelvic inflammatory process.

Treatment.—The treatment of these conditions, during the acute stage, is the same as for endometritis. The use of supportive and anodyne measures is, however, usual—the rectal administration of salt solution; the employment of the Fowler position; the use of a suprapubic ice-bag, and the hypodermic administration of morphine being almost routine. The operative removal of the diseased organ or the evacuation of the abscess cavity by the vaginal or abdominal route nearly always follows the subsidence of acute symptoms, and may be required earlier by the appearance or persistence of alarming symptoms.

IV. NEW-GROWTHS

In the present discussion of the gynæcological neoplasms no effort will be made towards either a pathological or organic classification or description. We shall consider only three types of tumors, and those only as they occur in two organs: cysts of the ovaries, and fibroid tumors and cancers of the uterus.

1. Ovarian Cyst. *Definition.*—An ovarian cyst is a tumor whose walls consist of the ovary and whose contents are fluid.

Cause.—The cause of this, as indeed of other forms of new-growths, is unknown.

Symptoms.—The earliest symptom of an ovarian cyst is that of almost any disorder of the upper genital tract—irregularity of menstruation, either menorrhagia or metrorrhagia. There may be pain in the region of the affected ovary, extending down the thigh on the same side. Subsequently there is a steadily increasing enlargement of the abdomen, which may assume enormous proportions if permitted to progress uninterrupted.

Treatment.—The treatment consists in the operative removal of the diseased organ.

2. Fibroid Tumor of the Uterus (Fibroma Uteri). *Definition.*—These tumors, as the name will indicate, are new-growths originating in the connective-tissue elements of the uterus. When occurring within the walls of the uterus, they are called intramural; when just beneath the peritoneal covering, subserous; and when just beneath the mucous lining, submucous.

Cause.—The cause is unknown.

Symptoms.—The first symptom is usually uterine hemorrhage, occurring with or between the menstrual periods and ordinarily becoming progressively more severe. As the growth progresses, abdominal enlargement occurs, sometimes as a single mass and sometimes as several globular masses. There may be pelvic pain; symptoms due to pressure on the rectum and bladder; and, frequently, anæmia due to excessive loss of blood.

Treatment.—The usual treatment is operative—either the enucleation of the growth when possible, or the removal of the uterus and growth together when necessary. Recently, treatment by Röntgen ray and by radium has given promise of encouraging results.

3. Cancer of the Uterus (Carcinoma Uteri). *Definition.*—Carcinoma of the uterus is a highly malignant new-growth of that organ, arising from its epithelial elements and frequently spreading to other parts of the body by metastasis. Its most frequent and malignant location is in the cervix, usually at the site of an old, unrepaired laceration.

Cause.—The cause is unknown.

Symptoms.—The more positive and definite symptoms of carcinoma of the uterus are usually of such late occurrence that their arrival should not be awaited before attempting a diagnosis. Any unusual bleeding from the uterus or leucorrhœal discharge after thirty-five years of age should lead to a careful examination by a competent physician and, in case of further doubt, the microscopical examination of exsected tissue. The later symptoms are hemorrhage; offensive, irritating leucorrhœa; pelvic pain, and, possibly, bladder or rectal symptoms from the extension of the growth.

Treatment.—The curative treatment consists in early diagnosis and radical operative removal of the diseased area and such immediately adjoining healthy tissues as may be safely taken. This would include uterus, Fallopian tubes, ovaries, and part of the parametrium and vagina. In late cases the palliative treatment consists in the control of symptoms and the delay of the disease's progress by use of the knife, cautery, chemicals, opiates, and, possibly, the Röntgen ray or radium.

INDEX

I

J

K

U

V